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PLENARY LECTURES

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INVESTIGATING THE HEALTH IMPACTS OF DUST

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Dust is ubiquitous in the atmosphere and is generated in various environments through both natural processes and human activity. Individual particles display a wide range of physical, chemical, structural and surface properties, which depend on source, formation, ageing, and transport under variable atmospheric conditions. Dust particles, therefore, comprise a wide variety of natural and anthropogenic materials, including: sea-salt particles; silicates, *e.g.*, asbestos, clays, cristobalite, feldspars, and quartz; oxides, such as hematite, magnetite, pyrolusite, and uraninite; sulfates, primarily gypsum; carbonates (calcite, dolomite); various alloys (*e.g.*, those of iron and manganese); glass, especially volcanic ash and fly ash; biogenic material, such as algae, bacteria, brochosomes, fungi, plant fragments, pollen, spores, and viruses; and combustion-derived carbonaceous particles (*e.g.*, soot). The detailed characterization of individual dust particles helps us in understanding their interactions with the atmosphere, the solid Earth, the hydrosphere and the biosphere, but it is also essential for investigations on the potential health effects of particulate matter (PM).

Millions of dust particles enter the human respiratory tract with each breath. Once inhaled, these particles can interact with the lung fluid or with various types of cells present in the lung. These interactions may induce adverse effects on health, both acute and chronic, and may also lead to the formation of endogenous particles (*e.g.*, calcite, apatite), and of Fe^{3+}-rich coatings on inhaled fibrous minerals (*e.g.*, ferruginous bodies). Adverse health effects associated with particle exposure and inhalation include: chronic obstructive pulmonary disease (COPD); chronic bronchitis; exacerbation of asthma; fibrosis; slower lung development in children; and lung cancer.

Inhaled coarse particles may be deposited on the surfaces of the conducting airways, *i.e.*, trachea, bronchi, and bronchioles. Inhaled fine particles ($PM_{2.5}$) can migrate to the alveoli in the deep lung, where they remain for long periods of time, whereas the finest fraction, *i.e.,* the ultrafine particles (<0.1 μm), may translocate to epithelial and interstitial sites and possibly to extrapulmonary organs. Epidemiological and toxicological studies have shown that exposure to fine particles is linked to increases in mortality and hospital admissions due to respiratory and cardiovascular diseases. There is increasing evidence, however, that coarser particles may also produce adverse health effects. In addition to being dependent on size, the interactions with the lung cells and the lung tissue are also influenced by other particle characteristics, including structure, chemical composition, shape, surface area and reactivity, sorptive properties, and solubility or biodurability.

The particle-lung interactions stimulate various types of biological and biochemical responses, including immune defense reactions, inflammation, and cytokine release. The mechanisms behind these responses as well as their dependence on particle properties are still poorly known, but they have been shown to involve oxidative stress via formation of reactive oxygen species (*e.g.*, superoxide, hydrogen peroxide, and hydroxyl radical), as well as the release of chemical substances (*e.g.*, inflammatory mediators) that trigger and perpetuate inflammation. To improve our knowledge of these biochemical processes and their relationship to particle properties, it is essential to perform careful toxicological experiments, which encompass the exposure of human lung cells and tissue cultures to variable doses of well-characterized dust particles. Additional knowledge about both the nature and the abundance of particles in human lungs and their possible role in disease development can be gained from microscopic investigations of brochoalveolar lavage (BAL) fluids (*i.e.*, fluids extracted from the lung), and from samples of lung tissue excised during biopsies or autopsies. This presentation will discuss various approaches to assessing the health impacts of dust and will describe experimental results obtained from in-vitro stimulation of lung cells with diverse types of PM, which have been found to be present in ambient air.

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ICE NUCLEATION BY DESERT DUST: WHAT, WHY, WHERE AND WHEN?

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The amount of ice present in mixed-phase clouds, which contain both supercooled liquid water droplets and ice particles, affects cloud extent, lifetime and radiative properties. The freezing of cloud droplets can be catalysed by the presence of aerosol particles known as ice nucleating particles (INPs) (1). One of the most important INP types is mineral dust aerosol from arid regions (2). It has been shown that, out of the minerals present in desert dust, a subset of the feldspar minerals dominates its ice nucleating ability (3). However, feldspars are a highly variable group of minerals with varying composition and crystal structure. New data, generated using our NIPI droplet freezing instrument (4), will be presented where we show that the alkali feldspars have the potential to nucleate ice at relatively warm temperatures, whereas the plagioclase feldspars have a much lower nucleating activity. In particular, potassium-rich feldspars have a characteristic ice nucleation efficiency which we relate to a certain type of crystal imperfection common in alkali feldspars. Work with thin sections of feldspar cleaved along crystallographic planes, demonstrates preference for nucleation on particular regions of the feldspar crystal. We have also identified several feldspar samples which are hyperactive ice nucleators, nucleating ice as warm as -2^{o}C in microliter volume droplets. These hyperactive feldspars tend to be relatively unstable when suspended in water, where the active sites responsible for nucleation seem to become inactive over time. These results indicate that there are multiple types of active sites present in feldspars, which have different activation temperatures and different stabilities in water. We will briefly present new aircraft based measurements (during the 2015 ICE-D campaign) of INP concentrations from within dusty layers off the coast of W. Africa. These results are compared to the laboratory generated parameterisations based on our measurements and others from the literature. Finally, the results of our global aerosol modelling study of ice nucleating particles will be presented where we show that desert dust is a major global INP type.

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RADIOGENIC ISOTOPES AND DUST IN THE OCEANS: CLUES TO CLIMATE CHANGE

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Windblown mineral dust plays a role in Earth's climate by affecting its radiative balance, either directly through scattering and absorption effects or, indirectly, through dust's ability to "seed" clouds. In addition, iron, an important limiting micronutrient for phytoplankton growth, is delivered to the ocean in dust so that increased dust fluxes have the ability to increase export production which, in turn, sequesters CO_2 from the atmosphere. In tandem with dust's ability to directly influence climate, dust deposited in deep ocean sediments yields important clues about the forcing mechanisms and responses of past climate change. Here, I will focus on radiogenic isotope tracers of dust in marine sediment records and the climate change constraints such records provide. Unlike the high-resolution dust records provided at the poles in ice cores, dust records in marine sediments, albeit usually at lower resolutions, are located across all latitudes of the globe.

Measuring past fluxes and provenance of dust to various ocean basins may yield information on changes in wind strength, source aridity, and patterns of atmospheric circulation, including the monsoon. The U-Th-Pb, Rb-Sr,and Sm-Nd are the most common radiogenic isotope systems used to determine dust fluxes and provenance. The ^{230}Th (half-life of 75.6 kyr) constant-flux proxy is, perhaps, the best way to measure past dust fluxes to the ocean. This proxy is based on the assumption that the flux of ^{230}Th delivered to the seafloor is constant and equal to the amount of ^{230}Th produced by the decay of ^{234}U in the water column. The amount of dust in a sediment interval can be estimated by measuring ^{232}Th, which is thought to have a relatively constant concentration in mineral dust. ^{230}Th-derived ^{232}Th fluxes should, therefore, reconstruct dust deposition over the ocean on millennial to 100-kyr timescales. The Sr, Nd, and Pb isotopic composition of sedimentary dust depends on the age and the Rb/Sr, Sm/Nd, and U/Pb ratios, respectively, of the lithologic units within the geographic province from which the dust is derived. When used together these isotope systems can fingerprint the continental source areas of dust delivered to the marine environment.

I will review and evaluate the use of radiogenic isotopes in constraining changing continental dust source and transport to the oceans on both spatial and temporal scales. By focusing on the radiogenic isotope compositions of the most likely sources of dust to the oceans from the Earth's deserts and adjacent arid regions, and comparing the same isotope ratios in ocean dust records, one can assess changes in atmospheric circulation patterns through time. Potential shifts in the Intertropical Convergence Zone (ITCZ), a zone of maximum precipitation which follows the thermal equator over the tropical ocean, and how such migrations are related to climate transitions, are examined. Similarly, shifts in wind belts at higher latitudes (i.e., the westerlies) and the relationship between such shifts and those of the ITCZ are investigated.

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ADSORPTION OF MOLECULES AND REACTIVITY ON SILICATE SURFACES FROM AEROSOLS BY COMPUTATIONAL CHEMISTRY

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Organic molecules are emitted directly into the troposphere from biogenic and anthropogenic sources. Silicates particles are present as components of atmospheric aerosols. The reactions of hydroxy free radicals with volatile organic pollutants are common in the troposphere. Heterogeneous reactions of atmospheric gases on aerosol particles play an important role in atmospheric chemistry. Although dust particles are abundant in the Earth's atmosphere, however the kinetics and adsorption mechanisms for these reactions are not well understood. Besides, the interaction of some molecules onto the silicate surface is also interesting to understand the tele-detection of extraterrestrial dust. This study is difficult to be performed experimentally and atomistic molecular modeling methods can be a useful tool for this study.

Quantum mechanics methods based on Density Functional Theory have been used to study the adsorption of organic molecules on models of crystal surfaces of silicates. Using some models of molecular clusters of silicate surfaces, the adsorption of small organic molecules, formaldehyde, aldehydes, and formic acid, onto silicate surface was studied along with the hydrogen abstraction reaction of OH free radicals. We found that the silicate surface is a good quencher of free radicals and aldehydes, adsorbed on the silicate surface, can react with OH free radicals to yield surface-bound formyl radicals and water. The presence of silicate surface does not change significantly the activation energy and theoretical kinetic studies show that this reaction is less favored on the silicate surfaces than in gas phase.

Besides, the adsorption of mixtures of H_2O, CO, CH_4, NH_3 gases as models of dirty amorphous ice was calculated onto several surfaces of the Mg silicate, forsterite. These molecules can be present in atmospheric and extraterrestrial environments. Weak physisorptions and strong chemisorptions happen in these systems along with the chemical dissociation of water molecule promoted by the presence of these adsorbate gases.

ORAL CONTRIBUTIONS

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PALEODUST VARIABILITY SINCE THE LAST GLACIAL MAXIMUM AND IMPLICATIONS FOR IRON INPUTS TO THE OCEAN

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Changing climate conditions affect dust emissions and the global dust cycle; in turn dust affects climate and biogeochemistry. In this study we compare observationally-constrained model reconstructions of the global dust cycle at different time slices corresponding to climate conditions since the Last Glacial Maximum. We discuss uncertainties in estimates of dust deposition in key oceanic regions, including the Equatorial Pacific, the North Atlantic and the Southern Ocean. We estimate soluble iron deposition to the oceans under different assumptions, highlighting the degree of uncertainty of this important variable for ocean biogeochemistry and the global carbon cycle. We show the role of sea ice acting as a time buffer and processing agent, which results in a delayed and pulse-like soluble iron release into the ocean during the melting season, with monthly peaks up to ~200 Gg/a released into the Southern Oceans during the Last Glacial Maximum.

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BUILDING A TIME SERIES OF SAHARAN DUST CHEMICAL COMPOSITION ON THE WEST AFRICAN MARGIN

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Considering the vastness of Sahara-Sahel region and the numerous dust emission areas within contrasting geological contexts, Saharan dust composition is by essence mineralogically and geochemically diverse. The large number of sources, whose contributions are both quantitatively and temporally variable, and are often mixed during dust outbreaks at changing spatial scales, makes it particularly challenging to satisfactorily appreciate the compositional variability of Saharan dust. In order to improve our understanding of this variability, we launched a continuous sampling of dust deposition at Mbour (~80 km south of Dakar) on the Senegalese margin in 2006, as part of the African Multidisciplinary Monsoon Analysis (AMMA) framework. The sampling site, located under the major corridor for Saharan dust transport, is ideally situated for monitoring mineral dust as they reach the North-eastern Tropical Atlantic and dust deposits have been collected for nearly a decade at a weekly (or better) resolution. The building of this long time series has two main objectives: first, document the temporal change in mineralogical and chemical composition of Saharan dust transported towards the Tropical Atlantic, and second, typify the mineralogical and geochemical signature of the major dust sources "feeding" the tropical Atlantic and identified with the help of back-trajectories, dust transport models and satellite data. Mass fluxes, grain-size, clay mineralogy measurements spanning the first few years of this unique time series, as well as a few discrete Sr and Nd isotope measurements across major Saharan outbreaks, have revealed significant compositional variations associated with seasonal shift in transport patterns, demonstrating contributions from various sources within distinct geological provinces [Skonieczny et al., JGR 116, 2011; EPSL 364, 2013]. Here we will present time series of Saharan dust chemical composition (major and trace elements) covering several seasonal cycles of dust deposition at Mbour. These chemical data nicely complement earlier mineralogical measurements and allow advancing our appreciation of Saharan dust compositional variability. Preliminary implications for the characterisation of the contributing sources chemical signatures will also be presented and discussed.

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CENTRAL ASIAN DUST EXPERIMENT (CADEX): LIDAR MEASUREMENTS AND COMPARISON OF LIDAR RATIOS AND DEPOLARIZATION RATIOS BETWEEN SAHARAN AND ASIAN DUST

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Currently, there is less known about the vertical dust distribution and its dynamics at the western margin of the Central Asian High Mountain Belt. The Central Asian Dust Experiment CADEX, which runs between October 2014 and September 2016, aims at closing this knowledge gap. The vertically resolved measurements are performed with a multi-wavelength depolarization Raman Lidar in Dushanbe (Tajikistan).

The contribution will give a short overview about results from these measurements. Often lofted layers of mineral dust in the free troposphere had been observed. Backtrajectory analysis for the lofted layers showed a west-to-east advection of these air masses. Sources in desert regions of West Asia but also in Saharan areas had been identified.

The heights of these lofted layers differ from day to day. Even heights of about 10 kilometers above ground level (in Dushanbe) have been observed. On their continuing eastward transport these high-level lofted aerosol layers may even overpass the highest mountains of the Pamir region by 3-4 km. So the West Asian dust might be mixed with the East Asian dust east of the Pamir region.

We investigated the optical properties of the lofted aerosol layers in detail. First evaluated measurements show that the particle depolarization ratios are slightly lower for West Asian dust compared to that of Saharan dust. Also the first measurements indicate lower lidar ratios of mineral dust traced back to West Asian source regions than lidar ratios of mineral dust traced back to Saharan areas. The different lidar ratios may be caused by differences in the iron concentration, the particle sizes, and/or by a different aging of the mineral dust particles during their atmospheric transport.

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OPTIMISATION OF LASER INDUCED BREAKDOWN SPECTROSCOPY (LIBS) TECHNIQUE FOR DETERMINATION OF MAJOR COMPONENTS OF MINERAL MATTER IN PM_{1O} AND $PM_{2.5}$

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Atmospheric aerosols or PM comprise a complex mixture of solid and liquid particles with different origin, composition, size and physical and chemical properties. The negative effects of PM on health, vegetation, ecosystems, materials and visibility have been largely recognised in literature. Moreover, PM alters the planetary energy balance absorbing or scattering solar radiation.

Among primary PM (those emitted directly to the atmosphere), mineral particles are the most abundant in terms of mass concentration. On a global scale, the main sources of mineral aerosols are natural (, arid and semi-arid areas or volcanic eruptions), although local emissions related to anthropogenic activities (industry or traffic resuspension) may acquire great importance, especially in highly populated urban areas. The composition of mineral matter is dominated by the major elements in rocks forming earth's crust (Si, Al, Ca, Fe, K and Mg) accompanied by a range of associated minor and trace elements such as Na, Ti, Mn, Rb, and Zr. The concentration of mineral matter. In certain areas characterised with low precipitation regime the proportion of mineral matter in PM_{10} may easily reach up to 30% on the annual basis.

In virtue of what has been exposed above, it is interesting to develop appropriate methods and techniques for both identifying and quantifying mineral matter concentrations with an appropriate time resolution and operability. Nowadays there are a variety of analytical techniques available for determining mineral matter concentrations although most of them require of an initial sampling, previous sample treatment and preparation and lab analysis which result in an economically costly procedure. Inductively coupled plasma - mass spectroscopy (ICP-MS), Atomic Absorption Spectroscopy (AAS) and X-Ray fluorescence (XRF) are the most common techniques for PM samples analysis. Regarding, automated equipment, XRF based devices are being used obtaining reasonable detection limits for metallic elements but with an elevated economical cost. Laser Induced Breakdown Spectroscopy (LIBS) is a fast and compact analytical technique which does not require sample preparation. Moreover, after an adequate design, LIBS can be applied to in-situ and continuous monitoring. Despite this potentiality, LIBS has rarely been used for chemical speciation in PM.

In this work we present the main results of the experiments conducted to optimise LIBS technique for determining the major components of mineral matter (Si, Al, Fe, Ca, K and Mg) on PM quartz fibre filters. To that end, a Nd:YAG laser and a Echelle spectrograph equipped with ICCD detection system were employed. Different parameters such as the laser energy, the time delay (delay from the initiation of the laser beam to the opening of the window during which signal will be recorded) and the time width (length of that window) were varied in order to obtain the optimal calibration curves for each element. Finally, LIBS technique was employed directly on PM filters which had been previously analysed by ICP-MS and results for the major mineral elements were contrasted.

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MODELING OF PM_{10} AND $PM_{2.5}$ BUILDING INFILTRATION DURING A DUST EVENT IN DOHA, QATAR

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Middle East Area (MEA) is well known as one of the main sources of dust storm events. The common causes for the creation of dust storms are the lift of giant mass of sand and dust, turbulent winds and convective Habbobs [1]. The occurrence of dust storm events varies during the year and differs for each country in the MEA. March and April periods usually present dust storms events with a peak of occurrence in June and July, while the phenomenon is weakening as September period approaches [2]. The transport of huge amounts of dust and sand is also responsible for transferring pathogens in large distances and as a result affecting the downwind ecosystem, population [3], and the human health [4]. During a severe dust storm event, the high velocities of dominant turbulent winds result in a rapid increase of the outdoor and indoor air PM concentration levels [5]. Dust storms not only affect the health of those outdoors but also the people living indoor as the particulate matter infiltrates through the buildings.

Despite the fact that MEA countries are suffering from frequent dust storm events, there is still a lack of knowledge regarding the health assessment in indoor environments (e.g. houses and industrial buildings) and the design of appropriate actions and mitigation measures in order to minimize the potential health effects [2].

The purpose of the present effort is to compute the particulate matter (PM) infiltration in a building during a dust storm event in Doha, Qatar, by using advanced numerical modeling techniques. More specifically, a combination of two available models, namely Quick Urban and Industrial Complex (QUIC) by LANL and CONTAM by NIST. The first is adopted for computing the external wind pressures including the meteorological effects, while the latter is a multi-zone model for indoor air quality (IAQ). QUIC is comprised by three models, namely the QUIC-URB (wind model), the QUIC-PLUME (Lagrangian dispersion model) and QUIC-CFD model. The last one employs a Computational Fluid Dynamics (CFD) technique combined with a zero-equation model based on Prandtl's mixing length theory [6-7]. In CONTAM framework a building is visualized as interconnected zones with airflow paths that act as a link between the individual zones and also the outdoor. Once parameters such as air flow rates outdoor and indoor are calculated, PM concentrations are estimated.

The use of CFD model (QUIC-CFD) improves the computation of wind pressures, velocities and pollutant concentrations, while the outputs of CFD model can be used as inputs to the multi-zone model (CONTAM). This combination is superior for more realistic predictions of airflow and pollutant transport in large buildings [8]. The numerical runs are focused on the prediction of wind pressure profiles and pollutant concentrations outside the building using QUIC and on the calculation of the air and pollutant concentration levels inside the building using CONTAM. The numerical predictions obtained are compared with measurement data during the dust storm event, presenting satisfactory agreement.

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CONTRIBUTION OF ATMOSPHERIC DUST TO FINE PARTICULATE MATTER IN TEHRAN, IRAN

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Tehran, the capital of Iran, is the largest metropolitan area in western Asia. About 9 million residents of this city have been exposed to severe air pollution conditions mainly caused by particulate matter (PM), frequently exceeding health standards. Like many other cities in the Middle East, a significant fraction of the PM is from dust in addition to other sources including vehicular and industrial emissions, and fossil fuel combustion for energy. Despite the significance of PM pollution in Tehran, there is little information available on the sources of PM, including the contribution of dust.

In this study, fine particulate matter ($PM_{2.5}$) filter samples were collected every 6 days for a year (Feb 2014 to Jan 2015) at Sharif University, which represents a typical residential area in Tehran. The samples were analyzed for chemical composition including ions, elemental components and organic and elemental carbon, and trace organic compounds. Chemical mass closure and source apportionment estimates were performed to evaluate PM composition and sources, including atmospheric dust. Moreover, the trends in chemical composition and source contributions during the year were assessed. Hourly PM_{10} and $PM_{2.5}$ were also measured at this station during the sampling period.

High levels of PM_{10} and $PM_{2.5}$ were observed during the study period with annual average concentrations of 91 μg/m^3 and 39 μg/m^3, respectively. The initial results indicate the contribution of dust to fine PM substantially varied from about 5%, during cold months, to 58%, during hot and dry months. The coarse particles ($PM_{2.5-10}$) trend were rather similar to the dust-related portion of $PM_{2.5}$, indicating the high contribution of dust to coarse particles. These result emphasize the significant contribution of atmospheric dust to PM during the hot and dry months of the year. The main anthropogenic sources were also determined to be vehicles, and their contributions will be quantified and compared to biogenic sources, which are mainly shown to be atmospheric dust. The trends of dust originated fine PM and their key components will be presented in more detail.

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THE HYPERACTIVE SOURCES OF DUST IN ICELAND

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Iceland has the largest area of volcaniclastic sandy desert on Earth or 22,000 km^2. The sand has been mostly produced by glacio-fluvial processes, leaving behind fine-grained unstable sediments which are later re-distributed by repeated aeolian events. Volcanic eruptions add to this pool of unstable sediments, often from subglacial eruptions. Icelandic desert surfaces are divided into sand fields, sandy lavas and sandy lag gravel, each with separate aeolian surface characteristics such as threshold velocities. Storms are frequent due to Iceland's location on the North Atlantic Storm track. Dry winds occur on the leeward sides of mountains and glaciers, in spite of the high moisture content of the Atlantic cyclones. Surface winds often move hundreds to more than 1000 kg m^{-1} per annum, and more than 10,000 kg m^{-1} have been measured in a single storm. Desertification occurs when aeolian processes push sand fronts and have thus destroyed many previously fully vegetated ecosystems since the time of the settlement of Iceland in the late ninth century. There are about 135 dust events per annum, ranging from minor storms to >300,000 t of dust emitted in single storms.

Dust can be generated from all the major sandy areas of Iceland; however the amount of finer particles that become dust varies with the surfaces. There are areas that produce more dust by far compared to the general sandy deserts; they have therefore been termed "dust plume areas" or "dust hot-spots". They are characterized by repeated charging of fine sediments with a relatively high proportion of finer (silty) materials which, upon repeated wind erosion become sorted downwind from the sources with loss of silt (dust) and an increasing saltation component (sand). Dust production is on the order of 30-40 million tons annually, some travelling over 1000 km and deposited on land and sea. Dust deposited on deserts tends to be re-suspended during subsequent storms. High PM_{10} concentrations occur during major dust storms. They are more frequent in the wake of volcanic eruptions, such as after the Eyjafjallajökull 2010 eruption. Airborne dust affects human health, with negative effects enhanced by the tubular morphology of the grains, and the basaltic composition with its high metal content. Dust deposition on snow and glaciers intensifies melting. Moreover, the dust production probably also influences atmospheric conditions and parameters that affect climate change.

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MINERAL DUST ACTING AS GIANT CLOUD CONDENSATION NUCLEI: AIRCRAFT MEASUREMENTS OF DUST-CLOUD INTERACTIONS IN SAUDI ARABIA

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Significant uncertainties exist with dust-cloud interactions for which complex microphysical processes link the dust aerosol and cloud properties. Under almost all environmental conditions, increased aerosol concentrations within polluted air masses will enhance cloud droplet concentration relative to that in unperturbed regions. The interaction between dust particles and clouds are significant, yet the conditions in which dust particles become cloud condensation nuclei (CCN) are uncertain. In order to quantify this aerosol effect on clouds and precipitation, measurement campaigns were conducted in central Saudi Arabia as well as in the Asir region of Saudi Arabia.

Ground measurements of aerosol size distributions, hygroscopic growth factor, CCN concentrations as well as aircraft measurements of cloud hydrometeor size distributions were done in Saudi Arabia from 2007 to 2009. Research aircraft operations focused primarily on conducting measurements in clouds to study their microphysical characterization, especially the preconditions necessary for precipitation. Aerosol measurements were also done during the climb to cloud base height and just below the cloud base.

Dust storms and regional background conditions were encountered during the study period. Under dusty conditions, the coarse (supermicrometer) fraction resembles freshly crushed rock. The particles are almost exclusively mineral dust grains and include common rock-forming minerals. The fine (submicrometer) fraction is dominated by particles of anthropogenic origin, primarily ammonium sulfate and combustion-derived particles. We studied the relationships between the properties of the aerosol and the droplet microphysics of cumulus clouds that formed above the aerosol layer. Under dusty conditions, when a large concentration of coarse-fraction mineral particles was in the aerosol, cloud drop concentrations were lower and droplet diameters larger than under regional background conditions, when the aerosol was dominated by submicrometer sulfate particles.

The presentation will include a summary of the analysis and results with a focus on the characterization of the dust aerosol and the microphysical properties of convective clouds in the central and Asir region of Saudi Arabia.

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SATELLITE RETRIEVALS OF DESERT DUST TRANSPORTED OVER THE RED SEA, AND AN ASSESSMENT OF THE RADIATIVE IMPACT OF DUST ON THE RED SEA

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There has been a recent upsurge in dust storm activity over the Middle East and the Arabian Peninsula over the last ten years, as a result of drought in the Middle East. One region that may be sensitive to such changes is the Red Sea, which is pinned in between the vast deserts of North Africa to the west, and Arabia to the east. In this work we analyse the inter-annual variability in dust activity over the Red Sea as retrieved from satellite data, using the SEVIRI instrument on the Meteosat Second Generation satellites, and the MODIS instruments on NASA's Terra and Aqua satellites. There is a pronounced north-south gradient in dust aerosol optical depth (AOD) across the Sea, peaking in the south in summer. There is however a strong inter-annual variability in this gradient. The subsequent radiative impacts of this dust gradient are also analysed, using top-of-the-atmosphere and surface retrieved fluxes from the CERES satellite instruments, also located onboard the Terra and Aqua satellites.

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CONSTRAINING THE SHIP CONTRIBUTION IN CENTRAL MEDITERRANEAN SEA FROM MEASUREMENTS OF PM_{10} CHEMICAL COMPOSITION AT LAMPEDUSA (35.5°N, 12.6° E) AND CAPO GRANITOLA (36.6°N, 12.6° E)

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Maritime transport is a relatively clean form of transportation per kilogram of material, and it is therefore currently gaining relative weight with respect to air and road transport.

Due to the use of heavy fuel oil, the ship generate, in addition to large amount of SO_2, NO_x, CO and CO_2, metals (V, Ni) and polycyclic aromatic hydrocarbons, which have a well-known hazardous effects to health. Currently, authorities are attempting to decrease the harmful effects of maritime transport pollution by restricting the fuel sulfur content in so-called Sulfur Emission Control Areas (SECAs). Although the legislation is focused only on sulfur emissions, the health and environmental effects of these emissions will depend on their physical and chemical properties.

Here we present the experimental identification and quantification of aerosols emitted from ships travelling along the main Mediterranean shipping route, in the region of the Sicily Channel. PM10 aerosol samples were collected during summer 2013 within the framework of the Chemistry and Aerosol Mediterranean Experiment (ChArMEx) at two sites located North (Capo Granitola, 36.6°N, 12.6°E) and South (Lampedusa Island, 35.5°N, 12.6°E), respectively, of the main ship route in the Sicily Channel.

The PM10 samples were collected whit 12 hour time resolution at both sites.

After weighting, the aerosol samples were analysed and ions, soluble fractions (in HNO_3 pH1.5 and in HNO_3-H_2O_2 in microwave oven) of selected metals, and elemental and organic carbon were determined.

The evolution of V and Ni concentrations (typical markers of heavy fuel oil combustion) was related to meteorological conditions, backward trajectories, wind intensity and direction, and ship traffic intensity in the Sicily channel. V concentration was generally lower at Lampedusa than at Capo Granitola, where it reached a peak value of 40 ng/m^3.

The La/Ce and La/V ratios were used to identify possible contributions from refineries, which are also expected to have elevated V and Ni amounts; refinery emissions are characterized by elevated La/Ce and La/V ratios, due to the use of La in the fluid catalytic converter systems. The combination of Rare Earth Elements (REEs) and airmass trajectories allowed to unambiguously identify the ship source in the Sicily channel.

In order to quantify the contribution of ship emissions to the aerosol load the characteristic ratio of the main aerosol species arising from ship emission ($nssSO_4^{2-}$/V, OC/V, NO_3^-/V) were roughly estimated from the dependency of ratios on V. If we assume that the lower limit of the ratio, found for high concentrations of V (high load of ship aerosols) may be ascribed to particles in which the contribution of ship emission is the dominant factor we could determines also sulphate, nitrate, and organic carbon amounts arising from this source. These ratios were used to quantify the ship contribution to PM10 from the V concentration in each sample.

The average ship emission contributions to PM10 were 2.8 and 4.0 μg/m^3, corresponding to 15.9% and 11.4%, at Lampedusa and Capo Granitola, respectively.

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DUST FROM UNPAVED ROADS: IS IT A SUBSTANTIAL PORTION OF REGIONAL DUST IN THE WESTERN US?

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The western U.S. is covered by a vast network of unpaved roads that are used for recreation, livestock management, and energy exploration/development. In addition, these activities are increasing exponentially in many areas, thus increasing the density and extent of unpaved roads. Elevated levels of aeolian dust has become a major land management and policy concern due to its influence on climate, weather, terrestrial ecosystem dynamics, landscape development and fertility, melting of snow and ice, air quality, and human health. Though it is well known that unpaved roads produce dust, the relative contribution of dust from existing roads or the implications of future road development to regional dust loading is unknown. To address this need, we have initiated a multifaceted research effort to evaluating dust emissions from unpaved roads regionally. At 34 sites arranged across various road surfaces and soil textures in southeastern Utah, we monitored dust emissions, local wind conditions, and vehicle traffic for 2-4 years. In addition, we evaluated fugitive dust potential using a portable wind tunnel while measuring road characteristics that could influence dust production.

Preliminary results suggest that roads are an important regional dust source, as emissions from roads are comparable to non-road, rural sources that are being monitored concurrently. While gravel roads produce more dust per day on average, per vehicle emissions are larger on dirt roads. Dust flux decreases with distance from the road edge on all road types, however this decline is less pronounced on dirt roads. Portable wind tunnel results indicate that TFV is consistently lower on dirt versus gravel roads across all soil types. Fugitive dust amount is generally larger and more variable on dirt roads compared to gravel roads. Initial analyses suggest that several easily measurable road surface characteristics can potentially be used to predict both TFV and sediment production, including: total gravel cover, gravel particle-size classes, clay content, and road compaction. The relation between TFV and total gravel cover in particular appears to be non-linear, with TFV increases rapidly above ~40% gravel cover.

Previous to this effort, we monitored dust production in this same region for 11 years at 85 stations. Using this data to estimate the amount of landscape-scale dust production, we are now combining these results, with the results from the road study, to produce a GIS-based model that estimates potential dust contributions from current and future scenarios of regional road development.

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CONSTANT CHINESE LOESS PLATEAU DUST SOURCE SINCE THE PLIOCENE USING SR, ND AND HF ISOTOPES

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Mio-Quaternary wind-blown Chinese loess records past aridification, monsoon and dust cycle history. Previous work on the source of dust on the Chinese Loess Plateau implies changes in source at the Quaternary-Pliocene boundary or at 1.2 Ma, coinciding with a major shift in monsoon dynamics (Sun 2005; Nie et al. 2014). Here we present detailed Sr, Nd and novel Hf isotopic data from multiple sites that show dust source remains the same across these boundaries. The use of established and novel isotopic tracers from multiple sites allows us to demonstrate that sediment geochemistry shifts can be solely explained by weathering changes. Nd and Hf isotopes show the dust was dominantly sourced from the Tibetan Plateau with some input from Alxa and the North China Craton. This shows that a major established and constant dust source on the northern Tibetan Plateau has been active and unchanged since the late Miocene.

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CHEMICAL COMPOSITION OF FINE $PM_{2.5}$ FROM SELECTED URBAN AND RURAL BACKGROUND AREAS IN POLAND IN RELATION TO THE ORIGIN OF AIR MASSES

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Air pollution by particulate matter (PM) is one of the most serious environmental problems of all developed and developing countries. Much attention is paid to fine PM factions – $PM_{2.5}$ (particles with aerodynamic diameter ≤ 2.5 μm), mainly due to their harmful impact on human health. The main goal of the paper is the analysis of the concentration, chemical composition and sources of $PM_{2.5}$, from urban and rural background stations. Daily $PM_{2.5}$ samples were collected from 3 air quality monitoring stations located in different parts of Poland, in Szczecin (West-Pomeranian Province, northern part of the country), Trzebinia (Lesser Poland Province, southern part) and Zloty Potok (Silesia Province, southern part). The study includes 2 periods of the year 2013, representing the heating (I-III) and non-heating (V-VII) seasons. For analyses of elemental and organic carbon content in $PM_{2.5}$ thermal-optical method was used, whereas ion content was determined by ion chromatography. Assessment of air mass origin was made by means of the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model (http://www.arl.noaa.gov/ready).

The daily mean concentrations of $PM_{2.5}$, and the concentration of its related components, varied in wide range of values and exhibited spatial and seasonal variations. Regardless of time of the year, the share of total carbon (TC) in $PM_{2.5}$ exceeded generally 40% of the total PM mass and was primarily determined by fluctuations in the share of organic carbon (OC), which was generally above 30% of the $PM_{2.5}$ mass. Ion composition of $PM_{2.5}$, from all measurement stations, was dominated by secondary inorganic aerosol (SIA), which accounted for (on average) ~ 34%, ~ 30% and ~ 18% of $PM_{2.5}$ mass, respectively in Trzebinia, Szczecin and Zloty Potok. Comparing the obtained results with the data recorded on different urban and rural background sites across Europe, it was found that SIA contribution in $PM_{2.5}$ mass is lower or comparable, while the share of secondary organic carbon (SOC) is usually higher.

It was also found that the seasonal variation of $PM_{2.5}$ concentrations and concentrations of its major components was mainly due to changes in the intensity of emissions of primary $PM_{2.5}$ and precursors of secondary $PM_{2.5}$ from combustion sources, which increases in heating period, while clearly falls in the non-heating period. Secondary aerosol, whose presence is related to oxidation of gaseous precursors emitted from fuel combustion and biomass burning, had the largest contribution in observed $PM_{2.5}$ concentrations. In addition, the contribution of traffic sources together with road dust resuspension, was observed. The share of natural sources (sea spray, crustal dust) was generally lower.

Analysis of air mass back trajectories indicated that in 2013 the analyzed stations were influenced by several source regions. In the heating season, air masses bringing the highest $PM_{2.5}$ concentrations came mainly from the North-East and East. In the non-heating season, the distribution of air flow directions at all measurement stations was quite uniform. The possible source region of the highest $PM_{2.5}$ concentrations was nearly the entire area of Poland (Trzebinia, Zloty Potok) and the nearest surroundings of the city (Szczecin). Spatial distribution of weighted average concentrations of analyzed $PM_{2.5}$ components, determined by Concentration Weighted Trajectories (CWT) method, was in parallel to spatial distribution of $PM_{2.5}$ concentrations, at all measurement stations. During both analyzed periods, the highest concentrations of $PM_{2.5}$ and its components were observed during inflow of slow-moving air masses, while the lowest ones were connected with the inflow of air masses from the West, coming mainly from the mid Atlantic Ocean.

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PFAS IN HOUSE DUST: WITHIN AND BETWEEN HOUSE VARIABILITY

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Per- and polyfluorinated alkyl substances (PFASs) comprise a wide range of compounds that have been produced and used in a wide range of industrial and consumer applications since the 1950s. These applications include indoor related products such as consumer products; stain-proof coatings on furnishing and carpets, oil resistant coatings on food wrapping, non-sticking coating on cooking utensils, water resistance in clothing and outdoor materials etc.[1,2] As a result, PFASs have been found at high concentrations in indoor matrices such as house dust and air.[3-5] This together with the PFASs' global spread in the environment, bioaccumulation potential, persistence and toxicity have resulted in increasing attention from the scientific community and policymakers.[6-8].

The aim of this study was to evaluate concentrations of PFASs in Norwegian house dust and to understand within-house and between house variability of anionic and volatile PFASs. In addition, the content of total extractable organic fluorine (TEOF) in house dust was evaluated to understand to what extent the targeted PFASs contribute to the TEOF.

The dust samples were collected in households in the Oslo area, Norway, during August 2015. The study included nine households and in each household six separate rooms. The 54 samples were collected on filters using an industrial vacuum cleaner (Nilfisk GM 80P) equipped with a special forensic nozzle with a one-way filter housing (KTM AB, Bålsta, Sweden) in the front of the vacuum cleaner tube.[5] The analysis covered a suite of 20 targeted PFASs; 16 anionic PFASs (FOSA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFBS, PFHxS, sum PFOS, 4:2-8:2 FTSA) and four volatile PFASs (4:2-10:2 FTOHs). The ionic PFASs were analysed by ultrahigh pressure liquid chromatography triple–quadruple mass-spectrometry (UHPLC–MS/MS), the volatile PFASs by gas chromatography (GC)–MS, and TEOF using a total organofluorine combustion ion chromatography (TOF-CIC) system.

Twelve of the 20 targeted PFAS were consistently detected in more than 50% of the samples; PFHxA, PFHpA, PFOA, PFDA, PFNA, PFUnDA, PFDoDA, PFBS, 6:2-8:2 FTS, and 8:2-10:2 FTOH, while the other eight were below detection limit in a major part of the samples. The targeted PFASs were detected in all rooms except in one room in one household in which all PFASs were below detection. The concentrations of individual PFASs as well as the sum of PFASs were lower than those of previous studies[4,5,9]. The results showed significant variability between houses for the anionic and volatile PFASs as well as for TEOF. For anionic PFASs, the results also indicate within-house variability with higher concentrations in dust from bedrooms (children and parents) and living rooms than the dust from bathroom, kitchen and entrances. No significant difference between rooms were found for the volatile PFASs and TEOF. These results suggest factors like building materials and consumer products (e.g., furniture, textiles etc.) affect the levels of PFASs in house dust. The anionic PFASs accounted for 10 to 100% of TEOF, which suggests some PFASs to remain unidentified.

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MULTI-RESIDUE SCREENING AND NON-TARGET ANALYSIS IN DUST

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In the modern world it has been estimated that up to 90% of our time is spent indoors, the indoor environment can expose us to a concentrated cocktail of chemicals. Indoor dust may be a source of chemicals and a sampler for a range of contaminants. Currently however, most studies to date have focused on individual compounds or classes of contaminants. A review on dust indicated that a large number of different chemicals have been identified in recent years.[1] These include polybrominated diphenyl ethers (PBDEs), pesticides, phthalates, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), perfluorinated compounds (PFCs) and to a lesser extent alkaloids, alkylphenols and derivates, dioxins, furans, musk fragrances, organophosphate esters (OPs), organotin compounds, parabens and polychlorobenzenes.

PBDE congener concentrations in serum and faeces of toddlers were significantly correlated to those in house dust and suggest that dust exposure plays a larger role in the PBDE body burden in toddlers than in their mothers, [2] this may be related to additional ingestion of dust as toddlers are apt to place toys and hands in the mouth, thus gaining additional exposure.

To our knowledge, scientific studies thus far focus on individual compounds or classes of compounds and do not take into account the total mixture of compounds present. Identifying a greater range of contaminants in dust provide a means to better identify potential human health hazards and may indicate compounds not traditionally monitored. Non-target screening focuses on the profiling and identification of as many organic contaminants as can be reliably identified, through their ion profile and where possible validated against standards, or libraries. In general, target analysis validated standard operation procedures are available whereas for non-target screening there are no defined guidelines or protocols. We developed a targeted multi-residue screening method to analyse a diverse array of compounds such as may be found in indoor dust. In combination with non-target screening, previously unreported compounds in dust can be tentatively identified.

A complex mixture of more than 200 compounds, including PBDEs, hydroxyl brominated diphenyl ethers (OH-BDE), OPs, organochlorines (OCs), PAHs, compounds in personal care products (PCPs), plasticizers, hormones and pharmaceuticals, were analysed with time of flight mass spectrometry using different ionisation sources (electrospray ionisation, atmospheric pressure chemical ionization and atmospheric pressure photoionization) in positive and negative mode. Dust samples from 3 countries, Czech Republic, Canada and United States were extracted and indicated a different chemical fingerprint for each country. Currently a range of extraction procedures are being investigated to maximize the recovery of such a diverse compound study and to validate the 3 countries non-target screening (validation of 'traditional' targets had been done previously). Once the most suitable method(s) is (are) validated for maximum recovery, additional samples will be studied from a range of locations for an in-depth analysis of human exposure.

This research provides a more in-depth approach to profiling and potential identification of contaminants in dust which will provide more comprehensive information for policy makers as well as general public on potential risks of exposure to dust. The use of non-target methodology may allow as yet unreported or unknown compounds to be looked at in the future through analysis of the non-target data files rather than relying on archived samples.

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CHLORINATED PARAFFINS IN INDOOR DUST AND MATERIALS

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Chlorinated paraffins (CPs) are straight chain alkanes usually with a chlorination degree of 30-70%. The CPs are generally divided into three groups; short-chain (SCCPs, C10-13), medium-chain (MCCPs, C14-17) and long-chain (LCCPs, C18-30). They are industrially high volume produced chemicals with a wide range of applications: flame retardants, plasticizers, lubricants, sealants and additives. The indoor environments may be subject to emission from indoor sources, such as paints, sealants (polyurethane foam sprays) and more. Despite this, the information on their occurrence and fate in indoor environments remain limited. Some of the CPs have been found to be toxic, persistent, subject to long-range transport and bioaccumulative and as such they have been subject to regional and global control strategies. The EU restricted the use of SCCPs in metal working industry and leather treatment in 2004 and SCCPs are included in the Aarhus protocol on Persistent Organic Pollutants (POPs) under the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP).[1] In addition, SCCPs are under consideration for inclusion in the Stockholm Convention on POPs.[2] Today, China is the main producer of CPs. Despite the control strategies on SCCPs, the overall annual production of CPs has increased from 50,000 tons in 1990 to more than one megaton in 2009.[3,4] In recent years, a raise in the background levels of CPs has been recorded in analytical laboratories in Europe, such as NILU, Norway. This indicates a more extensive use of CPs as well as presence in indoor environments. It underlines the need to study indoor levels and possible sources of CPs in indoor environments in combination with a thorough investigation of possible blank issues in order to ensure robust CP data.

In this study we present levels of CPs in indoor dust and the impact of polyurethane foam (PUF) sprays on levels in indoor environments.

Dust samples were collected from a range of indoor environments in Norway including households and offices. The dust samples were collected using a combination of wipe sampling and vacuum cleaning. The vacuum samplers were taken using an industrial vacuum cleaner (Nilfisk GM 80P) equipped with a special forensic nozzle with a one-way filter housing (KTM AB, Bålsta, Sweden) in the front of the vacuum cleaner tube.[5] The content of S/MCCPs in PUF sprays and their possible emission to indoor matrices were tested in two separate studies: i) by spraying PUF spray (MCCP 10-25% reported by manufacturer) inside a test cabin and collecting dust and passive air samples before, during and after the exposure; and ii) by spraying a range of different PUF sprays and directly extract and analyze the foam. In addition to analyse for MCCPs, which are reported to be a major part of the PUF, we also analyzed for SCCPs. The production of CPs in China are reported not to follow the traditional classification into SCCPs, MCCPs and LCCPs, hence the MCCPs added to products as polyurethane foam may also contain SCCPs. All samples were analysed using HRGC/HRMS. A 15m GC column was used to get sufficient chromatographic separation and the MS was operated in Electron Capture Negative Ionisation mode using methane as a moderating gas. The $[M\text{-}Cl]^-$ ions were monitored for each formula group of interest and the samples were quantified according to Tomy et al.[6]

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TIERED APPROACH MEASUREMENT STRATEGIES FOR INHALATION EXPOSURE TO NANOOBJECTS AND THEIR AGGLOMERATES AND AGGREGATES IN WORKPLACES

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Currently, a number of strategies to measure and evaluate exposure to nanoobject and their agglomerates and aggregates (NOAA) are proposed [1,2]. It is agreed that several levels of exposure assessment can be distinguished, i.e. initial-, basic - and comprehensive assessment. These levels can be used for a 'stand-alone 'assessment or nested in a tiered approach framework, where the objectives of the various levels or tiers vary. The initial assessment is focused on the potential for release of NOAA and emission into the workplace air. The basic assessment should provide evidence for presence of NOAA in the breathing zone, whereas the highest level should comprehensively characterize exposure to NOAA to enable dose estimates.

Direct reading instruments (DRIs), e.g. particle number counters, form the heart of the basic assessment In a desk study, the sensitivity and robustness of a number of decision rules (DRs) were tested, by statistical simulations and the evaluation of scenarios with measurement results from DRIs during activity and non-activity or background periods. This was done both by using a statistical approach to simulate exposure scenarios and by using existing workplace data (n=117). The performance of the decision rules was compared to the results of a statistical method to analyze time series (ARIMA) and evaluated for their sensitivity and specificity with respect to the consequences of the decision taken, i.e. terminate the assessment (ruling out) , proceed with the next tier (ruling in) , or go directly into risk management measures. Since the DRs could either be statistical parameters or fixed values, evaluation and decision making differs from compliance testing.

It was concluded that a decision on ruling out could not be solely based on the results of DRIs, however, data from sampling and off-line characterization should also be taken into account. A decision logic was proposed, which affords a systematical evaluation of all data [3].

Currently, the European Committee for Standardisation (CEN) is in the process of preparing a standard, which should provide guidance for each level of exposure assessment to NOAA and appropriate evaluation of its results [4].

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IMPORTANCE OF GAS LIQUID PARTITIONING COEFFICIENTS IN CHEMICAL SCRUBBERS: A CASE STUDY FOR AMMONIUM SULPHATE AND SWINE DUST

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Chemical air scrubbers are implemented in livestock production facilities to treat waste gas containing ammonia, volatile organic compounds and dust. During the operation of an acid (H_2SO_4) scrubber, ammonia is absorbed and dust particles are trapped into the scrubbing liquid. As a result properties of the washing liquid are changing continuously. The reaction of ammonia and sulphate (acid scrubbers, based on sulphuric acid) increases the ammonium sulphate (AS) concentration. Also, absorbed particles can change the organic content of the scrubber liquid. These factors can have an influence on the gas liquid partitioning coefficient (K_{AW}, air to water) of odorous compounds, present in livestock waste air. The higher K_{AW}, the more difficult it is to absorb odorous compounds in the scrubber liquid resulting in lower removal efficiencies and higher emissions.

The aim of this study is to determine the air water partitioning coefficients of five important odorous compounds: dimethyl sulphide (DMS), dimethyl disulphide (DMDS), hexanal (HEX), 2-methylpropanal (2-MP) and 3-methylbutanal (3-MB), in function of the ammonium sulphate concentration (0-300 g L^{-1}) and dust concentrations (0-2 g $^{-1}$). Particulate matter used in this study was collected from a swine stable at the Flemish Research Institute for Agriculture and Fisheries (Belgium). Also the temperature influence on the K_{AW} was investigated (4-25 °C). Next to the laboratory controlled liquids, also chemical scrubber liquid samples were evaluated and the K_{AW} was determined for the target compounds.

All gas liquid partitioning coefficients where measured with a newly developed dynamic absorption technique (DynAb method) using SIFT-MS (Selected Ion Flow Tube Mass Spectrometry) as measuring tool. Briefly, a pure nitrogen air stream is bubbled through liquid with known properties (Salt, dust concentration). At time zero, the pure air stream is switched to a contaminated air stream with a constant concentration of odorous compounds. From that time, the odorous compound starts to absorb in the liquid until there is an equilibrium between the liquid and the contaminated air stream. The outlet concentration is continuously monitored by SIFT-MS and results into a breakthrough curve. The area above this breakthrough curve is related to the absorbed mass in the liquid. The partitioning coefficient can be calculated if the liquid volume and air concentration are known.

When the temperature increases from 4 to 25°C, the K_{AW} increases with a factor 5. Raising the AS concentration (0 to 300 g L^{-1}), increases the K_{AW} with a factor of 10 (25°C). This implies that lower removal efficiencies will be obtained in scrubbers operating with high AS concentrations in the scrubbing liquid, due to a lower mass transfer. Field scrubbing liquid samples (from an operational scrubber) showed even a slightly higher K_{AW} when compared with pure (aq. distilled) ammonium sulphate solutions. In the concentration range of 0-2 g L^{-1} (25 °C) particulate matter, the K_{AW} was not significantly different in comparison to pure water. The organic content in scrubber liquids is likely too low to decrease the K_{AW} value. Also salts, present in the particulate matter, might increase the K_{AW}. The results prove that the determination of K_{AW} values of odorous compounds is important for scrubber reactor design in the field of livestock and bio-waste valorisation applications.

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ADVANCES IN SMARTPHONE-BASED FINE DUST SENSING

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Low-cost particulate matter sensing has received increasing attention in the last years. Especially scenarios that enable end-users to perform mobile air quality measurements with portable miniaturized samplers are challenging [1]. Such settings require instrumentation that is cheap and (ideally) can be integrated into handheld personal devices, like e.g. smartphones. Different promising approaches to achieve this exist, ranging from capacitive detection [2] over air-microfluidic MEMS sensors [3] to the adoption of classical optical sensing to mobile phones [4]. This talk will present advances in the latter approach: optical fine dust measurements using camera smartphones.

Regardless which technology will ultimately prevail: As sensors will eventually disappear into end-user devices in the future, untrained non-experts will perform the sampling to an increasing degree. This can be problematic in terms of data quality, as typical requirements for correct measurement procedures cannot be ensured. In professional measurement, results of high validity are warranted through a number of constraints that are typically not fulfilled in mobile and/or wearable environmental sensing. This usually includes a standardized measurement process in a controlled environment with a defined placement of the sensors that are periodically calibrated. In contrast, mobile low-cost end-user measurements are prone to systematic error in sensor readings.

This talk will explore different ways of dealing with such problems. In order to ensure that novice or untrained users perform a correct measurement procedure, those users typically have to be trained in advance. This is not feasible in participatory sensing scenarios, so other ways need to be found. As smartphones are equipped with multiple sensors and communication interfaces, an appropriate interface design can deliver in-situ training, help to encourage correct measurement, or even prevent measurement in case of incorrect device handling. Sampling could for example be prohibited, if the accelerometer in the smartphone detects motion or an undesired device orientation.

Aside from presenting approaches that target the user handling, we discuss an elegant approach for on-device signal processing that can directly stabilize sensor readings. It is agnostic to the employed sensing mechanism, as it is based on properties that are specific to the physical character of phenomena that can be modelled as particles. The idea behind the approach is to exploit the fact that such measurements are afflicted with sensor-dependent noise. Thus, it is possible to reconstruct the true signal from the noisy one [5]. In this way, certain sensor-aging effects may be disregarded, which can potentially reduce the need for frequent calibration.

Finally, aside from sensing techniques, we will discuss approaches that can be used to incentivize people to take part in participatory sensing, e.g. by embedding sensing as a mechanism into smartphone-based games.

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DERMAL UPTAKE OF PHTHALATE ESTERS AND ALTERNATIVE PLASTICIZERS USING 3D HUMAN SKIN EQUIVALENTS

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Phthalate esters (PEs) are a group of diverse chemicals commonly used in personal care products (PCPs) or as plasticizers e.g. in polyvinyl chloride (PVC). Their frequent uses make them ubiquitous in the indoor environment such as in air and dust. They are not covalently bound to the material and can easily leach from products by evaporation, migration, abrasion and diffusion [1, 2]. Furthermore, PEs are suspected endocrine disruptors and have been shown to cause effects related to the endocrine system in animal studies [3]. As a consequence, some PEs have been banned and replaced with alternative plasticizers [4-6]. Since dust can be a source of PEs and their alternatives, accurate exposure estimations should be done, especially for children, which can be at higher risk than adults (lower body weight, higher surface area to body volume ratio, higher probability to get in contact with dust). In order to assess dermal exposure to those substances, we conducted a skin absorption experiment using artificial 3D human skin equivalents. These skin models represent viable human epidermis layers with metabolic activity [7]. These skin models have been introduced very recently to study indoor pollutants [8, 9] and have never been used before to assess dermal absorption of PEs. The substances of interests were diethyl phthalate (DEP), diisobutyl phthalate (DiBP), di-n-butyl phthalate (DnBP), benzylbutyl phthalate (BBzP), diethylhexyl phthalate (DEHP), diethylhexyl adipate (DEHA), diethylhexyl terephthalate (DEHT) and diisononyl cyclohexane-1,2-dicarboxylate (DINCH). The experimental setup includes a blank, a negative control (Decabromodiphenyl Ethane) and 4 treatments, where the analytes were dissolved in acetone and application done in two doses (500 and 5000 ng/cm²) for the first two skin patches. The other two treatments consisted of the same dosing concentrations as above but using pure water as a solvent and, to verify increased metabolism rates shown in other studies [10], without bovine serum albumin (BSA) added in the RF. The duration of exposure was 33 hours and RF samples taken at 0.5 and 1 h after exposure, followed by sampling every two hours. At termination, samples were taken for: 1) well washes using phosphate buffered salt (PBS), 2) skin wipes using glass wool and 3) whole skin. Sample extraction and clean-up was performed using liquid-liquid extraction with MTBE-hexane 3:1. Also, ultrasonication of glass wool samples and homogenization of skin samples was done. Analysis was performed on GC-MS/MS. Results showed faster uptake of smaller molecular weight PEs as well as higher percentages found in the RF. Larger PEs were mostly found to remain on the skin surface implying slower permeation. Possible metabolic transformation, indicated by the overall low recoveries (< 20%) of the applied doses, is currently under investigation. Furthermore, estimations of human intake rates using the acquired data and investigation of the relative importance of dermal uptake via dust, PCPs, and air will be performed. In the future, more realistic exposure scenarios e.g. direct dust application will be conduction in order to assess bioavailability of those substances and to refine exposure estimations.

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TESTING AND OPTIMIZATION OF A TECHNIQUE FOR AEROSOL COLUMNAR COMPOSITION RETRIEVAL

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Atmospheric aerosols play a fundamental role in atmospheric processes significantly impacting environment, health and climate but strong uncertainties in aerosol properties retrieval are still present leading the scientific community to improve and intensify in situ observations together with remote sensing of aerosols and the use of models [1], [2].

The identification of aerosol composition represents a significant step for the evaluation of their impact on climate and human health.

A lot of study focus on aerosol composition at ground [3] but very few give information on aerosol composition over the atmospheric column [4] which is very important for modeling and radiative forcing assessment.

The aim of the present work is to test and optimize a technique to infer columnar aerosol composition starting from columnar radiometric data. The technique is based on the use of OPAC (Optical Properties of Aerosol and Clouds by Hess, [5]) aerosol types, as firstly proposed by Satheesh and Srinivasan, [6] and is applied to Aerosol Optical Depths (AODs) derived from the high resolution spectroradiometer Ocean Optics S2000. In particular the aerosol components considered for the present study are: Water Soluble (WS), Soot (BC), Sea Salt accumulation (SSacc), Sea Salt coarse (SScoa), Mineral transported (MT), Mineral nucleation (Mnucl), Mineral coarse (Mcoa), and Biogenic (Bio). Each aerosol component is assumed to have a log-normal size distribution with a fixed mean radius and mode width together with real and imaginary part of refractive indices. A sensitivity study has been performed on the number of components to use and on different values of input parameters to improve the technique performance.

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PM10 SOURCES IN THE CENTRAL MEDITERRANEAN BASIN: RESULTS FROM A LONG-TERM STUDY

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Strong natural and anthropogenic aerosol emissions, as well as important climatic forcings, affect the atmosphere of the Mediterranean Basin, which has been identified as one of the "Hot-Spots" in future climate change projections [1]. In this framework, the Station for Climate Observations was installed by ENEA (Italian Agency for New Technologies, Energy and Sustainable Economic Development) on the island of Lampedusa (35.5° N, 12.6° E, 45 m a.s.l.), which is far from continental pollution sources (the nearest coast, in Tunisia, is more than 100 km away). At the station, continuous observations of greenhouse gases concentration, aerosol properties, total ozone, ultraviolet irradiance, surface radiation, clouds and other climatic parameters are routinely carried out. PM_{10} samples have been collected on a daily basis since 2007, in order to study also the chemical properties of the aerosol and to gain information on the aerosol sources and their contributions.

After gravimetric mass measurements, samples are analysed using different techniques; this allows a comprehensive chemical characterization of the samples, including the determination of the ionic content by Ion Chromatography (IC), of the soluble metals by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES), of the total (soluble + insoluble) elemental composition by Particle Induced X-ray Emission (PIXE), and of the carbonaceous component (elemental and organic carbon, EC and OC) by Thermo-Optical Transmittance (TOT) analysis.

Source apportionment was performed exploiting the Positive Matrix Factorization (PMF) model on data relative to the periods 2007-2008 and 2012-2014.

Several episodes with PM_{10} exceeding 100 $\mu g/m^3$ were observed; minima were found to be around 10 $\mu g/m^3$.

Seven sources were resolved for the 2007-2008 data-set: sea-salt, mineral dust, biogenic emissions, primary particulate ship emissions, secondary sulphate, secondary nitrate, and combustion emissions. Source contributions to the total PM10 mass were estimated to be about 40% for sea-salt, around 25% for mineral dust, 10% each for secondary nitrate and secondary sulphate, and 5% each for primary particulate ship emissions, biogenic emissions, and combustion emissions. About one third of the total contribution of secondary sulphate was estimated to originate from ship emissions. Large variations in absolute and relative contributions of the different sources were found, depending on the season and on transport episodes [2].

Preliminary results from the 2012-2014 dataset confirm the main sources impacting the Central Mediterranean area. In addition, the determination of the aerosol carbonaceous component, not available in 2007-2008, allows improving the study by adding important pieces of information on the combustion sources.

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AIRBORNE PATHOGENS IN POULTRY HOUSES: HOW DO THEY RELATE TO DUST?

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The extent to which dust can contain and transport pathogenic microorganisms and cause infection in human and animals is uncertain. This paper reviews the state-of-the-art of airborne pathogens and the role of dust in poultry houses. It focuses on two pathogens reported to be airbone transmittable in broilers and laying hens: *Salmonella* spp. and *Mycoplasma gallisepticum*, respectively It discusses their measurement and behaviour in heavily dusty poultry houses and identifies key dust-related factors which may influence their detection in the air. Finally, future research needs are discussed. Impaction, impingement and gravitational settling (sedimentation plates) were used to sample airborne pathogens. Additionally, Polymerase Chain Reaction (PCR)-based methods were used to detect their presence in air samples. In an experimental broiler house, *Salmonella* spp. was recovered using impaction and gravitational settling but not using impingement. There was a strong correlation between airborne *Salmonella* spp. and ambient relative humidity and only a small correlation with PM2.5. In a commercial laying hen house, *M. gallisepticum* was only detected using qPCR in impingement samples. Dust characterization showed high proportion of feathers and manure in airborne PM10-2.5 and PM2.5. There was a strong presence of *M. galliseptcum* in inlet air. These sources should be considered to reduce airborne microorganisms. In summary, it is necessary to acquire more information on the relationship between dust and airborne pathogens and their behaviour in the air to design adequate techniques to reduce them in poultry houses. Research should address measurement issues and environmental factors (sampling method and physical and biological efficiency, time of the day, season, temperature and relative humidity) and dust-related factors (particle size, concentration and sources). Animals themselves and animal activity may play a key role, as well.

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BIOGEOCHEMISTRY AND MINERALOGY OF INDOOR DUST COLLECTED FROM HOUSEHOLDS IN URBAN AND PERI-URBAN AREAS OF ESTARREJA, AN INDUSTRIAL PORTUGUESE CITY

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This study focuses on data obtained from a pilot survey that was designed to assess the health impact of potentially toxic elements (PTEs) in household dust collected from private homes in Estarreja, a Portuguese industrial city. The study aims at assessing differences in the mineralogy and geochemistry of dust samples collected indoors and outdoors, to investigate probable controls in the oral bioaccessibility of the PTEs. A total of 21 households were recruited for the study and a self-administered questionnaire was provided to the residents. By filling the questionnaire, the participants were asked to characterise the general conditions of the physical environment of the house. Ethical approval for this study was obtained from the National Committee for Data Protection (Proc. nº 1241/2013). All participants gave written, informed consent to the study.

While composite indoor dust sample was collected from different house compartments using the High Volume Small Surface Sampler (HVS3) vacuum sampler, outdoor dusts were collected from different areas outside the house with a small brush and a plastic shovel. Qualitative and semi-quantitative mineralogical analyses were carried out by X- ray diffraction (XRD) using a Philips®/PanalyticalX'Pert-Pro MPD, Kα Cu (λ = 1,5405 Å) radiation, with 0.02º 2θ s-1 steps in goniometer speed, in order to assess the main and accessory minerals, their relative proportions, check the eventual heterogeneities, and establish the mineralogical markers. Semi-quantitative analysis of 55 chemical elements was carried out by Inductively Coupled Plasma - Mass Spectrometry.

Mineralogical phases identified include various silicates and aluminosilicates, carbonates, sulphates, oxides and hydroxides. Quartz, Feldspars, Phyllosilicates (namely Micas) and Calcite are the main minerals, accompanied by Opal C/CT, Dolomite, Siderite, Anhydrite and Graphite. Some accessory minerals, such as Fe oxides-hydroxides (Hematite, Lepidocrocite, Goethite, and Magnetite-Maghemite), Ti oxides (Anatase), sulphates (mainly Melanterite), Zeolites (namely Clinoptilolite-Heulandite), and Halite are relevant discriminating phases, namely between indoor and outdoor dusts. XRD profiles also revealed a relatively common presence of amorphous materials, more significant in some samples. While total concentrations of Hg, Cu, Ni, Cr, Cd and Zn are more elevated in indoor dusts, U, As, Mn and V dust contents are more elevated in the outdoor samples, being the differences statistically significant ($p < 0.05$). Lead concentrations are more elevated in indoor dusts but the differences are not statistically significant ($p > 0.05$). Furthermore, indoor PTEs concentrations are not correlated with outdoor dust PTEs contents. A previous study carried out with the data hereby described suggests that different PTEs sources are prevalent in indoor and outdoor environments of the houses (Reis et al. 2015).

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URBAN DUST AND CENTRAL OHIO PRECIPITATION

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Study of the deposition and solubility of mineral dust in the United States has focused primarily on rural regions and on the impact of dust on soil biogeochemistry. In this on-going research, we examine the solubility of dust collected during a long-term study of the stable isotopic composition of precipitation in Columbus, Ohio, the 15th largest city in the United States. Samples were collected in a stationary, open, exposed rain collector so that between rain events dry deposition was obtained. Rain and snow samples were collected over a two-year period during 2014–2015 and analyzed for major cations (Na^+, Ca^{2+}, Mg^{2+}, K^+) and anions (Cl^- and SO_4^{2-}) by ion chromatography. Chloride concentrations are low, ranging from >1 μM L^{-1} to 26 μM L^{-1}, and are not correlated to Ca^{2+}. Cation concentrations were corrected for seawater aerosol contribution using the chloride data. Soluble, sea salt-corrected Ca^{2+}concentrations ranged from 6 to 124 μM L^{-1} and demonstrated a strong positive correlation to the time elapsed since the antecedent precipitation event. Our results are compared to a longer term dataset (1999–2015) from the National Atmospheric Deposition Program (NADP) of wet deposition samples collected at Deer Creek State Park in Pickaway County, Ohio, 50 km southwest of Columbus. Mean sea salt-corrected Ca^{2+} concentration in our samples was 26 μM L^{-1}. Mean sea salt-corrected Ca^{2+} concentrations in the NADP samples was significantly lower ($p=0.0001$), at 5.6 μM L^{-1} with a range of 0.23–75 μM L^{-1}. Clearly dry deposition between precipitation events plays a major role in Ca^{2+} input to the city landscape. It is unclear whether this soluble calcium is from a local urban source or a regional agricultural source, because previous work has suggested the importance of agricultural dust sources in this area of the United States and also shown increased Ca^{2+} deposition to the Midwestern US between 1994 and 2010[1]. SEM analysis of dry-deposition collected separately is used to determine mineralogy of dust input to our samples and the possible source of the dissolved calcium observed.

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GEOCHEMISTRY AND MINERALOGY OF MOUNTAIN DUST IN NEVADA AND UTAH, USA

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Windblown dust is an important chemical and physical flux to mountains in the Western United States, yet the spatial variability in dust composition is poorly understood. In this study, we collected dust samples in eastern Nevada and northern Utah mountains during 2013-2015 to investigate temporal and spatial variability in the geochemistry and mineralogy of dust deposition. Winter dust samples were collected by isolating dust layers from snowpack and summer dust samples were collected in marble-covered bucket traps. Sample sites included the Snake Range (Great Basin National Park), central and northern Wasatch Range, and the western Uinta Mountains. Potential dust sources for these sites include playas, disturbed desert soils, and agricultural activities in the Great Basin Desert and Snake River Plain, as well as inputs from fossil fuel combustion and oil refineries, mining, industrial and other activities in the urban Wasatch Front. Winter dust was analyzed for mineralogy and for trace element concentrations and $^{87}Sr/^{86}Sr$ ratios after sequential leaching by acetic acid and nitric acid. Summer dust samples were analyzed only for mineralogy. Crustal enrichment factors for winter dust samples were calculated to evaluate potential contributions of anthropogenic trace metals. Data from the central Wasatch Range and Uinta Mountains follow on previous investigations of dust chemistry and mineralogy [1-5]. To our knowledge this is the first study to investigate dust composition in the Snake Range and northern Wasatch Range. Sequential leaching experiments of dust samples show very different behavior among the suite of elements. In samples from all sites, typically over 80% of the Ca, Sr, B, Cd, and Mn, and about 60% of the Co, Be, and Zn, was released with the acetic acid leach fraction. In contrast, a majority of the Fe, Sb, U, Li, Pb, Cr, and Cu was released with the nitric acid leach fraction. These results are important because they identify elements that are likely available for transport as solutes during snowmelt runoff (acetic acid fraction) and elements that are potentially transported with organic matter (the nitric acid fraction). $^{87}Sr/^{86}Sr$ ratios of dust were similar among all sites (~0.711) except for the northern Wasatch Range, where $^{87}Sr/^{86}Sr$ ratios were less radiogenic (~0.710). In most cases $^{87}Sr/^{86}Sr$ ratios in the nitric acid leachate were less radiogenic than the acetic acid leachate, highlighting the importance of mineralogy on Sr isotope composition. Enrichment factors suggest that dust from all sites is enriched in anthropogenic metals Pb, Sb, Cu, As, and Zn but dust from the central Wasatch Range is most enriched. Analysis of mineralogy data is still underway and will be used to identify similarities and differences between summertime and wintertime dust deposition across sites. Overall, these preliminary results suggest that the bulk of dust composition is similar over a large area but with subtle differences due to variable anthropogenic and natural sources.

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MINIATURIZED SINGLE-CHIP DETECTOR OF MICROMETRIC DUST

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Within the context of several efforts towards the realization of compact devices for distributed, portable, and personal particulate matter (PM) dosimetry [1-2], we present the first microelectronic chip enabling the detection of single dust particles, ranging from 1 μm to above 10 μm in diameter.

In 2014 we proposed an original and simple approach to detect single airborne particles by means of high-resolution capacitance measurement between properly-designed microelectrodes [3]. Beyond counting the number of particles which deposit on the sensor, the analysis of PM size distribution (i.e. *granulometry*) can be performed thanks to the volume dependence of the measured capacitance increase. The smallest particle diameter detectable by the first system, based on separated sensing microelectrodes and readout electronics (based on off-the-shelf components and featuring a noise floor of ~aF), was around 6 μm [3].

In order to target smaller diameters (extending the detection range down to fill the gap towards personal nano-particles exposure dosimeters based on electrometers [4]), we have moved to a new implementation, here presented, based on the design of a ***monolithic silicon chip combining the sensing electrodes and the readout electronics on the same CMOS device***. The combination of sub-micrometric lithography for electrodes patterning with the extreme proximity of the ultra-low-noise front-end amplification circuit significantly enhances the achievable performances, addressing the following important aspects: (i) smaller minimum detectable diameter, targeting 1 μm, (ii) larger detection area, (iii) signal insensitivity to the particle landing position on the sensor.

Since a large sensing area (1.15 mm^2) is in contrast with high capacitive resolution, it is partitioned in 32 sensing pixels, each connected to a dedicated amplification chain operating in parallel and cyclically sampled through a multiplexer. Each pixel (70 μm m by 500 μm) consists of 2 sets of interdigitated planar electrodes measured in a differential configuration for noise minimization. Each conditioning chain comprises a low-noise amplifier with an automatic circuit for compensation of the electrodes mismatch, a square-wave mixer and low-pass filter with selectable analog bandwidth.

The chip, fabricated in 0.35 μm AMS CMOS technology (2.4 mm by 2.5 mm) boasts a resolution of 65 zF rms with 40 Hz bandwidth (suitable for the clear discrimination of fast deposition events) allowing the detection of single dust particles of 1 μm diameter (giving ~700 zF signal) with a worst-case signal-to-noise ratio of ~10, as experimentally demonstrated in real-time multichannel tracking experiments, in good agreement with the results expected from numerical simulations [5].

Considering the power consumption (84 mW at 3.3 V supply) of this prototypal chip, it is straightforwardly employable in compact fixed stations to be spread in the urban environment. In perspective, tackling the challenges of significantly reducing the power dissipation and enriching the detector with active techniques for attracting and concentrating PM from the air onto the sensing surface (to be periodically cleaned like image sensors in reflex cameras), the compatibility of this solution with standard CMOS fabrication processes, allows envisioning the embedment of such single-chip PM detectors inside consumer portable devices such as smartphones and tablets. This would pave the ways to radically revolutionary monitoring scenarios of pervasive and participatory sensing.

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WET ELECTROSTATIC SCRUBBING FOR THE REMOVAL OF MARINE DIESEL ENGINE PARTICULATE MATTER

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The removal of particles from ships exhausts is a critical challenge for naval industry. The emissions of particles from ships are unrelevant on a worldwide perspective, but create significant pollution due to their geographic localization (e.g. [1,2]).

To date, commercial filtration units are able to treat all the constituents of particulate matter emissions only if applied to natural gas and ultra-low sulphur fuelled engines. Unfortunately, these represent a small fraction of the modern naval engines fleet. When applied to conventional Marine Diesel Oil or Intermediate fuel oils, filters cannot be adopted and wet scrubbers are the only viable options. However, naval scrubbers are meant to reduce sulphur dioxide emissions, and they can capture mostly particles larger than 2 microns. The lack of possible technologies to reduce particulate emissions in an effective and economic way is a major concern for the application of suitable regulation for particles pollution prevention.

Our group is developing wet electrostatic scrubbing, an innovative technique to reduce all the fraction of particulate, included the ultrafines and nanometrics. The implementation of this technology follows two different paths. On the one hand, we are developing prototypes and testing them in representative conditions (e.g. [3]), on the other hand, we are studying the dynamics of the scavenging of particles (either unipolarly charged or naturally charged) by means of charged droplets (e.g. [4-6]).

This paper discusses the main features of wet electrostatic scrubbing applied to the removal of submicron and ultrafine particles as those emitted by marine diesel engines, presenting experimental and modelling evidences on the functional dependences between the particle removal efficiency and the main process parameter and describing the latest findings in the system development.

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AERUS-GEO: A MSG/SEVIRI SATELLITE-BASED AEROSOL PRODUCT ALLOWING TO CAPTURE DUST EVENTS FOR THE LAST 10 YEARS OVER EUROPE AND AFRICA

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The aerosol signal derived from visible and near-infrared remote sensing observations can now be isolated thanks to a method allowing a proper separation of the atmosphere and surface components. This product is called AERUS-Geo (Aerosol and surface albEdo Retrieval Using a directional Splitting method - application to Geo data) and covers Europe, Africa, and the Eastern part of South America. It fully exploits the directional and temporal dimensions of the MSG/SEVIRI satellite signal through the use of a semi-empirical kernel-driven BRDF (Bidirectional Reflectance Distribution Function) model mimicking the radiative anisotropy for the surface/atmosphere coupled system.

The AOD values estimated at 0.63 μm and 1.64 μm serve to calculate an Ångström coefficient that is further used to classify the aerosol layer into a continental, maritime, or a desert type. The AERUS-GEO product compares favourably with measurements of several AERONET stations, MODIS-derived (Moderate Resolution Imaging Spectro-radiometer), and MISR-derived (Multi-angle Imaging Spectro-Radiometer) products within a 20% of accuracy. The method proves to be competitive, not only in tracking anthropogenic aerosol emissions in the troposphere but also in estimating dust events. In addition, the higher frequency of AOD products with AERUS-GEO provides the means to quantify the aerosol radiative forcing in a more accurate manner than using low-orbit satellite data.

The AERUS-GEO algorithm was implemented by the ICARE Data Center (http://www.icare.univ-lille1.fr), which operationally disseminates in near real time (NRT) a daily AOD product at 0.63 μm over the MSG (Meteosat Second Generation) disk since 2014. In addition to an NRT AOD product, also a long term reprocessing of satellite derived AOD still based on MSG/SEVIRI observations has been implemented. This allows to perform a thorough monitoring of the dust events over Europe and Africa for the last 10 years (2005 to 2015) for the benefit of a large scientific community.

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QUANTIFYING THE CONTRIBUTION OF LONG-RANGE SAHARAN DUST TRANSPORT ON PARTICULATE MATTER CONCENTRATIONS IN HOUSTON, TEXAS, USA USING DETAILED ELEMENTAL ANALYSIS

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The arid regions of North Africa are estimated to emit about 800 Tgy^{-1} of soil dust each year, 70% of the global total [1, 2]. The transatlantic transport of North African dust by summertime trade winds occasionally increases ambient particulate matter (PM) concentrations in Texas, USA above air quality standards. Exemptions from such exceedances can be sought for episodic events that are beyond regulatory control by providing qualitative supportive information such as satellite images and back-trajectories. As isolating air pollutant contributions is difficult in complex urban environments, the ability of detailed chemical speciation to differentiate sources is challenged because of the existence of myriad local sources. During a $PM_{2.5}$ and PM_{10} sampling campaign at two locations in the highly industrialized Houston Ship Channel area, a large-scale intrusion of Saharan dust was first identified through back-trajectories and satellite imagery. Source profiles for Saharan dust, local soil and road dust and several other developed as part of this research or obtained from the literature were input to the chemical mass balance (CMB) receptor model. This approach isolated multiple sources of mineral material to ambient aerosol loadings, including long-range transport, industrial emissions, and entrainment of local soil and road dust. To our knowledge, this is the first use of the CMB model to quantify the relative importance of desert dust to $PM_{2.5}$ and PM_{10} in the United States and complements other approaches put forth in Europe.

This research shows that chemical mass balancing can successfully isolate, differentiate and quantify the relative contributions from local and global mineral dust sources through detailed measurements of a wide suite of elements in ambient PM. Our procedure will be demonstrated using an example of a major dust storm originating in Northwest Africa in mid-July which eventually impacted air quality in Houston during late July. Daily $PM_{2.5}$ and PM_{10} samples were collected at two sites in Houston over a 2-week period encompassing the Saharan dust episode to quantify the transported mineral dust concentrations during this peak event. Average PM concentrations more than doubled during the Saharan intrusion compared with non-Saharan. Relative concentrations of several elements often associated with anthropogenic sources were significantly diluted by crustal minerals coincident with the large-scale Saharan dust intrusion. During non-Saharan days, local mineral dust sources including cement manufacturing, and soil and road dust contributed in total 26% to $PM_{2.5}$ mass and 50% to PM_{10} mass; during the three-day Saharan episode the total dust contribution increased to 64% for $PM_{2.5}$ and 85% for PM_{10}. Importantly, this approach was also able to determine that local emissions of crustal minerals dominated the period immediately following the Saharan dust episode: simple quantification of bulk crustal materials may have misappropriated this elevated PM to trans-Atlantic transport of Saharan dust.

Various lines of evidence were used to demonstrate that dust-laden African air masses reached the southern and eastern United States and had a major impact on air quality even overwhelming local emissions in Houston, Texas. To our knowledge, this is the first work to quantify the impact of African dust on airborne ambient PM in the USA and to place it in the context of other suspected local and regional sources [3]. This was accomplished using detailed elemental measurements of PM samples, including African dust, combined with source attribution using CMB. It is emphasized that the PM monitoring and X-ray fluorescence measurements routinely made in air quality studies may not be sufficient to quantitatively assess desert dust impacts in urban environments because of their limited sensitivity and the smaller number of marker elements that are measured, coupled with the lower frequency of elemental speciation measurements that are typically undertaken. This limitation would be particularly important in less industrialized urban regions where soil and road dust resuspension might dominate PM levels thus making it difficult to discriminate between local and global dust sources.

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ANTHROPOGENIC SIGNATURES AND INDOOR-TO-OUTDOOR RELATIONSHIPS FOR RARE EARTH ELEMENTS IN $PM_{2.5}$ AT A HIGH SCHOOL IN HOUSTON, TEXAS, USA

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Children are exposed to indoor air pollution for several hours that they spend in school in addition to the time they spend at home. It is probably more informative to monitor indoor air quality in schools rather than individual homes since it provides exposure information directly relevant to several hundred children [1]. We report results from a campaign designed to evaluate anthropogenic ambient contamination of indoor $PM_{2.5}$ at a high school near the heavily industrialized Houston Ship Channel. The principal objective of this work is to examine the association between primary particulate matter emissions of outdoor sources and metal composition of $PM_{2.5}$ in both indoor and outdoor school environments. We specifically tracked episodic emissions emanating from petroleum refineries by providing signatures of rare earth elements or lanthanoids. Indoor-to-outdoor (I/O) relationships for both $PM_{2.5}$ mass and its metal content were investigated through concentration ratios and regression analysis. Various tools including tracer element ratios, characteristic lanthanoid anomalies, ternary diagrams, and enrichment factor analysis were used to identify the samples that were significantly impacted by episodic releases of crude oil cracking catalysts from nearby refineries. Results were verified by coincident entries in the self-reported air emission event database maintained by the State of Texas. Possible outdoor sources and their contributions to PM masses were computed via chemical mass balancing. Modelling further allowed us to differentiate respective contributions of lanthanum-rich $PM_{2.5}$ emissions, leading to rare earth enrichment in indoor and outdoor aerosols.

Partisol-Plus 2025 air samplers (Rupprecht & Patashnick Co., Inc.) were installed inside a classroom and on the roof the school to concurrently collect paired indoor and outdoor airborne $PM_{2.5}$ samples over two months. A total of 13 indoor and 13 outdoor samples were collected on Whatman 46.2 mm diameter PTFE membrane filters. Samples were digested in Teflon vessels (HP-500 Plus) using a microwave oven (MARS 5, CEM Corp.). Two-stage acid-digestion (HNO_3, HF, H_3BO_3) and elemental analysis procedures developed previously by our research group were employed for all samples [2]. Eighteen representative (Li, Be, Na, Mg, Al, Si, K, Ca, Ga, As, Se, Rb, Sr, Sn, Sb, Cs, Ba, Pb), 15 transition (Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Y, Zr, Mo, Cd, Hf, W) and 15 inner transition elements (La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, U) were quantified in digestates by a quadropole inductively coupled plasma - mass spectrometry equipped with a dynamic reaction cell (DRC-q-ICP-MS; ELAN DRC II, PerkinElmer SCIEX). Ammonia was used as the reaction gas to reduce mass interferences for several elements, including Al, Ca, V, Cr, Mn, Fe, Ni, Co, Cu, Zn, As, Se, and Cd.

The La/V and V/Ni ratios as well as LaCeV ternary diagrams were used to differentiate the relative influence of local source emissions on lanthanoid composition of indoor and outdoor (i.e. ambient) $PM_{2.5}$. The resemblance between lanthanoid patterns of $PM_{2.5}$ and cracking catalysts demonstrated that episodic releases from refineries caused significant lanthanoid enrichment in indoor air. Importantly, rare earth element patterns in paired indoor and outdoor $PM_{2.5}$ during episodes showed significant anomalies compared to the upper continental crust, exhibiting La-enrichment over heavier members. La-enrichment in both indoor and outdoor $PM_{2.5}$, indoor/outdoor concentration ratios <1 for individual and total lanthanoids, and statistically significant positive correlations between indoor/outdoor concentrations of rare earths and PM mass and several other elements provided evidence that lanthanoid-bearing indoor PM concentrations were governed by outdoor infiltration. Receptor modeling attributed refinery emissions as the major contributor to lanthanum enrichment in both indoor/outdoor PM, particularly during episodic releases. This was followed by smaller inputs from oil combustion activities with negligible inputs from steel plants. To our knowledge, this is amongst the first work to report an anthropogenic lanthanoid-signatures of indoor particulates of outdoor origin.

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ELEMENTAL CHARACTERIZATION OF $PM_{2.5}$ AND PM_{10} EMITTED FROM LIGHT DUTY VEHICLES IN THE WASHBURN TUNNEL OF HOUSTON, TEXAS: RELEASE OF RHODIUM, PALLADIUM, AND PLATINUM

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Previous investigations of the metals content in airborne tunnel particulate matter (PM) have predominantly focused on non-platinum group elements such as Fe, Ca, Zn, Mn, Cu, Cd, Pb, As, Ni, Sb, Sn, Ba, and Ga [1, 2]. The isolation of vehicular sources in industrialized urban environments is complicated as these elements are also emitted by many other natural and anthropogenic sources. Quantifying Rh, Pd, and Pt in addition to these elements will facilitate accurate estimates of light duty vehicles' (LDVs') contributions to ambient PM as the presence of these elements in tailpipe emissions is attributed to the three-way catalytic converters used in emission control systems of gasoline-driven automobiles [3].

The objectives of this research are to (1) comprehensively characterize wide suite of elements in $PM_{2.5}$ and PM_{10} emitted from LDVs traversing a tunnel with emphasis on Rh, Pd, and Pt, (2) develop a novel LDV source profile by including platinum group elements (PGEs) as unique markers, and (3) quantitatively apportion tailpipe and non-tailpipe LDV emissions to airborne PM mass measured in the tunnel. Samples were collected over extended durations in the only operational vehicular tunnel in Texas (i.e. Washburn Tunnel), to obtain sufficient PM mass in order to accurately quantify numerous metals including PGEs at trace-levels using our newly developed method based on dynamic reaction cell-quadrupole-inductively coupled plasma-mass spectrometry [4].

We report the elemental composition, including Rh, Pd, and Pt, of total (i.e. tailpipe and non-tailpipe) $PM_{2.5}$ and PM_{10} emissions from predominantly gasoline-driven light-duty vehicles (LDVs) traversing the Washburn Tunnel in Houston, Texas, USA [5]. Accurate LDV source profiles incorporating three platinum group elements (PGEs) were derived for the first time. Average Rh, Pd, and Pt concentrations from the tunnel ventilation air supply were 1.5, 11.1, and 4.5pgm^{-3} in $PM_{2.5}$ and 3.8, 23.1, and 15.1 pgm^{-3} in PM_{10}, respectively. Rh, Pd, and Pt levels were elevated inside the Washburn Tunnel reaching 12.5, 91.1, and 30.1 pgm^{-3} in $PM_{2.5}$ and 36.3, 214, and 61.1 pgm^{-3} in PM_{10}, respectively. Significantly higher enrichment factors of Cu, Zr, Rh, Pd, Sb, and Pt (referenced to Ti in the upper continental crust) inside the tunnel compared with the ventilation air supply suggested that they are unique elemental tracers of PM derived from gasoline-driven LDVs. This highlights the importance of advancing methods to quantify the trace level PGE emissions as a technique to more accurately estimate LDVs' contributions to airborne PM. Using the emission profile based on PGEs and ambient quantification, mass balancing revealed that about half the fine PM mass in the tunnel could be attributed to tailpipe emissions, approximately one quarter to road dust, with smaller contributions from brake (7%) and tire (3%) wear. On the other hand, PM_{10} mostly originated from resuspended road dust (~50%), with progressively lower contributions from tailpipe emissions (14%), brake wear (9%), and tire wear (2%).

We improve upon earlier USA studies by reporting all three Pd-group PGEs (i.e. Rh, Pd, and Pt) emanating from an on-road fleet, nearly eliminating contributions from diesel-driven vehicles, providing data for fine and coarse size fractions, and updating elemental concentrations associated with LDVs for the first time in ~13-years [6, 7].

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RESPONSE OF MESOSCALE CONVECTIVE SYSTEM AND COLD POOL FORMATION TO DUST-RADIATIVE EFFECTS

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This study examines the role of dust in the development of a mesoscale convective system (MCS) over the central-west Sahara, and how a cold pool from the MCS affected wind-blown dust emissions. Moderate Resolution Imaging Spectrometer (MODIS) and Multi-angle Imaging SpectroRadiometer (MISR) retrieved aerosol optical depth (AOD) and Meteosat Second Generation dust-enhancement product were used to examine a dust outbreak that occurred between 13 and 15 August 2005. Satellite retrieval data also revealed that a moist tongue intruded into the Sahara and caused a MCS to develop near the edge of a strong moisture gradient. Using reanalysis we found that an African easterly wave merged with the Saharan heat low to form an intense surface low-pressure system. High wind speeds associated with the low-pressure system emitted a significant amount of dust, which potentially impacted the development of the MCS over desert. Cold pool outflow from the MCS then resulted in additional dust emission, with implications for long range transport. The Weather Research and Forecasting dust model was modified and used to numerically study the MCS case. The model reasonably reproduced the northward intrusion of the moisture tongue, the AOD, and the formation of MCS. Numerical experiments with (ON) and without (OFF) dust-radiation interactions were conducted to investigate the influence of dust-radiative forcing on the MCS and cold pool development. Mechanisms of the MCS development over desert, influences of dust-radiative forcing on the MCS' environment, and subsequent impacts of dust on the MCS development and cold pool intensity were investigated and will be presented.

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DESERT DUST MONITORING FROM PARASOL SATELLITE OBSERVATIONS OVER THE MEDITERRANEAN SEA

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Desert dust is a key atmospheric constituent, considered to be a harmful pollutant, interacting with continental and marine ecosystems and playing important roles in different aspects of weather and climate dynamics, the Earth's radiative budget, cloud microphysics and atmospheric chemistry. For many remote oceanic and continental areas of the globe, the only approach for monitoring desert dust emissions, transport pathways and impacts is via satellite observations. Although aerosol type unambiguous identification from satellite is still challenging, a number of recent algorithms not only retrieve aerosol optical depth (AOD, representative of all aerosols types), but also apply specific algorithm or methodology attempting to discern desert dust from the total aerosol signal.

POLDER-3 (Polarization and Directionnality of the Earth's Reflectances) has been launched on board the PARASOL microsatellite in December 2004. Although the PARASOL orbit has been lowered twice (in September 2009 and November 2011) compared to the other platforms of the A-Train constellation, the POLDER observations have furnished innovative retrievals of aerosol properties over a long time period (March 2005-October 2013). In this analysis we focus on POLDER-3 capabilities to derive both aerosol loads (Total AOD) and size properties (fine and coarse spherical/non-spherical components of the AOD, Angström coefficients) over marine surfaces.

In the context of the ChArMEx (the Chemistry-Aerosol Mediterranean Experiment) program, we focus on the Mediterranean basin, a region under the influence of a complex mixture of aerosols from marine and continental sources. Especially we aim to infer the ability of PARASOL to monitor specifically mineral dust exported from arid regions of North Africa, through analysis of the POLDER Non-Spherical Coarse Mode (NSCM) AOD product.

In order to evaluate if the PARASOL derived NSCM AOD product is reliable and fully representative of the mineral dust component, we examine its sensitivity and accuracy in different atmospheric aerosol conditions of the Mediterranean environment. PARASOL NSCM AOD retrievals are compared to coincident aerosol parameters derived from photometer measurements of AERONET Mediterranean sites. Analysis of AOD, Angström coefficients, size distribution and absorption properties derived from AERONET are performed in order to interpret PARASOL NSCM AOD peaks in terms of unambiguous presence of desert dust. Based on the results of this analysis, PARASOL observations will be used to investigate the main characteristics of desert dust events that occurred over the Mediterranean Sea over the period 2005-2013, especially variability in space and time, including frequency of occurrence and intensity of the episodes.

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A DUST LIBRARY OF PLASMONICALLY ENHANCED INFRARED SPECTRA OF INDIVIDUAL RESPIRABLE PARTICLES

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A library of infrared spectra of individual dust particles of about ~4 micron size from a variety of environments will be presented. Dust particles were captured in the holes of a plasmonic metal mesh and investigated with an imaging infrared microscope. This arrangement enables the recording of "scatter-free" infrared absorption spectra of individual particles even though the particles are smaller than the probing wavelengths. Inhalation of dust particles of this size has significant health consequences as these are among the largest inhaled into people's lungs. It is important to understand the optical and chemical nature of the particles that are inhaled from the perspectives of health, meteorology, and environmental science. The dust library includes results from our lab air, a home air filter, the September 11th 2001 World Trade Center event, the International Space Station, and a large sets of calibrant spectra of pure components known to be in dust. The spectra are sensitive to the amounts of various infrared active components and a Mie-Bruggeman model will be described that provides volume fractions of the components from different environments. Finally, a statistical analysis using single value decomposition will be presented which enriches the extraction of data from the dust library.

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EFFECT OF PARTICLE SHAPE AND HETEROGENEITY ON OPTICAL PROPERTIES OF ATMOSPHERIC DUST BASED ON FOCUSED ION BEAM TOMOGRAPHY OF INDIVIDUAL PARTICLES

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The direction of radiative forcing by atmospheric dust, and thus its effect on climate, is highly uncertain. This is related, in part, to the effect on optical properties from the shape and heterogeneity in chemical composition of individual particles. Here, we show how heterogeneity and shape affect light absorption and scattering based on 3-dimensional representations of individual particles acquired by focused ion-beam (FIB) tomography. Two types of dust were studied: Asian dust collected at Mauna Loa Observatory and urban dust from U.S. cities.

In FIB tomography, scanning electron microscopy and energy dispersive X-ray spectrometry combined with ion-beam milling produce electron images and element maps of slices through the particle, which are used to create the particle's 3-D representation. Spatial coordinates of the representation are then used with the discrete dipole approximation method to calculate the particle's absorption, overall scattering, and backscattering efficiencies.

For Asian dust, results showed that the single-scattering albedo (SSA, scattering/total extinction) ranged 0.80 to 0.97 and 0.84 to 0.97 for particles identified as mainly dolomite and calcite, respectively. SSA thus straddled the critical SSA for warming vs. cooling (0.86). SSA variation depended on size, shape, complex refractive index to account for absorbing impurities, and the presence of soot as an adduct. For equivalently-sized geometric shapes (spheres, cubes, and tetrahedra), SSA was almost always lower than the actual-shaped particles.

For urban dust from Los Angeles, SSA for a multi-phase mineral particle was substantially larger (by 19 %) when heterogeneity was not fully considered. For particles that were likely asphalt wear containing a mineral phase (montmorillonite or kaolinite), SSA for spherical core-shell models differed substantially (>10 %) from SSA for the actual particles. For heterogeneous particles from Seattle containing varying amounts of iron oxide, SSA ranged 0.54 to 0.97. SSA increased with particle size when iron oxide was the main component, but decreased when iron oxide was a minor component.

Our results show the importance of understanding the effects of particle shape and heterogeneity when geometric models such as core-shell models are used in determining radiative forcing by atmospheric dust.

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FINE DUST PARTICLE SIZE CONCENTRATION AND DISTRIBUTION DURING MAXIMUM LEVEL ACTIVITY IN A PIGGERY

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In many studies about dust in pig barns, the strong relationship between animal activity and dust concentration was highlighted (Pedersen and Pedersen, 1995; Haeussermann et al., 2008, Takai, 1992, Costa et al., 2009). Airborne particle concentrations within a livestock environment can be influenced by a wide complexity of variables: the type of administered feed (Heber et al, 1988), type of feed processing (Costa et Al., 2007), animal skin and hair, litters, faeces (Mankell et al., 1995), ventilation rate (Wang et al., 2000), air distribution (Maghirang et al., 1994), and the activity level of reared animals (Takai, 1992; Pedersen, 1993, Costa et al., 2008) contribute in a variable proportion to dust in animal buildings, moreover, animal activity induced by external inducements can rise or re-suspend dust particles in animal houses. The aim of this study was to evaluate the contribution of animal activity to dust concentration peaks in a fattening pig room, with particular regard to fine dust (PM_{10} and smaller particles, up to 0.25 μm), alveolar, thoracic and respirable dust. For this purpose, a fattening room with 363 animals with a mean age of 131 d and a mean weight of 72 kg, reared on concrete slatted floor in 16 boxes was used, animals are fed with liquid feeding 3 times a day. The piggery had a ventilation control system (FANCOM) based on a free running impellers (type Fancom FMS), for continuous, real-time monitoring of the ventilation rate. The room was equipped with three chimneys (16200 m^3/h). During the trial, dust was measured through a GRIMM Portable Laser Aerosol Spectrometer Model Mini-LAS 11-R, able to evaluate dust particles ranging from 0.25 μm to 30 μm, in mass and in counts; and to measure alveolar, thoracic and respirable dust continuously.

Measurements, performed at a height of 50 cm, or, at the respiratory apparatus level of pigs, showed that, soon after feed administration corresponding to animal maximum activity level (at visual observation), PM_{10} reached a peak of 1392 μg/m^3, as already described by Costa et al. (2009). The same trend of PM_{10}, with a peak of dust concentration occurring 18 minutes after increased animal activity, was measured for particles with aerodynamic size of $PM_{0.5}$, while smaller particles kept a constant trend with values around 8 μg/m^3. Mean value of inhalable particles was 2668 μg/m^3, 1347 μg/m^3 of thoracic particles, 308 μg/m^3 of alveolar particles. This extremely harmful environmental situation is linked to the extremely dry weather of this period in Italy (November-December 2015) and to the remarkable low relative humidity in the barn (around 32 %).

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FOGO ERUPTION 2014 (CAPE VERDE): AIR QUALITY MONITORING

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Fogo island is located on the south-west of the Cape Verde archipelago, in the Atlantic Ocean, some 800 km west of the Senegal coast, being the fourth biggest island (476 km^2) of the country. The origin of this archipelago is linked to the Cape Verde mantle plume, characterized by strongly alkaline magmas (Davies et al., 1989). Fogo, together with Brava, are the youngest (~5 Ma) and the most active seismic islands of the country (Olehowski et al., 2008). Fogo is also an active stratovolcano with a maximum altitude of 2,829 m above the sea level (Pico do Fogo) an numerous peaks above 2,500 m (Day et al., 1999).

A past giant lateral collapse on the eastern part of the Fogo island created a scar with 60-90º slope angles, with 800-1,000 m high along the western side, forming a continuous curved rock surface with 20 km long (Day et al., 1999), locally called as the Bordeira. Within the Bordeira is located Chã das Caldeiras, a flat plan area, and were the most fertile soils are located and the majority of the Fogo inhabitants live and/or work on agriculture and tourism activities.

The last Fogo eruption between November 2014 and February 2015, after 19 years of inactivity, and the lava expelled destroyed two villages in Chã das Caldeiras, previously evacuated, and covered vast agricultural areas, causing very large economic losses. Even though the eruption caused no direct deaths, large amounts of gases and dusts were expelled to the atmosphere. This region is also affected by the Harmattan winds, responsible for the transport of Sahara <10 μm dusts.

This research work focuses on the air quality monitoring and road dusts collection performed during the last Fogo eruption. Data reveal that all over the island both the PM_{10} and $PM_{2.5}$ concentrations largely exceeded the 24-h daily means stipulated by the World Health Organization (25 $\mu g/m^3$). The scanning electron microscope analysis showed that these particles are mainly composed by silica, sulphur, aluminium, titanium, calcium, potassium, magnesium, iron, chlorine, consistent with the lava mineralogical composition: titanaugite, apatite, ilmenite, pyrrhotite, hematite, among others. A description of the monitoring efforts carried out during the eruption and results of the data collected, will be presented.

This monitoring effort was carried out by a Collaboratory for Geosciences (C4G) team at the request and in collaboration with Instituto Nacional de Meteorologia e Geofísica, Cape Verde, and was made possible by an emergency financial support provided by Fundação para a Ciência e Tecnologia, Portugal.

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SINGLE PARTICLE ANALYSIS OF PLASMA-LINKED ATMOSPHERIC DEBRIS

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At present most studies dealing with the pathways of atmospheric dust are based on routine analyses of proxies and properties from the global population, or from a certain categories. We intend here to further promote the potential of single particle multi-analytical techniques to refine the relevance of dust events traced in present and past environments with respect to the initial atmospheric conditions and the forming processes involved in the production of nano-sized to coarse-sized composite debris from aerosol precursors. These nanostructured composites are the aerosol signatures left at the Earth's surface by lightning, transient heating, shock and radiolysis as fingerprints of storm, volcanism, hypervelocity atmospheric entry and solar activity[1].

The data base of present atmospheric aerosols has been retrieved from (1) short dust events (a few minutes) forming thin aerosol layers (<1 mm) traced for the last two years across a pilot region in South France (Perpignan); (2) local strewn fields of coarse debris following intense lightning episodes; (3) surface materials (soil, water) sampled at the exact spots affected by lightning strikes or lightning ball. The data base of past dust events is based on a selection of Holocene and Pleistocene continental and marine archives showing thin aerosol layers (a few mm thick). We have applied a similar method to two laboratory experiments : (1) production of amorphous hydrogenated carbon a-C:H filaments by Plasma Enhanced Chemical Vapor Deposition (PECVD), using a classical planar radiofrequency (13.56 MHz) reactor in CH_4 atmosphere at room temperature and low pressure (120 Pa)[2]; (2) production of nanostructured polymer composites by electric arcs testing different compounds of carbon-based precursors, mineral powder and water as analogues of atmospheric aerosols.

The single particle multi-analytical procedure comprises the successive stages: (1) gentle disaggregation, water sieving and selection under the binocular microscope of particular components; (2) compositional and structural characterization from micro to nanoscales using scanning electron microscopy with an EDS microprobe (SEM); (3) high resolution composition and nanostructure analysis using transmission electron microscopy (TEM); (4) Raman and infrared spectroscopy; (5) x-ray diffraction (XRD) patterns; (6) thermo-gravimetric analysis; (8) C_{14} dating and carbon isotope analysis.

The comparison of natural situations and laboratory experiments has allowed to define two types of composite debris: (A) nanostructured polymers formed of visco-elastic, well crystallized paraffin, in the form of translucent to colored films and filaments with nano-sized inclusions of metals, minerals and graphitic carbon; (B) brittle brecciated to hard glassy heterogeneous vesicular geopolymers showing the juxtaposition at microscales of nanostructured carbon-based polymorphs (polymers, graphite, diamond, amorphous carbon), nanostructured metal films and dense assemblage of mineral phases with sharp contact showing marked deviation from stoichiometry. The single particle method helps to interpret the type A polymers to have been formed from aerosols consisting of polymer gels and ionized nanoparticles due the interaction of CO_2 emissions by volcanism and/or anthropogenic activity, nanoparticle production, CO_2 and H_2O dissociation by electric arc and dusty plasma polymerization. Their widespread occurrence helps tracking past and present episodes of increased concentrations of atmospheric nano-sized particulate matter with potential risks for human health.

In contrast, the characteristics of the type B geopolymers suggest a formation by high energy processes, particularly transient heating due to lightning in electrically charged debris cloud and strong shock due to high pressure gradient. Their tracking in past archives using the single particle method should help to better understand megadrought episodes with sudden dust spikes which would provide critical clues for preventing their expected occurrence in the future.

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ICELAND - THE LARGEST ARCTIC AND EUROPEAN DESERT

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Iceland is extremely active dust region and with over 44,000 km^2 counts as the largest Arctic and European desert. Frequent dust events, up to 135 dust days annually [1], transport dust particles far distances towards the Arctic and Europe. Satellite MODIS pictures have revealed dust plumes exceeding 1,000 km. The annual dust deposition was calculated as 40.1 million tons yr^{-1}, which places Iceland among the most active dust sources on Earth [2]. About 5.5 - 13.8 million tons is deposited annually over the oceans around Iceland covering wide areas of 370,000 km^2.

Despite the location of Iceland in the high-latitude cold region, half of the annual dust events in the southern part of Iceland took place at sub-zero temperatures or in winter, when dust may be mixed with snow. We observed a "Snow-Dust Storm" in March 2013 when dust was transported over 250 km and consequently deposited on snow in Reykjavik [3]. The snow was nearly black with several mm volcanic dust layer close to the dust source, while a clumping mechanism was found in thin layer of impurities in Reykjavik. This has been the first observation of such mechanism in natural conditions.

Icelandic dust consists of fine reactive volcanic materials. It is dark in color and it contains sharp-tipped shards, often with bubbles. About 75 - 80 % of the material is a volcanic glass. However, extreme dust storms in Iceland transport also large proportion of organic material or diatoms. We conducted several experiments during winter campaigns investigating changes in albedo, bidirectional reflectance factor and other snow properties monitored on the clean snow and areas affected by the dust deposition through the following melting period. These experiments also included black carbon (BC) observations revealing that volcanic dust has similar effects on snow albedo as BC. This suggests that the Icelandic dust may both directly and indirectly act as a positive climate forcing agent and the dust may be a contributor to the Arctic warming.

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FLAME RETARDANT IN INDOOR DUST – MANY COMPOUNDS AND QUESTIONS ON MIXTURE TOXICITY

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Worldwide, people tend to spend more time indoors, make more frequent use of electronic equipment such as computers, and live in better insulated houses. Flame retardants (FRs) are used to delay combustion. They are used in relatively high quantities (percentages) in all sorts of materials. They can be released from electrical and electronical equipment and furniture through evaporation (off-gassing) or by wear and tear (small particles breaking off from foam, textile fibers, etc.). Due to their persistence, brominated (B) FRs have been found all over the world, as many of those are persistent and bioaccumulating and easily transported by air and particles. Recently, the discussion on exposure of humans to FRs has, however, got a different character. Instead of dietary exposure, e.g. through fish or milk consumption, exposure through uptake via inhalation, dermal uptake or hand-mouth contact, the latter especially for young children, became a central theme. In addition to the BFRs, also phosphorus-based FRs (PFRs) have been found. These are much less bioaccumulating and less persistent but are present indoors. There are many examples of combined applications of various FRs in the same product, often with one or more synergists. The 'Future Market Insights' industry analysis report 2014-2020 confirms that flame retardants markets will continue to grow, particularly in the Asia-Pacific region, driven by growth in the construction and automotive industries, and by regulations on fire standards. All FRs have their own characteristics and toxicity, which makes their analysis, evaluation and risk assessment rather complex. The list of FRs identified in indoor air and dust, in homes, school, offices and hotels, but also in cars and airplanes is long and growing. Among many examples, Ballesteros-Gómez identified tris(2,4,6-tribromophenoxy) 1,3,5-triazine (TTBP-TAZ) in plastic electronic products and house dust, showing that also new BFRs are still entering the market. We developed a screening method based on solvent extraction followed by liquid chromatography coupled to high resolution MS-TOF with different ionization sources and with direct probe MS analysis. A variety of flame retardants were found in many of the samples together with impurities and degradation products. The predicted values of toxicity and persistence of the compounds were calculated with the in silico software Toxtree. The perpetual problem of using chemicals without testing them properly is valid more than ever here. Although analytical instrumentation now enables very sensitive detection at the picogram level, the presence of so many FRs on top of many other compounds is clearly of concern with regard to possible human health effects. Not only the toxicity of individual FRs needs to be addressed, but also mixture effects of FRs and multiple other chemicals present indoors such as plasticizers and components in waxes, and metabolites. This is a huge task and will require collaboration by scientists, authorities and manufacturers.

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THE FLUX OF SAHARAN DUST TO PANAMA AND ITS INFLUENCE ON SOIL GEOCHEMISTRY

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The long-range transport of Saharan dust to South America, the Caribbean Basin, and even the southern United States has been demonstrated by both remotely sensed satellite data and direct measurements. The importance of this dust deposition on the geochemistry of soils in the Amazon Basin and Caribbean Islands, such as Puerto Rico and Barbados, has been clearly documented. In this work, we use Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) data and deposition models developed by in 2015 by Yu and others[1] and African dust geochemical data [2,3] to calculate the influx of both major and trace elements to the landscape in Panama. These deposition values are compared to our own soil geochemical data collected from soil pits in the Chagres River watershed of central Panama. The contribution of Saharan dust to soil chemistry was less than 0.5% of the total elemental concentrations found in the surficial soil samples, with K and P the highest at ~0.15%. Results are consistent with mass balances comparing the geochemistry of the dust to that of the local bedrock, which verified this indistinguishable contribution of dust to the chemistry of the soils. Unlike the other locations in the Caribbean Basin, it appears that the input of Saharan dust is not a major contributor of major or trace elements to the Panamanian soils, but could be significant in terms of continual inputs of P that aid in rainforest productivity.

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INNOVATIVE MESUREMENTS WITH A PORTABLE DEVICE FOR WIDE RANGE AEROSOL SIZE DISTRIBUTIONS

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A measurement of particle size distributions for Nano particles and particles in the µ-meter size range generally requires a combination of separated devices as Scanning Mobility Particle Sizers (SMPS) and Optical Particle Counters (OPC) or aerodynamic particle sizers (APS). The GRIMM Company developed a new compact and portable device that consists of an optical and electrical sensor in one device. It allows a wide range of particle size detection between 10 nm and 25 µm with 40 size channels with a time resolution of one complete scan of only 1 minute. Thus, very short-lived as well as highly time-varying particle sources can be examined. Figure 1 shows the MINI-WRAS device.

Figure 1: Grimm MINI-WRAS

The optical module is a newly designed particle spectrometer, which detects each individual particle and classifies its size accordingly (single particle counting).

A powerful laser diode is used as a light source. An internal monitor diode monitors the power of the laser diode and keeps it constant. A pin diode generates the detection signal, which turned out to be the best compromise between reliability and performance. The number of particles is determined by the number of stray light pulses per period, the particle size determines the amplitude of the scattered light. These measurements require a precisely controlled flow rate, which is determined continuously via aperture and pressure sensors.

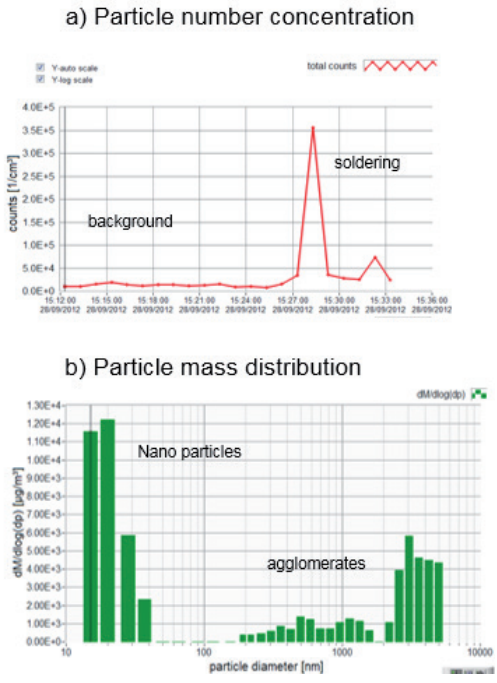

Figure 2: Measurements at workplaces with soldering a) total particle number concentration, b) particle mass distribution

The electrical module consists of three main components, the unipolar corona charger, a precipitation electrode and a Faraday Cup Electrometer (FCE). Once the aerosol particles (each single particle) are counted by the optical sensor and classified, they go through a short tube connected directly to the electrical sensor. Here all Nanoparticles can be reliably detected. Initially the particles are charged unipolar (positively) in the electric sensor with a corona charge. Then the particles go into a collecting electrode, where they are separated according to their electrical mobility. A portion of the aerosol stream passes through the collecting electrode and is recorded in the Faraday Cup Electrometer (FCE). Based on the current measured at the FCE, the volume flow, the geometry of the sensor and the charge efficiency of the particles, the size of the particles can be determined. The electrical sensor offers the possibility to determine the number of particles of a size distribution of particles similar to the optical sensor: A change of the electrode voltage in 10 steps classifies the particle size between 10 nm to approximately 200 nm in 10 classes.

The measured values of the two sensors are combined internally by a special electronics and firmware, such that the user receives measurements, which do not differ from the output of a single sensor in the nature and structure.

Measurement results for different applications (work-place, traffic, industry) will be presented.

Keywords: Aerosol instruments, Nano particles, Particle size distributions, Work place measurements.

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MARINE SEDIMENT RECORDS AS INDICATOR FOR THE CHANGES IN HOLOCENE SAHARAN LANDSCAPE: SIMULATING THE DUST CYCLE

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Marine sediment records reveal an abrupt and strong increase in dust deposition in the North Atlantic at the end of the African Humid Period about 4.9 ka to 5.5 ka ago (deMenocal et al., 2000; McGee et al., 2013). The change in dust flux has been attributed to varying Saharan land surface cover. Alternatively, the enhanced dust accumulation is linked to enhanced surface winds and a consequent intensification of coastal upwelling.

We present simulation results from a recent sensitivity study, where we demonstrate for the first time the direct link between dust accumulation in marine cores and changes in Saharan land surface during the Holocene. We have simulated timeslices for mid-Holocene (6 ka BP) and pre-industrial (1850 AD) dust cycle as a function of Saharan land surface cover and atmosphere-ocean conditions using the coupled atmosphere-aerosol model ECHAM6.1-HAM2.1. We prescribe mid-Holocene vegetation cover based on a vegetation reconstruction from pollen data (Hoelzmann et al., 1998) and mid-Holocene lake surface area is determined using a water routing and storage model (Tegen et al., 2002).

In agreement with data from marine sediment cores, our simulations show that mid-Holocene dust deposition fluxes in the North Atlantic were two to three times lower compared with pre-industrial fluxes. We identify Saharan land surface characteristics to be the main control on dust transport from North Africa to the North Atlantic. We conclude that the variation in dust accumulation in marine cores is likely related to a transition of the Saharan landscape during the Holocene and not due to changes in atmospheric or ocean conditions alone.

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THE SEPTEMBER EXTREME DUST DOWNFALL OVER THE EAST MEDITERRANEAN- A CEILOMETER STUDY

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On Septem ber 7th 2015, an unprecedented huge dust plume approached the southeast Mediterranean basin from northeast. According to the Israeli meteorological service it is the first time in 75 years of measurements, that a dust storm reached Israel in the beginning of September and lasts for a week producing dust concentrations of 1700μg/m^3 - 100 times over the average values. Dust storms are normally monitored in the east Mediterranean using satellites and ground based apparatus. Both methods cannot provide data on the vertical scale of the dust plume evolution. Fortunately, high-resolution micro LIDAR ceilometer network is gradually being established in Israel, providing this crucial information for the first time. The ceilometers, available both inland and on the sea shore enabled us to investigate the high altitude of 1000m dust penetration, sinking into the 250-500m mixed layer and finally the gradual 3D dissipation. In contradiction to conventional understanding of gradual descend of the dust, the ceilometers measurements show vertical fluctuation during the entire dust event ending with an ascent up to 2,000m at the end of the event. Furthermore, the ceilometers revealed the dust event duration was 7 days, compared to the 3-4 days defined by the low resolution models and partial information gathered in the ground particle monitors and radiosondes. The complementing picture gained by the various ceilometers, ground detectors, satellites and radiosondes will be presented. The dust spread, down fall and ascent in presence of the clear and cloudy mixing layer, typical to the various ceilometer sites will be emphasized. The similarity and differences between this event and the spring 2014 Saharan dust event monitored in Israel by these ceilometers and realized by the models will be discussed.

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MINERALOGICAL AND PHYSICAL INTERRELATIONSHIPS OF AIRBORNE MINERAL DUSTS CONTROLLING THEIR OPTICAL PROPERTIES

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The purpose of the project was to provide information on the mineralogical, chemical and physical interrelationships of about re-suspended mineral dust samples collected as grab samples from previously known global dust sources. Surface soil samples were collected from about 65 desert sites, including the southwestern USA (12), Mali (3), Chad (3), Morocco (1), Canary Islands (8), Cape Verde (1), Djibouti (1), Afghanistan (3), Iraq (6), Kuwait (5), Qatar (1), UAE (1), Serbia (3), China (5), Namibia (3), Botswana (4), Australia (3), and Chile (1).

The < 38 μm sieved fraction of each sample was re-suspended in an entrainment chamber, from which the airborne mineral dust could be monitored, sampled and analyzed. Instruments integrated into the entrainment facility included two PM_{10} and two $PM_{2.5}$ filter samplers, a beta attenuation gauge for the continuous measurement of PM_{10} and $PM_{2.5}$ particulate mass fractions, an aerodynamic particle size (APS) analyzer, and a three wavelength (405, 532, 781nm) photoacoustic resonator with integrating reciprocal nephelometer for monitoring absorption and scattering coefficients during the dust re-suspension process. Filter sample media included Teflon® membrane and quartz fiber filters for chemical analysis (71 species), and Nuclepore® filters for individual particle analysis by Scanning Electron Microscopy (SEM). The < 38 μm sieved fractions were also analyzed by X-ray diffraction for their mineral content while the > 38 μm, < 125 μm soil fractions were mineralogically characterized by optical microscopy. Particle size distributions were also performed on the < 600 μm sieved size fractions.

We will be presenting results on the optical measurements, also showing the relationship between single scattering albedo (SSA) at three different wavelengths, and chemical as well as mineralogical content and interdependencies of the entrained dust samples. Examples showing the relationships between the single scattering albedos of airborne dusts, and iron (Fe) in hematite, goethite, and clay minerals (montmorillonite, illite, palygorskite), will be discussed. The importance of iron bearing clay minerals as particle coatings, and individual iron oxides will be demonstrated.

Our goal is to release the experimental data of the optical, mineralogical, and chemical properties of dust samples collected at the multiple dust sources. These data can be applied in climate modeling, remote sensing, visibility, health (medical geology), ocean fertilization, and damage to equipment.

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QUANTIFYING DUST SOURCES IN FIVE COUNTRIES OF THE MIDDLE EAST

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Data mining of chemical results from the analysis of aerosol samples collected in 2005-2007 on Teflon® and quartz fibre filters, provided quantitative information on airborne dust and other air pollutants impacting on military sites in Djibouti, Afghanistan, UAE, Qatar and Kuwait [1]. The goal of the project was to provide chemical, mineralogical and morphological information on the dust and other air pollutants, which potentially impact on the health of US personnel deployed in the Middle East. Chemical analyses were performed on aerosol samples collected on filters at each of nine sites in five countries in the course of about one year. Statistical procedures applied to the chemical results for this component of the study include the calculation of correlation coefficients, Principal Components Analysis (PCA), and Positive Matrix Factorization (PMF) receptor modelling [2, 3]. From correlation matrices calculated on chemical results from Teflon® filters, *soil*, *salt* and *oil combustion* sources, and from correlation matrices calculated on chemical results from quartz fibre filters*, halite*, *carbonates*, *evaporites*, *phosphates*, *vegetative burn*, as well as *secondary ammonium sulfate and nitrate* were provisionally identified. Principal Components Analysis (PCA) is a multivariate statistical procedure which simultaneously considers all the chemical species and concentrations in the data set. In this study the chemical species were grouped into three to five Principal Components (PC's). This procedure was useful in identifying sources that fluctuate in their contributions, such as dust storms, and remote point sources intermittently impacting on a sampling site. PC's representing pollution sources with variable impact at each of the sampling sites, for the Teflon® filter set are *marine salt*, *soil dust*, *oil combustion*, *metals smelting*, and *secondary ammonium sulfate*, and for the quartz fibre data set are *marine salt*, *calcic soil*, *phosphate soil*, *combustion sources*, *vegetative burn*, *evaporites*, and *secondary ammonium sulphate and nitrate*. Positive Matrix Factorization (PMF) is a factorization technique by which the scores and loadings are constrained to non-negative values. The PMF factors provide signatures of source types (source profiles), i.e. they provide modelled assessments of the chemical compositions of pollution sources impacting on the sampling sites. PMF loadings furthermore provide assessments of the contributions (attributions) of modelled sources to individual samples PMF was applied to identify components of dust and other pollutants, and to assess their contributions at each of the nine sampling sites in five countries. Modelled PMF factors were labelled according to the major chemical species they contain, implying each represents the chemical composition (source profile) of a natural or anthropogenic pollution source. For Teflon these PMF factors were labelled as *Dust-Siliceous, Dust-Calcic, Dust Evaporite, Marine Salt and Sulfate/Pb/Zn*, while for quartz fibre data they were labelled *Dust-Calcic, Dust-Evaporite, Combustion Cement, Combustion Powerplant, Combustion Vegetative, Marine Salt, and secondary ammonium sulfate.* The PMF loadings varied by site, size fraction (TSP, PM_{10}, or $PM_{2.5}$) and season. Examples of typical PMF attribution results will be presented.

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THE EFFECT OF DUST LIFTING PROCESS ON THE ELECTRICAL PROPERTIES OF THE ATMOSPHERE

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Airborne dust and aerosol particles affect climate by absorbing and scattering thermal and solar radiation and acting as condensation nuclei for the formation of clouds. For this reason, they strongly influence the thermal structure, balance and circulation of the atmosphere. On Earth and Mars, this 'climate forcing' is one of the most uncertain processes in climate change predictions ([1], [2], [3]). Moreover, wind-driven movement of sand and dust largely contributes to the reshaping of planetary surfaces through processes like the erosion of rocks, the formation of sand dunes and ripples, and the creation and transport of soil particles. These processes are not confined to Earth, but also occur, for example, on Mars, Venus and Titan.

The knowledge of the atmospheric dust properties and of the mechanisms for dust settling and lifting into the atmosphere is important to understand planetary climate and surface evolution.

On Mars the physical processes responsible for dust injection into the atmosphere are still poorly understood, but they likely involve saltation as on Earth. Saltation [4] is a process where large sand grains are forced by the wind to move in ballistic trajectories on the soil surface. During these hops they hit dust particles, that are well bound to the soil due to interparticle cohesive forces, thus transferring to them the required momentum to be entrained into the atmosphere ([5], [6]).

It is known that this process is capable of generating strong electric fields in the atmosphere up to 100-150 kV/m [7]. This enhanced electric force acts as a feedback in the dust lifting process, lowering the threshold of the wind friction velocity (u*) required to initiate sand saltation ([8], [9]). The effect of the electric field is an important aspect of dust lifting process that needs to be well characterized and modelled. Although the literature reports several measurements of E-fields during dust devils events, there is only a limited number of measurements of atmospheric electric properties during dust storms or isolated gusts.

To solve some of the issues raised above we carried out a series of field campaigns in South-eastern Morocco during the 2013 and 2014 dust storm seasons. Here we show for the first time that, depending on relative humidity conditions, electric fields contribute to increase the amount of particles emitted into the atmosphere. This means that electrical forces and humidity are critical quantities in dust emission process and should be taken into account in climate and circulation models to obtain a more realistic estimation of dust load in the atmosphere.

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AN OVERVIEW OF RST-ASH PERFORMANCE IN DETECTING AND TRACKING ASH CLOUDS FROM SPACE USING POLAR AND GEOSTATIONARY SATELLITE DATA

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RST-ASH [1-2] is an algorithm developed for detecting and tracking volcanic ash clouds from space based on the Robust Satellite Technique (RST) multi-temporal approach [3-4]. The algorithm uses two local variation index in combination to identify ash plumes. The first one, which is the most sensitive to ash, investigates the Brightness Temperature Difference (BTD) of the signal measured at around 11 μm (T11) and 12 μm (T12) wavelengths. The second one analyses the spectral difference T3-T11, where T3 is the brightness temperature measured in the Medium Infrared region (MIR) at around 3.5 μm, to increase the confidence level of detection both in night-time and daylight conditions. Moreover, an optimized RST-ASH configuration analysing signal measured in the visible band of the Spinning Enhanced Visible and Infrared Imager (SEVIRI) data has recently been tested with good results to increase discrimination capabilities of ash from meteorological clouds on daytime data [5]. In this study, we present an overview of the RST-ASH performance in detecting and tracking ash clouds using polar and geostationary satellite data. Results achieved studying some recent ash events from different volcanoes like Mt. Etna (Italy), Eyjafjallajökull and Grímsvötn (Iceland) are analysed and discussed, assessing advantages arising from the use of RST-ASH in comparison with other established methods of ash detection. Furthermore, the capacity of the algorithm in correctly detecting ash affected areas as a starting point to characterize volcanic eruptions from a quantitative point of view [6] is investigated. The work shows that in spite of some limitations in terms of sensitivity/reliability, RST-ASH may represent a suitable tool for detecting and tracking ash plumes in different environmental/observational conditions. These results encourage the implementation of RST-ASH within integrated monitoring systems aiming at better supporting activities devoted to mitigate impact of volcanic eruptions on air traffic.

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MACROMOLECULAR ICE NUCLEI OF BIOLOGICAL ORIGIN AND THEIR POSSIBLE ATMOSPHERIC RELEVANCE

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Heterogeneous ice nucleation, a process where ice nucleation is triggered by foreign particles or molecules, so called ice nuclei, plays an important role in the microphysics of clouds. Ice clouds exhibit inherently different properties when it comes to interactions with radiation, if compared to clouds consisting of liquid droplets. Therefore these clouds influence the total albedo of the Earth. This renders heterogeneous ice nucleation in clouds a process of climate relevance.

Mineral dusts have long been thought to play the major role in the underlying processes of atmospheric ice nucleation. Biological particles often show higher freezing temperatures, but tend to be rather large and therefore have a fast sinking velocity in the atmosphere. Consequently, it should be unlikely to find such particles at relevant altitudes and therefore their role in the atmosphere was only poorly examined so far. However recent field studies found diverse biological material at altitudes of 8 km and higher [1]. In this context, our working group has shown that the IN of certain pollen can be washed off and are therefore macromolecular rather than particulate [2]. Those molecules can form much smaller particles or get attached to other particles and reach much higher altitudes than e.g. the pollen itself. Furthermore, Huffman et al. [3] showed an extreme increase of IN over woodlands during and after rain events, whereby they were able to link these IN to fluorescing biological particles. This leads to the conclusion that the relevance of biological IN might has been highly underrated in the past.

In general, cold temperatures cause stress to plants. This is particularly true for the vegetation at the Northern Timberline. Here plants experience night frost even during warm seasons. Therefore those plants had to develop coping mechanisms to prevent frost damages inside their cells. This leads to special interaction mechanisms between plants and water, making them highly interesting for our research. We examined various plant materials originating from the Northern Timberline, concentrating for the most part on berries and pollen. Hereby we mostly worked with extracts and juices without visible particulate content. Therefore it is safe to assume that the regarded ice nuclei are either macromolecular or nanoparticles. Additionally, selected samples have been chemically aged in the laboratory and then again examined in regards of ice nucleation activity, which gives a closer proximity to atmospheric processes. Our results show how far the range of ice nucleation active plant samples is. Further they indicate that at least some of the plants show close relations in the chemical nature of their expressed ice nuclei.

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SINGLE GRAIN AND STATISTICAL APPROACHES TO LOESS PROVENANCE – A CASE STUDY FROM BEIGUOYUAN, NW CHINESE LOESS PLATEAU

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Understanding of both the influence and response of dust in past climate is currently limited. Detailed investigation of past dust emission and transport through geological dust archives is central to resolving this. The Chinese Loess Plateau is the largest (over 440,000km^2), most detailed and important terrestrial aeolian archive. In places, the sequence stretches potentially as far back as 40 Ma; providing an extraordinary record of Asia's long-term climate. However, a lack of consensus over its specific sediment sources prevents understanding of the controls on past dust emission, determination of transport pathways, and interpretation of preserved proxies. Recent developments in single grain techniques, especially U-Pb zircon dating, have brought a new perspective to the provenance debate. The continued research has challenged a commonly accepted view that the Northern deserts are the Loess Plateau's source. Instead, the Northern Tibetan Plateau has been highlighted as the main source, with potentially a main role played by the Yellow River in the sediment delivery and distribution. However, many datasets are still limited by relatively few analyses and provenance variability within individual units (i.e. on a millennial scale), recorded across multiple proxies has not been examined. Commonly one or two samples are taken from extensive sedimentary units and accepted as representative of that unit, often with few grain analyses. Consequently, a statistically significant representation of the zircon U-Pb ages from a unit is not often achieved, and the extent to which samples from a particular unit represent the true variability of zircon ages through that unit is unclear. In an attempt to address this, this we here use the U-Pb dating technique applied to detrital zircons in combination with a novel use of Raman analysis of detrital garnets. We aim to both gain a better statistical representatively by using this data in combination with published data, and to assess differences between and within individual units at the loess sequence at Beiguoyuan. We note potentially significant changes in dust provenance within units and between sites, suggesting some variability in source. We discuss whether these indicate fundamentally different source areas or rather changing proportions of sediment delivery from the same sources.

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STIRRING UP HOUSE DUST: A REVIEW OF RECENT EXPERIMENTAL STUDIES ON HUMAN-INDUCED PARTICLE RESUSPENSION FROM FLOORING, CLOTHING, AND UPHOLSTERY

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In the indoor environment, particle resuspension is associated with human activities that induce a disturbance of settled dust. Such activities include walking, the crawling motion of an infant, disturbance of clothing and other fabrics, and movements on mattresses and other furniture. Human-induced resuspension is an important source of inhalable particles (< 10 μm in aerodynamic diameter) in buildings and is the mechanism by which biological material, including human- and animal-associated bacteria, fungal spores and their fragments, pollen grains, and dust mite and animal allergens, and particle-bound chemical contaminants, such as semi-volatile organic compounds (SVOCs), can be released from house dust to the air.

Past and ongoing experimental small- and large-scale chamber studies with human volunteers and mechanically-actuated systems (mechanical foot and simplified robotic crawling infant) have provided a means to mechanistically evaluate human-induced particle resuspension and to elucidate influencing factors (e.g. impact of relative humidity, flooring type, movement intensity). This presentation will provide a summary of recent experimental work on particle resuspension from flooring, clothing, and upholstery due to different types of human movements. We will introduce chamber methods, aerosol sampling techniques, and the application of material balance models to quantify resuspension and associated inhalation exposures. Resuspension rates and fractions from the various studies will be analyzed to understand the relative contributions of human-induced resuspension from different indoor surfaces to airborne particle concentrations. Future directions on indoor particle resuspension will also be discussed, including the use of laser-induced fluorescence (LIF)-based aerosol measurement techniques and quantitative PCR (qPCR) to study the resuspension of biological particles, as well as surface dust collection techniques for estimating the size-resolved surface concentrations of settled particles on indoor surfaces.

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THE IMPORTANCE OF SYNOPTIC-SCALE STORMS FOR DESERT-DUST EMISSION IN NORTH AFRICA

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Desert-dust dominates the aerosol burden by mass and has a multitude of effects in the Earth system, but state-of-the-art aerosol-climate models show large uncertainty in the emitted dust amount. Model diversity is partly associated with the shortage of observations of dust emission amounts for constraining and validating models. An alternative approach is to evaluate the meteorological processes that drive dust-emitting winds. The representation of near-surface wind is important since dust emission depends on the wind speed cubed after a soil-dependent threshold in wind speed is exceeded. Different meteorological processes are known to generate dust-emitting winds, but their relevance from a climatological perspective remains poorly understood.

The present work addresses synoptic-scale dust storms over North Africa, the most active dust source on Earth. The first climatological estimate of the dust-emission mass associated with Harmattan surges (HSs) is presented (Fiedler et al., 2015a). HSs manifest themselves as post-frontal strengthening of winds, which can activate dust sources in entire North Africa. HSs drive strong isallobaric winds near the surface that are used as an indicator of HSs for their automated identification. The detection algorithm is applied to ERA-Interim re-analysis for 1979-2010. Identified HSs are combined with derived dust emission to estimate their relative importance. The results highlight that HSs are associated with roughly one third of the emission mass in the annual mean, which is an order of magnitude larger than amounts associated with mobile cyclones alone (Fiedler et al., 2014). During spring, HSs are frequent and long-lived so that they can be associated with 30-50% to the monthly total emission. Spring has the overall largest total emission. Up to 80% of the total spring emission can be associated with HSs in northern regions. The importance of HSs for dust emission implies that aerosol-climate models need to accurately represent synoptic-scale storms. However, storm tracks and their change with climate have been uncertain in the last climate model inter-comparison project phase five (IPCC, 2013), underlining the need for further process-based evaluations of climate models (e.g., Fiedler et al., 2015b). Such knowledge would help to prioritize further needs in model development to reduce uncertainty.

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AEROSOL CHEMICAL COMPOSITION OF ASIAN DUST AT TAJIKISTAN

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The chemical composition of Asian dust at Dushanbe (Tajikistan) was characterized during the Central Asian Dust Experiment (CADEX). Aerosol samples were collected using a high volume DIGITEL DHA-80 sampler on quartz fiber filters in a 48 h sampling routine during the period of March to June 2015. The filters were analyzed for inorganic ions, trace metals as well as organic and elemental carbon (OC/EC).

The aerosol mass showed strong variation with aerosol mass concentration ranging from 20 µg/m³ to 110 µg/m³. The dust concentrations varied from 3 µg/m³ to 77 µg/m³. Days of high aerosol mass loadings were dominated with mineral dust which made about 80% of the aerosol mass while organic matter and inorganic ions made up about 70% of the aerosol mass during days of low aerosol mass loadings. The mineral dust composition showed different trace metal signatures in comparison to Saharan dust with higher Ca content and Ca/Fe ratios twice as high as that observed in Saharan dust. Strong influence of anthropogenic activities was observed in the trace metal concentrations with significantly high Zn and Pb concentrations ranging from 29 to 792 ng/m^3 and of 8 to 78 ng/m^3, respectively. The trace metals originated from combustion sources as well as metallurgical industrial emissions.

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DUST DRIFT DURING SEED DRILLING – OUTPUT OF A 4 YEAR STUDY

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Bee killing incidents observed in several countries placed a spotlight on a new pathway trough which pesticides could get in the environment and cause problems: the emission of pesticide laden dust particles during drilling operations. In 2011, we started to look at this relatively new phenomenon and the risks related to it in perspective to current agricultural practices in Flanders. To achieve this objective, an integrated experimental and modelling approach was used. The data and models resulting from this 4 year study could be helpful for risk assessments in other countries as well or to better understand the dust drift phenomenon in general. Some of the first results were already shown at previous conferences. An update will be given during the 2016 edition.

As a result of the selected CFD modelling approach, a lot of information about the physical and chemical properties of abraded pesticide-coated seed particles was needed and gathered. In some cases, results of different measuring techniques were combined to get more detailed information. To assess the dust drift potential of treated seed available in Belgium, several batches from different species were tested of which the Heubach method one of the most commonly used. The physical properties of dust particles were useful to interpret differences between seed species or between sowing techniques.

The geometry of each sowing machine and tractor used was measured-up and redrawn in a simplified in a 3D-mechanical CAD program (SolidWorks). The shape of specific machine-tractor-combinations was implemented in the Computational Fluid Dynamics models (CFD-models) in an adequately simplified way. Simplification was part of the validation process. The ultimate goal of the modelling approach was to develop a simulation model capable of predicting the effect of environmental parameters and of the seed drill design and settings on dust drift in field conditions. Validation of the CFD-models developed was done in a step-by-step way, based on experimental data gathered. First information gathered by the JKI (Julius Kühn-Institut, DE) in their wind tunnel setup was used to validate the mass transport model based on the outcome of the experimental setup and the particle properties. The airflow around a stationary operated machine was measured indoor using 1D (at the in- and outlets) and 3D (in a 3D grid around the machines and near the air flow channels)anemometers. The airflows predicted by the model were compared to the ones observed in practice. The dispersion and/or deposition patterns of abraded particles around statically operated seed drills was studied, both in an indoor set up an in the field. In case of the indoor experiments, the air flow pattern is shaped by the stationary operated seed drills only. In the field, the wind speed dominated over the airflow patterns observed. This data could be used to further optimize the model. Finally, the CFD approach was used to estimate the emission during drilling. In future, the output of the model should be compared to field-data gathered during drilling as a final step of the validation process.

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ASSESSMENT OF THE MINERAL DUST RELATED REDUCTION OF PHOTOVOLTAIC POWER GENERATION IN CENTRAL EUROPE WITH COSMO-ART AND ICON-ART

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At the beginning of April 2014 a mineral dust event was observed over Germany. Due to the meteorological situation the dust was transported from the source region Sahara to central Europe. At the German Weather Service (DWD), additionally to the standard model chain, the model system COSMO-ART [1,2] ("Aerosols and Reactive Trace gases") was used to forecast the dust load and to investigate the impact of the dust particles on radiation and cloud coverage. Both parameters are important variables concerning the yield of solar energy. In addition to the operational setup, COSMO-ART describes online the temporal development of mineral dust particles and their feedback on radiation and cloud formation. Every 24 hours a simulation was started where for the initialization of the dust the concentrations from the previous run were used. Furthermore these dust concentrations served as boundary data for the high resolution target domain covering France and Germany where the two-moment scheme of Seifert and Beheng [3] was activated instead of the standard bulk scheme that is usually used in COSMO for the operational weather forecast. Sensitivity runs were carried out to study the impact of the dust particles on the state of the atmosphere and to analyze if the consideration of the actual dust load instead of climatological values leads to an improvement of the weather forecast during such situations. It can be shown, that the dust load lead to an increase of the ice crystal density and caused a decrease of the global radiation in southern Germany by more than 100 Wm^{-2}. This shows the great importance of including dynamic mineral dust for the forecast of photovoltaic energy yield.

As a consequence of the findings of the previous investigation and an expressed strong interest of our industrial partners issuing solar power forecasts DWD initiated a research project named PerduS ("Photovoltaik Ertragsreduktion durch Saharastaub") which is due to start in March 2016. The core component of PerduS will be the mineral dust forecast of the new global online-coupled modelling system ICON-ART [4,5]. In the course of the project, system components which are required for a reliable power forecast will be evaluated, developed further and coupled to form an operational integrated forecast system at DWD. KIT as project partner and original developer of the ART modules focuses its efforts on the extensions to ICON-ART which are of particular relevance for its application in the context of solar power forecasting, e.g. including the parameterization of the pollution of photovoltaic plants. The industrial project partner Meteocontrol adjusts its solar power forecasting system to the specific products provided by the dispersion model simulations.

The results of study of the April 2014 event as well as the basic concepts of PerduS will be presented.

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A METHODOLOGICAL FRAMEWORK FOR VALIDATION OF PARTICULATE MATTER DISPERSION MODELLING BASED ON LICHEN BIOACCUMULATION DATA

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Atmospheric dispersion models are frequently used as a management tool to estimate transport, transformation and deposition of atmospheric pollutants. Beside algorithmic features, model reliability depends on the quality of input emission data and meteorological fields, completeness of chemical kinetics modules, proper calibration of gas/particle interactions and wet and dry depositions, and topography [1]. The issue of modelling validation is receiving increasing attention and, consequently, research efforts are required in order to assess the accuracy of air pollutant dispersion simulations. Model predictions are traditionally compared to relatively expensive and spatially coarse ground-based observations from air-quality monitoring networks [2]. On the other hand, previous suggestions of validation by low-cost, high-spatial resolution and time-integrated bioaccumulation data [3], have not yet been implemented in large, environmentally complex area. Lichens are widely used bioaccumulators, often exploited as an effective tool for air pollution impact assessment and monitoring.

In this study, we tested two particulate matter (PM) dispersion simulations run by SPRY and CALPUFF models for two reference time periods: (*i*) the whole year 2005, selected as representative of the local average meteorological conditions; (*ii*) the six-month period preceding the collection of two native lichens and corresponding to the maximum age of the collected material. The content of 17 elements was assessed by ICP-mass and AA- spectrometry in 80 lichen samples collected at 40 sites distributed according to a systematic design over a 176 km^2 area, highly heterogeneous in terms of soil types, land use classes and with a remarkable climatic seasonality.

PM concentrations predicted for (*ii*), but not for (*i*) were correlated to bioaccumulation data, confirming that the reference period is a key controlling factor for reliable modelling of air pollution dispersion. Element content at the sampling sites largely differed according to soil type and lichen species (*Flavoparmelia caperata* and *Xanthoria parietina*, 54 and 26 samples, respectively). In *X. parietina*, the effect of soil particle resuspension, decoupled from that of airborne depositions using Al content in soil samples [4], could not be excluded. Conversely, the content of Cr, V and Pb in *F. caperata* was associated with PM concentrations simulated for the six-month period and georeferenced at the sampling sites. In particular, airborne Cr in lichen samples showed a unimodal pattern along the main wind direction at increasing distance from a major emission source, congruent with PM concentrations predicted by the modelling simulation. Besides the evidence that Cr is emitted by industrial processes related to the source, observations of element content in PM collected by passive samplers around the source consistently confirmed a significant higher Cr content in operating compared to non-operating periods.

In conclusion, our study provides a solid methodological framework for validation of dispersion model simulations, particularly suitable in case of heterogeneous areas and when PM concentrations are largely below the regulation limits.

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IMPACT OF SAHARAN DUST ON PARTICULATE MATTER LEVELS IN PORTUGAL

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Mineral dust from deserts contributes largely to the content of tropospheric aerosols and impacts air quality in several regions across the globe. Every year, eroded mineral soils are carried from the North Africa arid regions to the Mediterranean countries, including Portugal. The main objective of this work is to assess the impact of the long-range transport of desert dust over Portugal, studying both a long–term period (one year) and the most important transport episodes.

The influence of African dust outbreaks in the PM levels is quantified using mineral dust concentrations simulated by two atmospheric modelling systems, NMMB/BSC-Dust [1] and WRF-CHIMERE [2]. Simulations from the NMMB/BSC-Dust include the regional domain covering North Africa, the Middle East and Europe, with a resolution set to 1/3° in the horizontal and to 40 σ-layers in the vertical. WRF-CHIMERE was run for three nested domains, using the same configuration as used in the Portuguese operational air quality forecast system: the coarse domain, covering Southern Europe and Sahara Desert with a horizontal resolution of 125x125 km^2; a second domain covering Iberian Peninsula with 25x25 km^2 of horizontal resolution; and the last high-resolution domain covering mainland Portugal, with 5x5 km^2. The year in analysis is 2012.

Surface data from the national air quality measurement network is used in this study to characterize particulate matter (PM) levels in Portugal. Simulated dust concentrations are compared with PM measurements from the rural background sites (which reflect also non-dust aerosols) and models performance is discussed. In addition, AERONET direct-sun observations are also used to complement the validation exercise and to identify and/or select dust episodes. Preliminary results confirm that dust is an abundant type of natural atmospheric aerosol in the planetary boundary layer in Portugal. Moreover, both models are able to simulate the observed mineral dust peaks. Among the metrics calculated with simulated dust concentrations at surface level and PM10 observations, we highlight correlation coefficients higher than 0.5 and low values of bias, which show the importance of mineral dust contribution for the total aerosol mass in the remote areas of the country.

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EVALUATION OF DUST SURFACE CONCENTRATION FORECASTS IN THE CANARY ISLANDS

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Mineral dust predictions from a number of operational and research centres around the world are daily exchanged in the framework of the WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS). Moreover, the SDS-WAS Regional Center for Northern Africa, Middle East and Europe computes the multi-model median after interpolating the model outputs to a common grid mesh of 0.5-degree resolution. Forecasts of dust optical depth (DOD) are routinely evaluated with sun-photometric (AERONET) and satellite (MODIS) aerosol products. However, there is not a systematic evaluation of dust surface concentration, especially close to the dust sources, because of the lack of suitable observations.

In the present work, dust surface concentration and DOD forecast by seven models (BSC-DREAM8b, MACC, DREAM8-NMME-MACC, NMMB/BSC-Dust, GEOS-5, NGAC and MetUM) for two years (2013-2014) is compared with PM10 observations (particulate matter with aerodynamic diameter less than 10μm,) recorded by the Air Quality Control and Monitoring Network of the Canary Islands (Spain). The region, located in the sub-tropical Eastern Atlantic (roughly 100 km west of the Moroccan coast), is frequently affected by intrusions of Saharan dust. Since PM10 measurements integrate particles of different origin, including anthropogenic and natural aerosols, the contribution of mineral dust to the total PM10 is estimated using a statistical method[1].

Complementarily, aerosol optical depth (AOD) from the AERONET station of Santa Cruz de Tenerife is compared with DOD simulated by the models. In this case, in an attempt to restrict the evaluation to those cases in which mineral dust is the dominant aerosol type, only those retrievals with an Ångström exponent lower than 0.6 will be considered in the comparison.

Quasi-permanent subsidence in the free troposphere together with frequent trade winds in the lowest troposphere, especially during summer, result in a strong and stable thermal inversion (located on average at 1400 m a.s.l) that separates a dry free troposphere from a relatively fresh and humid oceanic boundary layer. The proximity to the Sahara desert and the regional atmospheric circulation exert a decisive influence on the dust climatology of this region. From autumn to spring, frequent low-altitude Saharan dust outbreaks (< 1000 m a.s.l) are observed. Conversely, long-range dust transport above the trade wind inversion layer (> 1500m a.s.l) is observed from early summer to early-autumn.

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APPLICATION OF A VISIBILITY-BASED PRODUCT TO MONITOR DUST EVENTS

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In-situ measurements of particulate matter concentration are systematic and with high spatial density in Europe, but very sparse, discontinuous and rarely near-real-time available close of the main dust sources. Satellite products present global coverage. However, they usually integrate the aerosol contents over the vertical column and do not provide information about the dust contents close to the ground. Furthermore, the presence of overlaying clouds can prevent the dust to be detected.

Since the data sets of weather records have an excellent spatial and temporal coverage, observations of horizontal visibility included in meteorological reports can be used as an alternative way to monitor dust events. Visibility is mainly affected by the presence of aerosol and water in the atmosphere. Therefore, the use of visibility data has to be complemented with information on present weather to discard those cases where visibility is reduced by the presence of hydrometeors (fog, rain, etc.).

Within the framework of the World Meteorological Organization's Sand and Dust Storm Warning Advisory and Assessment System we have developed a near-real-time product displaying those stations where visibility is reduced to less than 5 km by the presence of airborne dust. According to various empirical relationships found in the literature relating visibility and dust surface concentration[1][2], this value corresponds to a PM10 of about 300 $\mu m \cdot m^{-3}$.

This work shows how this product complements the information provided by other observing systems (air quality monitoring stations, sun photometers, vertical profilers or satellite products) and numerical simulations presenting its application in tracking several dust episodes.

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EFFECT OF PARTICLE SETTLING ON LIDAR PROFILES OF LONG-RANGE TRANSPORTED SAHARAN AEROSOLS

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A large amount of desert aerosol is transported in the Saharan Air Layer (SAL) westwards from Africa over the Atlantic Ocean. Due to convection induced by solar heating of the ground, the SAL is often well-mixed over the continent. When the SAL reaches the ocean it is lifted over colder layers and convection gets significantly weaker or vanishes. Knowledge about convection in the SAL over the Atlantic is limited but convection can have significant consequences for size distributions and radiative properties of the transported Saharan aerosol. Lidar profiles of transported Saharan aerosol may contain some information about vertically-resolved changes of the aerosol microphysics which motivated us to perform the present study.

We present modelled lidar profiles of long-range transported Saharan aerosol assuming that initially the SAL is well-mixed and that there is no vertical mixing of air within the SAL when it reaches the Atlantic. We consider Stokes gravitational settling of aerosol particles. The lidar profiles are calculated using optical models for irregularly-shaped dust particles [1] and the settling-induced particle removal as function of distance *dz* from the SAL top.

Our modelled lidar ratios increase within the SAL with increasing height (decreasing *dz*). For example at a lidar wavelength of 532nm, the lidar ratio of our reference desert mixture increases with height, i.e. from 49sr at *dz*=1000m to 53sr at *dz*=200m and 57sr at *dz*=100m. The modelled vertical changes of the lidar ratio, however, are too small to be measured by Raman lidar because of the low signal-to-noise ratios of the Raman signals. We find a decrease with height for the backscatter coefficient and the particle linear depolarization ratio δ_l [2]. For example, in case of our reference desert mixture, δ_l at 532nm decreases from 0.289 at *dz*=1000m to 0.256 at *dz*=200m and 0.215 at *dz*=100m. We compare these results to ground-based lidar measurements in Barbados performed during the SALTRACE field campaign [3] and find agreement within the expected uncertainties.

Using CALIOP δ_l data averaged over three months, Yang et al. [4] found an increase of δ_l profile with height over the Western Atlantic and explained it with a minimal model assuming that particles with more spherical shape fall faster and have lower δ_l than particles with stronger deviation from spherical shape. We tested this model for shape-induced gravitational sorting using explicit optical modelling and Stokes settling velocity calculations for irregular dust particle shapes and conclude that the model of Yang et al. [4] is not a plausible explanation for the effect that gravitational particle settling has on δ_l profiles. In our sensitivity study we find that the size dependence of the gravitational settling is significantly more important for the δ_l profile than the shape dependence of the settling velocity. It seems conceivable to us that the increase of the δ_l profile with height found by Yang et al. [4] in the measurements is an averaging effect since the bottom of the SAL often gets mixed with the marine layer (characterized by small δ_l) and the height of this mixing layer varies with time.

Uncertainties in the comparison between modelled and measured profiles are considerable and include measurement uncertainties, uncertainties due to assumed particle shapes, uncertainties due to other particle mixture properties, and uncertainties due to the assumptions about processes in the SAL over the continent and the ocean. For example, the δ_l profile decreases for each investigated irregular particle shape, but the exact δ_l profile shape is sensitive to dust particle shape. As a consequence, with the information available to us it is not possible to determine whether vertical mixing of air occurred during the transport of the SAL measured at Barbados. Further investigations with additional measurements and models are needed to complement our study.

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IMPACT OF SHIP TRAFFIC TO SOME POLLUTANTS CONCENTRATION IN THE CITY OF VENICE

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Ports have always had a dual nature: on the one hand they are hubs for tourism and commercial activities, providing wealth and prosperity of the neighbouring towns; on the other hand they are source of atmospheric pollution, creating great concern, since they are often located near city centres. Great attention has been paid to minimize pollution from road traffic, while that produced by ship traffic was considered only in recent years, despite contributing nearly 50% of total atmospheric particulate in several medium-size port-cities.

This work was conducted in the framework of the POSEIDON (POllution monitoring of Ship Emission: an IntegrateD approach fOr harbor of the Adriatic basiN) project (MED programme 2007-2013). The objective of POSEIDON activities is to quantify the relative contribution of maritime traffic to atmospheric pollutants concentration in four port-cities of the Adriatic Sea (Brindisi, Venice, Patras and Rijeka). At the same time POSEIDON proposes to identify policy gaps and to support the proposal of integrated common strategies and future actions for sustainable development of coastal area in the Adriatic Sea.

This study focuses on the port-city of Venice. The ship traffic impact was quantified using different methodologies and referring to various pollutants that are not yet included in the current legislation on ship emissions:

1. $PM_{2.5}$ and particle number concentration (PNC), using data at high temporal resolution [1];
2. PM_{10} and $PM_{2.5}$ at low resolution, using atmospheric vanadium data [2];
3. Metals in PM_{10}, conducting a source apportionment (Positive Matrix Factorization technique) [2];
4. Gaseous and particulate PAHs, adopting a double sampling method [2, 3].

With the exception of PNC, data were collected from 2007 (or 2009) to 2013, permitting the evaluation of the effect of the European Directive 2005/33/EC (which was enforced on 1st January 2010) on the air quality of Venice. The outcomes showed a decrease in the contribution of ship traffic to particulate matter, both from measurements at high and low resolution. On the contrary, the contribution to metals and PAHs seems to be stable or even increased, over the years.

From this work it is clear the need to add other pollutants in the legislation which regulates shipping emissions: i) ultrafine particles, since a stronger shipping contribution was observed to PNC respect to $PM_{2.5}$; ii) metals and particulate-PAHs, since no decrement was observed after the introduction of the 2005/33/EC Directive.

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EFFECT OF DUST STORMS ON CONCENTRATION AND CONTENT OF FUNGI IN THE ATMOSPHERE OF HAIFA, ISRAEL

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Dust storms moving from large deserts on the planet are phenomena that affect air quality in vast areas all over the world. An annual amount of desert dust subjected to regional or global airborne migration has been estimated as 0.5 to 5.0 billion tons [1]. Dust storms originating primarily in the Saharan desert heavily affect the East Mediterranean mostly during the winter and spring seasons. The biogenic component of the dust contains numerous fungal fragments, mostly spores, which are extremely mobile and can be transferred by wind for very long distances [2]. The main goal of our study addresses the qualitative and quantitative aspects of dust-associated fungal communities sampled during dust events in the years 2004-2005 in Haifa, Israel, and their comparison with the communities sampled on adjacent clear days. The effect of particulate matter concentrations and elemental composition of the atmospheric particles on fungal communities was also estimated. Airborne fungi were collected with the Six Stage Andersen Viable Impactor. Their taxonomic identification was based mainly on morphological characteristics; one repeatedly isolated type of non-sporulated colonies was identified employing the molecular method. During six dust events and the adjacent clear days, 98 species were collected - 79 and 32 species in dusty and clear days, respectively. The dust-associated fungal communities were significantly richer than the communities of clear days (Wilcoxon signed-rank test, $p=0.03$). Remarkable increases in the concentration of airborne fungi during the dust events have been also revealed. The Canonical correspondence analysis showed that the concentration of fine atmospheric particles was the dominant environmental factor influencing the distribution of these species followed by the concentration of geological elements and coarse particles.

Nearly half of the collected species were melanin-containing. Moreover, conidia of some light-colored fungi from the genera Penicillium and Aspergillus frequently recorded in the air are known to contain greenish pigments of a melanin nature [3]. Protective pigmentation of cell walls with melanin and melanin-like pigments makes airborne fungal propagules less susceptible to UV radiation damage [4]. Both typical soil-borne fungi and fungi of phylosphere (in an approximate proportion of 2:1) combined the collected airborne mycobiota. All species of phylosphere origin found in the air of Haifa are melanin-containing, and a great majority of them produce large, thick-walled and multi-cellular spores. Such morphological adaptations protect these fungi not only from the harmful influence of UV radiation but also from desiccation, which is crucial for their long distance dispersal.

On a whole, the study revealed a distinct pattern of distribution of fungi in the atmosphere of Haifa that was strongly affected by Saharan dust storms. It is actual and important in the light of recently increasing desertification of the Mediterranean region which results in the increase of frequency, density, and duration of dust events in Israel. Many of fungal species collected during dust events are known as potential pathogens and allergens that produce huge amounts of small spores (2.1-3.3 μm) able to penetrate easily the human respiratory system and cause severe public health problems.

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MINERALOGY AND MORPHOLOGY CHANGES AFTER LONG RANGE TRANSPORT OF VOLCANIC AEROSOLS: THE 2010 EFJ VOLCANIC PLUME

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In 2010, the EFJ volcanic plume was transported and dispersed over large parts of Europe and impacted airtransport due to the closure of large parts of European airspace. We investigated by automated single-particle analysis using CCSEM/EDX the chemistry and the morphology of fine ash particles sampled along the trajectory of the plume and also resuspended ash close to the volcano. Airborne samples were actively collected during flights over the North Atlantic, the North Sea and along the Belgian-German border during May 2010. Resuspended particles were sampled actively at ground level in Iceland on the flanks EFJ after the eruption at the end of August 2010. Automated single-particle analysis using CCSEM in BSE modus coupled with EDX was performed on the samples. The overall chemical compositions of all samples are similar and match EFJ bulk rock's. However, the average mineralogy and morphology of the volcanic plume differ distinctly from one location to another. In Iceland, the cloud was rich in dense crystalline phases, aerosol aggregates and elongated particles with rough surfaces. Lighter and more compact, often leached single glass particles with smooth surfaces dominated over the North Sea and continental Europe. Gravitational settling is the main process by which the plume evolved with increasing atmospheric residence time. Selective sedimentation was driven by particle density and size but also by particle shape where surface roughness probably promoted aggregation and surface coating close to the source. The nature of volcanic plumes change not only in average grain size, but also in phase composition. The hazard, which it poses to air traffic, too has to take into account these changes during transport.

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CELLULOSE AND THEIR CHARACTERISTIC ICE NUCLEATION ACTIVITY- FREEZING ON A CHIP

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The influence of clouds on the Earth's climate system is well known (IPCC, 2013). Cloud microphysics determines for example cloud lifetime and precipitation properties. Clouds are cooling the climate system by reflecting incoming solar radiation and warm its surface by trapping outgoing infrared radiation (Baker and Peter, 2008). In all these processes, aerosol particles play a crucial role by acting as cloud condensation nuclei (CCN) for liquid droplets and as an ice nucleation particle (INP) for the formation of ice particles.

Freezing processes at higher temperatures than -38 °C occur heterogeneously (Pruppacher and Klett 1997). Therefore aerosol particles act like a catalyst, which reduces the energy barrier for nucleation. The nucleation mechanisms, especially the theory of functional sites are not entirely understood. It remains unclear which class of compound nucleates ice.

Here we present a unique technique to perform drop- freezing experiments in a more efficient way. A self-made freezing- chip will be presented. Measurements done to proof the efficiency of our setup as well as advantages compared with other setups will be discussed.

Furthermore we present a proxy for biological INPs, microcrystalline cellulose. Cellulose is the main component of herbal cell walls (about 50 wt %). It is a polysaccharide consisting of a linear chain of several hundred to many thousands of β (1→4) linked D-glucose units. Cellulose can contribute to the diverse spectrum of ice nucleation particles. We present results of the nucleation activity measurements of MCCs as well as the influence of concentration, preparation or chemical modification.

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IDENTIFICATION OF ICE NUCLEATION ACTIVE SITES ON FELDSPAR DUST PARTICLES

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Mineral dusts originating from Earth's crust are known to be important atmospheric ice nuclei. In agreement with earlier studies, feldspar was found as the most active of the tested natural mineral dusts. Here we investigated in closer detail the reasons for its activity and the difference in the activity of the different feldspars. Conclusions are drawn from scanning electron microscopy, X-ray powder diffraction, infrared spectroscopy, and oil-immersion freezing experiments. K-feldspar showed by far the highest ice nucleation activity. Finally, we give a potential explanation of this effect, finding alkali-metal ions having different hydration shells and thus an influence on the ice nucleation activity of feldspar surfaces.

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GIANT AEROSOLS OBSERVATIONS AND EFFECTS

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Aerosols affect the meteorological and climate system as well as health and transport in different ways. In particular, giant and ultragiant particles (> 5 μm diameter) can act as Giant Cloud Condensation Nuclei (GCCN) and as Ice Nuclei (IN). Nevertheless, their distribution and impact in the atmosphere and climate is not well known, hence the observation and study on these particles is relevant. Therefore, the aim of this study is to investigate tropospheric aerosols by exploiting the synergy of two ground-based remote sensing instruments: multi-wavelength Raman lidar and cloud radar. The first is sensitive to small size aerosols, while the second can detect coarser particles.

In order to achieve the goal of the study, first a novel methodology has been developed to automatically detect giant and ultragiant aerosols with a cloud radar. By applying it to a 6 years dataset, this is the first study in which giant aerosols have been methodically observed and characterized by using cloud radar measurements. Second, the analysis of lidar measurements simultaneous to cloud radar aerosol observations has allowed to identify aerosol types and has shown that lidar and radar are sensitive to different parts of the aerosol size distribution: the two instruments observe different particles. Accordingly, the retrieval of the aerosol size distribution and the microphysical properties retrieval has been done for each instrument measurements separately and afterwards combined. In this way, the synergistic use of both instruments allows to enlarge the size range in which aerosols can be characterized (from ultrafine to ultragiant particles) for the first time. Finally, the effects of giant aerosols on the local meteorology is presented. The study reveals how giant aerosols affect the regional precipitation by enhancing the accumulated precipitation and the maximum rain rate.

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SEPARATION OF FINE DUST, COARSE DUST AND MARINE AEROSOL COMPONENTS OVER BARBADOS USING A THREE-WAVELENGTH POLARIZATION RAMAN LIDAR

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Mineral dust is spread over the entire globe. To study the long-range transport of dust almost free of anthropogenic influence, the trade-wind-transported Saharan dust over the Caribbean offers a unique possibility. Therefore the Saharan Aerosol Long-Range Transport and Aerosol-Cloud Interaction Experiment (SALTRACE) was performed on the easternmost island of the Caribbean, Barbados (13°N, 59°W). Three measurement periods in 2013/14 were chosen to cover the summer and winter seasons. Dust events are more frequent in summer, whereas in winter pure marine conditions prevail and only a few dust/smoke plumes reach Barbados.

In the framework of this experiment we use a complex lidar system equipped with Raman channels (387 and 607 nm) and a 532 nm high spectral resolution lidar (HSRL) channel to receive day time (HSRL) and night time (Raman) extinction profiles. The system is able to measure the linear depolarization ratio at 355, 532 and 1064 nm simultaneously. To ensure the quality of the depolarization measurements various quality checks and calibrations were performed. Additionally, it was compared to the EARLINET reference polarization lidar system POLIS of the Ludwig-Maximilians-University, Munich. The linear depolarization ratio provides information about the shape of the particles and therefore let us distinguish between mineral dust, biomass burning smoke and maritime aerosols. With the extended POLIPHON technique presented by Mamouri and Ansmann [1], it is furthermore possible to separate fine and coarse mode dust. The depolarization at three wavelengths provides additional information to reduce uncertainties. An AERONET sun photometer was deployed at the measurement site to constrain the retrieval. The airborne in-situ measurements during the first SALTRACE campaign in summer 2013 provide the particle size distribution for the Saharan air layer to compare the remotely retrieved fine-mode fraction. A separation of the dust's fine and coarse mode will give insight in dust removal processes during long-range transport of dust and can be compared to dust transport models.

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NOT ALL FELDSPAR IS EQUAL: A SURVEY OF ICE NUCLEATING PROPERTIES ACROSS THE FELDSPAR GROUP OF MINERALS

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Aerosol particles act as Cloud Condensation Nuclei (CCN) and Ice Nucleating Particles (INP) in the atmosphere and so are vital for formation processes of mixed phase clouds and in turn effect the hydrological cycle and climate. One of the major types of INP in the atmosphere is wind-blown mineral dust [1]. In past years a lot of emphasis for INP research was placed on the clay group of minerals but recently the feldspars have shown to be much more active than clay minerals [2]. The feldspar group is a complex group of minerals with varying compositions and mineral structure. Previous studies have suggested that K-feldspars act as the most active INPs out of the feldspar group [2-4], but overall very few feldspars have been examined for their ice nucleating ability. In this study we have quantified ice nucleation by 15 characterised feldspar samples [5]. The 15 feldspars have been studied for heterogeneous immersion mode nucleation, using a microliter droplet freezing assay [6], and their corresponding ice nucleating efficiencies derived in terms of $n_s(T)$. We confirm that K-feldspars are generally the most active of the feldspar group. However caution is to be applied as some feldspars (both K-feldspar and Na rich albite) can display hyperactive ice nucleation properties. Plagioclase feldspars (those rich in Na and Ca) are found to be the least active feldspars. Albite (the sodium end-member) is observed to have an efficiency between the K-feldspars and feldspars containing Ca in the plagioclase group, unless it has 'hyper active' sites. The two samples which acted as hyperactive INP (TUD #3 microcline and Amelia albite) were left in suspension for a number of months along with a microcline sample (BCS 376 microcline). The sodium rich Amelia albite's activity as an INP dropped by16ºC in 16 months. The highly active TUD #3 microcline only saw a 2ºC drop in freezing temperature during 16 months and the BCS 376 microcline saw no change. It is seen that the highly active sites responsible for the hyperactivity of Amelia albite and TUD #3 microcline are unstable and will be the most susceptible to weathering attack in the atmosphere yet these hyper active samples could play an important role in cloud formation processes.

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QUATERNARY MINERAL DUST DEPOSITS IN TAIWAN - A NEW PALEOCLIMATIC ARCHIVE

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Pleistocene and Holocene mineral dust deposits are widely distributed in continental Eurasia and in marine sediments of the western Pacific and its bordering seas. They are important archives for paleoclimatic reconstructions, in particular for atmospheric circulation models [1]. As the modern aeolian dust transport to the East China Sea and South China Sea is estimated to be in the magnitude of 20 $gm^{-2}a^{-1}$ [2], the island of Taiwan can be suspected to preserve also Quaternary dust accumulations.

Fine-grained sediments are widely distributed in Taiwan in all altitudes up to > 3000 m a.s.l. [3], but they mainly cover Pleistocene fluvial terraces in the mountain foreland, where the well-sorted silty layers reach a thickness up to several meters. The majority of existing studies interpret these deposits as in situ weathered cover layers and a product of soil formation according to their yellowish to reddish colour [4]. However, a similarity to loess has also been suggested [5], but no long range transported (LRT) deposits have been reported before.

We interpret these sediments as aeolian deposits with a significant content of LRT dust. Here, we present detailed particle size data from several archives, which show a ubiquitous presence of a fine silt population in the particle size distributions not only in loess like sediments but even in colluviums, overbank and fluvial deposits. We introduce a tentative model of Pleistocene dust deposition and re-sedimentation in Taiwan and discuss its implication for the atmospheric circulation over East Asia along with ideas for future research approaches.

As Taiwan is an isolated high mountain island at the junction of the Eurasian continent and the western Pacific Ocean with elevations up to 3952 m a.s.l., Quaternary aeolian deposits in Taiwan have an enormous potential for future paleoclimate research in monsoonal East Asia.

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MIXING AND DEPOSITION PROCESSES DURING LONG-RANGE TRANSPORT OF SAHARAN DUST

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Mineral dust from arid and semi-arid regions plays an important environmental role due to its ability to alter the Earth's energy budget by aerosol-cloud-radiation interactions as well as due to its impact on the biogeochemical cycle and air quality. The Sahara desert is the world's main dust source contributing at least 50% to the global dust load. Large amounts of dust are carried towards the Caribbean within the Saharan Air Layer (SAL), with maximum transport in late boreal spring and early summer. During long-range transport, the dust particles are transformed by aging and mixing, which may have significant but as yet unquantified effects on the dust impact on radiation, cloud properties, and the biogeochemical processes of ecosystems.

This study focuses on the important role of mixing and deposition processes on the distribution, lifetime, and particle properties of mineral dust. Regional dust modelling is used to investigate the long-range transport of Saharan dust across the Atlantic Ocean towards the Caribbean. More specifically, we address the questions of (1) how the Saharan dust export towards the Caribbean region is influenced by the atmospheric circulation over West Africa and (2) which role the different removal and mixing processes play during long-range transport? In addition to the potential importance of sporadic downward mixing, a particular focus is on the effect of non-sphericity on gravitational settling of dust particles. The emission, transport, dry and wet deposition of Saharan dust as well as the effect of dust radiative forcing are simulated with the regional model COSMO-MUSCAT. The COSMO-MUSCAT simulations are combined with trajectory analysis to study particle aging and dust-cloud interactions. The model results are compared against various standard observations. In the Caribbean and across the tropical Atlantic, field measurements are available for model evaluation from the transatlantic cruise of the research vessel Meteor in May 2013 and from the Saharan Aerosol Long-Range Transport and Aerosol-Cloud Interaction Experiment (SALTRACE) at Barbados Island in June to July 2013.

First results show that as the source activity, dust deposition is driven by the atmospheric circulation patterns over West Africa. Convective mixing controls dry deposition in the tropics and can explain sporadic deposition events in the subtropics. In contrast to previous, mainly global studies, considering dust particle non-sphericity has a significant impact on dry deposition fluxes. Overall, this study provides an improved model-based assessment of the varying contribution of Saharan dust to the aerosol burden across the Atlantic Ocean.

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METALS IN INDOOR SETTLED DUSTS IN TORONTO, CANADA

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Samples of indoor settled dusts from houses, offices, classrooms, and laboratories in Greater Toronto Area, Canada were collected and the total concentration of nine metals (Ba, Cd, Cr, Cu, Hg, Mn, Ni, Pb, and Zn) were determined. Mercury concentrations were determined using cold vapor atomic fluorescence spectroscopy (CVAFS), whereas the concentrations of eight other metals were determined using inductively coupled plasma atomic emission spectroscopy (ICP-AES). The results showed that the highest level of heavy metals was in the laboratory dusts. Metal concentrations (except those for Mn and Zn) in household, office, and classroom dusts were comparable. Cd, Cr, Cu, Ni, and Zn concentrations in the laboratory dusts and Cu and Zn concentrations in household, office, and classroom dusts exceeded the Canadian Soil Guideline. Metal concentrations in the indoor dusts found in this study were, in general, consistent with those reported in literature. Among the metals studied, Cd, Cu, Hg, Pb, and Zn showed the greatest enrichment in the indoor environments relative to their crustal abundances.

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MONITORING THE LEVELS OF PARTICLE MATTER-BOUND MANGANESE: AN INTENSIVE CAMPAIGN IN AN URBAN/INDUSTRIAL AREA

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There is a growing interest in ambient air manganese exposure, particularly in susceptible subgroups like children and infants. Occupational exposure effects to high/moderate levels of manganese in ambient air have been widely reported mainly linked to neurological problems. However, recent studies suggest that health effects due to non-occupational manganese exposure may be also associated with neurotoxic disorders, including motor and cognitive deficits [1, 2].

Since manganese is not considered as a carcinogenic element and despite many works have identified effects of manganese exposure on human health, there is not a specific European regulation that establishes limit values for manganese in air. However, the World Health Organization (WHO) has proposed as a guideline an annual average limit value of 150 ng/m^3.

The present study aims to monitor the manganese levels in the particulate matter throughout the Santander Bay, located in the region of Cantabria (northern Spain). Previous studies developed in the region have shown high concentrations of manganese in ambient air [3] according to WHO criteria. The location of a ferroalloy plant in the area, which specialises in silicomanganese and ferromanganese alloy production, has been identified as the most likely source of manganese.

The intensive sampling campaign carried out at the Santander Bay has been designed as follows: nine monitoring sites (one location per month) have been chosen covering as many angles from the likely manganese source as possible, in order to contemplate all possible wind direction scenarios. Whenever possible, closed locations from the source were selected, distances ranging from 0.3 to 2.5 km. Among the selected sampling locations there are schools, high schools, cultural centres, etc.

The 24-h PM sampling has been carried out by means of a low volume sequential sampling device (PM_{10}, 2.3 m^3/h) equipped with a 15 filter cartridge. PM_{10} has been collected onto 47 mm quartz fiber filters, 28 samples at each location, making a total of 252 filters. Once the gravimetric determination was performed, the filters were subjected to microwave assisted acid digestion (HNO_3:H_2O_2 with a mixture of 8:2 ml) based on UNE-EN 14902:2006. Inductively coupled plasma mass spectrometry (ICP-MS) was then used for metal analysis. In addition to manganese, Ti, V, Cr, Fe, Ni, Cu, Zn, As, Mo, Cd, Sb, Pb were also analyzed, in order to look for correlations between them.

According to the results obtained in the present sampling campaign, the highest daily urban background manganese level at Santander Bay reached 3200 ng/m^3 with a monthly average higher than 150 ng/m^3 in some of the monitoring sites. Although monthly samplings have been carried out in each location, these results suggest that manganese concentrations in ambient air in some sites of the Santander Bay would exceed the 150 ng/m^3 established by WHO as an annual average guideline value.

The results of this sampling campaign will be utilized to develop manganese air dispersion models, which will be a useful tool for the regional administration and for future epidemiological studies.

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CENTRAL ASIAN DUST EXPERIMENT (CADEX): FIRST YEAR LIDAR MEASUREMENTS: OPTICAL PROPERTIES, AEROSOL OPTICAL THICKNESSES, HEIGHTS, SOURCES AND SEASONALITY OF DUST LAYERS OVER TAJIKISTAN

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Tajikistan lies in the midst of major dust sources such as the Taklimakan desert, the Central Asian Aralkum, Kyzylkum and Karakum deserts, the Iranian Dasht-e-Kavir and Dasht-e-Lut deserts, and the Thar desert in north India. Therefore, Tajikistan is frequently struck by severe dust events of local or distant origin. Dust has a direct and indirect influence on the radiation budget, formation of clouds and precipitation, thus it plays an important role in the climate system. This is of particular importance for Tajikistan and whole Central Asia being hotspots of climate change. Nevertheless, measurements of mineral dust in the atmosphere are rare in Central Asia, although they are highly needed to understand the transport of dust across Central Asia and to assess its influence on weather and climate.

The goal of the Central Asian Dust Experiment (CADEX) is therefore to perform continuously height resolved measurements of aerosol properties over Tajikistan. Within the CADEX campaign a PollyXT multiwavelength polarization Raman lidar is operated continuously in Dushanbe/Tajikistan since March 17, 2015. With this automated system we obtain vertical profiles of the backscatter and extinction coefficients, the depolarization and the lidar ratios, as well as the Ångström exponents. Furthermore a CIMEL sun photometer (CE318-N), a GRIMM particle counter (EDM 180), a Digitel filter sampler (HVS DHA-80) and standard meteorological stations are operated on the measurement site (38°33’34” N, 68°51’22” E, 864 m a.s.l.).

The data evaluation is ongoing, first results of the first year of lidar measurements are presented in this contribution. Statistical results as well as case studies of individual dust events in the boundary layer as well as of lofted layers of long-range transported dust will be shown. Aerosol optical thicknesses, layer heights, and optical properties are analyzed on seasonal differences. Backtrajectory analysis is used to identify possible source regions of the dust over Tajikistan.

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ESTIMATING THE IMPACT OF MINERAL AEROSOLS ON CROP YIELDS IN MARGINAL FOOD PRODUCING REGIONS

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A large number of food-insecure nations exist in regions of the world where dust play a large role in the climate system. While the impacts of common climate variables (e.g. temperature, precipitation, ozone, and carbon dioxide) on crop yields are relatively well understood, the impact of mineral aerosols on crop yields have not yet been thoroughly investigated. The aim of this research is to develop the data and tools necessary to understand mineral aerosol impacts on crop yields in regions of the world that are food insecure.

On large scales, dust may affect yields by altering the amount and type of radiation reaching the plant, altering local temperature and precipitation, or if dust emissions are local, by depleting the soil of nutrients or by defoliation via particle abrasion. We model the impact of dust on crop yields with statistical models because we are uncertain which impacts will dominate the response on national and regional scales considered in this study. Multiple linear regression is used in a number of large-scale statistical crop studies to estimate yield responses to various climate variables. In alignment with previous work, we develop a large number of multiple linear crop models, but build and improve upon this simplified method of regression with machine-learning techniques (e.g. random forests and model trees) in an effort to identify important statistical predictors and isolate how dust may affect yields on the scales of interest.

In order to perform such a comprehensive analysis we have developed a crop-climate dataset for maize, soybean, groundnut, sorghum, rice, and wheat for the regions of North Africa, West Africa, East Africa, South Africa, and the Sahel (as well as each of the countries therein). We predict that the impact of dust on national and regional crop yields will likely manifest in altered radiation and surface temperatures, while nutrient loss and defoliation are likely more important on more local scales. The application of the aforementioned machine-learning techniques to a large number of climate variables and composite climatic indices will highlight other possible ways in which dust may exert control on agricultural production.

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ESTIMATES OF GROUND SURFACE CHARACTERISTICS FOR OUTBREAKS OF THE ASIAN DUST STORMS IN THE SOURCES REGION

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In this study we confirmed that there is a high correlation between outbreaks of the Asian Dust Storms and the ground surface characteristics of sources region. Based on the survey of the soil composition we quantified the fractional amounts of dust particles originating from ADS. The particles were found in varying but significant amounts in topsoil layers of dried-up lakes and river basins, degraded pasturelands and abandoned croplands. In addition to that, in the field survey, we also measured the reflectance of bare land, the dry grass (NPV) and the green grass (PV), which allowed us to clarify differences of the distribution of these features in the R-NIR spectrum feature space.

As part of our categorization methodology we relied on predefined parameters such as Normalized Dust Difference Index and Brightness Temperature. Both of these metrics were instrumental in accurately quantifying blowing dust intensity and identifying ground surfaces and clouds in the South Eastern Gobi desert in Mongolia. Importantly, we noted that due to large quantities of clay deposits in DLs the NDDI values were found to be larger for DLs compared to other areas.

Statistical test results for the Critical Ground Surface Condition (CGSC) such as NDVI, Soil particles (concentration of clay (%) in surface soil), SMI and TRI in the Asian Dust Storm source areas, including the influence on dust storm outbreaks, show that the Asian Dust Storms that occurred in the past originated from the dry basins, where hot spots of vegetation were poor and where many lakes had dried up. We discovered that the dried-up lake in the inland Asia were a new sources of outbreaks of the Asian Dust Storms. We also concluded that the main cause of outbreaks of ADS is global warming and long-term draughts in inland Asia.

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IMPACT OF ASIA DUST ON REGIONAL ENVIRONMENT AND CLIMATE

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In this study, we summarize the typical transport paths of East Asian dust, which affect regional and global climates, and discuss numerous effects of dust aerosols on clouds and precipitation primarily over East Asian arid and semi-arid regions. Compared with the aerosols of Saharan dust, those of East Asian dust are more absorptive of solar radiation, and can influence the cloud properties not only by acting as cloud condensation nuclei and ice nuclei but also through changing the relative humidity and stability of the atmosphere (via semi-direct effect). Converting visible light to thermal energy, dust aerosols can burn clouds to produce a warming effect on climate, which is opposite to the first and second indirect effects of aerosols. Over Asian arid and semi-arid regions, the positive feedback loop in the aerosol-cloud-precipitation interaction may aggravate drought in its inner land. Impact of Asia dust on regional environment, especially on haze weather, are also presented in this study.

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RETRIEVAL OF COMPLEX REFRACTIVE INDICES OF MINERAL AEROSOL FROM THE ULTRAVIOLET TO THE THERMAL INFRARED

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Due to their ability to absorb and scatter radiations, aerosols play an important role in the energy budget of the earth-atmosphere system. However, quantitative estimations of their effects are quite uncertain due to their large spatial and temporal variability in terms of concentration and physical properties.

Measurements from space-borne instruments are the only way to observe aerosol distributions from regional to global scales. For instance, thermal infrared radiometers such as MODIS or SEVIRI are routinely used for aerosol detection. Nevertheless, these broadband sensors are not suitable to distinguish the aerosol chemical or mineralogical composition. Recent high spectral resolution infrared sounders such as IASI or TANSO-fts are able to overcome these limitations. However, to fully exploit the hyperspectral instrument capabilities, precise optical properties (i.e. refractive indices (RI) of various particles are needed.

This work aims to measure high resolution extinction spectra of modeled aerosols from the ultraviolet (UV) to the thermal infrared (IR) regions of the electromagnetic spectrum to derive accurate values of the corresponding RI. The latter are generally performed through absorbance or transmittance measurements from bulk material or diluted particles in solid pellets leading to possible experimental limitation, such as lack of knowledge of the particle size distribution. In this study, extinction spectra of model aerosol by UV-visible spectroscopy and FTIR spectroscopy have been collected.

Quartz particles (99 %, Sigma Aldrich) were dispersed by a mechanical way in a flow of nitrogen (5 L/min) within a glass container. The continuous flow of aerosol particles was introduced into a 10 m multi-pass cell within an FTIR spectrometer (Antaris IGS Analyser, Thermo Scientific) and a 1 m single-pass cell within a UV-visible-NIR spectrometer (MAYA 2000 PRO, Ocean Optics). Aerosol size distributions have been measured at the exit of the spectrometers with an aerodynamic particle sizer spectrometer (TSI APS 3321).

The RI are determined by combining Kramers-Krönig relations, the Mie theory and an iterative process. This allows minimizing errors in the retrieval procedure. The RI obtained are compared to those extracted from data-bases (HITRAN, GEISA, ARIA) and demonstrates the power of this new approach. The methodology will be also validated by performing experiments with calibrated quartz microspheres (99.9 %, AngströmSphere) of diameters D=0.5 and 1 μm and results will be discussed.

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ASIAN DUST OPTICAL PROPERTIES FROM AERONET SUNPHOTOMETER MEASUREMENT IN GOBI-DESERT REGION OF MONGOLIA

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Dust and Sand aerosols are significant components of the Earth atmosphere, affecting regional climate change. Gobi and Deserts over south part of Mongolia are one of principal dust source regions in East Asia. AERONET has played an important role in the characterization of key aerosol types: urban-industrial aerosol, biomass burning aerosol, desert dust and marine aerosol [1].

All of the column-integrated spectral aerosol measurements in this study were made with a Sun photometer observations of AERONET Dalanzadgad site over Gobi-Desert region of Mongolia. Direct Sun photometer measurements were made once every 15 min at 340, 380, 440, 500, 675, 870, 940 and 1020 nm at Dalanzadgad site. In this study, Aerosol optical thickness 500 nm was retrieved and Angstrom exponents obtained at 870 nm in 2014 from AERONET Sun photometer which available Level 2.0 Quality Assured Data.

We have analyzed Aerosol Optical Thickness (AOT), and derived Angstrom exponent acquired by the Gobi-Desert region of Mongolia. Spring and early summer has the highest seasonal average AOT and minimum seasonal average appears in winter. Monthly average Angstrom exponents are indicates that aerosol mixtures of both coarse and fine mode particles, specially dust aerosol pattern over Dalanzadgad dominantly in spring (March-April).

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Keywords: AERONET Sun-photometer, Aerosol optical thickness, Angstrom exponent.

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PERFORMANCE EVALUATION OF A BUOYANCY-MODIFIED K-Ɛ QUARRY DUST DISPERSION MODEL

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This paper presents an evaluation of the performance of a buoyancy-modified k-ε dust dispersion modelling tool for predicting fugitive dust deposition from a series of bench blast events at a case study surface quarry. The dust clouds are modelled as volumetric emissions and their subsequent dispersion simulated by coupling the Eulerian solution of the flow-field obtained from the FLUENT k-ε turbulence solver with the Discrete Phase Model (DPM), which provides stochastic tracking of the particulates in a Lagrangian reference frame. The model coefficients of the turbulence solver have been modified and source terms have been added to the turbulence closure equations in accordance with work by Alinot and Mason (2005), to permit simulation of both adiabatic and diabatic atmospheric stability conditions. These modifications make the model compatible with Monin-Obukhuv Similarity scaling of the atmospheric surface layer. Additionally, the inclusion of a wall distance scalar permits the model to replicate atmospheric flow and turbulence profiles which conform to the shape of the quarry terrain. A post-processing procedure is implemented to account for the contribution of mesoscale wind direction variability to the lateral spreading of the dust plume. This involves the use of a Gaussian probability weighted average of a number of simulations performed for a range of wind directions within three standard deviations about the mean wind direction, wherein the standard deviation is parametrized using an empirical equation by Moore (1976).

Using empirical formula presented by Holtslag and Van Uden (1983) for the pre-processing of meteorological data for atmospheric modelling purposes, the Monin-Obukhuv scaling parameters which describe the turbulent state of the atmosphere have been derived from routine meteorological data recorded during a month-long monitoring campaign conducted at the case study quarry. The dust emission clouds observed at the quarry following bench blasting were previously generically characterized by Silvester et al. (2009).

In the current work, dust deposition measurements from a network of Frisbee deposition gauges at the site are used to validate the predictions of the Computational Fluid Dynamics (CFD) model. Accordingly, statistical performance metrics described by Hanna et al. (2004), namely, the FAC2 (Fraction of values within a factor of 2 of observations), the MG (Geometric Mean), the FB (Fractional Bias) and the NMSE (Normalized Mean Square Error), have been applied to evaluate the degree of uncertainty in the model predictions. The dust deposition predictions of the proposed CFD model are compared to those of the Gaussian model UK-ADMS, to demonstrate how the superior complex terrain resolution capabilities of the CFD model translate to improved accuracy of the deposition predictions as quantified by the performance metrics. In conclusion, this work illustrates that the combined effects of complex quarry topography and variable atmospheric stability on the transport and dispersion of fugitive dust are best captured using a CFD-based modelling methodology.

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SOURCE APPORTIONMENT OF WINTERTIME PM2.5 MASS OBSERVED IN WARSAW AGGLOMERATION USING RECEPTOR MODELS

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Atmospheric particulate matter (PM) has been studied intensively for many years because of its serious effect on human health (e.g. Pope and Dockery, 2006). It is estimated that 3.2 million premature deaths per year worldwide are attributable to outdoor PM2.5 exposure, and according to the business-as-usual emission scenario the contribution of outdoor PM2.5 air pollution to premature mortality will escalate up to 6.2 million by 2050 (Lelieveld et al., 2015).

Identification of PM sources is therefore essential to develop air quality improvement strategies and Air Quality Plans in order to control and reduce ambient PM concentrations. For source apportionment purposes, the so-called receptor models are often used, that range from simple techniques applying elementary mathematical calculations and basic physical assumptions, up to complex models requiring pre- and post-processing of data. In the recent years, shifting from simple towards more advanced methods is observed (Belis et al., 2013), among which Positive Matrix Factorization (PMF) has been widely used in studies dealing with air pollution in urban areas worldwide (Johnson et al., 2011; Belis et al., 2013).

The aim of present work is to analyse wintertime profile of PM2.5, as well as its components, mass concentrations in Warsaw, Poland and to identify emission sources and areas. To this end dedicated long-term field campaign is performed during winter 2015/2016, for the first time in the capital of Poland. Daily PM2.5 samples are collected using low volume sampler and concentrations are determined by standard gravimetric measurement method according to the EN 14907 norm. For analyses of elemental and organic carbon content in PM2.5 thermal-optical method is used, while contents of ion as well as major and trace elements are determined by ion chromatography and inductively coupled plasma (ICP), respectively. Source contributions to PM2.5 concentrations are estimated using PMF model by means of the US EPA software, while for identification of the probable PM2.5 source locations Potential Source Contribution Function (PSCF) is applied. The PSCF examines air mass back trajectories in conjunction with atmospheric pollutant concentrations and/or source contributions identified by PMF, allowing for spatial identification of potential emission areas. Air mass back trajectories are computed using HYSPLIT4 model (Draxler & Rolph, 2013).

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STRUCTURE OF DOUBLE DUST LAYERS OVER THE GOBI DESERT PRELIMINARY IOP OF JSPS CORE-TO-CORE PROGRAM

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Dust plays an important role in forming both a climate and an ecosystem. The Gobi Desert, located across Mongolia and China, is one of the great sources of the Asian dust. Grasslands are mainly distributed in the north of the Gobi Desert. There is an interaction between the grasslands and the desert. The Mongolian grasslands that have a rich ecosystem with a variety of wild animals and plants act as a barrier to prevent the desertification that extends northward from the desert. In order to investigate Asian dust and environmental regime shift, an international cooperative program, which is supported by the Japan Society for the Promotion of Science (JSPS), has started since 2014. An intensive observation period (IOP) is planned to be carried out in the Mongolian grassland, Gobi and Taklimakan Deserts in the spring of 2016, by using the research network of JSPS Core-to-Core Program.

As a preliminary IOP, a field campaign was carried out in Mongolian grassland and Gobi Desert from late March to early May 2015 by Nagoya University, Kanazawa University, Rakuno-Gakuen University and IRIMHE, Mongolia. Three instrumented cars were used to observe mineral / bioaerosols, aerosol size distribution, AOT, meteorological elements, soil moisture, surface vegetation etc. from Ulaanbaatar (47.9N, 106.9E; urban / grassland) to Dalanzadgad (43.6N, 104.4E; desert). A ceilometer (Vaisala CL51) has been installed at the Dalanzadgad Meteorological Observatory in order to observe the Asian dust in a source region since May of 2013 [1]. The lidar network of NIES at Ulaanbaatar, Saynshand and Zamyn-uud is available [2].

During the campaign, we experienced a severe dust storm during 29 and 30 April 2015 in Dalanzadgad, when the cold front was approaching there. The ceilometer observation showed that a surface dust layer was developed for seven hours from 19 LST 29 April to 1 LST 30 April, and its peak height was 1.3 km AGL. At the same time, a thin dust layer appeared aloft at 1.5 km AGL and continued from 23 LST 29 April to 9 LST 30 April. According to surface meteorological reports (SYNOP), the upper dust layer was estimated to be advected from surrounding areas. As a result, two dust layers appeared over Dalanzadgad. The first one is a locally formed dust layer and the second one is an advected dust layer.

The continuous ceilometer observation at Dalanzadgad caught various types of dust storms in the Gobi Desert since 2013. For example, Kawai et al. (2015) observed a dust event on 22 - 23 May 2013 and showed a transport process of dust from the atmospheric boundary layer to the free troposphere along the cold front surface [3]. Most of the dust events have a single layer because Dalanzadgad is a source of the Asian dust. But the present case has double dust layers. The detailed structure and trajectories of two dust layers and their characteristics of aerosol particles are reported in this presentation.

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DEVELOPMENT AND FIELD TEST OF A PNEUMATIC SEEDER FOR A SUSTAINABLE REDUCTION OF RISKS TO THE ECOSYSTEM AND THE USER BY DUST OF SEED DRESSINGS

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In 2008 around 12,000 bee colonies were lost in the south-west of Germany because of particulate emissions contaminated with Clothianidin being discharged in the process of sowing maize [1]. The following evaluation of this incident led to the conclusion that the quality of the seed dressing as well as the pneumatic seeding technology used was not sufficient in order to suppress particulate emissions of pesticides in a satisfactory manner with regard to human health and the environment [2].

Nevertheless, there is a strong need for seed dressing in agriculture being a highly effective method of plant protection in practice. Therefore, it is necessary to develop a pneumatic seeder, which reduces the drift of particulate emissions from seeding to a minimum being acceptable with regard to human health and the environment.

In order to decrease particulate emissions from seed dressings the aim of the study is the improvement of an universal pneumatic seeder which is suitable for sowing a wide range of different seeds. Therefore it is necessary to learn more about the abrasion characteristics of different seed dressings under different conditions. For these examinations the Heubach-Dustmeter which is described in DIN 55 992 part 1 is used and has been identified as a standard method [3]. First results show differences between varieties and different dressings. It can be confirmed that the use of coupling agents and glues in the seed dressing can improve the adherence.

In a second step it is necessary to identify system components of the seeder, where seed dressing can be abraded and leakages in the pneumatic system, where dust can be emitted. Here, the focus is on the dosing system, the conveying system, the distributor and the sowing coulter. In addition, areas on the seeder, the tractor and the field are determined by using were dust particles can be deposited. Therefore the standard method for testing drift is used as described in [4] and is complemented by using additional collectors on the seeder and the tractor.

First results show that the sowing coulter emits the most dust, as expected. But also leakages in the connection between distributor and conveying system can emit small amounts of dust particles. One part of these particles deposit on the soil as desired. But particles can also be detected on the tractor and the seeder. Areas with high amounts of dust particles are the steps above the sowing coulter and the circular harrow. Around the stairway to the tractors cabin and on the control panel for hydraulics in the back of the tractor dust can be detected, too.

From these experiences it can be stated, that the optimized seeder needs an airtight conveying and distribution system, so that even small dust particles can only be emitted by the sowing coulter near to the soil. This would reduce the risk to the ecosystem and the user in a technically easy way.

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INCREASE IN AIR POLLUTION OF URBAN ENVIRONMENTS IN THE EAST-MEDITERRANEAN DUE TO NATURAL DUST EPISODES

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Studies in the eastern Mediterranean have shown evidence of increases in the strength and frequency of dust-raising activity. Other studies in the region have suggested that exposure to mineral dust increase morbidity. Gaps remain in our knowledge about the association between dust events and corresponding PM exposure levels inside buildings. This study focuses on dust analyses in urban environments in Israel. An average daily net contribution of dust to PM10 of 122 μg m-3 was calculated for the entire study period (2000-2015). Real-time measurements during dust events revealed that indoor PM10 and PM2.5 levels fluctuated with the dust intensity and duration. In a typical strong event outdoor daily PM10 concentrations can reach above 2000 μg m−3 and the indoor PM peaked at about 700 μg m-3. Indoor air tends to remain dusty long after the dust event. A spatial analysis at the city scale showed significant variability in PM distributions during dust events. The results serve to improve our understanding of dust storm behavior with implications for air quality in urban environments and health issues.

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DUST EVENT IN THE GOBI DESERT IN MAY 2013 CAPTURED BY A LIDAR NETWORK

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Asian dust is originated in the arid regions of East Asia such as the Gobi Desert and the Taklimakan Desert. The strong wind raises the dust from the ground surface to the atmospheric boundary layer (ABL), which is the bottom layer of the atmosphere. If the dust reaches the free troposphere over ABL, it can be transported over a long range by westerlies [1]. Some kind of mechanism is necessary for the vertical transport of the dust from ABL to the free troposphere. A previous study [2] suggests that a warm conveyor belt in a cold frontal system is one of the mechanisms.

Lidar is a useful system to observe the vertical distribution of aerosols with high resolutions of time and height. The AD-Net, which is a lidar network for continuous observation of vertical distributions of Asian dust and other aerosols in East Asia, has two dual-wavelength lidars in the eastern part of the Gobi Desert [3]. They are located at Sainshand and Zamyn-Uud, Mongolia. Zamyn-Uud is about 200 km southeast of Sainshand. In addition, we have operated a ceilometer (Vaisala CL51) at Dalanzadgad, which is located in the central part of the Gobi Desert [4, 5]. The ceilometer uses a lidar system with a laser of a single wavelength. This study aims to reveal the spatial distribution of the dust by using a new network of the AD-net lidars and the ceilometer.

A dust event occurred in the Gobi Desert on 22–23 May 2013. The strong wind (~16 m/s) was generated by a developing low pressure system with a cold front. The cold front extended from northeast to southwest and moved southeastward. It passed Dalanzadgad, Sainshand, and Zamyn-Uud in this order. At three sites, a dust layer shown by large attenuated backscatter coefficient extended from the ground surface to a height of about 2 km above ground level (AGL). During the dust event, the cold front passed, and a cold air mass replaced a warm air mass. The maximum top height of the cold air mass was less than 2 km AGL.

Some dust floated along the surface of the cold front over the cold air mass. It is suggested that the dust was transported by a warm air ascending along the surface of the cold front (a warm conveyor belt) in the cold frontal system. The warm conveyor belt was validated by trajectory analyses. At Dalanzadgad, the floating dust was observed around a height of 1.2 km AGL, and its amount was small. At Sainshand and Zamyn-Uud, the dust reached a height of 4 km AGL, and mixed with clouds. These results suggest that the dust was transported to a higher height by the warm conveyor belt while the cold frontal system moved through the Gobi Desert. The dust reached the free troposphere and can be transported over a long range by the westerlies. The warm conveyor belt in cold frontal system is a mechanism to transport dust from ABL to the free troposphere. This work was supported by JSPS Core-to-Core Program (B. Asia-Africa Science Platforms).

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PRIMARY MEASURES FOR PARTICULATE MATTER EMISSION REDUCTION IN BIOMASS COMBUSTION SYSTEMS – AN OVERVIEW

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The Ambient Air Quality Directive (2008/50/EC) identifies the impact of ambient particulate matter (PM) on health effects and defines threshold levels for PM in the ambient air. One important source for PM is the utilisation of biomass in small-scale residential heating systems (RHS) for room heating and domestic hot water supply. For RHS a broad variety of biomass combustion systems is presently available. Thereby boiler systems as well as different types of stoves can be distinguished. Even if during the last years a significant increase of new installations of modern biomass combustion systems has been recognised, in most European countries the current stock of applications is dominated by old systems. This leads to the situation that residential biomass combustion in many European regions is one of the main sources for PM_{10} and $PM_{2.5}$ emissions and strongly indicates the huge potential for PM emission reduction that can be achieved by the substitution of old by modern systems in the residential heating sector.

PM emissions from biomass combustion are categorised into coarse fly ashes and aerosols (PM_1), whereby aerosols are generally dominated in the PM fraction from modern small-sale biomass combustion systems. While coarse fly ashes will be formed by entrainment of fuel, ash and charcoal particles from the fuel bed with the flue gas the formation of aerosols is more complex. These aerosols can be divided in inorganic aerosols as well as organic (condensed hydrocarbons) and soot (elemental carbon) particles. Inorganic aerosols are built from volatile and semivolatile ash forming elements and represent a fraction which is mainly influenced by the chemical composition of the fuel used. On the other hand soot and condensed hydrocarbons are a result of incomplete combustion and poor burnout conditions. Old biomass combustion systems show, due to their low technological level, significantly higher PM as well as gaseous emissions than modern systems. This not only concerns their magnitude but also the chemical composition. It has to be mentioned that aerosols from old biomass combustion systems are dominated by organic and soot compounds while aerosols from modern biomass combustion systems mainly consist of inorganic salts. Furthermore, organic and soot particles are indicated to be more harmful for human health as inorganic salts. In the last years comprehensive R&D work has been performed in many European countries with the result of a strong improvement of small-scale biomass combustion systems leading to minimised gaseous as well as PM emissions. In addition higher efficiencies of the systems have been achieved. Within this work an advanced understanding of formation mechanisms as well as the influence of combustion conditions on the health effects of PM emission has been obtained. Because of this better knowledge a more focused development for low dust concepts is possible.

When developing low dust concepts for small-scale biomass combustion systems the reduction of coarse fly ash emissions forms a first step. This can be achieved by optimised grate and primary combustion zone geometries as well as by appropriate separation zones. For the reduction of PM_1 emissions an optimisation of the burnout quality is required. Air staging forms the basis for modern low-emission combustion concepts in all capacity ranges. The separated distribution of primary and secondary combustion air in different zones leads to an improved mixing of the combustion air with the flue gases as well as sufficient residence time of the flue gases in the combustion chamber at high temperatures. This leads to a reduction of PM emissions, especially organic and soot particle formation is minimised. To inhibit the release of ash forming elements (mainly K) from the fuel to the gas phase and to further reduce inorganic aerosol formation, the fuel bed temperature has to be kept as low as possible. This can be realised by extreme air staging strategies as well as application of flue gas recirculation through the fuel bed. In order to develop optimised geometries (grate, combustion chambers, etc.) as well as air staging and extreme air staging concepts computational fluid dynamics (CFD) simulations have become an important, time and cost saving, tool. For all measures mentioned before it is of great relevance that the process control system meets the requirements of the combustion system in all operation phases, especially during partial load and transient operation phases. Furthermore, the application of advanced control systems (model based control, etc.) is recommended to ensure high burnout quality in all phases. The correct dimensioning of the combustion as well as the heating system (buffer management, etc.) leads to a minimisation of start-up and shut-down procedures as well as prevent partial load operation aiming in a reduction of PM emissions. Avoiding operating errors (usage of inappropriate fuels, incorrect air distribution control) by adequate user training, clear instruction manuals and information are also very simple and cost efficient primary measures for PM reduction.

In conclusion, the optimisation of operation parameters by primary measures showed a big potential for innovative and cost-efficient PM emission reduction techniques. Nevertheless, further R&D to fulfil future international and national legal requirements, in particular for low dust concepts, is recommended.

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SAHARAN DUST AS A CAUSAL FACTOR OF SIGNIFICANT CLOUD COVER ALONG THE SAHARAN AIR LAYER IN THE ATLANTIC OCEAN

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Previous studies showed that, over the global ocean, there is no noticeable hemispheric asymmetry in cloud fraction (CF). This contributes to the balance in solar radiation reaching the sea surface in the Northern and Southern hemispheres. Despite the fact that, over the global ocean, there is no noticeable hemispheric asymmetry in cloud fraction, over the significant area such as the tropical Atlantic the hemispheric asymmetry in CF takes place. The tropical Atlantic (30°N – 30°S) is frequently affected by Saharan dust intrusions. Based on MODIS cloud fraction (CF) data during the ten-year study period, we found that these dust intrusions contribute to significant cloud cover along the Saharan Air Layer (SAL) [1, 2]. The area of SAL with significant CF is characterized by limited precipitation. This indicates that clouds along the SAL are not developed enough. The temperature inversion below the SAL base prevents deep cloud formation; this explains limited precipitation in these zones. On the other hand, meteorological conditions below the temperature inversion at the SAL base include significant atmospheric humidity and the presence of large amounts of settling dust particles together with marine aerosols. As known, aerosol species often combine to form mixed particles, with properties different from those of their components [3]. Mineral dust particles are known to be not very efficient cloud condensation nuclei (CCN), unless they are coated with soluble materials [3]. Airplane measurements showed that dust transport over the sea could lead to sea-salt coating on dust particles [4]. Coating settling dust particles with sea-salt could modify them into efficient CCN. Being below the temperature inversion and acting as efficient CCN, Saharan dust particles coated with sea-salt contribute to the formation of shallow stratocumulus clouds. This physical mechanism, based on the influence of Saharan dust on stratocumulus clouds below the temperature inversion, could explain the observed significant cloud cover (CF up to 0.8 – 0.9) along the Saharan Air Layer [2]. The significant cloud fraction along the SAL together with clouds over the Atlantic Inter-tropical Convergence Zone contributes to the 20% hemispheric CF asymmetry between the tropical North and South Atlantic. This leads to the imbalance in strong solar radiation, which reaches the sea surface between the tropical North and South Atlantic, and, consequently, affects climate formation in the tropical Atlantic. Saharan dust is also the major contributor to hemispheric aerosol asymmetry over the tropical Atlantic. The NASA GEOS-5 model with aerosol data assimilation was used to extend the MERRA reanalysis with five atmospheric aerosol species (desert dust, sulfates, organic carbon, black carbon, and sea-salt). The obtained ten-year (2002 – 2012) MERRA-driven aerosol reanalysis dataset (aka MERRAero) showed that, over the tropical Atlantic, when the hemispheric asymmetry in dust aerosol optical thickness (AOT) was the most pronounced (particularly in July), dust AOT averaged separately over the tropical North Atlantic was one order of magnitude higher than that averaged over the tropical South Atlantic [1]. Dust and carbonaceous aerosols were distributed asymmetrically relative to the equator, while other aerosol species were distributed more symmetrically.

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PARTICLE FLUXES IN THE ATLANTIC OCEAN AT 12°N

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Particle export of organic matter is an important mechanism for the sequestration of atmospheric CO_2. In tropical oceans, particle fluxes are considered to be rather low due to low productivity as a result of low nutrient inputs. However, productivity is enhanced by Saharan dust deposition, river discharge, and nitrogen fixation. This brings both refractory lithogenic material and new nutrients into the system, affecting primary production and particle export that transfers CO_2 from the surface into the deep ocean.

In order to determine the particle fluxes involved, an array of sediment traps were moored at 1200 m and 3500 m depth from October 2012 until November 2013, at five stations along a transect at approximately 12°N latitude. Seven sediment traps were recovered and particle fluxes were analysed and determined i. e. in their organic matter, biogenic carbonate, biogenic silica and lithogenic content. In general, the highest total mass fluxes are found at the stations M1 (23°W) and M5 (57°W), which are the stations closest to the African and South American continent, respectively. Lowest total mass fluxes were found at station M2 (37.5°W), which is slightly shifted to the north from the 12^0 transect. However, $\delta^{15}N_{tot}$ values show a decreasing trend from around +3‰ proximal to the African continent to almost 0‰ in the distal western Atlantic, suggesting an increasing contribution of nitrogen fixation with accompanying new nutrients to the ocean. Here, at station M4 (49°W), two large peaks appear in the particle fluxes at both 1200 m and 3500 m depth, one in spring (second half of April), dominated by biogenic carbonate, and the other by biogenic silica in fall (late October/early November). The fall peak appears to be sourced in the Amazon River more than 1000 km from the mooring site – causing a bloom of diatoms. The spring peak appears to arise due to changing seasonal conditions; rising SST possibly combined with dust deposition, causing a spring bloom. Both peak fluxes are associated with elevated organic and lithogenic fluxes. In general, lithogenic fluxes decrease from station M1 to station M3 (38°W), and increase again from station M3 to station M5. While the lithogenic fractions of stations M1 to M4 are dust influenced, station M5 is most likely affected by the Amazon and Orinoco River dispersal.

Overall, the particle mass fluxes are similar in composition. For organic matter, the correlation with the lithogenic fraction is strongest and is increasing from east to west. This implies an interaction between both components through a potential ballasting effect on organic carbon export accompanying CO_2 sequestration.

See also: www.nioz.nl/dust

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DUST SEDIMENTATION RATES IN LOESS-SOIL FORMATION OF CASPIAN DEPRESSION AND ITS CORRELATION WITH THE LATE QUATERNARY TRASGRESSIONS AND REGRESSIONS OF THE CASPIAN SEA

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As part of the study of the history of the Caspian Sea in the Late Pleistocene and for the last few years we focused on understanding the structure of loess-soil series of the Lower Volga region, in particular the reference section of Srednyaya Akhtuba. It is well known that throughout its history the Caspian Sea was characterized by unsustainable levels, which resulted in frequent changes of transgressive and regressive basins [1]. The structure of the Quaternary deposits of the Caspian is characterized by alternating marine and continental deposits [2]. Continental deposits of the northern coast of the Caspian Sea within the Caspian lowlands are of alluvial and aeolian genesis. The most interesting and lasting stage of active formation of loess-soil deposits (by aeolian sedimentation) is characterized by time of Atelian regression [3], when here on the dried sea terrace in arid climate condition existed steppe landscapes [4].

In the studied section of Srednyaya Akhtuba (located on the left bank of the Volga River, near the city of Volgograd) in its middle part is opened thick layer of continental deposits represented by eight meter typical loess formation [5] , passing at the bottom to interbedding horizons of buried sols (up to 1.3 m) and loess (up to 0.4 m). In the study, a series of samples were picked for a number of analyzes. We obtained the first dating results by optically stimulated luminescence (OSL). Thus, the upper limit of Atelian deposits are characterized by age of 25-30 thousand years (3 samples), while the age of the first determined buried soil is 120 thousand years (two samples). Thus, the Caspian depression for nearly 80-90 thousand years existed in dry arid conditions, with dry-steppe landscapes. These new materials have allowed for the first time to obtain a reasonable absolute OSL age of Atelain sediments. After determining the absolute age of another15 samples from the eight-meter thickness of continental deposits of Atelain horizon we will be able to estimate the rate of aeolian sedimentation in Late Quaternry of Northern Caspian.

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EXPERIMENTAL STUDY OF THE EFFECT OF SHOE TYPE ON WALKING-INDUCED RESUSPENSION

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Human occupant is known to be a source of indoor particulate matters mainly due to walking-induced resuspension. Many recent studies have focused on the effects of activity level, flooring type and relative humidity, while the effect of shoes has received little attention. The numerical simulation presented by Zhang et al. (2008) suggests that shoe groove depth has substantial impact on particle resuspension. The present study is the first to investigate the shoe effect experimentally. The goal of this study is to investigate the effect of shoe groove patterns (horizontal grooves, vertical grooves and no groove) along with flooring materials (tile, PVC flooring and carpet).

The experiments were conducted in a controlled environmental chamber with a human participant who performed stomping activity. Flooring samples were soiled with 6 g m^{-2} of ISO 12103-1 A1 Ultrafine Test Dust prior to each experiment. Stomping-induced air velocity at 6 locations along the edge of the shoe, airborne particle concentrations and electrical charges carried by airborne particles were measured. Resuspension fractions were estimated using a two-compartment mass balance model, described by Qian et al. (2008). For all flooring materials tested, no groove shoe was associated with highest average stomping-induced air velocity and resuspension fraction. For shoes with a grooved pattern, higher air velocities were observed in locations parallel to the groove direction. Carpet exhibited higher resuspension fraction than tile for 8-10 micron particles. Different polarities were observed. Airborne particles resuspended from carpet were negatively charged while those from tile and plastic floor were positively charged.

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LOESS-PALEOSOL SEQUENCES AT THE NORTHERN EUROPEAN LOESS BELT IN GERMANY: DISTRIBUTION, GEOMORPHOLOGY AND STRATIGRAPHY

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Pleistocene loess is distributed along the mountain front of the Central European Mountain Belt in northern and central Germany and its adjacent areas. Examples from two regions, the Lower Rhine Embayment and the northern foreland of the Harz Mountains, show, that the distribution of loess and the development of loess-paleosol sequences (LPS) are controlled by relief, climate, tectonics, the distance to larger river system, and the distance to the Scandinavian ice sheet. In addition, more oceanic climate in the west versus continental climate conditions in the east also influenced the LPS. For both key areas new loess distribution maps are presented and key sections especially for the last glacial cycle are compared and summarized.

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DUST SOURCES AND DUST SINKS IN THE MOUNTAINS OF CENTRAL AND HIGH ASIA

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In the mountain areas surrounding the deserts of Central Asia aeolian mantles composed mainly of silt and sandy silt are widespread. Their distribution and relation to environmental and geomorphological conditions were described in previous paper [1, 2 and references therein]. The origins of silt-sized particles are the glaciers and paleoglaciers in the mountain regions. In addition, dry river beds may represent local sources especially for coarser grain sizes and (paleo)lakes for silty and carbon enriched materials. , Fine silt can be transported as far travelled dust especially by the Westerlies e.g. in the Qilian Shan [3]. Most of these aeolian mantels in Mongolia [4] and southern Tibet [6] date to late glacial and early Holocene times. These fluctuations are synchronously with cold - arid and warmer - more humid climatic conditions. However, in the Qilian Shan, the northernmost north-eastern Tibetan Plateau, a continuous accumulation of loess has been observed due to the proximity to dust sources. In contrast, in the other parts of north-eastern Tibet, no common signal in the timing of the loess deposition has been observed. While in the area of the Qinghai Lake loess deposition occurred mainly during the late glacial and the early Holocene in the nearby Qaidam Basin accumulation took place during the middle to late Holocene. Varying (local) source areas and different moisture conditions as important sediment suppliers are responsible for the variable pattern.

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MONITORING OF BIOCIDES IN THE AIR AND DUST OF THE NATURAL HISTORY MUSEUM IN ROUEN (FRANCE)

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For more than 100 years, organic and inorganic biocides have been used for preservation of collections of natural history museums. Indeed, these organic material are susceptible to insect and fungal attack. Thus, both organic biocides such as DDT, lindane, paradichlorobenzene, formaldehyde [1]), and inorganic compounds such as arsenic trioxide or mercuric chloride ($HgCl_2$) [2] have been used. This may represent a risk for staff as they may be exposed to these substances by skin contact, ingestion of dust or by inhalation volatiles compounds or airborne particles. In this work, we present the results from a monitoring of these biocides in the air and dust of the Natural History Museum of Rouen (Normandy, France).

Concerning organic biocides, active air sampling was performed using adequate sorbent (charcoal, XAD-2, silica-DNPH) as well as quartz fiber filter for collecting both the gas phase and airborne particle. The sorbent and filter were extracted with solvents and analyzed by GC/MS. Concentrations up to 38.9µg/m^3 (paradichlorobenzene), 31.5 µg/m^3 (DDT/DDD), 56.1 µg/m^3 (formaldehyde) were measured. However these values remained below reference regulatory limits (OSHA PEL TWA). Dust samples were collected using vacuum cleaner and extracted with solvent prior to GC/MS analysis. Concentrations in dust were high especially for DDT/DDD (158-968 mg/kg) and less for Lindane (up to 1.5 mg/kg). However, considering a daily intake of 100 mg of dust per day, these value remains below the tolerable daily intake values for these substances.

Regarding inorganic element, airborne particles were sampled on cassettes holding glass microfiber filter, filters were then digested with acids under microwave irradiation and solutions were analyzed by ICP-OES. Only arsenic concentrations in the air were regularly over the recommended value of 2µg/m^3 (NIOSH REL TWA). Dust sample were also analyzed after digestion by ICP-OES analysis. They were most often contaminated with arsenic and lead (0-1.85 mg/kg for arsenic and 0-60 mg/kg for lead). For arsenic, considering an intake of 100 mg dust per day, this lead to daily intake values regularly close to the $BMDL_{01}$ values of 0.3 µg/kg/d b.w. day thought to cause lung cancer. For lead, when detected, all values were above the $BMDL_{01}$ value of 0.5 µg/kg/d b.w. thought to be causing developmental neurotoxicity. Regarding lead, this contamination is likely to be due to the use of lead-paint in the Museum. In the gas phase, Hg(0) was also analyzed using an atomic mercury analyzer, highest concentrations were measured in the herbarium storage area (0.15-0.20 µg/m^3) with peak value up to 1.1 µg/m^3 when dusting was performed. Nevertheless mean concentrations of Hg(0) remained below the recommended value of 1µg/m^3 for a chronic exposure (WHO) and well below the reference regulatory limits of 50 µg/m^3 for workers (OSHA PEL TWA).

In conclusion, it was shown in this study that the concentrations in the air of the studied substances are below regulatory limits except for dust where they have been regularly found close or over the recommended limits. Moreover, this study helps to better understand the risk associated with this pollution and to implement preventive actions such as wearing protective equipment for the staff (gloves, masks and gowns) when dusting specimens or premises.

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MIGRATION OF ORGANOPHOSPHORUS FLAME RETARDANTS FROM CLOSED CELL FOAM TO SETTLED DUST

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Many industrial and consumer products, such as electrical and electronic products, furniture, plastics, textile, and building materials are manufactured with organophosphorus flame retardants (OPFRs). OPFRs can leach or diffuse out of the products and are released to the surrounding air and accumulate in indoor dust, leading to human exposure. OPFRs, including tris(2-chloroethyl) phosphate (TCEP), tris(1-chlor-2-propyl) phosphate (TCPP), and tris(1,3-dichloro-2-propyl) phosphate (TDCPP) are semi-volatile organic compounds (SVOCs) and are U. S. Environmental Protection Agency (EPA) action plan chemicals for chemical assessments under the Toxic Substances Control Act (TSCA). Due to their physiochemical properties, these OPFRs attach to dust particles on indoor surfaces and airborne suspended dust and partition between gaseous and particulate phases. Limited information is available on the mechanisms through which OPFRs migrate from products into dust on the surface of products. This research studied the transfer of TCEP, TCPP, and TDCPP from polyisocyanurate rigid polyurethane foam (PIR-PUF) to settled house dust on the foam surface through direct contact. The house dust was obtained from household vacuum cleaner bags that were collected in 2000-2001 during U. S. EPA's Children's Total Exposure to Persistent Pesticides and Other Persistent Organic Pollutants (CTEPP) study. The house dust was irradiated to eliminate microbiological activity, sieved with 150 μm sieve, and then conditioned at 160°C to remove quantifiable TCEP, TCPP, and TDCPP before use. The organic carbon (OC) was 20.11 ± 0.56% (w/w) and total carbon was 20.83 ± 0.48% (w/w) by thermal-optical analysis (TOA). The mean particle size was 67.88 ± 0.21 μm with the range from 0.92 to 259.75 μm and the surface area was 3.60±0.02 m^2/g. The PIR-PUF was made by ICL Industrial Products with 0.5 % of total flame retardants (TCEP/TCPP/TDCPP) in the foam. Seven OPFR-containing PIR-PUF pieces (15 cm x 3 cm x 1.1 mm) and seven OPFR-free aluminium foil pieces (15cm x 3 cm x 0.04 mm) were placed in a 53L stainless steel small chamber at 1 air exchange rate (ACH) and 50% relative humidity (RH). Each piece of PIR-PUF and aluminium foil was loaded with about 0.1 g of house dust as evenly as possible. During the test, pieces were removed from the chamber at different times and the dust was collected and extracted to determine its OPFR content. The test lasted for 480 hours. The results show that the OPFR concentrations on the dust from OPFR-free aluminium foil were all below the instrument detection limit and those on the dust from OPFR-containing PIR-PUF were increased steadily over exposure time. The migration due to dust/source partitioning was not significantly affected by the volatilities of the OPFRs. The OPFR dust/PIR-PUF partition coefficients were estimated by the ratio of the migration concentration of OPFRs in the house dust at the end of the test to its concentration in the source, which are found to be 1.76×10^{-3}, 3.40×10^{-3}, 3.74×10^{-3} for TCEP, TCPP and TDCPP, respectively. This study should shed light on the correlation of OPFR concentrations in settled dust and the surface material. Other work is undergoing to better characterize the factors that affect the degree of migration of OPFRs on dust. The results could help to fill the data gaps required for interpreting the exposure data and for risk assessment.

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SAHARAN DUST IMPACT IN CENTRAL ITALY: COMPARISON OF THE EU METHOD WITH QUANTIFICATIONS BASED ON THE PARTICULATE ELEMENTAL COMPOSITION AND PMF ANALYS

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In southern Europe, Saharan dust may give a significant contribution to PM. The European legislation allows the subtraction of natural aerosol to fulfill the PM10 standards; different approaches have been proposed to assess this contribution, by both model-based methods and PM time series analysis. Specific EU Guidelines provide the Member States a common protocol: it first requires the identification of all days affected by Saharan intrusions; the net African dust contribution is then calculated from the PM10 concentration values measured in rural background sites during Saharan-days by subtracting a regional background level.

However, as the impact of desert dust is characterised by an increase of all soil-related elements and changes in elemental ratios, field campaigns followed by elemental analysis can be very accurate and reliable methods to assess the real contribution of these episodes at the ground level. In this context, the detection with very high sensitivity of all the crustal elements makes Particle Induced X-ray Emission (PIXE) a very effective tool.

Since 90s, several sampling campaigns were carried out by the authors in Tuscany (central Italy), and long time series of elemental concentrations were obtained by PIXE. A review of these data was accomplished with the aim of identifying the occurrence of Saharan dust transport episodes over long periods and characterising them in terms of composition and impact on PM concentration, tracing back their contribution to the exceedances of the PM10 limit value. The Saharan dust net contribution was assessed following the approach described in Nava et al. (2012): the mineral dust component is first calculated using the oxide formula (corrected for sea salt and possible anthropogenic contributions); the net African dust contribution is then calculated on the identified Saharan episodes by subtracting an estimated soil dust background. As collected samples were analysed by several techniques, thus obtaining an extended chemical speciation, receptor modelling (namely PMF, Positive Matrix Factorisation) was also applied to identify aerosol sources and quantify their contributions. In most of the cases, PMF successfully separated the Saharan dust factor from the local dust one, thus allowing the quantification of the impact of desert dust on PM10 concentration.

In this work, results obtained by different approaches (EU method, elemental composition + oxide formula with soil dust background subtraction, extended chemical speciation + PMF) are discussed and compared. It is worth noting that the EU method has been tuned, validated and widely applied in Spain, but its “exportability” to other regions is still under debate. In particular, one key point of this approach, i.e. the selection of a proper network of rural background stations, is particularly critical in Italy where many rural stations are “near-city” stations and may be affected by different anthropogenic contributions. In this contest, the comparison with different method, based on PM elemental composition, is particularly useful and may be used to tune (selection of the best regional background network, choice of the best percentile), improve and validate the EU procedure.

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SIMULTANEOUS DETERMINATION OF CHEMICALS IN INDOOR DUST FOR POTENTIAL HUMAN EXPOSURE ASSESSMENT

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Human exposure to indoor contaminants is becoming a relevant concern considering the huge amount of time people spend indoor and the growing number of emerging chemicals that are used in a wide variety of products such as additives[1] (e.g. plasticizers, polymer property modifiers, filler, stabilizers, flame retardants, surfactants) in plastics, electronics, building materials, furniture, textiles and cleaning products. The role that dust plays in the human exposure to indoor contaminants is of a paramount importance since it has been identified as a significant carrier of organic contaminants[2] including flame retardants (FRs), perfluorinated substances (PFASs), organophosphate esters (OPEs), phthalate esters (PEs), polychlorobiphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), pesticides and synthetic musks[3].

Because a broad range of compounds are present in dust, we developed an analytical method for the simultaneous determination of the aforementioned classes of chemicals but also for screening other suspects and unknowns. Ultrasonic extractions with mixtures of hexane and acetone at different percentages were tested to evaluate the most efficient extraction condition for the selected compounds. In order to reduce the matrix complexity, the extraction was followed by an automatic purification step carried out by separating the extract into five fractions of increasing polarities using a Gilson GX-271 ASPEC™ system. Silica SPE cartridges (particle size 40 µm, 60 Å pore diameter, 500 mg/3 mL) were used with a non-destructive clean-up to ensure that target chemicals were not degraded. The fractions were analysed by GC-MS and LC-MS. The developed extraction and fractionation method was validated by recovery tests and the feasibility of the procedure was assessed through the analysis of a standard reference material for dust (SRM 2585) which contains a considerable number of organic contaminants. The application of the method was finally tested on real dust samples from vacuum cleaner bags. Samples were collected in 2014 in the Oslo area (Norway) within a sampling campaign conducted by the European A-TEAM project (Advanced Tools for Exposure Assessment and bioMonitoring). The cohort involved 60 participants, from whom samples relevant to external exposure (food, hand wipes, indoor air and house dust) and internal exposure (blood, urine, hair, fingernails and saliva) were collected with the aim to identifying how and to what extent we are exposed to consumer chemicals, and how we can best monitor their presence in the body, the food and the indoor environment.

Suspect and non-target screening of the dust fractions by GC and LC coupled to high resolution time of-flight MS was performed. Both ESI and APCI sources were used. The identification of the compounds was performed by "Multi target screening analysis" instrument software in which the identification of compounds is based on accurate mass, isotopic pattern and retention time. Obtained results will be utilized in a modelling exposure assessment study.

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WASTE BURNING AEROSOL IDENTIFICATION IN RESIDENTIAL WOOD COMBUSTION AREA

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Estonia's health impact assessment study showed that due to fine PM in ambient air the life expectance has shortened up to 13 months, with the highest decrease in city centers or areas with extensive domestic heating [1]. During domestic heating often incomplete combustion occurs, where organic material in the presence of chlorine causes the formation of chlorinated organic by-products, such as polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs), and hexachlorobenzene (HCB) [2]. Trash burning can also be an important organic aerosol source. Currently, this source is not included in most emission inventories, and there are only a few studies available [3]. As Estonia has a well organized municipal solid waste systems it can be assumed, that people are not burning waste to dispose of it, but it could be considered more as a habitual behaviour. According to the members of Chamber of Chimney Sweepers evaluation, in addition to the wood, paper and cardboard waste, people also tend to burn Tetra Pak's, sanitary napkins, diapers, various plastic packages, shoes, textile etc. According to the Estonian Environmental Inspectorate, it is difficult to assess the exact number of people who still practice burning household waste since such activities are done clandestinely. Taking into account that wood and wood chips account > 90% of the fuel used for residential heating, than burning waste can be an important contributor to particle pollution and the issue is an important topic to address.

For measuring PMx particles emitted during waste combustion in household stoves, emission tests were carried out in the Estonian Environmental Research Centre's (EERC) stove laboratory. To evaluate the time series of burned household waste, the amount of municipal solid waste generated in five year intervals starting from 1990 and ending with 2013 was applied to the mixed municipal waste sorting experiments from years 2002, 2007/2008 and 2012/2013. To generate real-life situation hardwood was combusted together with household waste. PMx measurements included both filter and online sampling with ELPI+ (10 l/min) and ELPI (30 l/min) (Dekati Ltd). In addition an investigation of aerosol chemical composition in ambinet air in Tartu (Estonia) using Aerodyne Aerosol Chemical Speciation Monitor (ACSM) was conducted. The measurements were carried out in 2014-2015, with the measurement point near to roadway and residential wood combustion (RWC) area. The ACSM measured non-refractory PM1 chemical composition (Org, SO4, NO3, NH4 and Chl) with a time resolution of 30 min. The TSI Aerodynamic Particle Sizer (APS) was used to measure particle number size distributions between 0.5 and 20 µm aerodynamic diameter with a time resolution of 30 min. 7-wavelength aethalometer (MAGEE Scientific, model AE33) were used for black carbon (BC) determination. Aethalometer collects aerosol particles on a quartz fiber filter and measures the resulting light attenuation at 370, 470, 520, 590, 660, 880, and 950 nm. Additionally, gas concentrations (NO, NO2, CO, CO2,), ambient air temperature (°C), relative humidity (%),wind speed (m/s) and direction were measured during the whole campaign. In addition metals (As, Cd, Sb, Sn) and organic waste burning tracers (phthalic and terephthalic acids) were analyzed from the high-volume PM2.5 filters.

For investigating the potential sources of measured particles, positive matrix factorization (PMF) was performed using SoFi 5.1 software [4] for the ACSM data. Five factors were identified according to the m/z ratio - biomass burning aerosol (BBOA, m/z 29, 60, 73), oxidized organic aerosol (OOA, m/z 43, 44), hydrocarbon-like organic aerosol (HOA, m/z 27, 41, 43, 44, 55, 57, 69, 71), cooking aerosol (COA, m/z 41, 43, 55, 57) and plastic burning aerosol (PBA, m/z 43, 55, 69). From the high-volume PM2.5 filters waste burning markers were identified.

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LIDAR RETRIEVAL IMPACT ON FU-LIOU-GU RADIATIVE TRANSFER MODEL

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The aerosol and cirrus cloud impact on climate change is still not well characterized and it is one of the major uncertainties. This impact is typically evaluated in terms of enhancement or reduction of the radiative energy (or heat) available in the atmosphere and at the Earth's surface, through the use of radiative transfer models (RTM). RTM evaluate the radiative forcing (RF) only on a local basis as the thermodynamic profile of the atmosphere and other parameters are required as input for a given location at a certain time.

In some previous works, the dust aerosol forcing was evaluated assuming an exponential vertical dependence of the aerosol layer, up to a certain user defined cut-off point (Gu et al. 2011). This introduces a large source of error that can be eliminated measuring directly the aerosol vertical profile using an aerosol lidar. The aerosol vertical profile is an available output also from the numerical weather prediction models, but still the accuracy is poor (Lolli et al., 2014), introducing then large errors in the radiation budget calculations. Nevertheless, lidar measurement still have uncertainties that are depending on the used lidar technique, the instrument experimental setup, and the applied retrieval method.

The purpose of this work is to quantify the sensitivity of the Fu-Liou-Gu (FLG; Fu and Liou, 1992; Gu et al., 2011) RTM to estimate the aerosol-cloud net radiative forcing using different lidar instruments/algorithms/techniques applied to the retrieval of the extinction coefficient, used as input parameter of FLG. The sensitivity analysis is carried out calculating the radiative forcing both from simulated synthetic lidar data with different noise level and effective vertical resolutions and from real lidar data measurements. Results of the sensitivity analysis on the RF estimation will be quantitatively discussed.

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POTENTIAL EXTERNAL CONTAMINATION OF PNEUMATIC SEED DRILLS DURING SOWING OF DRESSED MAIZE SEEDS

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The use of pneumatic drills in maize cultivation has helped raise the quality of sowing and ensure higher productivity, but it has caused dispersion in the atmosphere of some harmful substances (neonicotinoids) normally used for dressing maize seeds. Some of the dust particles released in the airstream from the fan may also be deposited on the machine's external surface, becoming dangerous for the environment and for operators. The aim of the present study was to analyse the amount of dust coming from the seed dressing, which can be deposited on the frame of pneumatic seed drills during maize sowing operations. Tests were performed with different drills and in different operating conditions.

Data analysis showed that a significant amount (up to 30%) of the tracer can be deposited on the drill body. When the wind was not present (tests carried out in the field in static position and in dynamic conditions), higher quantities of tracer were collected and the forward speed did not influence significantly the tracer deposit on the seed drills. In contrast, the presence of the wind can reduce the tracer deposit on the frames of the seed drills. The use of different devices that were designed to prevent dust dispersion were able to limit up to 95% but was not able to eliminate the external contamination of the seed drill.

The particles present on drills could become a serious problem for the operator during the filling of the drill because farmers generally do not use any personal protective equipment for this operation. Additionally, the environment can be contaminated if pesticide remains on the drill, generating point source pollution when the drill is parked outside and is subjected to rainfall.

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DUST DEPOSITION AND MIGRATION OF THE INTERTROPICAL CONVERGENCE ZONE THROUGH THE LAST GLACIAL CYCLE IN THE CENTRAL EQUATORIAL PACIFIC

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Atmospheric mineral aerosols (windblown dust particles) have the potential to affect Earth climate processes, ranging from enhancing the albedo to increasing export productivity (i.e., carbon export) in the deep ocean. Deep-sea sediments are good repositories for information relating to dust delivery and provide clues for reconstructing changing sources and pathways of dust deposition. Such reconstructions yield important information about changes in atmospheric circulation and how they relate to changes in climate. The Intertropical Convergence Zone (ITCZ), a zone of maximum precipitation which follows the thermal equator over the tropical ocean, likely behaves as a barrier that prevents the major part of northern-hemisphere-sourced dust from being supplied to the southern hemisphere, and vice versa. Hence, if northern- versus southern-sourced dust in equatorial sediments can be traced, we should be able to track the location of the ITCZ and its migration through ice-age climate transitions.

We examine variations in dust deposition during the last 25,000 years in the central equatorial Pacific. During this interval, the Earth's climate shifted from full glaciation to the current relatively stable and warm Holocene epoch. The study area is a location where modeled dust fluxes are poorly constrained and where the ITCZ is well defined, with minimal continental influence, and a diminished magnitude of changes associated with the El Niño-Southern Oscillation (ENSO). Using analyses of radiogenic isotopes in sediments, we assess the changing provenance of sedimentary dust through time and, therefore, the degree to which shifts in the ITCZ occur. We focus on three cores along a meridional transect at approximately 160° W (0°28' N, 4°41' N, and 7 °2'N). By measuring the radiogenic isotope ratios of neodymium (Nd) and lead (Pb), we are able to successfully distinguish between different potential dust sources in the aluminosilicate fractions delivered to our sites, and how these sources have varied through time. We find evidence for distinct dust sources from Asia and two regions in South America (the Northern Central Volcanic and Southern Central Volcanic Zones). A glacial-interglacial transition in dust sources is most prominently observed in the middle core at 4°41' N. The timing of this transition suggests that the ITCZ in the central equatorial Pacific Ocean had a more southerly position (at least a 2.5-degree shift) during the last glacial and through the entire deglacial period. A gradual shift toward more radiogenic Nd and less radiogenic Pb isotope values throughout the entire Holocene period in all three cores suggests a gradual, rather than abrupt, migration of the ITCZ over the last 10 kyr or so.

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DUST DEPOSITION DURING THE EARLY HOLOCENE ON THE LOESS PLATEAUS OF THE VOJVODINA REGION IN NORTHERN SERBIA

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The Northern Serbian province of Vojvodina is a lowland area encompassing the confluence of the Danube, Sava, Tisa (Tisza), Drava, Morava, Karaš and Tamiš (Temes, Timiş) rivers, which separate several remnant loess plateaus. Loess sediments in the Vojvodina region are among the oldest and most complete loess-paleosol formations in Europe. These thick sequences contain a detailed paleoclimatic record since the Early Pleistocene. The better preservation of Serbian loess-paleosol sequences compared to other European loess records is most likely related to the continuous presence of much drier conditions in the region and the persistence of stable "plateau" accumulation.

The luminescence chronology of accumulation derived from several loess sections raises has started to address the timing of the onset of Holocene soil (S0) formation in the region. The chronological results demonstrate a lack of intensive pedogenesis and continuation of Aeolian dust depostion during the Early Holocene in some of the investigated sections at the Titel and Tamiš loess plateaux. This evidence leads to an important question about the validity of previously generalized direct stratigraphic correlations between regional terrestrial environmental archives and global marine and ice core records.

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ICELANDIC DUST AND CRYOSPHERE: EXPERIMENTAL RESULTS ON SNOW AND ICE

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Interaction of dust with snow and ice is of hydrological, environmental and climatic importance via surface darkening and increased melt. For example, Saharan dust can affect the albedo (reflectivity) and long-term mass balance of an Alpine glacier, and Asian dust may induce darkening of Himalayan snow. In the Arctic, Iceland is the most important dust source.

We have found Icelandic dust particles to be highly light-absorbing, similarly to black carbon (BC) particles. However, the spectral signatures, and hydrophilic/hydrophobic properties of Icelandic dust particles of different origin were found to vary.

In this presentation, we give a summary of our Arctic experimental results of the impact of different types of Icelandic volcanic dust particles on snow properties. The presented results focus on work organized by the Finnish Meteorological Institute either outdoors or in the laboratory conditions. We also compare our dust and snow results with the results we have for black carbon (BC) and snow [1, 2].

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PARTICLE ANALYSIS OF INDIVIDUAL SHIPS USING PLUME CATCHING BY THE MEGA-CHAMBER

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International shipping is facing several environmental challenges, both in the form of new harder legislations but also due to an increased public environmental awareness. The allowed maximal fuel sulphur content (FSC) is controlled by the International Maritime Organization (IMO). In sulphur emission control areas (SECA) the FSC was reduced to 0.1% in 2015. As nearly 70% of ship emissions occur within 400 km of coastlines, the reduction of SO_2 emissions will have a substantial effect in coastal areas and harbour cities [1]. This will put a demand on an operational compliance monitoring system. The development of such has been the goal of the project Identification of Gross Polluting Ships (IGPS) at the Optical Remote Sensing group at Chalmers University of Technology. The IGPS-system utilizes state of the art in-situ measurement technologies to monitor the CO_2, SO_2, NO_x and particles emitted in the plumes of individual ships [2]. Using the assumption that all sulphur in the fuel is emitted as SO_2, the measured SO_2 to CO_2 ratio is used to calculate the FSC in the fuel used. However earlier studies have found that 1% to 16% of the sulphur in the fuel is emitted in other forms, possibly SO_4^{2-} in condensed phase [3-7]. Hence the assumption that all sulphur is emitted as SO_2 yields an underestimation of the true sulphur content in the fuel. In order to quantify this, a particle into liquid sampler (PILS) in combination with an ion chromatograph (IC) was used to analyse the SO_4^{2-} to SO_2 ratio of ship plumes passing the IGPS measurement station at Älvsborgsön at the entrance of the port of Gothenburg. However the short presence of the plume has shown to be a problem for the applied particle sampling using a Scanning Mobility Particle Sizer (SMPS) and a Particle-Into-Liquid Sampler (PILS) for which a sampling time of up to 5 minutes in the plume is required. In this work a new method for the preservation of plumes which allows to expand the extraction times from seconds to minutes allowing the use of critically slow sampling and analyse methods. By the use of a large volume fast flow sampling Multiple Exhaust Gas Analyse (MEGA)-chamber together with gas and particle instruments, exhaust plumes from individual ships were sampled and analysed. Particle number and mass concentrations as well as gaseous compounds in the plumes were measured using a state of the art setup of gas and particle instruments. Depending on wind speed and the distance of the ship from the measurement station the dilution and sampling time of the exhaust plume will differ. By the use of the multiple exhaust gas analyse (MEGA)-chamber it is possible to catch a part of the plume to allow a longer sampling period in order to chemically analyse both the gas and particle phase of the exhaust plume. The ranges for the calculated emission factors (EF) were for black carbon (BC): 0.2-1.3 g/kgfuel, sulphate (SO_4^{2-}): 0.2-0.6 g/kg_{fuel}, sulphur dioxide (SO_2): 2 to 18 g/kg_{fuel}, particle number (PN): 0.1-1.9·1016 $\#/kg_{fuel}$ and particle mass (PM): 2.8-6.8 g/kg_{fuel}. Fuel sulphur contents (FSC) of 0.15 to 0.96 % were calculated for the examined ships using these measurements. The obtained results were in line with earlier measurements performed at the same site without use of the MEGA-chamber and compared well with literature studies.

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UPPER MIOCENE SAHARAN PLUME DUST DEPOSITS ON GRAN CANARIA ISLAND: PRELIMINARY RESULTS

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Gran Canaria is regularly affected with Saharan Plume Dust that brings around 15.6 g m^{-2} of **NM**P to the island each year. This sediment covers the soils of the island and part of this is reworked by fluvial processes and ordered in thicker fluvial-lake bodies. The Saharan Desert is the origin of this dust and hence the, plume indicates its presence. We have sampled different fossil soils and detrital sediment in Gran Canaria from around 14.1 Ma to the present day. Eolian quartz was detected by X-ray diffraction and SEM-EDS analysis in soils developed on lava flows and ignimbrites from the Phonolitic-Trachytic Formation (Alkaline Declining Stage of Gran Canaria) with an age of < 9.7 Ma, that is during the Tortonian event (upper Miocene), but not in older deposits (<14.1 Ma). The Tortonian is characterised by a decrease in the distribution and volume of an extensive Antarctic ice sheet and incipient glaciation in the Northern Hemisphere. The high latitudes show significant warming, but some Southern European proxy data (e.g., Southern Spain) also support more arid conditions [1]. Could the dust deposits found in Gran Canaria (<9.7 Ma) be the youngest evidence of Saharan Desert formation? Shuster et al. [2] identified eolian deposits with an age of 7 Ma in the northern Chad Basin, evidence of the desert conditions in the Saharan region; Sneut et al., [3] found similar evidence in an earlier age (ca 8-7 Ma) sediments.

The Saharan region has shifted northward from the southern polar area since the Ordovician (500-440 Ma) to its current position by the Miocene (ca 10-20 Ma) and to its current (16º-32º N) latitudinal and arid conditions (100 ± 50 mm y-1). During tectonic migration emersion (Devonian: 395-345Ma; Triassic: 225-190Ma; Eocene-recent: 50Ma) and marine (Devonian-Permic: 345-280 Ma; Paleocene-Eocene: 65-50 Ma) conditions were present [4]. The paleogeography of the Northern Saharan limits has substantially changed from the Miocene to Holocene [5]. Aside from geographical location, it is necessary to consider tectonic controls in the climate. In this sense, the Paratethis disappearance, the closing of the Panama Isthmus, and current Canarian intensity variations could have contributed to the global climatic oscillations in the Saharan region.

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CONTRIBUTION OF IN-PORT SHIPPING EMISSIONS TO GASEOUS POLLUTANTS AND PARTICULATE MATTER OF DIFFERENT SIZES IN AN ADRIATIC PORT-CITY

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Shipping is one of the transport sectors less regulated, although more than 80% of world trade is transported by ships [1] and its share of total anthropogenic emissions is significant, with effects on climate, human health and air quality, especially in coastal areas. Recent studies [2] demonstrated the effectiveness of implementation of the 2005/33/EC European Directive in reducing the impact of ship traffic on aerosol concentrations at local scale, however, the effect on climate is more uncertain. Detailed information regarding the size distribution of the impacts to particles and their correlation with gaseous emissions is needed to investigate the complex air quality-climate interaction of this source. Much of the literature studies focus on NO_X, SO_2, and particulate matter (PM) emissions while there is a gap of knowledge about the size distribution of emitted particles, especially in coarse fraction.

This study was done in the framework of POSEIDON (POllution monitoring of Ship Emission: an IntegrateD approach fOr harbour of the Adriatic basiN) project (MED 2007-2013). The aim was to estimate the contribution of in-port ship emissions to gaseous atmospheric pollutants and to PM of different sizes in a port-city in South-Eastern Italy (Adriatic Sea), after the enforcement of the low-sulphur fuel EU-Directive. Measurements were taken at high temporal resolution at the Passenger Terminal site in the harbour area of Brindisi (40° 38′ 43.32″ N-17° 57′ 36.39″ E). Data collected by a Mobile Laboratory, were gaseous pollutants (NO_2, NO, O_3, SO_2; 5 min resolution), particle number concentrations (PNC; 1 min resolution), particle size distribution in the range 0.25-32 μm (1 min resolution) and NO_2 and SO_2 flow-rate emissions with a DOAS (Differential Optical Absorption Spectroscopy) remote-sensing system, called GASCOD (Gas Absorption Spectrometer Correlating Optical Differences). The Port Authority provided data of ship traffic and a video camera was used to synchronize all measurements and visually estimate number of vehicles (cars, trucks) during loading/unloading of ships at berth. Characterization of ship plumes in aspect of particle size, gaseous concentrations, duration, ratio NO/NO_2, was performed. The impact analysis [3] was applied separating manoeuvring (arrival/departure of ships) and hotelling (loading/unloading activities) phases. Results showed that the primary contribution to PM_1 and $PM_{2.5}$ was significantly lower with respect to those to PNC for both phases, confirming that the majority of the particles emitted were in the ultrafine size range. Manoeuvring phase was characterized by higher impacts to SO_2, NO, and NO_2 than those to PNC, PM_1 and $PM_{2.5}$. Hotelling phase represented a significant share of the impact for NO, NO_2, PNC but gave a low contribution to SO_2 impact (due to low-sulphur fuel). Ultrafine particles (D_p<0.25 μm) represented 99% of the absolute contribution to PNC in number concentrations but only 18% of the contribution to mass concentrations. The two phases had significant impacts to ultrafine and coarse (D_p>1) fraction while accumulation mode particles (0.25<D_p<1 μm) were mainly influenced by manoeuvring.

The availability of data for 2012 [4] and 2014 allowed to analyse trends in terms of shipping emissions and relative contributions to particle concentrations. Comparison of NO_2 and SO_2 emissions estimated through the emission inventory with those measured with the DOAS system showed a good agreement suggesting that DOAS could be a useful tool for investigating this pollution source.

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ACTRIS FOR COORDINATED LONG-TERM OBSERVATION OF AEROSOLS, CLOUD-AEROSOL INTERACTIONS, AND TRACE GASES IN EUROPE

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The ACTRIS-2 project, funded by Horizon 2020, addresses the scope of integrating state-of-the-art European ground-based stations for long term observations of aerosols, clouds and short lived gases, capitalizing on the work of FP7-ACTRIS. It aims at achieving the construction of a user-oriented RI, unique in the EU-RI landscape for providing 4-D integrated high-quality data from near-surface to high altitude (vertical profiles and total-column) which are relevant to climate and air-quality research. ACTRIS-2 develops and implements, in a large network of stations in Europe and beyond, observational protocols that permit the harmonization of collected data and their dissemination.

ACTRIS-2 represents a fundamental step towards the establishment of the atmospheric component of the Integrated European Observing System and a clear upgrade in services offered to users.

It offers networking expertise, upgraded calibration services, training of users, trans-national access to observatories and calibration facilities, virtual access to high-quality data products. Through joint research activities, ACTRIS-2 develops new integration tools that will produce reusable scientific or technical progresses in infrastructures, thus, shaping future observation strategies. Innovation in instrumentation is one of the fundamental building blocks of ACTRIS-2.

In particular, ACTRIS2 offers the framework for connecting the data collected, archived and made available by ACTRIS2 with current state-of-the-art aerosol/cloud models with assimilation and prediction capabilities on one hand, and climate models on the other. Use of quality-checked aerosol profile data will be set up through case studies and measurement campaigns for evaluation, assimilation and retrospective assessment of the models. The strong link established in ACTRIS2 between observers and modelling communities fosters the cross-fertilization of the 2 domains. New data products are designed and are being implemented in ACTRIS2 for facing the modeller needs.

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INVESTIGATING THE DIRECTIONALITY OF MODERN DUST IN THE ALPINE ZONE OF THE UINTA MOUNTAINS, UTAH, USA

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The Uinta Mountains are a prominent sub-range of the Rocky Mountain system in the western United States. Large areas of the Uintas are above altitudinal treeline, and abundant evidence indicates that long-term dust deposition plays an important role in alpine pedogenesis. To evaluate the extent to which regional sources contribute to the dust flux into the Uinta alpine zone, a specially designeddust sampler was deployed in June 2013 at an elevation of 3700 m asl. A remote weather station operating at this location since 1998 reveals a strongly bimodal wind regime, with winds either from the NNW (dominant in winter) or SSE (summer). Mean monthly wind speeds are highest from January through April (>7 m/s) and lowest from July and August (~4 m/s). Mean wind gusts are highest in April (~25 m/s), coinciding with the seasonalswitch from NNW to SSE wind dominance. Maximum recorded windspeeds are in excess of 45 m/s.The sampler uses solar-powered fans to pull air (~3000 L/m) through a 7.5-cm diameter tube packed with glass beads. A wind-actuated switch connected to a pair of fans allows the collection of separate samples for the two primary wind directions. The collector was emptied in October 2013, July 2014, June 2015, and October 2015. Biannual visits to the site in 2013 and 2015 allowed calculation of discrete summer dust fluxes. In both years, the summer concentration of dust from the SSE was ~2x that from the NNW (80 vs. 45 ug/hr of fan time). In contrast, in the winter 2013-14 concentrations were much greater in the NNW wind (233 vs. 68 ug/hr).These results suggest that SSE winds deliver more dust in summer, and NNW winds deliver more dust in winter. For the 12-month collection representing 2014-15 (not seasonally separated) the overall dustiness of the SSE wind was ~2x greater (192 vs. 105 ug/hr of fan time) suggesting that southerly source dominates on an annual basis. Grain size analysis reveals that samples from both directions are dominated by medium-fine silt (~15 μm), although NNW samples contain a secondary mode of coarse silt (~50μm), giving NNW dust a coarser average grain size (31 μm vs. 19 μm). North dust has considerably more very fine sand and coarse silt whereas SSE dust has more medium silt.XRD analysis reveals that all dust samples contain quartz, illite, K-spar, plagioclase, and amphibole. The summer 2013 sample from the NNW also contains a poorly ordered mineral with wide d-spacing, perhaps smectite or hydobiotite. ICP-MS analysis reveals that many trace elements are more abundant in the NNW or SSE sample depending on the season, although Moand Sn are more abundant from the NNW year round. Dust from both directions has a negative Eu anomaly, and the summer 2013 dust sample also has a negative Ce anomaly.

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THE STUDY OF DUST STORMS IN WEST ASIA USING MULTI-SOURCE DATA

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Countries of Western Asia recently experienced intensified dust storms which are formed in vast desert areas of the region. This study is an attempt to investigate spatial and temporal characteristics of dust storms by using multi-source data including remotely sensed data, simulations and observations. The TOMs-OMI Aerosol Index (AI) is used to designate large-scale limits of dust sources from 1981 to present. Subsequently MODIS deep blue (AOD) is examined to identify locally main dust sources of the region. In order to study the 3D behavior of dust plumes, high-resolution vertical profiles of CALIPSO Vertical Feature Mask (VFM) is used. In addition to satellite measurements, the vertical distribution of dust is simulated by the NASA-Unified (NU) WRF model. Finally, ground-based observations including visibility data, AERONET 550nm AOD and PM10 are used to verify remotely sensed data and simulations.

The long-term analysis of TOMs-OMI AI determined desert areas of Iraq and Saudi Arabia as two main large-scale dust sources of the region. The study of high-resolution MODIS images disclosed newly formed strong dust sources in the middle of Iraq. NU-WRF simulations and CALIPSO measurements indicate that dust plumes are mostly transported in layers below 2km over Mesopotamian lowlands but rise to mid and high atmospheric levels when they enter the mountainous regions of western Iran. Although NU-WRF and CALIPSO managed to depict the 3D distribution of dust particles, they, especially the NU-WRF simulations, show significant disagreements with surface observations. It is worth mentioning that since the surface measurements are mainly subjective (visibility measurements in particular), Thus a high degree of caution should be exercised when using them for validation.

Keywords: Dust Storms, Remotely sensed data, NU-WRF, Ground-based observations, Verification.

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LONG RANGE TRANSPORT OF ASIAN DUST OBSERVED BY USING GROUND AND SATELLITE LIDAR SYSTEMS AT CHUNGLI (25N, 121E)

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Asian dust as the world 2nd largest dust sources affects the global environment and climate seriously through long range transport. In the spring of 2009 and 2010 a few severe dust storms arrived Taiwan as shown by various ground based monitoring stations which measured PM10 indices increase by factors of 10-30 over various cities. In this paper, we report properties of dust for these events observed by using ground lidar and other instruments. A lidar at Chungli has been operating to observed aerosols by using a combined Raman systems at wavelengths 532/355/387/407 nm and polarization lidar at 532 nm. Measurements of backscattering, polarization, lidar ratio, and water vapor simultaneously are compared with ground air quality measurements including particulate matter, pollutant CO, O3, and NOx etc. to show correlations. CALIPSO space lidar data and model studies are also employed for understanding the transport path, weather system and effects on climate and precipitation.

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VIABILITY REDUCTION OF BIOAEROSOLS WITH PRESENCE OF ENVIRONMENTAL DUSTS

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Desert regions continue to discharge large amount of dusts and they circulate around the globe [1]. These desert dusts bring the important minerals to distant area and supply essential elements as nutrients for various trophic levels. In other case, the dust from Saharan desert was suspected to act as carrier for biological components such as fungus across Atlantic Sea to Caribbean sea to cause coral leaf damage [2]. Furthermore, Iwasaka *et al.* reported the presence of nucleic acid on the surface of the dust in China, indicated abundance of some biological components as a part of the dust from desert atmosphere [3]. The aerosols with biological components as bioaerosols can be transported a long distance which may reach downwind and/or surrounding regions to cause possible health effects to human and livestock. Here we present some of laboratory measurements of viability change of bacterial bioaerosols together with different environmental dusts. A single type of dust and model airborne bacteria, DH5α *Escherichia coli*, was used to assess the dust affecting a viability reduction of the DH5α bacteria in a Teflon reaction chamber. The viability reduction of the DH5α model airborne bacteria were measured with a culture method. The examined airborne dust materials were 1) phosphate buffer solution (PBS) as a control, 2) desert sand from Mongolia, and 3) sludge dust from coastal area of Japan. The dust and DH5α bacteria were introduced into the each sides of dual Teflon chamber system (64 L × 2). Initial conditioning for 5 min., the particle size distributions were measured by an optical particle counter with size range from 0.3 to 10 μm. Upon the establishment of roughly equal particle concentrations in both side of chambers, two components were mixed by an internal fan to enhance the mixing of air mass for only 30 sec. at the initial stage. After the active mixing period, the reaction of two components were sustained for 60 min. then the mixed aerosol was sampled with BioSampler for one minute. The result indicated that the co-existence of DH5α with desert dust from Mongolia significantly decreased the viability and with the sludge dust from Japan significantly increased viability of the airborne DH5α compare to the control PBS dust ($p<0.05$). The results indicated that the different types of airborne dust influenced the viability of airborne bacteria. From the field survey of aerosol monitoring in spring of 2015 in Mongolia, the different aerosol size distribution patterns were observed in several regions of Gobi desert area. The different particle size distribution patterns of dust may act as possible indicator to estimate the influencing factor for the viability of biological component. In addition, the chemical and/or physical characteristics of environmental aerosol are considered as important factors attributing the viability of the bioaerosols. Further understanding of the dust characteristics as co-existing aerosols in the atmosphere may contribute for a health risk assessment of bioaerosols.

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INVESTIGATION OF AIRBORNE MYCOPLASMA BOVIS WITH DIFFERENT DUSTS IN LIVESTOCK FARMING

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Mycoplasma spp. are chronic pathogens for livestocks to cause serious disease and to have economical loss especially in cattle [1, 2]. The most common *Mycoplasma* spp. affecting cattle is *Mycoplasma bovis* (*M. bovis*), which causes respiratory disease, otitis media, arthritis, mastitis, and more. From a clinical point of view, *M. bovis* cause chronic symptoms and often unresponsive to antimicrobial therapy [3], thus, it is important to improve prevention and control measure of *M. bovis* in livestock farming. This investigation focuses on understanding the behavior of airborne *M. bovis* together with different dust in the cattle farming. We hypothesized that dust has an effect as a carrier of airborne *M. bovis*, in the livestock farming. To investigate this idea, a mixture of dust and *M. bovis* was examined in a reaction chamber system. The investigated livestock dusts were sawdust, roughage, and TMR (Total Mixed Ration), which were typical bedding material and feed used at dairy cattle farm in Rakuno Gakuen University. The examined materials were prepared by grinding and sieving to select size less than 2 μm, then autoclaved and dried at 40 ºC for at least 48 hrs. before the experiment. A single type of dust and aerosolized inactivated *M. bovis* bacteria by elevated temperature were introduced into the each sides of dual Teflon chamber system (64 L × 2). After 5 min of the initial conditioning, the particle size distributions were measured by an optical particle counter with size range from 0.3 to 10 μm. Upon the establishment of roughly equal particle concentrations in both chambers, the two components were mixed by an internal fan to enhance the mixing of air mass for only 30 s at the initial stage. After the active mixing period, the reaction of two components were sustained for 60 min then the mixed aerosol was sampled with Sioutas cascade impactor (four cut-off size ranges from 0.25 to 2.5 μm) and BioSampler for one minute each. After the sample collection, aliquot of the extracted DNA from each sample was subjected to the quantitative real time PCR for comparison of the copy number of *M. bovis*. Among the dust measurements, the particle concentrations of roughage had decreased for all size ranges more than sawdust and TMR over the 60 min. period. The experiment of dust and *M. bovis* mixture indicated that the airborne *M. bovis* DNA copy numbers of 0.25 μm size fraction decreased significantly ($p<0.05$) and the roughage dust decreased more than sawdust and TMR. The result clearly indicated that the presence of roughage dust has an effect for the DNA copy number of the airborne *M. bovis*. Different physical and/or chemical properties of roughage dusts may have attributed. Since all of the examined dust contained some kind of plant driven materials that the specific surface structures of dusts might have played an important role. This investigation examined only the inactivated *M. bovis*, the viability of bacteria was not tested. Further investigation with active (live) bacteria with a presence of different dust may reveal the specific conditions and/or substances to affect the viability of airborne *M. bovis*, which would help to assess the health quality in livestock farming environment.

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USING LACUSTRINE ARCHIVES TO RECONSTRUCT POST-GLACIAL DUST DELIVERY TO THE UINTA MOUNTAINS, UTAH, USA

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Eolian dust deposition is an important factor in the geoecology of mountain environments. In mountains of the western United States, prior work has focused on the effects of dust deposition on hydrology, surface water quality, soil development, and nutrient cycling. Studies have also concluded that dust deposition, as well as properties of the dust, changed with European settlement of the surrounding region in the 1800s. However, long-term variability of the dust system has received much less attention. We utilized sediment cores from two high-elevation lakes in the Uinta Mountains, a prominent sub-range of the Rocky Mountain system in northern Utah, to investigate dust deposition over the post-glacial period. Depth-age models were generated for the cores using AMS radiocarbon dating of (primarily) terrestrial macrofossils, and sediments were analyzed geochemically with ICP-AES and ICP-MS to produce time-series of major and trace element abundances. Properties of modern dust were assessed using dust collectors deployed in the vicinity of the lakes in 2011. Properties of local sediment were determined for regolith and bedrock sampled from the watershed of each lake. This approach permits characterization of two end-member sources of clastic sediment entering the lake: allochthonous dust and autochthonous regolith. Bivariate plots of immobile elements reveal that lake sediment is a mixture of these two end members. Elemental ratios are particularly useful in distinguishing the influence of dust on lake sediment over time. For instance, the abundance of Ca is greater in dust than in local regolith, whereas Al has the opposite relationship. Therefore, the Ca/Al ratio is a useful index for dust deposition. Using measured values of Ca/Al in dust collected near Marshall Lake, as well as ratios in regolith from the Marshall Lake watershed, the Ca/Al ratio throughout the Marshall Lake core was converted to a record of "percent dust" spanning the past 12,700 years. Dust content rose in the early Holocene, and reached sustained high values (30-40%) in the middle Holocene. After dropping ca. 4 ka BP, values rose again over the past 2000 years. This pattern suggests that dust delivery to the lake varied over the post-glacial period. An apparent maximum in dust delivery ca. 5-6 ka BP is strikingly synchronous with known episodes of regional aridity recorded by low water levels in Bear Lake (Idaho/Utah) and Lake Tahoe (California/Nevada). Trace element ratios will be used to reinforce this interpretation, and the identical approach will be applied to the second lake core to test for synchronicity of reconstructed dust variability.

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THE INFLUENCE OF THE ATLAS MOUNTAINS ON THE IMPACT OF AFRICAN DUST EVENTS IN SOUTHERN/SOUTH-EASTERN SPAIN

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We show that the Atlas Mountains Range have a strong influence on the impact of African dust outbreaks in the Iberian Peninsula (IP). The Atlas is primarily a barrier that interferes with upper air circulation, being a key element for cyclogenesis and for the development of convective storms which lead to density currents. But it also acts as a barrier that deflects the northward motion of African dust-laden air masses to the IP; less frequently, those masses pass over the Atlas and reach the IP in a south-to-north track.

African dust-laden air masses affect southern/south-eastern Spain (located at the western edge of the Mediterranean, quite close to the African continent) in about one-third of the days, with higher frequency in summer. During most of the African dust outbreaks, Mediterranean air masses reach the area at the lowest heights, while African advections arrive above the boundary layer primarily with southwestern pathways. The most intense episodes are associated to dust-laden flows passing directly over the Atlas Mountains. Depending on the meteorological situation, the flows either descend the northern slope of the Atlas down to the Alborán Sea and are injected directly into the boundary layer of the southern IP, or maintain their altitude and are transported into well-defined layers over the IP. In the first case, the impact is strong at the ground level (PM10 concentrations) and in the second case is less intense at the ground but the columnar dust burden (AOD) is strong. Two events are prototypical of these contrasting situations: the most intense episode in terms of PM10 registered in southern Spain [1], daily PM10 = 309 μg m^{-3} at the background rural station of Víznar on October 11, 2008; and the episode of September 4-7, 2007 which was the second most intense in terms of AOD in the IP [2, 3], while daily PM10 at Víznar was limited to 35 μg m^{-3}.

The dust outbreak of October, 2008 was outstanding due to the huge amount of dust mobilized in northern Africa and transported northwards. The event started with the interaction between an upper level cut-off low and the Atlas, the formation of a deep low over a large area centered over Algeria, gave rise to convective storms, the formation of a cool pool and the development of a density current, as well as severe weather in the entire region. Virtually in all the strongest African episodes (daily PM10 > 100 μg m^{-3}) registered at Víznar during the period 2002-2009, dust-laden flows were injected at low levels into the boundary layer of the southern IP after passing over the Atlas, similarly to the October 2008 episode. However, dust mobilization in northern Africa was less intense in these cases.

Air quality data and column-integrated aerosol properties (ground-based and satellite-derived), meteorological records, vertical profiles from radiosoundings, ERA-Interim data and a massive analysis of ensembles of back-trajectories calculated at multiple heights have been used in this study.

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ASSIMILIATION AND FORECASTING OF DUST. A STUDY WITH A REGIONAL MODEL

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WRF-Chem (Grell et al., 2005) is an atmospheric model with on-line chemistry that simultaneously predicts weather and atmospheric composition including dust. To improve initial conditions for the model and its forecasting skill assimilation of satellite dust indices for Aerosol Optical Thickness (AOT) at 550 nm developed by Ciren and Kondragunta (2014) is employed. The indices were derived from MODIS (Moderate-resolution Imaging Spectroradiometer) and Visible Infrared Imaging Radiometer Suite (VIIRS) multispectral AOTs based on the differences in dust reflectance at 412, 440, and 2130 nm. The assimilation procedure relies on the Community Radiative Transfer Model (CRTM), which serves as an interface for assimilation of radiances within the Gridpoint Statistical Interpolation (GSI), and on an application of 3D-Var methodology developed for chemical species by Pagowski et al. (2010). Modeling domain spans the continental USA. The forecasts are verified against dust observations from IMPROVE sites (Tong et al., 2012) and against Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO).

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DEPENDENCE ON ALTITUDE OF AEROSOL INTENSIVE PARAMETERS DURING DUST OUTBREAKS OVER THE CENTRAL MEDITERRANEAN

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The impact on the Earth's climate of some key aerosol species such as biomass burning, pollution, desert dust, and sea salt, is widely recognized. It is also well established that the vertical characterization of the aerosol optical properties is of peculiar importance to better quantify the aerosol impact on climate [1]. Airborne High Spectral Resolution Lidar (HSRL) measurements were used in [2] to characterize the vertical distribution of different aerosol types over Europe, the Sahara desert and the Cape Verde Islands by the aerosol lidar ratio, the particle linear polarization ratio, and the color ratio (CR, ratio of the aerosol backscatter coefficient at 532 and 1064 nm). Lidar measurements at 355, 532, and 1064 nm, respectively, have been used in this study to investigate the dependence on altitude of the aerosol optical and microphysical properties during dust outbreaks occurred on the 2011-2015 years at a coastal site of southeastern Italy. More specifically, the typing of the aerosol properties during dust outbreaks over the Central Mediterranean and hence, monitored few hundred kilometers away from source areas, represents one of the main objectives of this study. The aerosol properties were characterized by the vertical profiles of the extinction coefficient at 355, 532, and 1064 nm, respectively, the color ratio (CR(z)), the Ångström coefficient for different wavelength pairs ($Å(\lambda_1, \lambda_2, z)$), the fine mode fraction ($\eta(z)$) at 532 nm, and the fine modal radius ($R_f(z)$), in addition to the columnar lidar ratio (LRs) values. Note that CR(z), $Å(\lambda_1, \lambda_2, z)$, $\eta(z)$, $R_f(z)$ and the columnar LRs at 355, 532, and 1064 nm, respectively, are intensive aerosol parameters and as a consequence, they are independent on the aerosol load. The Constrained Iterative Inversion-Graphical Framework (CII-GF) retrieval scheme [3] was applied to the lidar measurements to retrieve the vertical profiles of the investigated aerosol parameters. The CII retrieval procedure is based on backscatter lidar measurements at 355, 532, and 1064 nm, respectively, combined with the aerosol optical thicknesses from AERONET sun/sky photometer measurements collocated in space and time, to retrieve the vertical profiles of aerosol extinction coefficients at different wavelengths. Then, a graphical framework was used to estimate height-resolved $\eta(z)$ and $R_f(z)$ values from the $\Delta Å(z) = Å(355, 532, z) – Å(532, 1064, z)$ versus $Å(355, 1064, z)$ plot [3, 4]. The HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model version 4.8, from NOAA/ARL was used to identify main air flows at the study site and investigate the dependence of the aerosol intensive parameters on the back trajectory pathways. It is shown that desert polluted (DP) particles were on average monitored during desert dust outbreaks occurred few hundred kilometers away from the source areas. In fact, the Mediterranean basin is a sink where aerosol from deserts and anthropogenic areas converge, in addition to the marine aerosol generated by the Mediterranean Sea itself and/or transported from the Ocean. Consequently, mixed aerosols are ubiquitous over the Mediterranean basin. The ability of the Ångström coefficient versus the fine-mode fraction plot for typing DP particles was first demonstrated. Note that plots showing the lidar ratio versus the particle depolarization ratio were mainly used in previous studies for typing desert dust particles. We found that DP particles were characterized by Å(532, 1064 nm) and $\eta(\%)$ mean values ± 1 standard deviation (SD) equal to 0.5±0.2 and 50±10%, respectively. The R_f and CR mean values ± 1 SD were equal 0.16±0.05 μm and 1.3±0.3 respectively for DP particles. The consistency between the intensive columnar aerosol parameters retrieved from lidar measurements and the corresponding columnar parameters obtained from sun/sky photometer measurements supported the adopted retrieval scheme and the typing of the monitored DP particles. Desert dust typing results were also supported by the comparison with previous studies.

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CLOUD CONDENSATION NUCLEI FROM DIESEL AND KEROSENE FLAME SOOT PARTICLES AGED IN A SMOG CHAMBER

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Gas and particles emitted by jet aircraft engines lead to the formation of contrails in the upper troposphere that may evolve in persistent cirrus-like clouds when atmospheric conditions are favorable. The detailed mechanisms of the formation of contrails are still not well understood especially as soot particles are hydrophobic. As soon as soot particles are ejected in the atmosphere, they undergo rapid chemical and physical transformation including photochemistry and radical chemistry on the surface, condensation of low-volatility compounds, change of size and/or morphology. In order to better describe the formation of CCNs from soot particles, each of these fundamental processes should be investigated using model soot particles and well controlled simulated atmospheric conditions. New experiments have been set-up in order to study the change of cloud condensation nuclei activation due to atmospheric aging. Briefly, soot particles are sampled from a jet turbulent diffusion flame supplied with Diesel or Kerosene fuel using a home-made quartz diluting probe and introduced in the atmospheric simulation chamber CESAM [1]. Changes of the particle hygroscopicity have been studied by measuring their activation for three different sets of simulated atmospheric conditions in the chamber: irradiation by Xe lamps to simulate solar light, oxidation by ozone and oxidation by OH radicals. In the latter case, the CCN activation curves reach a plateau for supersaturation higher than 0.8% that leads tothe determination of the critical supersaturation (S_c). All results are then used with κ-Köhler theory [2] in order to derive a single hygroscopicity parameter κ. Although the data analysis is still in progress, some early conclusions can be addressed already. The critical supersaturation is almost the same when comparing Diesel flame and Kerosene flame. For both fuels, soot particles become rapidly hydrophilic when OH radicals are generated in the simulation chamber. These original results bring new insight for understanding the process which transform soot particles into CCNs and give new insights on the formation mechanisms of contrails.

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SAHARAN DUST TRANSPORTED OVER EUROPE: LIDAR OBSERVATIONS AND MODEL EVALUATION OF THE RADIATIVE IMPACT

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Three years of measurements of aerosol vertical profiles (2007-2009) made at the LIDAR station of L'Aquila, a site in central Italy that is part of the EARLINET network, are studied by means of welltested radiative transfer models to analyze the radiative impact of mineral dust aerosols transported from the Sahara desert. Sixteen major episodes of desert dust transport are considered; the radiative analysis is conducted in terms of diurnal averages of the top-of-atmosphere radiative flux changes (TOARFC) with respect to a reference "clean" aerosol profile not perturbed by long-range transported desert particles. The aerosol size distribution, needed as an input parameter for the Mie scattering program to obtain single scattering albedo, asymmetry parameter and extinction scaling over the whole wavelength spectrum, is obtained from simultaneous surface measurements with a multi-channel aerosol spectrometer. The calculated average net TOARFC is +2.3 and +3.0 W/m2 in clear and total sky conditions, respectively. Solar, planetary components account for -0.42 and +2.7 W/m2 in clear sky and +0.93 and +2.1 W/m2 in total sky conditions, respectively. The large effective radius of these coarse mode soil dust particles (reff=1.5 μm) makes the longwave planetary component of the TOARFC dominant over the solar component, at least for typical continental surface albedo values (0.18 on average, at L'Aquila). The solar component, however, shows a pronounced sensitivity to the surface albedo and becomes dominant over the longwave component for both an ocean albedo (0.07) and a typical surface-snow albedo (0.4), with TOARFC values of -6.3 and +10.6 W/m2, respectively.

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EVALUATION OF A MODIFIED DRILL FOR REDUCING ABRASION DUST EMISSIONS DURING SOWING OF SEED DRESSED WITH THIACLOPRID

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The seeds treated with pesticides can release small quantities of abrasion dust containing active ingredients (a.i.) during sowing operations [1]. Honey bees and other pollinating insects are particularly sensitive to the exposure of dust containing neonicotinoids insecticides [2]. For this reason, in 2008 Italian government has suspended the authorization of neonicotinoids (thiamethoxam, imidacloprid and clothiadinin) and of fipronil for maize seed dressing. Recently, a different neonicotinoid, the thiacloprid (Sonido™), has been recommended for maize seed treatment, because the a.i. is much more tolerated by honey bees in comparison with other neonicotinoids.

Among the strategies to adopt for reducing the dust dispersion, a key factor is played by the drill. We developed a device that, applied to a conventional pneumatic drill, operates an effective reduction of dust drift. The prototype works by acting the recirculation and the filtration of the dust [3, 4]. In this paper, we report the results of tests carried out with an improved version of the prototype equipped with a final stage containing an additional electrostatic filter.

The test aimed to assess the dust drift of thiacloprid in field and to provide information on: 1) the effectiveness of the prototype to reduce the drift; 2) the potential exposure of honey bees flying nearby the sowed field; 3) the potential quantity of a.i. inhalable by the operator during sowing operations.

The detected amounts of a.i. appear below the concentrations reported as dangerous for honey bees; however, they can be useful in the study of sub-lethal effects.

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A MULTI-SCALE THEORY FOR THE ATMOSPHERIC DYNAMICS OF SUBTROPICAL DUST-STORM FORMATION

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Dust storms in Africa and the Middle East often have a major impact on the global aerosol composition. There are major dust storm sources in the subtropics including the Bodélé Depression of Chad, the Arabian Peninsula, and northwestern Africa near the Atlas Mountains. Previous studies have investigated the transport of dust from these regions, particularly across the Atlantic to North and South America, but less research has been carried out on the involved synoptic-mesoscale atmospheric processes which cause dust storms. The present work addresses multi-scale processes for three severe subtropical dust storms from these regions: (1) the Harmattan surge in northwest Africa on 2 March 2004, (2) the low-level jet episode over the Bodélé Depression on 8 December 2011, and (3) a dust outbreak in Saudi Arabia on 9 March 2009. In order to analyze the dust storm generating processes, we utilized MERRA reanalysis, MODIS, EUMETSAT, and CALIPSO satellite images, rawinsonde soundings, surface observations, and Weather Research and Forecasting (WRF) numerical simulations at 54, 18, 6, and 2 km horizontal resolution. The focus of this work is to understand the multi-scale atmospheric processes that generated the dust storms.

The analysis of each dust storm separately and an in-depth comparison of the events shows commonalities among them: (1) well-organized baroclinic synoptic scale systems, (2) minor dust emission events prior to the formation of the primary large-scale dust storms, (3) cross mountain flows producing a strong leeside near-surface inversion layer prior to the large scale dust storm, (4) thermal wind imbalance in the exit region of the mid-tropospheric jet streak developed over the mountains at the time of the inversion formation, (5) storm formation in the lee of nearby mountains (Atlas in Northwest Africa, Sarawat in Saudi Arabia, and Tibesti in the Bodélé depression), (6) dust storm formation was accompanied by high ageostrophic isallobaric low-level winds, and (7) substantial low-level turbulence kinetic energy (TKE) generation that coincides with a leeside Kelvin/edge wave. Dust emission initially occurred in narrow meso-β scale zones parallel to the mountains, and later reached the meso-α scale when suspended dust was transported away from the mountains. The common dynamical characteristics of these events will be summarized in a unified theoretical explanation of the atmospheric processes involved in such subtropical dust storm events. Such knowledge would help us to further improve dust-emitting processes in coarse resolution models.

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MINERAL DUST: INVESTIGANTING VOC'S OXIDATION KINETICS AND PRODUCT FORMATION

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Mineral dust influences radiative transfer through direct absorption and scattering of solar and terrestrial radiation. Surfaces of uplifted minerals also initiate a series of chemical conversion, of both inorganic and organic species, thereby altering the atmospheric composition. In addition, these particles also carry photochemical properties so far mostly unconsidered. It is only recently that the photocatalytic nature of mineral dusts has been suggested and discussed (Chen et al. 2012 and George et al., 2015), especially their reactivity towards organic compounds. For instance, Styler and Donaldson (2012) reported CO2 formation when sand and volcanic particles coated with oxalic acid were illuminated.

In order to assess the importance of photocatalytic transformations of volatile organic compounds (VOC) on mineral dusts, we now initiated an investigation focusing on the associated kinetics and reaction mechanisms on Arizona test dust (a widely used proxy for mineral dust). We therefore report here on the conversion of butanol, a proxy for oxygenated organic compounds, under simulated atmospheric conditions with respect to light irradiation intensity, humidity and gas phase concentration. Arizona test dust contains 2-5% of Fe2O3 and 0.5-1% of TiO2, both important semiconductors that can lead to photocatalytic oxidation of organic compounds.

The experimental apparatus include a coated-wall flow tube reactor coupled to a High Resolution Proton Transfer Reaction Time of Flight Mass Spectrometer (PTR-ToF MS), providing reaction kinetics and product formation information. Seven actinic lamps surround the reactor and temperature is maintained constant by circulating thermostatically controlled water throughout an outer jacket. Experiments were carried out in atmospheric pressure.

Our results clearly show that light drastically affect the uptake kinetics, by promoting fast reactive uptake of the selected VOCs. For instance, in the case of butanol, light changes this system form unreactive to very reactive, leading to the production of more oxygenated products, such as aldehydes i.e., methanal, ethanal and propanal, which are important sources of atmospheric radicals. Therefore, we will present how light could trigger new particle phase chemistry and how this feeds back into atmospheric chemistry.

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IDENTIFYING ERRORS IN DUST MODELS FROM DATA ASSIMILATION OVER NORTHERN AFRICA

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Airborne mineral dust is an important component of the Earth system, e.g., Earth's radiation balance, cloud microphysics and is important for many forecast applications, e.g. air quality, and is increasingly been predicted prognostically in weather and climate models. The recent development of data assimilation for remotely sensed aerosol optical depths (AODs) into models offers a new opportunity to better understand the characteristics and sources of model error. Here we examine data assimilation increments (DAI) from MODIS AODs over northern Africa in the Met Office global forecast model. Comparisons with unassimilated AERONET data from the region show that assimilation improves dust forecasts.

We find that the model underestimates dust AOD under light winds, and overestimates under strong winds. This is consistent with (sub-) mesoscale processes lifting dust in reality, but being missed by the model. Dust is overpredicted in the Sahara and under-predicted in the Sahel, which is potentially linked to the model's land surface.

Using Earth observations (EO) of lighting and rainfall as a proxy for moist convection, we show that haboobs (cold pool outflows from moist convection) are an important dust source in reality, but haboob dust is missing in the model, since the parametrized convection fails to represent haboobs. Results suggest that dust from haboobs may make 10-30% of the summer time western Saharan-Sahelian dust emission. The approach shows promise to serve as a systematic framework for future model evaluation and development and highlights the importance of either parametrizing haboobs or resolving moist convection.

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THE IMPACT OF AFRICAN DUST ON $PM_{2.5}$ AND PM_{10} AIR QUALITY IN THE CARIBBEAN BASIN

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Decades of aerosol measurements on Barbados and Miami have yielded a broad picture of African mineral dust transport to the Caribbean Basin. These measurements show that in summer the aerosol mass is often dominated by dust. At such times over 90% of the dust mass is comprised of particles less than 10 μm aerodynamic diameter and thus fits the EPA criteria for PM_{10}. About a third of the mass is $PM_{2.5}$. A number of sites in the Caribbean monitor PM using the same instrumentation (TEOMs) commonly deployed in European and United States networks. By comparing data from individual islands that have multiple monitoring sites (e.g., Puerto Rico and Martinique), it is shown that during dust events PM_{10} and $PM_{2.5}$ concentrations track very closely across the individual island sites. The local PM_{10} "background" is typically in the range 10 to 20 μg m^{-3}. Thus local sources are overwhlmed by advected dust and dust events stand out clearly in the record. During dust passage at a specific site, hourly data show remarkably smooth transitions from low values to maxima then decreasing steadily. This coherence suggests that the aerosol mass is well-mixed and not torn apart during transit. Moreover the PM measurements track with the movement of dust clouds over the islands as observed by satellites [1]. Thus these data will enable us to relate surface dust concentrations with the column loading. In this way dust movement can be tracked at PM sites along the Gulf Coast [2] and southeast coasts of the United States [3] and to South America [4,5]. To assess the specific impact of African dust on PM_{10} in the region, I compare the daily records of dust measurements at Miami and Barbados with concurrent measurements made at proximate PM sites. I then use these relationships and the long term dust measurements at Barbados and Miami to assess the long-term variability of PM_{10} across the region. At Barbados the record goes back 50 years and thus provides a basis of assessing the effects of climate variability on PM transport. This study shows that there is great variability on scales ranging from daily to decadal. The impact of the droughts in the 1970s and 1980s was particularly significant. Across the Caribbean, the rates of exceedances of the WHO PM_{10} guideline, 50 μg m^{-3}, is comparable to those observed in many major urban areas in Europe and the US. The dominance of dust in large PM_{10} events and the absence of major pollution sources on many islands offers the opportunity to study the health impacts of desert dust in local populations with minimal effects from local aerosol sources. An ad hoc aerosol PM network has been configured across the region. These data when coupled with ground-based and satellite remotely-sensed aerosol products will provide an excellent test-bed for the development of dust aerosol modeling products which could be used to produce air quality forecasts so that susceptible communities in the region could be alerted.

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DEVELOPMENT A METHODOLOGY FOR TRACE ELEMENT CHARACTERIZATION OF ATMOSPHERIC PARTICLES BY LASER ABLATION AEROSOL PARTICLE TIME-OF-FLIGHT MASS SPECTROMETRY (LAAP-TOF-MS)

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With the recent launch of a new, commercial (field) instrument, the so-called laser ablation aerosol particle time-of-flight mass spectrometer (LAAP-TOFMS) from AeroMegt GmbH (Solingen, Germany), information on the vacuum aerodynamic diameter and chemical composition of single aerosol particles becomes available. The instrument is based on particle sizing using two 405 nm scattering lasers and chemical composition analysis of single aerosol particles via ablation/ionization by a 193 nm excimer laser and detection in a bipolar time-of-flight mass spectrometer. Here we present the performance of this instrument after systematic optimization of the relevant parameters (particle number concentration, particle size, particle morphology, particle composition and the particle source). In particular, we highlight the quantification process, both for the particle size calibration and the measurement by LAAP-TOF-MS, using a suite of auxiliary instruments (particle generator, differential mobility analyzer and optical particle counter) to aid in this process.

The detection efficiency is a product of the scattering efficiency of the laser diodes and the ionization efficiency or hit rate of the excimer laser. The scattering efficiency was found to vary between 0.6 and 1.9 % with an average of 1.1 %; the relative standard deviation (RSD) was 17.0 %. The hit rate exhibited an excellent repeatability with an average value of 63 % and an RSD of 18%. In addition to laboratory tests, ambient air was sampled by LAAP-ToF-MS during a period of six days at the campus of Aix-Marseille University, situated in the city center of Marseille, France.

The obtained results are in good agreement with the data obtained by optical particle counter and the PM 2.5 data obtained by the local air monitoring station. Also several metal ions were detected during this field campaign such as lead, cerium, titanium and tin.

The analytical LAAP-TOF-MS methodology developed enables quantitative, high temporal resolution measurements of the chemical composition of ambient particles, and offers a novel approach for chemical characterization of single atmospheric particles, providing new insights in aerosol science and atmospheric chemistry and physics, in close relation to health effect studies.

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ASSESSMENT OF ACUTE HEALTH EFFECTS OF URBAN WINTERTIME PM EPISODES

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In the European Union (EU), particulate matter (PM) is one of the key indicators of air pollution, especially in urban areas. PM not only has a relatively long atmospheric lifetime and can travel over long distances, but also it is characterized by variable physical and chemical features. Therefore, it remains a major concern regarding public health (e.g. WHO, 2013). According to the European Environmental Agency (EEA, 2014), as much as one third of the EU urban population is exposed to levels of PM10 (particles with an aerodynamic diameter <10 μm) exceeding daily air quality limit value (50 $\mu g/m^3$). Due to the fact that airborne PM consists of a heterogeneous mixture of particles that varies in size and chemical composition in space and time, it poses more danger to human health than any other common air pollutant, and the variety of PM-related diseases which can lead to significant reduction of human lifetime is tremendous (Kim et al., 2015).

Despite the efforts aiming at reduction of emissions of both primary, and the precursors of secondary particles, severe PM episodes are still observed in many places in Europe, including Polish cities such as Cracow or Warsaw (Reizer et al., 2014). Due to the specificity of Polish primary energy structure, in which hard coal and lignite account for about 50%, the episodes observed in Poland may potentially be more hazardous for health of the exposed population.

The aim of present work is to analyse and estimate the magnitude of adverse health outcomes related to PM episodes observed in several Polish cities. Data on daily PM concentrations in 2006-2012 was collected for Warsaw, the Tricity and the Upper Silesian Agglomerations. After identification of the most severe episodes, control periods (no-episode periods in the same season of the year) were chosen for comparison. Along with air quality data, the values of basic meteorological parameters were also gathered. Epidemiological data included daily numbers of deaths recorded in respective cities, with regard to the assigned causes (e.g. cardiovascular or respiratory diseases). Spatial and temporal changes in mortality were analysed, with control of the meteorological indicators treated as confounders. The results allowed for qualitative and quantitative assessment of the adverse health impacts of severe PM episodes.

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INVESTIGATING THE CONTRIBUTION OF DUST PARTICLES IN THE SUBMICRON FRACTION AT A WEST AFRICAN SITE

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Numerous campaigns have been conducted in Western Africa to characterize Saharan dust, the most important one being AMMA (African Monsoon Multidisciplinary Analysis) from 2002 to 2010 [1]. During one of the special observing periods, in Jan.-Feb. 2006, chemical characterization of particles were performed in M'Bour (Senegal), Banizoumbou (Niger) and on board aircraft using filter sampling and individual particle analysis [2]. Ground-based sampling resulted in the determination of internal and external mixing of dust, sea salt (SS) and carbonaceous aerosols at the surface (< 2 km) layer [3]. Flament et al. (2011) [4] established the composition of the coarse (2-10 µm) and fine (< 2 µm) fractions and even though dust clearly dominated the coarse fraction with 75-90% of the mass, an important variability of its contribution to the fine fraction was highlighted, with values ranging between 17 and 76%.

Our dataset has been acquired in M'Bour (located on the coast of Senegal) during the SHADOW (SaHAran Dust Over West Africa) campaign (Mar. 2015-Jan. 2016). In particular, the PM_1 total mass concentrations were measured by a Tapered Electronic Oscillating Microbalance equipped with a Filter Dynamic Measurement System (TEOM-FDMS). A 7-wavelength aethalometer (AE33) and an Aerosol Chemical Speciation Monitor (ACSM) were used to determine absorption coefficients and the chemical composition of the non-refractory (NR) PM_1 fraction, respectively. Our study provides the first long-term chemical characterization of the submicron fraction in West Africa with less than 30-minute time resolution.

The first period of the field campaign (POI-1, Mar.-Jun. 2015) corresponds to the dry season and shows high variability both in terms of chemical composition and mass concentrations. The first half of the observation period was marked by Saharan desert dust episodes. The absorption measurements were used to deconvolve the contributions of black carbon and iron concentrations in PM_1 using a method proposed by Fialho et al. (2014) [5]. Sea-salt contribution was derived from mass closure calculations for days under oceanic influence and found to be negligible in the submicron fraction at the site. The combination of all the contributions allowed for an indirect monitoring of dust. An average iron concentration of 0.58 µg m^{-3} with a maximum at 11.2 µg m^{-3} during the dust event is consistent with a previous study [6] made in Banizoumbou where a mean value of 10 µg m^{-3} for iron in PM_{40} was determined. Our average Fe/PM_1 ratio of 4.5% is also in agreement with the 4% of iron among submicron particles reported by Chou et al. (2008) [7]. Measurements showed that about 2/3 of the PM_1 total mass was explained by the NR-PM_1 and BC concentrations, leaving about 1/3 for dust over the whole campaign. At the daily timescale, dust contribution to submicron particles is clearly larger (> 40%) at the beginning of POI-1 when most of the days were influenced by continental air masses. Dust reached a maximum contribution of 87% on April 10th, while during the second part of POI-1, dominated by oceanic air masses, this contribution dropped to less than 20%.

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SOURCE APPORTIONMENT OF SUBMICRON PARTICLES IN WEST AFRICA USING POSITIVE MATRIX FACTORIZATION

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Over the last few years, the long-term chemical composition of submicron aerosols (PM_1) has been characterized using high-time resolution monitoring instruments such as the Aerosol Chemical Speciation Monitor (ACSM). The organic fraction is furthermore investigated with Positive Matrix Factorization (PMF) in order to differentiate organic sources [1,2]. Yet, to the best of our knowledge, only one campaign has been carried out on the African continent, in Welgegund, South Africa [3]. In our study, we offer the first insight of long-term PM_1 chemical characterization and source apportionment in West Africa thanks to parallel measurements of Non-Refractory ($NR\text{-}PM_1$) species, Black Carbon (BC) and total PM_1 mass concentration. Our instrumentation was implemented at the AERONET [4] station of M'Bour (Senegal) in addition to instruments dedicated to optical and physical measurements deployed especially during the SHADOW (SaHAran Dust Over West Africa) campaign (Mar. 2015-Jan. 2016).

The dataset acquired during the first period (Mar.-Jun. 2015), hereafter referred as POI-1, has shown high variability both in terms of chemical composition and mass concentrations. The first half of the observation period was marked by intense but short $NR\text{-}PM_1$ pollution events, sea breeze phenomena and longer Saharan desert dust episodes. During the second half of the POI-1, the sampling site was mainly under the influence of marine air masses. The air masses on days under continental and sea breeze influences were dominated by organic aerosol (OA) species (40%) whereas sulfate was predominant (40%) for days under oceanic influence. Nonetheless, measurements showed that about 2/3 of the PM_1 total mass was explained by the $NR\text{-}PM_1$ and BC concentrations

PMF preliminary results clearly depicted Cooking-like (COA) and Hydrocarbon-like (HOA) OA profiles with contributions up to 20-23% each, pointing out local combustion sources such as traffic, residential/industrial cooking and open waste burning areas. On the other hand, more than half of the organic fraction was attributed to Oxygenated OA species (OOA), with above 40% of More Oxidized (MO-OOA) and 17% of Less Oxidized OA (LO-OOA). Pollution roses showed that MO-OOA as well as sulphate were coming from oceanic air masses, suggesting long-range transport for those species whereas LO-OOA was mainly encountered under continental winds. COA and HOA seem to be carried on site from two specific directions, respectively North-West and North-East, with maximum levels encountered in the morning for HOA and after 6 p.m for COA. Back-trajectories are under investigation to explain observations made during specific events (sea breeze, dust storms).

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GEOSTATISTICAL ANALYSIS OF XRD AND SEM DATA OF SAHARAN DUST IN SANTIAGO ISLAND, REPUBLIC OF CAPE VERDE

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Cape Verde is located in an area of massive dust transport from land to ocean, and is thus ideal to set up sampling devices that will able the characterization and the quantification of the dust transported from Africa, namely from Sahara.

Aerosol sampling was performed at Praia airport during one year and mineralogical composition was studied by X-ray diffraction and scanning electron microscopy. A total of 103 samples corresponding to 12 months of sampling, were analysed. Qualitative and semi-quantitative mineralogical analyses were carried out by X- ray diffraction (XRD) using a Philips®/PanalyticalX'Pert-Pro MPD, Kα Cu (λ = 1,5405 Å) radiation, with 0.02º 2θ s-1 steps in goniometer speed, in order to assess the main and accessory minerals, their relative proportions, check the eventual heterogeneities, and establish the mineralogical markers. Selected samples were also analysed by scanning electron microscopy (SEM – Hitachi, SU 70) and energy dispersive X-ray spectrometry (EDS – EDAX with detector Bruker AXS, software: Quantax) operated at 3–30 kV.

Mineralogical phases identified include various silicates and aluminosilicates, carbonates, sulphates, phosphates, oxides and hydroxides. Iron hydroxides, such as lepidocrocite and goethite, and carbonates, such as calcite and siderite, are the most discriminating phases, allowing to differentiate 3 subsets: A) Iron hydroxides rich; B) Calcite rich; C) Siderite rich (7, 8, 15). Samples showing higher HiVol conc. belong to first group, whereas those with lower HiVol conc. belong to second one. On the contrary, silicates, such as quartz, feldspars and phyllosilicates (mainly micas), did not show any particular tendency, being ubiquitous and generally on small amounts.

The results of the XRD semiquantification as well as of the SEM-EDAX analysis were submitted to Principal Component Analysis, in order to clarify the identification of the main sources and origins of the particles sampled. Finally, established groups were submitted to Discriminant Analysis.

The identification of the main sources and origins of the particles sampled in the archipelago is being carried out by integrating complementary tools such as Positive Matrix Factorization, Chemical Mass Balance, Multilinear Regression Analysis, Air Mass Back trajectories analyses, meteorological data and particle size segregate analysis.

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HETEROGENEOUS INTERACTION OF ISOPROPANOL WITH MINERAL DUST SURFACES UNDER SIMULATED ATMOSPHERIC CONDITIONS

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Mineral dust constitutes a key component of atmospheric aerosols. According to recent estimations, every year, 1600 Tg of mineral dust is released into the atmosphere, representing the largest mass emission rate of aerosol particles at a global scale.[1, 2] Dust surfaces may provide the seedbed for specific interactions with trace gas molecules, and therefore, could play a key role in the transformation and environmental fate of many atmospheric species. The interactions of mineral dusts and their components with atmospheric trace gases have generated a great deal of interest over the past 15 years.

In the current study, the heterogeneous interaction of isopropanol with Gobi desert dust was investigated under simulated atmospheric conditions using synthetic dry air as a bath gas. The experiments were carried out with the smallest sieved fractions of the dusts, i.e. inferior to 100 μm. N_2 sorption measurements, granulometric analysis, X-ray Fluorescence and Diffraction (XRF and XRD) measurements were conducted to determine the physicochemical properties of the particles. The kinetic adsorption/desorption studies were performed using a novel experimental setup combining long path transmission Fourier-Transform InfraRed spectroscopy (FTIR) and Selected-Ion Flow-Tube Mass Spectrometry (SIFT-MS) for the detection of the gas phase species. The initial uptake coefficients, γ, of isopropanol were measured as a function of several environmental parameters (gas-phase concentration, temperature, relative humidity, mineral dust mass). Furthermore, the adsorption isotherms of isopropanol were determined within an extended temperature range and the results were simulated using Langmuir model to obtain the maximum surface coverage, N_{max}, the equilibrium constants, K_{lang}, and the enthalpy of isopropanol adsorption, ΔH_{ads}. The impact of H_2O to the adsorption isotherms was also determined in the relative humidity range of 0-50% at room temperature. Beside the kinetic study, a series of experiments are conducted to investigate the degradation of isopropanol (a) under UV light conditions and (b) in presence of O_3. To the best of our knowledge this is the first quantitative laboratory study reporting the heterogeneous interactions of isopropanol with mineral dust.

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DUSTFALL – IMPACT OF SAHARA DUST ON AIR QUALITY FORECASTS IN AUSTRIA

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Aerosolized Particulate Matter (PM) has an important influence on the radiation budget, cloud physics and cloud properties, the visibility, but also on air quality and consequently on health. PM in urban regions is mostly of anthropogenic origin (traffic, burning of fossil and biomass fuels, industrial pollution) whereas natural sources contribute the majority of PM on a global scale, e.g. mineral dust from the Sahara. The Saharan dust (SD) is episodically transported over thousands of kilometers with synoptic wind patterns towards Europe and reaches Austria about 20 to 30 days per year. This can cause an increase of the PM-concentration and in extreme cases also limit value exceedances far away from the region of origin.

Forecast of PM and consequently air quality is important in the context of protecting the population from its adverse effects. Therefore, the Central Institute for Meteorology and Geodynamics (ZAMG) computes forecasts for the SD-concentration in the atmosphere as well as forecasts for ground-level PM-concentrations twice a day which are published on the ZAMG-homepage

(http://www.zamg.ac.at/cms/de/umwelt/luftqualitaetsvorhersagen). Besides these forecasts, also air quality for the same and the following day is presented on the homepage in form of the “Common Air Quality Index (CAQI)”. Since forecasts tend to underestimate actual PM-concentrations, the models have to be evaluated and improved regularly.

The recently started project focuses on the detection and quantification of the intensity of Sahara dust events (SDEs) at the high altitude meteorological observatory at Mount Sonnblick (SBO). To include information from monitoring sites of the Austrian air quality networks, an optical method for the determination of SDEs on PM_{10} filter samples will be evaluated, and subsequently used to identify regional differences in the occurrence and intensity of SDEs. We will compare the actual ground level measurements with the ZAMG forecasts for SD-PM. Forecasts of the SD-concentration in the atmosphere are evaluated with spectral UV-measurements and the resulting Aerosol Optical Depth (AOD).

The overall aim of the project is an improvement of the detection of SDEs as well as an improvement of the insights and processes concerning the long-range transports of SDEs. Consequently, this allows an improvement of model forecasts of PM-concentrations and an improvement of the air quality forecast during SDEs.

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MASS CONCENTRATION AND SIZE-DISTRIBUTION OF ATMOSPHERIC FINE, ULTRAFINE AND NANOPARTICLES IN THE URBAN AREA OF COMO, NORTHERN ITALY

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Background and aims – Aerosol particles are recognised to have a strong impact on the environment and to be of concern in health-related effects. An emerging literature suggests an increased toxicity for ultrafine particles (UFPs) compared to larger particulates on a per mass basis [1], especially considering that the respiratory deposition fraction of these particles increases sharply with decreasing size [2]. Consequently, toxics-containing UFPs are potentially more harmful when inhaled and information about the size-distribution of airborne PM, together with its chemical composition, appear to be needed for an accurate evaluation of its toxicity. Nevertheless, such information are still scarce and limited on a local scale. Therefore, in order to explore this basic knowledge, an experimental design investigating the mass concentration and size-distribution of atmospheric fine, ultrafine and nanoparticles was planned at an outdoor urban background site in Como, Northern Italy.

Experimental and methods – The experimental approach was designed to integrate different meteorological and environmental conditions and to obtain a representative number of particulate samples. The sampling equipment consisted of different monitoring devices. A 13-stage Low Pressure Impactor (DLPI) was used for the collection of size-segregated particulates in the 0.03 – 10 µm size range. To evaluate DLPI performance and accuracy, during most of the sampling weeks $PM_{2.5}$ was also monitored via an Harvard-type Impactor (HI), combined with a Leland Legacy pumping unit operating at a flow rate of 10 L m^{-1}. An external weather station was also used to characterize meteorological conditions during the study period at the sampling site. Measurements generally started between 9-10:30 A.M. on Monday morning and lasted until Friday morning, using a 96-h sampling duration every sampling week, for a total of 10 monitored months, so that the collected data could be divided into an heating and non-heating season and could be representative for the whole year.

Results – Results revealed an excellent and significant correlation and a good overall agreement between HI and DLPI methods, allowing them to be classified as comparable and characterized by a reciprocal predictability. The PM concentration levels varied greatly between the different sampling weeks and the mean values measured during the non-heating period were statistically lower than those observed during the heating period for all the particulate size fractions. On average, 70% of the PM_{10} mass consisted of $PM_{2.5}$, with a minor contribution of the coarse $PM_{2.5-10}$ fraction. PM_1 was the major component of $PM_{2.5}$ (83%), with the 94% of the PM_1 mass in the $PM_{0.1-1}$ range, that, on average, accounted for more than 50% of the total PM_{10} mass. $PM_{0.1}$ played only a minor role in the particulate mass concentration (< 4% of the PM_{10}) and the contribution of the nanoparticles' fraction ($PM_{0.06}$) was even lower and less relevant (< 1%). Strong and significant correlations were found among the different PM size fractions, especially between the $PM_{0.1-1}$ accumulation mode and the PM_1, $PM_{2.5}$ and PM_{10} fractions, confirming its primary role in the particulate mass determination.

Ambient air particles exhibited a trimodal distribution, with a first and sharp peak, more marked during the heating period, between 0.4 and 0.5 µm, and other two slight peaks in the coarse mode, centered on ≈ 3 and 8 µm. On average, the annual $PM_{2.5}$ and PM_{10} concentrations exceeded the WHO AQG limits of 10 µg/m^3 and 20 µg/m^3, respectively.

Conclusions and future developments – This paper gave a first outlook on the mass concentration and size-distribution of atmospheric PM within the Como urban area. The research study will be integrated with the elemental analysis of some potentially toxic trace metals in the collected fine, ultrafine and nano size fractions, to enable the identification of potential emission sources in the study area and the assessment of potential toxicological impacts on humans of those metals.

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EFFECT OF SAHARAN DUST ON THE AMBIENT MICROBIOME

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We evaluated the impact of Saharan dust storms on the local airborne microbiome in a city in the Eastern Mediterranean. Samples of particles with diameter less than 10 μm (PM10) were collected during two spring seasons on both dusty and non-dusty days. DNA was extracted and partial 16S rRNA gene amplicons were sequenced using Illumina platform. Bioinformatic analysis showed the effect of dust events on the diversity of the atmospheric microbiome. Taxonomic analysis showed that the relative abundance of desert soil-associated bacteria increased during dust events, while the relative abundance of anthropogenic-influenced taxa decreased. Quantitative polymerase chain reaction (qPCR) measurements of selected clinically significant antibiotic resistance genes (ARGs) showed that their relative abundance decreased during dust events. The antibiotic resistance gene profiles on dust-free days were similar to those in aerosol collected in a poultry farm, indicating a strong agricultural influence on the local ambient profiles. In conclusion, dust storms affect the local airborne microbiome by introducing new soil-associated bacteria that disappear as the dust sediments, suggesting that the bacteria are transported attached on the dust particles. Dust storms do not seem to be an important vector for known ARGs.

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POSSIBLE HEALTH EFFECTS OF REPEATED EXPOSURES TO RE-SUSPENDED URBAN DUST

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Exposure to particulate re-suspended road dust in large cities and urban canyons can be harmful to the exposed population. However, the underlying mechanisms that lead to health effects are not yet elucidated. It is postulated that exposure to repeated small, environmentally relevant concentrations can affect lung homeostasis. This study compares the impact of repeated exposures to re-suspended urban dust on mouse lungs with focus on inflammatory and oxidative stress parameters. Aqueous extracts from urban PM collected in metropolitan London were administered to mice by 5 repeated intratrachal instillations (IT). Multiple exposures increased cytokine levels in both the lung fluid (BALF) and in the blood serum, indicating a systemic reaction. mRNA levels of antioxidant/phase II detoxifying enzymes decreased by exposure to the PM extract, but not when metals were removed form the extract by chelation. Finally, disruption of lung tissue oxidant-inflammatory/defense balance was evidenced by increased levels of lipid and protein oxidation. Unlike the response to a single exposure to the same dose and source of extracts, multiple exposures result in lung oxidative damage and a systemic inflammatory reaction. These could be attributed to compromised capacity to activate the protective Nrf2 tissue defense system. This study suggests that the lungs can overcome a single dose of environmentally relevant PM concentration by increasing protection mechanisms such as Nrf2 signaling and its related enzymes without causing damage to lipids and proteins. However, after repeated exposures to the same dose, the Nrf2 signaling pathway is compromised and cannot cope with the increased oxidative stress, thus leading to protein and lipids damage. Metals in near roadway PM are largely associated with brake and tire wear. While efforts to mitigate the health effects due to air pollution focus on reducing tailpipe emissions, the sources of metals near roadways and streets are typically overlooked by roadway emissions control.

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CONTROLLING SAHARAN DUST EXPORT: DUST SOURCES AND ATMOSPHERIC CIRCULATION OVER NORTH AFRICA

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Studies analysing satellite observations illustrate the spatial and temporal distribution of active (and thus emitting) dust sources [e.g., *Schepanski et al.*, 2007, 2009, 2012]. Here, we present a study discussing the atmospheric dust life-cycle over North Africa including its dust transport pathways towards Europe and across the Atlantic toward the Caribbean. We link satellite-based information on the spatio-temporal distribution of dust source activation (DSA) events that are inferred from 15-minute MSG SEVIRI dust observations as described by *Schepanski et al.* (2007, 2009, 2012) to atmospheric circulation regimes over North Africa, which determine on the one side the surface wind speed distribution and thus the dust emission flux, and on the other side the dust transport pathways and hence the dust destination region.

In order to quantitatively link dust sources, emission fluxes and transport to atmospheric circulation regimes, numerical simulations of the atmospheric dust life-cycle using the mesoscale atmosphere-aerosol model system COSMO-MUSCAT are performed. In particular we have analysed the spatio-temporal distribution of dust sources, atmospheric circulation patterns such as the Monsoon flow, the Harmattan flow, the dynamics of the Saharan heat low, and Mediterranean cold surges, and transport pathways towards Europe and the Caribbean. All atmospheric feature show a significant variability in their spatial extent respectively centre location and strength, which affects the spatio-temporal distribution of DSA events and dust transport pathways ultimately determining atmospheric dust concentrations over populated areas in Europe and overseas.

Altogether, the results from this study aim at illustrating the relevance of knowing the dust source locations in concert with the atmospheric circulation. Ultimately, this study addresses the question of what is finally transported toward Europe and across the Atlantic from which source regions - and fostered by which atmospheric circulation pattern. Outcomes from this study contribute to the understanding of varying atmospheric mineral dust contributions to the aerosol burden affecting populated areas around Europe and across the Atlantic.

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EFFECT OF WOOD PRE-TREATMENT ON OPERATING CONDITIONS AND PM EMISSIONS DURING COMBUSTION AT LABORATORY SCALE

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Wood pellets have become an important fuel in domestic heat generation, since the coasts of fossil fuels are rising and the emissions are nearly CO_2 neutral. All households are incited to turn to the use of biomass as energy source for domestic heating. In contrast to other wood based fuels, the utilisation of pellets is easy and automatic feeding to the boiler is possible. Furthermore, the pelletisation densifies the wood and produces a fuel with high energy content. On one hand, wood pellets are a convenient choice for domestic fuel because of their simplicity of implementation and their low cost. But on the other hand, wood pellets combustion is a source of fine Particle Matter ($PM_{2.5}$) [1]. In the last decade, numerous studies were devoted to the evaluation of emission factors for gaseous compounds or $PM_{2.5}$ from residential wood combustion appliances. Most of them have attempted to compare pollutant emissions as a function of both the nature of the wood and/or technologies of the domestic heating appliances [2]. Investigations on both influences of the wood preparation and pre-treatment on PM emissions are scarce.

An aerosol is composed of mineral and organic particles. The mineral part mainly consists in metallic trace elements, sulphates, nitrates, ammonium and salts (KCl, K_2SO_4, $CaCO_3$, CaO…). The organic part is itself composed of elemental and organic carbon. Elemental carbon (EC) is represented by black smoke and soot, so mostly carbon (close to 100%). Organic carbon (OC) is constituted of Polycyclic Aromatic Hydrocarbons (PAH), Volatiles Organic Compounds (VOC) and others organic molecules.

This work aims to study the influence of the nature of the biomass fuel and its pre-treatment on both emission factors of gaseous and particulate pollutants generated by new domestic heat generation in real use conditions. Indeed, these last years, domestic wood heating manufacturers have highly optimised combustion conditions, thanks to new technologies development, to respect the new European legislation proposed in 2022 [3]. To increase the environmental performance of these installations, this study aims to establish relationships between the properties of the biomass fuel used (type, size, chemical composition, moisture rate, ash content …) and the emission factors of gaseous and particulate pollutants generated by combustion in real domestic conditions.

Studies on pre-treatment of wood fuel have been carried out at laboratory scale by sawdust distilled water washing operation. Rinse water and dry biomass have been analysed by Atomic Absorption Spectroscopy (AAS) and results show that contents in elements such as Potassium, Calcium and Magnesium could be mainly reduced in wood by washing operation with reduction yields ranging from 20% for Calcium and Magnesium and 60% for Potassium. The consequences of having less of these alkali and alkali-earth elements in the woody fuel would minimise particulate matter concentrations in the exhaust and dry corrosion phenomena in heat-exchangers. These points would be checked by performing burning tests of wood washed pellets in a domestic stove. Lixiviation of wood logs in external conditions by rainwaters would also be studied in order to point out chemical differences on biomass fuel and their impacts during domestic combustion tests in several appliances as insert and stoves.

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ACTIVITIES IN 15 YEARS OF AD-NET, A LIDAR NETWORK FOR ASIAN DUST STUDIES

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Since 2001 National Institute for Environmental Studies (NIES) has been conducting a networked observation of Asian dust by lidars (AD-Net). The fundamental concept of lidar operation is maintained for 15 years, and principle of data sharing, timeliness, and contribution for policy making is always considered. In ACE-Asia campaign, 3 lidars in Tsukuba, Nagasaki and Beijing were operated as a part of lidar alliance in East Asia[1]. Obtained results were utilized for CTM validation and comparison with airborne measurement[2,3]. Since then, simple but reliable Mie-scattering lidars were deployed in Japan, Korea, China and Mongolia by NIES with collaborating organizations. All lidars measure vertical profiles of 532/1064 nm backscatter with depolarization ratio of 532 nm. 4 profiles per hour are automatically obtained regardless of whether conditions, and all data are transferred to NIES and processed uniformly.

Fundamental analysis assumes that lidar ratio (S1) is constant, and Asian dust and spherical (mainly anthropogenic) particles whose depolarization ratios are 35% and 0% respectively, are externally mixed. In clear sky conditions Fernald's inversion is applied with S1=50sr for 532 nm backscatter, then obtained extinction coefficient is divided into two components, dust extinction and spherical extinction using depolarization ratio. Although this procedure assumes simple optical properties of airborne particles, obtained results are useful and utilized wider in both scientific communities and governmental organizations. For example, dust density near the surface obtained by AD-Net lidars are distributed via WWW for citizens by Ministry of Environment Japan. As for validation, mass concentration of dust by filter sampling was compared with dust extinction coefficient near the surface[4]. Also, the relationship between dust extinction and meteorological reports of floating dust by human observers in Japan was examined[5].

AD-Net lidar data were assimilated for dust concentration in a CTM with 4D-VAR[6], and utilized in epidemiological studies focusing on health impact of Asian dust in Japan[7,8,9]. Some lidars were utilized for the validation of aerosol and cloud structures measured by CALIPSO, and comparison with AOD measurements by MAX-DOAS and skyradiometer. In recent years several AD-Net lidars acquired capability of Raman scattering measurement in night time. This improvement is devoted to more reliable/useful estimation of aerosol components in East Asia.

Nowadays AD-Net is a hub of remote sensing network of Asian dust and co-existing particulate matters, and is contributing to GALION of GAW, WMO. More reliable/useful aerosol dataset will be processed in the combination of lidar network and chemical transport models which includes various kind of observations for data assimilation sources.

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THE ELSA-DUST-STACK-2016: RECONSTRUCTION OF THE DUST AND LOESS DEPOSITION DURING THE LAST 60 000 YEARS IN EIFEL MAAR LAKES

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The ELSA project (Eifel Laminated Sediment Archive) has drilled a total of 50 sediment cores from Holocene/ late Pleistocene maar lakes of the Eifel/Germany. The bottom water of the Eifel maar lakes is frequently anoxic; accordingly all cores are laminated and 4 cores have been varve counted back to 35 000 BP. These cores are also absolutely dated by 137Cs, 210Pb, 14C, event correlation, paleomagnetism and tephra chronology. In particular the well dated tephra during the last 60 000 years allow an excellent core to correlation.

The eolian dust/loess history is best studied in core DE3 from the Dehner Maar, where pollen and macroremain vegetation proxies are first used to distinguish the arid and humid phases of the last 60 000 years in general. The arid phases during MIS3 and MIS2 are, however, best characterized by high eolian dust content, which is quantified by dust storm layer thickness during the last Glacial, annual resolution grain size detected from petrographic thin sections, and carbonate content from μXRF analysis.

Dust activity during MIS 3 was high during all stadials after 46 000 BP and reached high values after 32 000 in spring after snowmelt, which is well visible as meltwater clay suspension layers. The dust content reached its maximum at 23 000 BP when spring melting events disappeared until – 15 000 BP. The central European landscape must have been under most arid conditions during the LGM and dust activity extended also into summer, well visible from an increase in dust layer thickness. The annual resolution dust records allow inspection of the seasonality of glacial dust storms, which most likely occurred in each year during spring/summer. Ongoing annual resolution frequency analysis of the dust layers allows insight into the seasonality of aridity extremes during the entire last 60 000 years.

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VERTICAL PROFILES OF AEROSOL AND DROPLET PARTICLE SIZE DISTRIBUTIONS OBTAINED FROM BALLOON BORNE RADIOSONDES DURING THE ICE IN CLOUDS EXPERIMENT – DUST (ICE-D) CAMPAIGN

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This presentation discusses balloon borne measurements of particle concentrations and size distributions made during the Ice in Clouds Experiment – Dust (ICE-D) campaign, based in Cape Verde , August 2015 [1]. The main aim of the ICE-D campaign was to study the impact of desert dust on the primary nucleation of ice particles in clouds and the subsequent development of precipitation and glaciation. The project utilized both ground based and aircraft based instrumentation to characterize aerosol and cloud particles in and around clouds. Measurements were taken in both low dust and high dust environments to study the ability of aerosols to act as Ice Nuclei (IN) and Cloud Condensation Nuclei (CCN).

Alongside the ground and aircraft based measurements, balloons were launched from Instituto Nacional de Meteorologia e Geofisica (INMG), located on Sal island, Cape Verde. Each payload consisted of a GRAW DFM-09 meteorological sonde for measuring temperature; humidity; pressure and position, and a University of Hertfordshire Universal Cloud and Aerosol Sounding System (UCASS) for measuring particle size and concentration. The UCASS is a low-cost disposable device which detects and sizes particles on the basis of laser light scattering. In this case, a 658nm linearly polarized source is scattered by a particle in the sample volume, and a spherical mirror directs the scattered light (in the angular region of 27^{o}-113^{o}) onto the detector where the intensity is measured, the particle size is then determined using a mie approximation. During the campaign, the UCASS devices were configured to measure aerosol in the range 0.4-15µm (based on a refractive index of 1.52+0.0002i). Data from these soundings provided vertical profiles of aerosol concentrations, giving a unique opportunity to test and validate remote sensing retrievals co-located with the soundings.

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SOURCE APPORTIONMENT OF PARTICULATE POLYCYCLIC AROMATIC HYDROCARBONS IN URBAN ATMOSPHERE OF NCR DELHI

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Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous persistence organic pollutants (POPs) [1]. Several, PAHs are known toxic, mutagenic and carcinogenic compounds [2,3].Understanding the contributions of the various emission sources is critical to appropriately managing PAH levels in the environment.In the present study, PM_{10} samples were collected at two sampling sites (S1:urban background and S2: central Delhi site) in NCR Delhi from July 2013 to January 2014. The concentrations of 16 selected polycyclic aromatic hydrocarbons (PAHs) in aerosols were quantified for source apportionment analysis.The sum of 16 PAHs in PM_{10} at S2 ranged from 26 to 172 ng m^{-3}, whereas atS1 it varies from 23 to 102 ngm^{-3}.The sources of PAHs to ambient air in NCR, Delhi were determined by using source apportionment methods (molecular diagnostic ratios and principal component analysis). At S2, vehicular emissions in the form of diesel and gasoline exhaust were major emission sources. On the contrary,coal combustion, oil combustion, wood combustion and Gasoline powered vehicle related emissions were major contributor of particulate PAHs atS1in NCR Delhi.Study clearly indicates the major PAHs emission sources in the NCR Delhi were traffic related and coal combustion, oil combustion and wood combustion related sources, which draws attention towards immediate measures for PAHs control in NCR Delhi.

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HIGH SAMPLING RESOLUTION LUMINESCENCE DATING OF DUST ACCUMULATION ON THE CHINESE LOESS PLATEAU OVER THE PAST 200 KA: COUPLED DUST MAR AND GRAIN-SIZE RECORDS

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Recent work has demonstrated the importance of obtaining detailed and independently dated mass accumulation rate (MAR) data coupled with grain-size records from dust records such as loess sequences in constraining past atmospheric dust activity [1]. Furthermore, radiometric chronologies are crucial to the correct interpretation of the sedimentation history and climate signals recorded in loess-palaeosol sequences. Traditionally quartz OSL has been used as an absolute chronometer but the range of this signal is usually limited to <70 ka; feldspar signals have the potential to date much further back in time but were hampered by instability of the traditional infra-red stimulated luminescence (IRSL) signal measured at ambient temperature. However, recent breakthroughs in luminescence dating of feldspar have identified stable feldspar post-IR IRSL signals that can be used for dating [2]. For Chinese loess, numerical feldspar post-IR IRSL chronologies can now be derived back to at least 200 ka, and possibly to ~250 ka (bottom of palaeosol S2), allowing detailed independently dated MAR data to be obtained well beyond previous studies. This represents a significant advance for understanding the timing of dust accumulation and the preservation of monsoon climate records in China. In this project several loess sections located along a N-S transect across the Chinese Loess Plateau were sampled at high resolution (~20 cm for luminescence, 5 cm intervals for grain size distribution and magnetic susceptibility) over the last two glacial interglacial cycles. In this way we present independently dated climate records alongside coupled MAR and grain-size records for loess-palaeosol sequences in China, the latter crucial in the reconstruction of past atmospheric dust activity [1]. Our results allow us to identify the timing and scale of major changes in dust MAR in loess sequences, such as a major pulse between 22 and 27 ka, while in some sequences close to the desert margin, our results demonstrate that there are major discontinuities in the sedimentary record, with up to a whole glacial-interglacial cycle missing. Such gaps in the record are of great significance for understanding climate records from loess. Our robust and detailed chronologies allow the first full loess dust accumulation rate analysis over two glacial cycles.

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CHINESE LOESS PLATEAU STORAGE OF QUATERNARY-PLIOCENE YELLOW RIVER SEDIMENT ERODED FROM NE TIBET

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The potential source regions of the vast Chinese Loess Plateau deposits are numerous. Variously the sandy deserts to the north and northwest of the Plateau have been proposed as major sources, as have major intercontinental mountain belts, large sedimentary basins, dried lake beds, and most recently the Yellow River system. Resolving this uncertainty is crucial to understanding past dust dynamics, terrestrial sediment routing, long-term Asian climate history and in the interpretation of one of the most important global climate archives. Here a new hypothesis is presented that links the Tibetan Plateau, northern Chinese deserts and Chinese Loess Plateau through sediment routing and terrestrial sediment storage via the Yellow River system [1]. The Yellow River is one of the world's major sediment bearing rivers but little is known about its sediment sources, sinks and evolutionary history, as well as its past role in sedimentary dynamics of Northern China. Here the first detailed and multi-technique modern and palaeo- Yellow River sedimentary provenance data using detrital zircon U-Pb, heavy mineral and sediment petrographic methods are presented. This is compared to provenance data from the Loess Plateau and other potential source regions. The results indicate that Chinese loess has similar provenance signals to the river's sediment load upstream of the Loess Plateau and that this has remained constant for at least 3.6 Ma. In contrast, the provenance signature of the river sediment load flowing past the eastern Loess Plateau shifts to a North China Craton provenance, indicating that the Loess Plateau and parts of the northern Chinese deserts are acting as large-scale terrestrial sediment sinks for the upper reaches NE Tibetan plateau derived Yellow River material. This implies that at least the coarser Chinese Loess Plateau deposits are derived from monsoon driven fluvial denudation of the Tibetan Plateau rather than from increased Asian aridification. It also suggests the Chinese Loess Plateau is a major sink for NE Tibetan plateau-derived sediment, and provides a means to asssess the denudation history of that area.

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BEREAL – DEVELOPMENT OF A NEW TESTING METHOD CLOSE TO REAL-LIFE FOR DOMESTIC BIOMASS ROOM HEATERS

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Introduction: Domestic biomass heating using firewood and wood pellets is one of the most important sources regarding air pollution in urban and rural areas. Especially particulate matter (PM) is one of the most critical parameter concerning emissions from biomass combustion. Currently, PM measurement at small scale biomass combustion systems is typically investigated by measuring total PM with gravimetric measurement methods. However, PM emissions of domestic biomass room heaters have a share of about 90 % of the smallest fraction PM 1 and 99% of PM2.5. Thus, emissions from biomass combustion have a high health impact, because of the emitted respirable dust. Additionally, PM emissions include carcinogenic compounds, e.g. polyaromatic compounds (PAC) like benzo(a)pyrene. An exposure to those emissions can lead to irreversible health diseases till premature death. Current PM emission threshold values only concern of total PM emission values. In the EU these thresholds became more and more stricter in the last years. However, these thresholds are valid for standard type testing results under laboratory conditions. Emissions in the field are significantly higher than under standard type testing conditions which is done under optimal operating conditions without respecting typical user habits and transient operating conditions (i.e. ignition phases). Thus, it is necessary to get to a more realistic assessment of type testing for domestic biomass room heaters in order to better reflect real-life conditions and to enhance manufacturers to optimize their products with respect to real-life operation. A new approach for a testing method regarding real-life conditions of biomass room heating appliances was investigated in the European FP7 project **"beReal – Advanced Testing Methods for Better Real Life Performance of Biomass Room Heating Appliances"**.
Purpose of work: The aim of the project is to develop a testing method regarding real-life conditions for domestic room heaters (firewood roomheaters according to EN 13240 and pellet stoves according to EN 14785) which should be established as a label testing method on the European market.
Approach: In a first step an European wide survey (> 2000 respondent) was conducted to examine the typical operating habits of end-users in order to evaluate real-life operating conditions of such appliances. Furthermore, the influence of different parameters on gaseous CO, OGC and PM emissions as well as on thermal efficiency, were evaluated (e.g. ignition modes, influence of draught conditions and fuel properties). As a result the first draft version of the new beReal test method for firewood roomheaters (EN 13240) and pellet stoves (EN 14785), respectively, was developed. Analysing interval for the beReal test method is an entire operation cycle, which consists of several batches (firewood roomheaters) or different load phases (pellet stoves), including starts at cold conditions, nominal and part load operation. This approach was assessed by a comprehensive validation procedure, including several firewood roomheaters and pellet stoves. Additionally, the beReal results were compared to standard type test results. Out of the validation process the final advanced beReal method was defined. Next step is to evaluate real-life relevance as well as the reproducibility of beReal methods (firewood and pellet) in field tests and a round robin test. Finally, the new beReal test method will be implemented in a European label scheme.
Scientific innovation and relevance: Current standard type test methods for domestic biomass room heating appliances do not reflect real-life operations sufficiently. Therefore, it is necessary to make a new assessment of type testing focussing stronger on field conditions. beReal is a first step into a new approach regarding real-life operation. Furthermore, manufacturers of room heaters are claimed to optimize their products for real-life operation.
Results and conclusion: The development of the beReal methods for firewood roomheaters and pellet stoves with a more realistic determination of real-life PM emissions are the main outcome of the project. First results showed that official EN type test results differed up to a factor of 15 compared to beReal test results. Further the beReal approach showed a good repeatability as well as the feasibility to better differentiate between high and low quality products in terms of emissions and efficiency.
The new beReal test methods – once implemented as standard – should be capable of leading to further technological innovation and improvement, especially for PM emission reduction in real-life operation, and finally to a satisfaction of future market and legal requirements.

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DUSTTRAFFIC: TRANSATLANTIC TRANSPORT AND DEPOSITION OF SAHARAN DUST

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Massive amounts of Northwest African dust are transported westward over the Atlantic Ocean towards the Americas each year. These dust particles are thought to feed back on climate through a number of mechanisms including reflection of solar energy at the top of the atmosphere, absorption of energy that was reflected at the Earth's surface in the lower atmosphere, changes of the Earth's albedo, and fertilisation of both terrestrial and marine ecosystems.

We are monitoring Saharan dust transport and deposition using an array of instruments that was deployed along a transect between Northwest Africa and the Caribbean at 12°N. In October 2012, we deployed five moorings along this transect between 23°W and 57°W with sediment traps that collect all material settling down through the water column on a temporal resolution of about two weeks. In November 2013, we added three dust-collecting buoys to the transect. The instruments on these buoys filter air to collect the dust particles that are suspended in the air just above sea level. In January 2015, the instruments were recovered and re-deployed for the third time, so that two years of sampling can help us understand the temporal and spatial variability of Saharan-dust deposition and its marine environmental effects. In this presentation we will introduce the projects in the framework of which this study is carried out, and present preliminary compositional data (grain-size, mineralogy, chemistry) on both spatial and temporal scales.

See: www.nioz.nl/dust

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LABORATORY INVESTIGATIONS OF MINERAL DUST-CATALYZED ATMOSPHERIC PHOTOCHEMISTRY

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Although dust events primarily originate in remote arid regions, dust particles undergo efficient long-range transport, and thus have the potential to contribute to contribute to reductions in air quality and human health in distant urban regions. Here, we present first results from our new laboratory, which focuses on dust-catalyzed photochemistry in polluted urban environments.

During transport, the size distribution of dust shifts toward smaller diameters; these smaller particles are enriched in photoactive Ti and Fe oxides, which we have previously shown to promote a variety of photochemical processes at the dust surface.[1,2] In order to assess the extent to which the inherent photoreactivity of dust changes as a result of transport-induced size fractionation, we used a fluorescence probe technique to measure the photochemical production of reactive radicals by realistically generated, size-selected dust samples.

In a separate set of experiments, we used a suite of particle and gas-phase analytical instrumentation to investigate the interaction of model urban gas-phase organic species with dust aerosol under realistic humidity/illumination conditions in an atmospheric reaction chamber.

Together, these experiments contribute to our understanding of the mechanism(s) via which dust particles catalyze reactions and the atmospheric consequences of dust–pollutant interactions.

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TODDLER EXPOSURE TO THE ENDOCRINE DISRUPTING CHEMICAL TRIPHENYL PHOSPHATE (TPHP) IN THE HOME ENVIRONMENT

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Toddlers are at increased risk for exposure to flame retardant chemicals (FRs) with endocrine disrupting properties, which are potentially harmful for the toddler's development. Triphenyl phosphate (TPhP) is a phosphorylated FR and is used in PVC and electronic equipment to prevent spread of fire [1]. TPhP has estrogenic effects and is able to induce mature adipocyte differentiation [2]. FRs leach out of products and end up in indoor dust, and they are ingested, absorbed or inhaled by humans. Toddlers are more prone to ingest house dust because of their specific behavior: playing in the proximity of the floor, frequently seeking support of furniture and mouthing of hands and toys [3].

This study aims to assess toddler exposure to TPhP in the home environment.

Fourteen toddlers were visited at home. Three samples of indoor dust in the area of the main activity of the child were analyzed for TPhP: floor dust, dust from electronic devices and surface dust. Wipes were collected from both hands of the toddler. The extraction was carried out using accelerated solvent extraction (ASE) and the extract was measured with liquid chromatography (LC) combined with mass spectrometry (MS).

TPhP was detected in all types of dust samples and in hand wipes. The highest concentrations were found in dust from electronic devices (Median=683 ng/g) (standard error=636.5)), followed by floor dust (404 (679.6)) and surface dust (303 (69.6)). TPhP was detected on the hands of 79% of the toddlers (2.7 ng/wipe (1.6)). Detection percentages were respectively 100, 85, 79 and 57 for floor dust, dust from electronic devices, hand wipes and surface dust.

This is the first study to determine TPhP in hand wipes from toddlers. TPhP was detected in floor dust, dust from electronic devices, surface dust and hand wipes. Although concentrations are considerably lower in hand wipes than in the environmental samples, the majority of hand wipes contained TPhP. The percentages of detection implicate a possible exposure route for toddlers, which needs to be explored further in order to guarantee a healthy environment for the toddler's development.

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DEVELOPMENT AND FUTURE PLANS OF THE AEOLIAN DUST PREDICTION OF JAPAN METEOROLOGICAL AGENCY

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Japan Meteorological Agency (JMA) has been providing operational Aeolian dust information with a numerical prediction model (MASINGAR, Tanaka et al. 2003) since 2004, and completed a major update of the system (MASINGAR mk-2) in November 2014. We will present an overview of JMA's Aeolian dust prediction as well as its recent developments and future plans.

The Aeolian dust prediction model (MASINGAR mk-2) is based on the global climate projection model of the Meteorological Research Institute (MRI) of JMA (Yukimoto et al. 2014). The aerosol process in the model includes five major aerosol species (mineral dust, sea salt, sulfate, black carbon and organic matter), with an update dust emission scheme (Tanaka and Chiba, 2005). Statistical verification of the model against the synoptic surface observations around Japan exhibits the threat score (TS) for dust prediction is improved in the new model mainly for the first 3 days of the forecast period. The verification results also suggest that the new model reduces overestimates of the surface dust concentration around Japan.

We are planning to upgrade the horizontal resolution of the prediction model from current T_L159 (~110 km) to T_L479 (~40 km) in FY2016. Preliminary results of the model verification show the improvement of forecasting scores and we expect that this upgrade will lead to more improvement of dust predictions. In addition, MRI has been developing an aerosol data assimilation system with the local ensemble transform Kalman filter (LETKF) using satellite retrieved aerosol optical depth (AOD) data (Yumimoto et al. 2015). We are planning to use the AOD observation with Himawari-8, JMA's new geostationary satellite. The RGB and NIR band of the Himawari-8's Advanced Himawari Imager (AHI) allows us to retrieve AOD and particle size information with the unprecedented temporal resolution and spatial coverage. A feasibility study of the LETKF data assimilation system using Himawari-8 AOD shows a good performance for dust predictions.

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TOWARDS ROUTINE CEILOMETER AND LIDAR NETWORKS FOR AEROSOLE PROFILING

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Triggered by the eruptions of Eyjafjallajökull/Iceland in Spring 2010, European Meteorological and Hydrological Services started to establish a European network for aerosol profiling based on Lidars and ceilometers. Nowadays ceilometers, e.g. the Vaisala CL51 and the Lufft CHM15K Nimbus, allow for the detection of aerosol layers in the atmosphere up to tropopause region. But even older systems established in past years, which are still in use at many places, are able to detect aerosol layers in the lower troposphere provided their optical thickness is not too low.

Based on experience gained during the European COST action EG-CLIMET (ES0702) another two European consortia established in 2013 and continue the work on harmonizing national ceilometer networks with respect to routine operations, data exchange and data formats (E-PROFILE, led by MeteoSwiss, see http://www.eumetnet.eu/e-profile) and harmonized aerosol profile retrievals (TO-PROF, COST ES1303, see http://www.toprof.imaa.cnr.it/), actively supported by EARLINET, the European Aerosol Research Lidar Network. Such combined networks of ceilometers and advanced lidars systems have already shown their value for providing the four-dimensional aerosol distribution over larger areas [1].

The Deutscher Wetterdienst (DWD), Germany's national meteorological service, contributes to the European ceilometer network with its 74 CHM15K Nimbus instruments (as of November 2015), which are all on-line (see www.dwd.de/ceilomap) and provide freely accessible quick looks of range corrected signals. It is anticipated that the range corrected signals will be superseded by attenuated backscatter coefficients in spring 2016. This step from a more qualitative view to quantitative results requires calibration of the instruments, which is currently performed within TO-PROF mainly by members of DWD, MeteoSwiss, Météo-France, and EARLINET [2], [3].

Several Saharan dust episodes in recent years were already tracked and analyzed by the network and results will be shown during the conference. Although not being in the focus of DUST 2016 it should be noticed that the network is also able to detect and track volcanic ash plumes and biomass burning plumes from Canadian wildfires. Moreover, data from the network have been successfully used to validate model data from the COPERNICUS Atmospheric Monitoring Service (CAMS).

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THE EFFECT OF SURFACE ROUGHNESS ON PARTICLE RESUSPENSION

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Particle resuspension studies indicate that surface roughness is one of the primary factors in determining particle detachment from surfaces in both indoor and outdoor environments. Applying an external force to a particle on a surface via mechanical or pressure driven flow, the particle will separate from the surface via rolling detachment when the net moment of the hydrodynamic force is greater than the adhesion resistant moment. Accordingly, the critical shear velocity for resuspension of a particle of a given size can be experimentally determined under different flow conditions. However, the estimated critical shear velocities from different studies ranged widely, even for wind tunnel investigations where the flow is relatively well characterized. Much of this variability can be attributed to surface roughness, which largely affects the particle adhesion force. For this study, results of reported experimental particle resuspension wind tunnel studies were examined, and current semi-empirical models for particle removal were applied to compare the experimental data with modelling results. Knowledge gaps in the literature were identified relating to particle size (particles smaller than 5 μm in diameter), particle type (types/sizes relevant to microorganisms and health and climate related scenarios), surface type (common rough surfaces, such as asphalt, concrete), and environmental conditions (ranges of relative humidity). To address these knowledge gaps, a new resuspension wind tunnel was designed and fabricated that operates at high flowrates, variable humidity, and allows for the use of a range of substrates and particle types. Initial results from the resuspension wind tunnel experiments will be presented and compared with the results from literature studies.

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CHEMICAL COMPOSITION OF PM2.5 DURING WOOD COMBUSTION IN DOMESTIC APPLIANCES HAVING HIGH ENVIRONMENTAL PERFORMANCE

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Environmental impact of the residential wood combustion appliances, in term of particle emissions, has generated much interest in the last decade. These investigations led the industrial and scientific communities to a better understanding of the combustion process and the development of new technologies in order to optimize the combustion, thus limiting pollutant emission factors [1]. However, a decrease of the amount of pollutant emitted is not the only factor to be taken into account in assessing the effectiveness of the new technologies in terms of environmental and human health impact. A chemical characterization, especially for particles emitted, is necessary.

The wood combustion appliance used is an insert equipped with a preheating system for air combustion (ADS®) with injection in the centre of the flame and the C2Box® device which allows a post-combustion of the gases. Experiments were performed in normative conditions. Characterisation of particles consisted to determine the total carbon (TC) fraction, and its repartition between organic (OC) and elementary (EC) carbon, the fraction of PAH, hydrocarbon and levoglucosan. Analyses of PAH and hydrocarbons in the gas phase were also performed.

It was observed that the total carbon fraction of TSP evolves during the wood load combustion. Particles produced during the inflammation phase, which corresponds to the first minutes of the load combustion, are characterised by a high carbon fraction (~45%), essentially of organic carbon (~40%). After 16 or 32 min of combustion, the carbon fraction of particles decreases to about 20% with approximately half organic carbon.

Gaseous PAH dominate with an emission factor of 5 mg per kg of dry wood (dw) compared this of adsorbed PAH with a value of 0.23 mg/kg_{dw}. Naphathlene represents 75% of the total phase gas while Indeno[1.2.3-c.d]Pyrene, Dibenzo[ah]Anthracene and Benzo[ghi]Perylene representing 66% of the total adsorbed phase of TSP. However, considering the toxic equivalent factors (TEF), the human health impact of adsorbed and gaseous PAH is almost the same.

This work was carried out in the framework of the ESPACE Bois project supported by the Agence De l'Environnement et de la Maitrise de l'Energie (ADEME).

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ORIGIN OF CENTRAL GREENLAND LAST GLACIAL DUST: NEW CLAY MINERALOGY AND SR-ND-HF ISOTOPIC DATA FROM NORTHERN HEMISPHERE LOESS DEPOSITS

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Dust in Greenland ice cores is used to reconstruct the activity of dust emitting regions and atmospheric circulation for the last glacial period. However, the source dust material to Greenland over this period is the subject of considerable uncertainty. Here we use new clay mineral and Sr-Nd isotopic data from eleven loess samples collected around the Northern Hemisphere and compare the $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ isotopic signatures of fine (<10 μm) separates to existing Greenland ice core dust data (GISP2, GRIP; [1]; [2]).

Smectite contents and kaolinite/chlorite (K/C) ratios allow exclusion of continental US dust emitting regions as potential sources, because of the very high (>3.6) K/C ratios and extremely high (>~70%) smectite contents. At the same time, Sr-Nd isotopic compositions demonstrate that ice core dust isotopic compositions can be explained by East Asian (Chinese loess) and/or Central/East Central European dust contributions. Central/East Central European loess Sr-Nd isotopic compositions overlap most with ice core dust, while the Sr isotopic signature of Chinese loess is slightly more radiogenic. Nevertheless, an admixture of 90–10 % from Chinese loess and circum-Pacific volcanic material would also account for the Sr–Nd isotopic ratios of central Greenland LGM dust. At the same time, sourcing of ice core dust from Alaska, continental US and NE Siberia seems less likely based on Sr and Nd isotopic signatures. The data demonstrate that currently no unique source discrimination for Greenland dust is possible using both published and our new data [3]. Thus, there is a need to identify more diagnostic tracers.

Based on initial Hf isotope analyses of fine separates of three loess samples (continental US, Central Europe, China), an apparent dependence of Hf isotopic signatures on the relative proportions of radiogenic clay minerals (primarily illite) was found, as these fine dust fractions are apparently zircon-free. The observed difference between major potential source regions in $^{176}Hf/^{177}Hf$ that reach several εHf units and the first order clay mineralogy dependence of Hf isotopic signatures means there is strong potential for distinguishing between the two hypothesized Greenland dust sources using Hf isotopes [3].

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VARIATIONS IN RADIOGENIC SR-ND-HF ISOTOPES, RARE EARTH ELEMENT ANOMALIES AND PARTICLE SIZE IN SAHARAN DUST ALONG A TRANSECT IN THE ATLANTIC OCEAN

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Approximately 180 Tg of Saharan dust is transported across the Atlantic Ocean every year[1]. The dust delivers nutrients that can potentially stimulate phytoplankton growth, transport bacteria and pathogens, and act as mineral ballast particles in the ocean. In the atmosphere, the dust can also scatter and absorb incoming and reflected solar radiation, affecting the Earth's radiation balance. In order to study the impacts of dust on climate and the ocean, present-day Saharan dust is sampled in the Atlantic Ocean with subsurface sediment traps moored along a transect at 12˚N. To investigate the possible effects of lithogenic particles other than Saharan dust in the samples, for example suspended sediments from the Amazon river, a selection of samples from different seasons and locations along the transect were analyzed for radiogenic Sr, Nd and Hf isotopic composition and REE anomalies. The results are compared with literature data from possible source areas, but also to Saharan dust sampled between 2003-2011 on Barbados in the West Atlantic[2]. Prior to analysis, the lithogenic fraction of the marine sediment-trap samples was isolated from the bulk samples using a multi-step leaching protocol. Analysis of both the bulk sample and the sample after leaching allowed for examining the influence of removing the marine component from mineral dust on geochemical systematics. The geochemical data is combined with grain-size analysis to further examine the potential control of particle-size distribution on the composition. In addition to sediment-trap samples, we have also analyzed soil samples from Mauritania, Africa. Combined with the available Sr-Nd isotope data from the literature, these results help interpret the potential link between soils in the source regions to the deposition sites.

Our results indicate there is a relationship between the Nd-Hf isotope composition of mineral dust with distance from potential sources in west Africa, which can be potentially due to the so-called "Zircon effect", indicating a relation between Hf isotopes and dust particle size. A relation between Nd isotopes and particle size is absent, as also previously demonstrated in the literature[3]. The Sr isotopes of the bulk samples resemble seawater Sr isotopic composition, due to the high amounts of $CaCO_3$ in the (bulk) samples. The Sr isotope composition of the lithogenic fraction, in contrast, are significantly more radiogenic, and the Nd-Sr isotope compositions of the leached samples fall within the values reported for Western Sahara and Mauritania. Rare earth element anomalies in the dust samples suggest Saharan dust sources, and a comparison with limited data from the literature indicates that the contribution from sediments of the Amazon River are negligible.

See also www.nioz.nl/dust

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SECTOR ANALYSIS AND LONG-TERM TRENDS EVALUATION OF PM DATA FROM THE CZECH ACTRIS AND EMEP SITE KOSETICE

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Presented study is based on 1996-2012 PM data from Košetice Observatory (Czech Republic). The Observatory (49°35´ N, 15°05´E, 534 m a.s.l.), operated by the Czech Hydrometeorological Institute (CHMI), was established in 1988 as a station specialized in air quality monitoring at the background scale. The observatory is involved in following long-term monitoring programmes: GAW/WMO (Global Atmosphere Watch), EMEP/ECE (Co-operative Programme for Monitoring and Evaluation of Long-range Transmission of Air Pollutants in Europe) and ICP-IM (International Co-operative Programme on Integrated Monitoring). Thanks to its excellent location and long-term homogeneous data series, the Observatory has been included into several European projects. Regarding atmospheric aerosols, the first was EUSAAR (European Supersites for Atmospheric Aerosol Research), followed by more widely composed EU FP7 and later Horizon 2020 project ACTRIS (Aerosols, Clouds, and Trace Gases Research Infrastructure Network). More detailed information is available in [1]. Monitoring of PM_{10} concentrations at Kosetice Observatory started in 1996 within national air quality monitoring network operated by CHMI. Measurement of $PM_{2.5}$ then started in 2004.

The nonparametric Mann-Kendall method [2] was used for statistical evaluation of trend significance. Sector analysis was elaborated using EMEP tools. The daily sector values, prepared by EMEP MSC-W [3] for every EMEP stations within the period 1985-2012, are based on 96 h backwards trajectories.

Gradual decline in PM emissions after 1989 in the Czech Republic was caused by general decrease of industrial production and reduction in electricity generation in conventional thermal power stations. In the beginning of the new millennium the decreasing trend was interrupted and the emissions stagnated.

Statistically non-significant decreasing trend of PM_{10} concentration at Košetice Observatory was detected in the whole period under review. Downward trend is statistically more significant in the summer, than in the cold period. The decreasing tendency visible in the period 1996-1999 was temporarily stopped in the beginning of this century. The concentrations slightly increased due to meteorological conditions and changes in combustion practices in small towns and villages. This tendency was registered to 2006 (with the highest values in 2003). After 2007 the mean annual concentrations dropped to the level before 2000.

Trend evaluation in individual sectors shows that the highest concentrations are measured when the air masses from eastern directions predominate and the lowest values are measured when they come from the west. Most significant decreasing trend was found in air masses with origin in the sout-western directions. On contrary, increasing trend was detected in episodes when the observatory is affected by airmasses from northeast, which corresponds with the rising trend in heavily polluted region on Moravian-Polish border located in this direction.

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PARTICULATE MATTER SOURCE IDENTIFICATION AND SPATIAL DISTRIBUTION AROUND THE HIGH POLLUTED TRAFFIC SITE AT STUTTGART NECKARTOR IN SOUTHERN GERMANY

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At the high traffic road at Stuttgart-Neckartor (80 vehicles per day) the monitoring station operated by the state Baden-Württemberg shows the highest PM10 pollution in Germany with up to 100 exceedances of the 24h limit value at 50 µg/m3. To find out the contribution of the sources at this site a special experimental program had been realized: Parallel to the official continuous PM10 monitoring and the 24h PM10 sampling size fractioned PM samplings with cascade impactors had been carried out at this station and in the neighboured park. Four PM size fractions collected on the impactor plates had then been investigated by electron microscopy and EDX analysis. The particles of these different fractions could be much better separately identified than if the filter of the total dust would have been analysed. On several inversion winter days such samples had been collected, analysed and quantified: The PM fraction < 1 µm was found to be Diesel soot, up to 20%. Between 1 and 2,5 µm we found background salts - ammonium sulfates and nitrates - with agglomerated soot particles, around 36 %. The particles in the size range of 2,5 to 10 µm were mainly re-suspended road particle with a contribution of 44%. These results gave the basics for a followed road cleaning project for improving the PM10 air quality situation.

In a further project part the air pollutant distribution was investigated along a part of the high traffic road through the urban area of Stuttgart passing the Neckartor monitoring station. The air pollutants were measured in April, May and June 2014 using portable instrumentations fixed on two bicycles operated by two students. The instrumentation comprised a Grimm optical particulate matter counter for PM10 and PM2,5, a Scintrex LMA-3 (liquid chemiluminescence analyser) for NO_2 and a GPS instrument to correlate the measured concentrations with the way they went. Around the location of the stationary monitoring station the highest concentrations were found. The measurements demonstrate that green park areas are useful arrangements to limit the urban exposure to traffic-related air pollutants. In comparison to PM the NO_2 concentration decreased more with a significantly stronger gradient when going from the high traffic road to a near-by park area. The NO_2 concentration is significantly and the PM concentration is strongly influenced by the source of the motor traffic. The urban background concentration had a significant influence on the PM10 concentration. The study illustrates the utility of the sensing system carried on bicycles for the determination of the spatial air pollutant concentrations in the urban area.

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POLYBROMINATED DIPHENYL ETHERS AND NOVEL FLAME RETARDANTS IN HOUSE DUST IN DENMARK – LEVELS, PATTERNS AND CHANGES OVER TIME

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House dust has been recognized as a source of exposure to polybrominated diphenyl ethers (PBDEs), in particular for children [1]. Since the EU ban of the commercial PBDE Penta- and OctaBDE mixtures in 2004 and the regulation of DecaBDE through the EU Restriction of Hazardous Substances (RoHS) Directive, replacements might have been in use [2]. Building on our previous results on PBDEs in house dust from Denmark and associations with perinatal exposure [3], the present study addresses i) PBDE levels in dust sampled in 2014 in comparison with 2007, ii) the occurrence of novel flame retardants (NFRs) in samples from both years.

The NFRs studied here included bis(2-ethylhexyl)tetrabromophthalate (BEH-TEBP), 2-ethylhexyl-2,3,4,5-tetrabromobenzoate (EH-TBB), 1,2-bis(2,4,6-tribromophenoxy)-ethane (BTBPE), decabromodiphenyl ethane (DBDPE), 2,3-dibromopropyl-2,4,6-tribromophenyl ether (TBP-DBPE) and dechlorane plus (DDC-CO). Furthermore, hexabromocyclododecane (HBCD) was included although globally banned since 2013.

While TBP-DBPE was below detection limits in several dust samples, the remaining NFRs were detected in all samples from 2007 and 2014. DDC-CO had relatively low concentrations (median < 5 ng/g for each of the isomers). HBCD had the highest concentration (median of 200 ng/g, predominated by γ-HBCD), followed by DBDPE > BEH-TEBP > BTBPE ~ EH-TBB, based on median values. None of these median concentrations reached the median value of BDE-209 of 432 ng/g obtained in 2007 [3]. As previously observed for PBDEs, distributions were skewed with arithmetic means clearly higher than medians, suggesting that exposure might be much above average for certain individuals. Likewise, the NFR composition in dust varied, with individual dust samples containing more BEHT-TEBP or BTBPE than DBDPE.

The large variation in the data prevents 2007 and 2014 data from being significantly different, but there are indications of higher concentrations of DBDPE, BEH-TEBP and EH-TBB in 2014 than in 2007. While BDE-209 remained unchanged from 2007 to 2014, BDE-47 appeared lower in the 2014 samples. Similar developments have been reported from the USA [4]. BDE-209 and DBDPE were found to be correlated in the dust samples, which might reflect similar use patterns. Future work will focus on the significance of the occurrence of these compounds in dust for questions of human exposure.

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REASONS FOR THE INTERANNUAL VARIABILITY OF SAHARAN DUST SOURCE ACTIVATIONS AT THE EXAMPLE OF 2007 AND 2008

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North Africa, including the Saharan desert, is the largest source of mineral dust worldwide and characterized by a multiplicity of different source regions. Local and large-scale meteorological processes like the morning breakdown of nocturnal low-level jets, convective systems, or cyclonic activity can cause the activation of potential dust sources regions. These dust source activations (DSA) show a strong variability on diurnal, seasonal, and interannual time scales. Whereas the diurnal and seasonal variations can be linked to the dominant local atmospheric circulation pattern, reasons for the interannual variability of DSA are largely unclear.

Recent studies analyzing satellite images at a sub-daily temporal resolution illustrate a significant interannual variability with regard to observed DSA events [1]. DSA events inferred from 15-minute IR dust index images calculated from MSG SEVIRI observations highlight a particularly strong variability for the two years 2007 and 2008 with a sudden increase in the number of observed DSAs between the end of 2007 and early 2008 resulting into a significantly higher level of DSA during the whole year 2008 compared to 2007 [2].

Here we discuss potential reasons for the large differences in the observed number of Saharan DSAs between the two years 2007 and 2008. Satellite observations (SST, precipitation, dust) and results from numerical model simulations (regional and global scale) are used complementarily to identify atmospheric and oceanic features that may control DSA over North Africa. In addition to considering changes in atmospheric circulation patterns, which directly affect near surface winds and consequently DSA, we also discuss teleconnections such as the impact of sea-surface temperature (SST) changes and the Madden-Julian Oscillation (MJO).

Outcomes from this study show that several individual forcing mechanisms contributed to the enhanced number of DSA in 2008. This includes classical North African circulation features like the West African heat low and Mediterranean cold surges, which predominantly result in changes in the Sahel rainfall distribution and the mid-tropospheric wind pattern. Our results further show that changes in the SST in surrounding ocean basins (i.e., the Indian Ocean) act as controlling factors, which govern the development and strength of most of the regional circulation patterns and finally forces the DSA. Beside these large-scale forcing it appears that the activation of alluvial sediments, which could develop after heavy rainfalls in 2007 especially in the mountainous areas of the Sahel region, significantly contributes to the enhanced DSA in the following year. Understanding the mechanisms, which drive the interannual variability in DSA, will strengthen our knowledge of the North African dust cycle and its contribution to the global aerosol burden, which is a key aspect in understanding the climate effects of airborne mineral dust.

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PARTITIONING BEHAVIOR OF VOCS BETWEEN DUST AND AIR

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Intensive agricultural activities are the source of multiple air pollutants including inorganic gases (NH_3), volatile organic compounds (VOCs) and airborne particulate matter (PM). Next to their effects on the acidification (NH_3) of the environment, local residents can suffer from severe odour nuisance caused by these emissions, particularly in areas with high population densities. Odorous compounds are not only present in the free gas phase but undergo a partitioning between the gas phase and particulate matter making particles possible odour carriers. This partitioning behaviour has been scarcely investigated. Therefore, in order to investigate this partitioning behaviour, an advanced analytical method was developed using selected ion flow tube mass spectrometry (SIFT-MS).

Selected Ion Flow Tube Mass Spectrometry or SIFT-MS is a relatively new analytical technique for the real-time measurement of trace-gases and VOC concentrations. With this technique, target molecules are ionized by chemical ionization using H_3O^+, NO^+ and O_2^+ precursor ions, produced by a microwave discharge source. Product ions and unreacted precursor ions are formed and are analyzed by a downstream quadrupole mass filter. Concentrations of the target compounds can be calculated using the reaction rate constants, and detection limits in the order of 1 ppb can be obtained. The SIFT-MS real-time measurement offers unique and new opportunities to characterize materials and to study the interaction of VOCs with materials.

The developed method was used to determine the particle-to-air partitioning coefficients of 4 important organic odorants (acetic acid, butanoic acid, phenol and dimethyl disulphide) having different physical chemical properties. The method makes use of inverse frontal chromatography. The column is packed with the material under study. In this case, particles with an aerodynamic diameter less than 10 µm (PM_{10}), collected from a pig stable using high volume sampling (PM10 head, 500L/min, several days of sampling). A constant air stream with a constant VOC concentration (containing the target compounds) was generated in a home-made system and was injected as a step function onto the chromatographic column. The response of the step experiment was monitored by the SIFT-MS and resulted in breakthrough curves. From these registered breakthrough curves, dimensionless particle-to-air partitioning coefficients can be calculated. They ranged from $13 \times 10^3 \pm 3.1 \times 10^3$ for dimethyl disulphide to $16 \times 10^5 \pm 1.7 \times 10^5$ for phenol. Partitioning coefficients can be estimated using octanol-air partitioning coefficients available from the literature ($r^2 = 0.94$). The results show that particles were enriched in VOC but the fraction of sorbed volatiles was low (<0.11%) at a PM_{10} concentration of 1 mg m^{-3}.

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USING CATS AS MODEL FOR INDOOR EXPOSURE AND ASSOCIATION TO FELINE THYROIDOGENICITY

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Thyroidogenic disruption as an endocrine endpoint is of growing concern for human health and the environment. Hence, the MiSSE project (Mixture aSSessment of EDCs) is specifically aiming to assess the indoor exposure situation to thyroid hormone disrupting compounds (THDCs), and accordingly the mixture effects of these compounds. As cats and toddlers have a similar behavior with their grooming and hand-to mouth activity cats are here used as sentinels for human and child exposures to indoor related chemicals and their thyroidogenic effects. Recently, an association was demonstrated between domestic cat's thyroid health status and levels of brominated flame retardants in their blood [1]. We have further investigated the exposure pathway via dust by correlating the levels in the two matrices dust and cat blood. The THDCs are searched for by applying *in silico* similarity models comparing known THDCs [2-3] and using target analysis of a selection of key-THDCs.

We will report the progress halfway through the project, focusing on dust contaminants and inform about the future perspectives regarding mixture effects and evaluation of the indoor exposure to a set of emerging compounds of concern.

Samples and Methods - Seventeen families in the Stockholm/Uppsala region, Sweden, participated in the study (2013-2014). The families should have a healthy pet cat and at least one child living at home (<10 years old). The cat's thyroid status was evaluated by measuring the levels of total serum thyroxin (T4) and thyroid stimulating hormone (TSH). All cats were clinically healthy at sampling. In total, blood serum was drawn from 29 pet cats and stored at -20°C prior to analysis. The study was performed with permission from the Swedish Board of Agriculture and Uppsala Ethical Committee on Animal Studies (No. 31-10466/12).

In parallel, dust samples were vacuumed from the living room and bedrooms of the participating families. Still-standing dust were collected using a dust collector ((Dustream™, Indoor Biotechnologies Ltd., Wiltshire, UK) containing a disposable filter (mesh size 40 μm) attached to a household vacuum cleaner tube. The dust was collected from surfaces little influenced by daily life e.g. walking and/or containing bread crumbs and soil. Typical sampling areas were book shelves, TV furniture's and around other electronics, window benches, on top of hanging and standing lamps, wall strips, but also on top of sofas and armchairs and around the beds. Sampling of human and cat hair was avoided, as well as large assembly of gravel or other influences from the outside. The samples were sieved (1 mm) and stored in aluminum foil and kept at -20°C until analysis.

The target analytes, e.g. brominated flame retardants, organophosphorus compounds, organochlorines, perfluoroalkyl substances and some phenolic compounds have been determined with GC and LC-MS/MS instrumentations. Statistical correlations between cat serum and house dust in paired samples have been assessed. In addition, an Effect-Directed Analysis approach utilizing advanced chemical instrumentation and bioassay guided fractionation will be performed on the household dust in the strive to identify key-THDC.

Acknowledgements: This project is founded by FORMAS (No. 210-2012-131). Thanks to all the families and cats partitioning in this study. For more information see www.aces.su.se/misse/.

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SYSTEMATIC ANALYSIS AND INTERPRETATION OF MINERAL LUNG DUST

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In our study we analysed the inorganic particles in 13 samples extracted from human lung tissue obtained either during autopsies or biopsies. All patients suffered from pulmonary diseases like pleural mesothelioma, silicosis or lung carcinoma. We analysed the present mineral particles with respect to their size, shape, mineralogical identity, spatial distribution and particle number.

It is well known that inhaled mineral dust can cause severe health problems like asbestosis, which is caused by the inhalation of fibrous dust from one of the six industrially defined asbestos minerals actinolite, amosite, anthophyllite, crocydolite, tremolite and chrysotile.

However, dust from non-fibrous minerals like quartz can also increase the occurrence of cancer or other lung diseases.

The aim of this study was therefore to collect data for the non-fibrous particle contributors to lung dust. This is necessary because minerals like quartz, talc, kaolinite or iron oxides were found to be etiological for different diseases of the respiratory tract [1]. For mineral identification we used manual TEM analysis as well as automated single-particle analysis via SEM/EDX.

To be able to distinguish between particles from an exterior source and endogenous minerals we directed our attention to possible formation as well as breakdown reactions in the lung dust.

We found first evidence that P- and P-Fe-rich particles, resembling ferruginous bodies known from fibrous minerals, also seem to form in the presence of non-fibrous particles. In addition, as many clay, mica and feldspar particles tend to accumulate in the lungs they seem to be broken down by internal processes to form secondary SiO_2 particles.

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IMPACT OF THE 0.1% FUEL SULPHUR CONTENT LIMIT IN SECA ON PARTICLE EMISSIONS – CASE OF LOW-SULPHUR RESIDUAL MARINE FUEL OIL

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Since January 2015 the maximum allowed sulphur content in marine fuels used in Emission Control Areas considering sulphur oxides (SECAs) is limited to 0.1 % m/m S. Designated European SECAs today are the Baltic Sea together with the English Channel and the North Sea and are established by the International Maritime Organisation (IMO) to limit emissions of sulphur oxides [1]. The driving force for implementation was to reduce impact of shipping on acidification. During the process, focus changed to the health aspect of particle emissions [2], and it is assumed that reduction of the fuel sulphur content will reduce the emissions of particles considerably. The implementation of the fuel-sulphur limit force ship owners to use low-sulphur marine fuel oils, alternative fuels, or abatement technologies, to comply with the regulation. Until late 2014, the distilled marine diesel oil was assumed as the low-sulphur alternative to the heavy fuel oil (HFO). However, in the end of 2014 a new low-sulphur residual marine fuel oil (LS-RO), which is a type of HFO, appeared on the market and are today used by ships operating in SECAs. To our knowledge, there are no previous studies that compare emissions from a HFO and a LS-RO, and particularly emissions of the particles, which cause negative health effects. The aim of this study is to investigate how the fuel shift and reduction in fuel sulphur content will affect the particle emissions. The measurements were performed on the same ship before and after the fuel switch, in order to show if use of LS-RO is one solution to reduce emissions of particles from ship operations or if further regulations of fuel quality is needed.

The measurements have been made on-board a ship operating in the Baltic Sea during two separate occasions; Campaign 1 in November 2014 and Campaign 2 in April 2015, i.e. before and after the sulphur content in marine fuels was limited to 0.1 % S. During Campaign 1, the ship used a HFO (0.48 % m/m S) for propulsion and for Campaign 2 a LS-RO (RMB30, 0.092 % m/m S) was used. The measurements of the particle emissions were made with an Engine Exhaust Particle Sizer (EEPS, Model 3090, TSI Inc.) and a dust monitor (Grimm, Model 1.108). A thermodenuder was used to quantify the amount of solid particles. Further, the properties of the particles were characterized with a Multi Angle Absorption Photometer (MAAP, Model 5012, Thermo Scentific) for content of black carbon (BC), with thermal-optical (elemental and organic carbon) and ED-XRF (elements) analyses of collected filter samples.

The results of this study show that combustion of the HFO results in a higher particle mass emitted (total emission and solid fraction), than that of the LS-RO. The number of particle emitted was of the same order of magnitude for the two fuels, i.e. the reduction of sulphur content did not result in reduced particle number emissions. The particle number size distribution for the respective fuel type was of unimodal type with a peak at 34 nm for HFO and 19-22 nm for LS-RO. The size distributions were of similar character for both the total emission and solid fraction, and dominated by nanoparticles (diameter below 50 nm).

This study indicates that use of LS-RO as low-sulphur alternative in SECAs will reduce the particle mass emitted, but not necessarily reduce number of particles emitted. This emphasizes that the fuel quality and content of other compounds in the fuel are important when impacts on emissions of particles and the consecutive environmental consequences are considered and impacts of current and potential future legislation evaluated.

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COMPOSITION AND BIOLOGICAL EFFECTS OF SHIP DIESEL ENGINE AEROSOL EMISSIONS: JOINT ANALYSIS OF AEROSOL PROPERTIES AND THE MOLECULAR BIOLOGICAL EFFECTS ON HUMAN LUNG CELLS

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Ship engine emissions are important regarding lung and cardiovascular diseases in coastal regions worldwide. The Virtual Helmholtz Institute-HICE (www.hice-vi.eu) addresses chemical & physical properties and health effects of anthropogenic combustion emissions. Typical lung cell responses to combustion aerosols include inflammation and apoptosis, but a molecular link with the specific chemical composition in particular of ship emissions has not been established.
We exposed human lung cells to exhaust fumes from a ship engine running on common heavy fuel oil (HFO) and cleaner-burning diesel fuel (DF) as well as to emissions of wood combustion compliances (for reference) by an air-liquid interface exposure system (ALI). A special field deployable ALI -exposition system and a mobile S2-biological laboratory were developed for this study (1).
Human alveolar and bronchial basal epithelial cells (A549 and Beas2B) as well as murine macrophages (RAW) were ALI-exposed to fresh, diluted (1:40-1:100) combustion aerosols. Subsequently the cells were toxicologically and molecular-biologically characterized (2). Advanced chemical analyses of the exhaust aerosols (including high end methods such as AMS, GC-MS, FT-ICRMS or photo ionization mass spectrometry (3)) were combined with transcriptional, proteomic and metabolomic profiling to characterize the cellular responses.
The HFO ship emissions contained high concentrations of toxic compounds (transition metals, organic toxicants) and particle masses. The cellular responses included inflammation and oxidative stress. Surprisingly, the DF ship emissions, which predominantly contain rather “pure” carbonaceous soot and much less known toxicants, induced significantly broader biological effects, affecting essential cellular pathways (e.g., mitochondrial function and intracellular transport). This was largely unexpected. The experiments with the murine RAW cells confirm the conclusion drawn from the experiments performed with the human alveolar and bronchial basal epithelial cell lines.
Therefore the use of distillate fuels instead of HFO for shipping (this is the current emission reduction strategy of the IMO) appears insufficient for safely diminishing health effects. The study suggests rather reducing the particle emissions by secondary measures (filters) than only changing the fuel (1).
In the case of wood combustion the reduction of soot and carcinogenic aromatic compounds is suggested. Furthermore the shipping emissions are compared to the emission of different wood combustion compliances.

Keywords: Ship emissions, Lung cell lines, Air liquid exposure, Molecular biological response, Wood combustion

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POSTER CONTRIBUTIONS

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TWELVE THOUSAND YEARS OF DUST: THE HOLOCENE GLOBAL DUST CYCLE CONSTRAINED BY NATURAL ARCHIVES

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Mineral dust plays an important role in the climate system by interacting with radiation, clouds, and biogeochemical cycles. In addition, natural archives show that the dust cycle experienced variability in the past in response to global and local climate change. The compilation of the DIRTMAP (Dust Indicators and Records from Terrestrial and MArine Palaeoenvironments) paleodust data sets in the last 2 decades provided a benchmark for paleoclimate models that include the dust cycle, following a time slice approach. We propose an innovative framework to organize a paleodust data set that builds on the positive experience of DIRTMAP and takes into account new scientific challenges by providing a concise and accessible data set of temporally resolved records of dust mass accumulation rates and particle grain size distributions. We consider data from ice cores, marine sediments, loess–paleosol sequences, lake sediments, and peat bogs for this compilation, with a temporal focus on the Holocene period. This global compilation allows the investigation of the potential, uncertainties, and confidence level of dust mass accumulation rate reconstructions and highlights the importance of dust particle size information for accurate and quantitative reconstructions of the dust cycle. After applying criteria that help to establish that the data considered represent changes in dust deposition, 45 paleodust records have been identified, with the highest density of dust deposition data occurring in the North Atlantic region. Although the temporal evolution of dust in the North Atlantic appears consistent across several cores and suggests that minimum dust fluxes are likely observed during the early to mid-Holocene period (6000–8000 years ago), the magnitude of dust fluxes in these observations is not fully consistent, suggesting that more work needs to be done to synthesize data sets for the Holocene. Based on the data compilation, we used the Community Earth System Model to estimate the mass balance of and variability in the global dust cycle during the Holocene, with dust loads ranging from 17.2 to 20.8 Tg between 2000 and 10 000 years ago and with a minimum in the early to mid-Holocene (6000–8000 years ago).

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DEVELOPMENT OF AN ONLINE SEQUENTIAL EXTRACTION (OSE) METHOD FOR THE ELEMENTAL CHARACTERISATION OF FINE DUST SOURCES

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Fine mineral dust (<0.45 μm), originating from diffuse and numerous sources, resides ubiquitously in the atmosphere, potentially adversely affecting the climate, and influencing human and ecosystem health. Targeted monitoring and reduction of fine dust emissions from the most critical dust sources requires a reliable method of identification, which presents an analytical challenge. Current methods of dust source characterisation are often based on modelling and observations of the physical properties of fine dust. If chemical analyses are employed, total elemental contents in dust are targeted using total or near-total sample digestions. These methods, while effective, have serious limitations when sample masses are small. To counter these limitations, we have developed an online sequential extraction (OSE) technique.

To develop the method, a number of samples were obtained representing local dust sources near Jülich (Germany), including agricultural soil, mine wastes and road dust. The OSE technique applies a modified four-step Tessier sequential extraction scheme to elute elemental species from the sample matrices in order of decreasing mobility. Eluted samples are analysed using High-Performance Liquid Chromatography (HPLC) instrumentation with Inductively Coupled Plasma Mass Spectrometry (ICP-MS), whereby data are obtained during extraction in real-time. By comparison to the determination of total elemental contents, the OSE method provides rapid information on detailed sample properties and potentially a more reliable identification of dust sources.

Preliminary experimentations with the OSE technique have demonstrated promising results, whereby clear differences in the elemental profiles of each sample type were observed. For example, manganese in road dust was primarily detected within the first (water soluble) fraction, while in soil the manganese was principally eluted in the third (acid soluble) fraction. To advance the development of the OSE method, we will employ chemometrics to convert the current information into more meaningful qualitative and quantitative data. In future, the method will be refined and optimised for application to airborne dust samples. By providing a reliable method to trace dust sources, the OSE method is expected to serve as an effective tool in the identification, monitoring and management of sources contributing to airborne dust loads.

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INVESTIGATION OF PARTICULATE MATTER AND MOULD SPORES IN HORSE STABLES

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Many horses have allergic reactions especially when they are exposed to microbiological pollutants like mould spores [1]. For the employed people and the riders moving within the stables the particulate matter and mould spore loads are of health interests too. To characterize the pollution of different horse stable systems the concentrations of particulate matter (PM10) and mould spores were investigated in five different stables. Continuous monitoring and integrated samplings were used for PM10 determination. Also the PM size distribution was measured using an Anderson cascade impactor. For the mould spore measurement different methods were used [2,3].

The results show that in stables with bad ventilation considerably higher PM10 concentrations are observed than in such ones with better ventilation. During bad ventilation average PM10 concentrations of 290 µg/m^3 were found and peak concentrations up to 2750 µg/m^3 during cleaning the horse boxes. In an open stable and in stables with open paddocks the PM10 pollution was much lower. In the open stable the inside concentrations were nearly the same as outside, e. g. 113 to 15 µg/m^3. The contamination of the air in the stables with mould spores showed apart from one in all stables a good correlation to the PM10 concentrations. The most existing mould spores were Cladosporium sp. 6454–9430 KBE/m^3, Wallemia sebi 330–1758 KBE/m^3, Penicillium sp. 567 KBE/m^3 and Eurotium sp. 390 KBE/m^3.

In addition to the air quality measurements in all stables the fed hay had been investigated on mould spores. Some kinds of hay contained only low concentrations. But there were also others which were strongly polluted. This kind of hay caused distinct coughing fits of allergic horses.

As conclusion it can be stated that for low PM pollution in horse stables a good ventilation and the avoidance of PM emitting activities in the stables are important preconditions. In respect of horse coughing the content of mould spores in the hay is of great importance.

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IN-SITU DIAGNOSTICS DURING PLASMA SYNTHESIS OF NANOPARTICLES

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Together with the explosively increasing number of nanoparticle applications in various fields (e.g. contamination control, bio-medicine, paint and coatings, semiconductors, solar cell industry, etc.) the urge for superior control over parameters such as nanoparticle size, refractive index, monodispersity and chemical composition requests the upmost from particle production techniques.

Utilizing plasma for nanoparticle synthesis has demonstrated its potential because of its sensitive control regarding particle size and monodispersity. Moreover, due to the presence of highly energetic (electrons) and reactive (radicals) species, plasma-synthesis enables extremely complex chemistry at room temperature not only forming the nanoparticles' bulk material, but also to the end of surface passivation which is crucial for successful application of, for instance, quantum dots. Since nanoparticles gather a permanent negative charge once synthesized in plasma, the - per definition - positive plasma potential allows for plasma-confinement of these particles on extremely long time scales. The latter provides possibilities to apply consecutive steps with respect to plasma-surface chemistry. Hence, synthesized nanoparticles can be multi-coated in on and the same plasma event.

For the sake of control over all mentioned physical and chemical processes, plasma and particle diagnostics are inevitable. In this contribution we present a full arsenal of state-of-the-art and in-situ diagnostic tools to probe plasma and particle properties. This set of diagnostics includes (360^0 Mie scattering and single-wavelength ellipsometry to probe the size and refractive index of single particles, charge determination from plasma-particle interaction under varying apparent gravity conditions, and Microwave Cavity Resonance Spectroscopy (MCRS) and Laser-Induced Photo-detachment (LIPD) to probe plasma charging of particles and the formation of particles).

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PHYSICOCHEMICAL CHARACTERIZATION OF PARTICLES EMITTED DURING THE THREE PHASES OF WOOD LOGS COMBUSTION IN DOMESTIC APPLIANCES

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Ambient particles have a significant part in respiratory disease [1], in the modification of the radiative balance of the earth [2] and change the chemical composition of clouds [3]. Despite the knowledge of these effects, many characteristics of the particles remain unknown. In order to reduce risks, the most important sources of emissions have to be targeted. Residential wood energy is described in many studies as a main source. Even if the emission factor depends not only on the kind of sampling but also on the country, wood energy is an important source of particles [4], particularly in logs stove [5]. In logs stoves, the combustion can be divided in three parts: ignition, homogeneous combustion and heterogeneous combustion [6]. These stages have their own characteristics and therefore their own pollutants emissions. The ignition is the most polluting step, followed by heterogeneous combustion. Few studies have characterized the particles emission during these three different stages. To go further, two new technologies will be used in this study: X-ray microanalysis and Organic Carbon /Elementary Carbon (OC/EC) analyzer.

The X-ray microanalysis has been performed on a Scanning Electron Microscope (SEM) equipped with a module Energy Dispersive Spectroscopy (EDS). This machine allows a semi-quantitative elementary analysis of the observed particles. Software for automatic recognition of the particles was added to the device, allowing a better analysis on a set number of particles. With this microscope, some families of particles have been defined, and high resolution pictures of particles have been acquired with a FEG SEM (Field Emission Gun).

The OC/EC analyzer allowed understanding which type of carbon is preferentially emitted during each combustion phase.

The experimentations have been processed on an airtight logs stove of 6kW on a test device according to EN 13240 norm. Many analysis have been performed during the complete combustion:

- Flue gas composition (O_2, CO, NOx, VOC, NMVOC, …);
- Granulometric composition of particles in number;
- Total Suspended Particles in mass.

Some other samplings were shorter, and repeated for each step of combustion:

- Filter for the SEM;
- Filter for the OC/EC analysis;
- Particulate Matter in mass (PM_{10}, $PM_{2.5}$, PM_1).

For each combustion stage, the emissions as well as the emitted particles have been accurately analyzed and characterized. The influence of the stage on the particles characteristics has been shown. Results of this study allow a better understanding of the formation mechanism of particles and thus enable the development of new technologies, in particular to prevent particles formation and imagine new systems to treat fumes.

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ELEMENTAL ANALYSIS OF AIR PARTICULATE MATTER BY MEANS OF TOTAL REFLECTION X-RAY FLUORESCENCE

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The analysis of air particulate matter (PM) is one of the main issues of environmental pollution assessment studies. We designed, realized, optimized and validated a new method for heavy metals analysis in PM collected on filtering membranes by means of total reflection X-ray fluorescence (TXRF). The new process for sample preparation and storage is realized by the SMART STORE device, and consists in sandwiching the sample between two polymeric foils. The sample is protected from external contamination, material loss is avoided and the sample can be stored for further investigations. After preparation, the samples can be directly analyzed by several non-destructive X-ray based techniques. TXRF spectrometry is particularly promising for its capability to detect heavy metals at very low concentrations (ng/cm^2). Moreover, it offers the possibility to perform multi-element analysis, offering the unique advantage of sample screening [1]. Quantitative elemental chemical analysis by TXRF of air PM collected on Teflon filters prepared as described is possible [2, 3].

Indeed, the novelty of this analytical approach is that filter samples were analyzed directly by different XRF instruments configuration and did not require chemical pretreatment to leach elements from the aerosol particulates as usually are necessary in other spectroscopic techniques such as ICP-MS [4]. Results of TXRF analysis highlighted that the proposed strategy of atmospheric aerosols on 'as-received' filters leads to precise and accurate quantification of heavy metals, thereby leaving samples unaltered for further studies or possible subsequent analyses by other methods. In addition, analysis of Teflon filters prepared according to SMART STORE method was performed also by micro-energy dispersive X-ray fluorescence (μ EDXRF) as well as synchrotron radiation (SR-TXRF) techniques. Validation of quantitative results is still ongoing.

This approach can be also used for other kinds of samples. Indeed we have shown that it's possible to analyse PM collected on leaves used as biomonitors [5]

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ASSESSMENT OF GC×GC-HR-TOFMS AS A SCREENING TECHNIQUE FOR THE IDENTIFICATION OF ORGANOHALOGENATED CHEMICALS WITH CAT HAIR AS A MODEL FOR INDOOR EXPOSURE

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Household dust can be a major source of human exposure to environmental contaminants such as organohalogenated chemicals (OHC). Pets, especially cats, show similar behavioural traits to toddlers, such as hand-to-mouth activities, and have been presented as a potential bio-sentinel for indoor pollution exposure [1]. Apart from inhalation, their meticulous grooming methods make them particularly susceptible to exposure to house dust and in turn, to the chemicals accumulated on/ in dust. Levels for OHC, including organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs), and brominated flame retardants (BFRs) have been reported in cat blood [1–3] and concentrations for bromophenols, BFRs, PCBs, and OCPs were reported in hair samples taken from pet cats and dogs from Pakistan [3]. Hair, as a non-destructive monitoring system, has been used as a bio-indicator for human exposure to persistent organic pollutants (POPs). Mass spectrometry is the detection technique most extensively used for quantitative and qualitative analysis of these persistent, bio-accumulative and toxic compounds. The large number of possible compounds that can be detected, along with their degradation products, presents an analytical challenge; to confidently detect, identify, and interpret the unprecedented quantity of data generated by the modern mass spectrometers and to accurately quantify environmental contaminants. Advances in commercially available mass spectrometers capable of producing high-resolution mass spectra allow for a single experiment to resolve more discrete chemical compounds. By combining comprehensive two-dimensional chromatography (GC×GC) with high resolution time-of-flight mass spectrometry (HR-TOFMS), the peak capacity of the chromatographic separation process is increased with the added advantage of recording high resolution mass spectra. With appropriate mass spectral information and accurate mass measurements, elemental composition of compounds can be calculated, which allows rapid identification of molecular ions (and fragments) belonging to homologous series based on their common mass defect [4]. GC×GC-TOFMS has successfully been used for environmental forensic investigations and also applied for the investigation of OHC micro-contaminants [5,6]. Cat hair, extracted using destructive and non-destructive techniques, was used as sample model to investigate the feasibility of utilising GC×GC-HR-TOFMS as a non-targeted screening technique to develop a method for the identification of halogenated compounds in environmental matrices. This technique will be used to complement the various instrumental techniques utilised for targeted analysis of halogenated organic pollutants in environmental matrices to evaluate the capability to perform metrologically traceable reference measurements. Results obtained from the non-targeted and targeted analysis are discussed.

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CASE STUDY SIMULATION OF WRF-CHEM MODEL FOR FORECASTING DUST CONCENTRATION OVER MONGOLIA

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In this work, the ability of the Weather Research and Forecasting model coupled with the Chemistry (WRF-Chem) model using the Shao's dust scheme is evaluated. The WRF-Chem model was adopted for forecasting the hourly 5 array dust during 13-16 Apr 2015 over Mongolia.

The computational domains were chosen of 434x764x43 grid points with horizontal resolutions of 3 km respectively. The model was initialized with real boundary conditions using GFS (Global Forecast Model) model and NCEP FNL (Final) reanalysis data.

In the estimation of dust emission amounts, surface information such as vegetation cover and the soil types in the dust source region is required [1]. It is important to use as much realistic surface data as possible to obtain an accurate estimation of dust emission amounts. In this study, new static data for soil texture and vegetation cover data were input into WRF-Chem to improve the surface conditions in the model simulations.

The simulations are compared with surface synoptic data and dust observation station data and are found to agree well with the observations. The synoptic systems that generated the dust storms and the evolution of the dust patterns are analyzed. A strong dust event, which is accompanied by a synoptic front, occurred for April 14-15. During the event, the maximum concentration of PM10 reaches 700 mg/m^3 at 3 m height at Tsogt-Ovoo in Mongolia, which is located in the northern Gobi Desert.

This case study demonstrates that WRF-Chem presents great potential for simulating dust storms and providing useful guidance in early warnings over Mongolia. However, extensive model evaluations are still needed to understand the performance of the model under various environmental conditions.

This work was partly supported by JSPS Core-to-Core Program (B. Asia-Africa Science Platforms).

Keywords: WRF-Chem, Dust emission, Gobi-desert.

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POTENTIAL CRUSTAL AND ANTHROPIC CONTRIBUTION TO ATMOSPHERIC AEROSOL PARTICLES BY USING LICHEN-BAG TECHNIQUES IN THE AGRI VALLEY (SOUTHERN ITALY)

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The presence of trace elements in the atmosphere has long been of concern in relation to environment [1] and human health [2]. The monitoring of the trace element-related atmospheric pollution is a very complex problem particularly because the concentrations of atmospheric pollutants are characterized by a high spatial and temporal variability that depends upon several factors. The most common approach to the measurement of trace elements in the total atmospheric aerosol particles involves the use of traditional instrumental methods. At present, in addition to traditional methods, a simple, inexpensive, active biomonitoring method with lichen-bag technique can be used to estimate air quality. At the same time the need to quantify the contribution of different sources to the atmospheric aerosol concentrations is to take into particular consideration. In this context, the present study deals with the investigation of the potential crustal and anthropic contribution to atmospheric aerosol particles by using lichen-bag techniques. The study was performed in the Agri Valley (Basilicata Region - Southern Italy), an area of international concern since it houses one of the largest European on-shore reservoirs and the biggest oil/gas pre-treatment plant (i.e., Centro Olio Val d'Agri – COVA) within an anthropized context [3]. In particular, the concentrations of 17 trace elements (Al, Ca, Cd, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, P, Pb, S, Ti and Zn) were measured in lichen bags exposed in 59 selected monitoring points over a period of 6 months (from October 2011 to April 2012) and 12 months (from October 2011 to October 2012). The 17 trace elements analyzed were used to evaluate the possible Crustal Material (CM), Smoke (Sm), Sea Salt (SS), Sulphate (Sph) and Trace Element-related Anthropogenic (TEA) contributions. Finally, the existence of a continuous broad variation of these contributions in the region of interest was tested using a Trend Surface Analysis (TSA).

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EVALUATING DUST CONTRIBUTIONS TO THE SOLUTE CHEMISTRY OF MOUNTAIN STREAMS IN NORTHERN UTAH, USA

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Aeolian dust is an important physical and chemical flux to mountain snowpack, with potentially significant contributions of trace metals and solutes to mountain streams during snowmelt. However, it is difficult to differentiate dust contributions in runoff from soil erosion and weathering inputs. Sr isotopes show promise as a tracer of the soluble fraction of dust through the hydrologic system. We analyzed $^{87}Sr/^{86}Sr$ ratios, Sr concentrations, and other parameters in bulk snowpack (wet and dry deposition), dust, and snowmelt runoff in three snowmelt dominated watersheds northern Utah during snowmelt in 2014 and 2015. The Provo River, Logan River, and Little Cottonwood Creek watersheds were selected because they provide contrasting geologic settings to evaluate dust contributions to water chemistry. Sr concentrations and $^{87}Sr/^{86}Sr$ ratios ranged across the watersheds and varied throughout the snowmelt season. For each sampling site, a two component mixing model was developed with end members of bulk snowpack (dominated by dust contributions) and pre-runoff river baseflow (assumed to represent groundwater contributions). Mixing models for the upper Provo River at the Soapstone sampling site indicated that over 40% of the Sr load was from dust during the 2014 snowmelt season at peak runoff, with early season samples plotting below the mixing line likely due to soil water contributions. In 2015, mixing models indicated that dust contributed about 20% of the Sr load at Soapstone. Further downstream on the Provo River at the Hailstone sampling site, mixing models were less conclusive because the majority of stream samples did not plot on the mixing line. Soil water is perhaps the dominant source of Sr at Hailstone with a larger watershed and more complex lithology relative to the Soapstone site. Likewise, water samples collected at Little Cottonwood Creek did not plot on the mixing line with endmembers of snowpack and groundwater, suggesting that soil water is a more important source of Sr relative to dust. At the Logan River, mixing models indicate that approximately 20% of the Sr load in the river was from dust. These preliminary results suggest that dust on snowpack is an important but variable source of soluble elements during snowmelt and that dust shoulud be considered when investigating solute loads in mountain streams. Additional work is underway to utilize other isotopic tracers such as $\delta^{11}B$ and $\delta^{11}B$ to provide further evidence of dust contributions to stream solute loads, and mixing models will be improved by adding measurements of solute and isotopic composition of soil water. Along wih evaluaing new tracers, future work will also include looking at dissolved organic matter to understand trace-metal- DOM complexes, where we believe certain trace metals can be accounted for and examined.

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SUBWAY DUST COLLECTION BY MAGNETIC MESH FILTERS

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Outdoor air quality near the ventilation duct of metro-subway is greatly influenced by discharging dust from the tunnel. Circulation air flow along the internal duct of underground facilities relevant to the subway contains a large volume of iron oxides. Ironic dust which is generated mainly by attrition of railway and train wheels is designed to be expelled out through vertical duct over the ceiling of the tunnel. In accordance, some of dust could be discharged to the outside by train draft, but some are returning down to the tunnel or elsewhere.

Thus this work attempted to collect such iron containing dust using magnetic filters. Test dust was collected from a station ventilation chamber of a station in downtown area of Seoul, and coal fly ash was also observed for the comparison in the lab scale experiment. A few permanent magnets (1,650 ~ 3,000G) formed different magnetic force field in the wire mesh filter. Experimental rig was designed as test dust repeatedly passing through the magnetic filter layer.

As a result of the evaluation, particle collection efficiency for PM-10 and PM-2.5 was up to 63% and 53% with 3,000G respectively. Use of permanent magnets aided simple operation without external electric power. The present magnetic mesh filters are believed that they are plausible for the primary collectors to reduce the aerated dust with very low pressure resistance, less than 5% of total pressure drop.

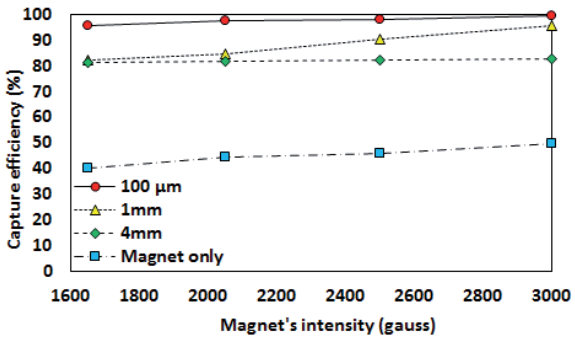

Fig. 1. PM10 capture with magnetic intensity.

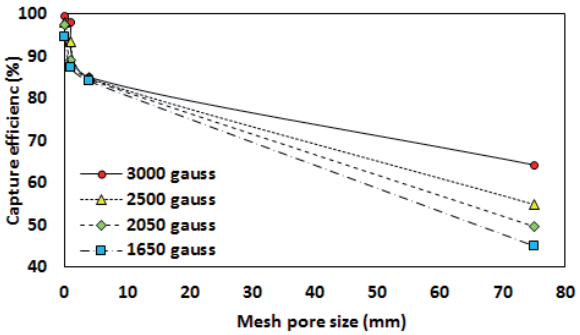

Fig. 2. PM10 capture with filter mesh opening.

Keywords: Subway dust, Magnetic filter, Mesh filter, Ventilation duct.

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SAHARAN DUST RESEARCH ACTIVITIES AT THE ATMOSPHERIC OBSERVATORY "EL ARENOSILLO" (SW SPAIN)

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ATMOSPHERIC PRODUCTION OF NANOSTRUCTURED PARTICULATE MATTER BY LIGHTNING STRIKES

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In spite of their high frequency (100/s) and their large scale occurrence across lands and seas, lightning strikes are at present not viewed to exert a major influence on atmospheric aerosols. The transformation of surface materials into nanosolids by lightning has only been suggested to possibly occur at the ground during energy dissipation based on laboratory experiments. Our contribution intends to further expand the role of lightning strikes on atmospheric plasma processes by showing its direct effect on the dust cycle through the production of nanostructured particulate matter from gas and dust aerosols by electric arcs, transient heating and shock[1].

Our approach is based on the comparison of three range of data : (1) surface materials (soil, water) sampled at the exact spots where lightning strikes hit the ground; (2) particulate matter aerosols collected for two years from a pilot region in South France (Perpignan) which occurred as short-term events (a few minutes) following meteorological conditions marked by intense lightning; (3) experimental arc discharges using a copper fuse wire within a wooden box filled with different materials; various amount of quartz sand, lime, chalk and water have been tested as equivalent of the aerosols in the atmosphere.

For these three situations, water sieving has allowed to extract a suite of common particles on which we have performed a multi-scale characterization with complementary analytical techniques (binocular microscope, SEM-EDS, HRTEM, XRD, FTIR-Raman spectrometry, stable isotopes).

The common particles comprise four types of components : (a) grains with metal coatings; (b) metal spherules and films; (c) mineral-metal-polymer composite agglutinates and grains; (d) translucent to colored polymer films and filaments. Based on the arc discharge experiments, the type a components correspond to the intact materials that have been coated by a thin film formed of carbonaceous compounds and metal droplets produced by the electric arc. In contrast, the type b, c and d components are new products formed from the dusty plasma that the electric arc generated by total dissociation of the initial materials. Based on the arc discharge experiments, the polymer phases appeared in the type b, c and d components when water, lime and chalk have been introduced to the composite materials. All the type b, c and d components and the metal coatings on the type a grains display a nanostructural pattern that can be subdivided into three sub-types depending on the geometry of the nanosolids : framboïds, filaments and films. The nanostructuration and the diverse nanosolids encountered perfectly match the range of products formed by dusty plasma using various gas (CH_4, NH_3, C_2H_2) or hydrocarbon liquid precursors under laboratory experiments[2]. This similarity allows to decouple the effects of lightning strikes in the atmosphere : (1) formation within the electric arc of a dusty plasma by dissociation of water, gas and solid particles and partial melting around the plasma due to transient heating; (2) synthesis of nanostructured components by agglutination of the nanoparticles and by polymerization in the dusty plasma; (3) production of geopolymers by demixtion of the nanostructured components and their mixing with melted or intact aerosols.

The production of the polymer components only in the presence of water as shown by the arc discharge experiments suggests that the water content in the atmosphere plays key role in the transformation of carbon-based precursors (gas, liquid or solid) into solid particulate matter. The intimate imbrication of the carbonaceous solid phases within the different type b, c and d components as a result of plasma polymerization strengthens the originality of solid polymer production by lightning strikes in the atmosphere as compared to all other geological processes that form carbon-based solid at the Earth's surface. Based on the production of the polymer components from carbon sources of mineral origin (chalk) shown by the arc discharge experiments, the wide range of C_{14} values obtained on the polymers collected from recent aerosol events shows that the polymers formed by dusty plasma from aerosols preserve the carbon isotope values of the precursor materials. Based on isotope and structural signatures of the polymers formed by in the atmosphere by dusty plasma, future investigations will help to estimate the contribution of lightning strikes to the long term carbon sequestration by plasma transformation of CO_2 and particulate carbon into highly resistant nanosolids.

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TRACKING THE ROLE OF ATMOSPHERIC PLASMAS AT THE EARTH'S SURFACE USING THE 4 KYR BP MEGA-DUST EVENT

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The role of atmospheric plasma initiated by lightning on the dust cycle has up so far remained ignored in spite of their high frequency (100/s) and wide occurrence across terrestrial and marine surfaces. We report here the results of an exploratory research that was aimed to test the potential of electric arcs, transient heating and high pressure shock on the production of particulate matter from gas (CO_2, CH_4, NH_3, C_2H_2) and solid aerosols. Experiments by electric arcs and laboratory plasma have been performed at the different energy and pressure levels that match the atmospheric conditions and using composite materials similar to the main gas and solid components encountered in the atmosphere. The data base can now be used to evaluate the nature and magnitude of the manifestations initiated at the Earth's surface by high energy atmospheric phenomena, by tracking their distinctive footprints in paleodust archives. This innovative method is applied here to three records of the 4.2-4 kyr BP mega-dust event in order to further elucidate its exact relevance: (1) the erratic fall of composite dust, the unprecedented soil deflation and the sudden collapse of the Akkadian monumental earthen architecture from diverse archives in Northern Syria; (2) the Banda Aceh paleotsunami (Lampuuk bay, Sumatra, Indonesia); (3) the sharp sedimentation change in the MD032601 marine core from Adelie land (Antarctica).

The three records show the occurrence of similar signatures relevant to plasma processes: (1) translucent to colored nanostructured films and filaments formed of semi-crystalline paraffin with metal nanoparticles; (2) scoria-like to breccia-like mineral-metal-polymer composite agglutinates with nanostructured carbon-based polymorphs (polymers, graphite, diamond, amorphous carbon); (3) hard, fluidal, glassy components of heterogeneous composition with carbon-based nanoinclusions. Fresh marine micro-organisms embedded in a metal-rich thin polymer film have been extracted from the scoria-like components of both the Banda Aceh paleotsunami and of the Northern Syria dust layer. These last two records display abundant well preserved fragments of the local vegetation also embedded within thin polymer film with metal nano and micro-particles. A similar thin polymer film is detected around the windblown aggregates of the Northern Syrian eroded surface soils that have been trapped at sheltered places. Based on their mechanical and structural properties, the semi-crystalline polymers are shown to have formed in the atmosphere by heterogeneous catalysis due the mixing of metallocene nanoparticles and polymer gels that have been produced by electric arcs from gas precursors. These forming conditions explain their exceptional properties, particularly hydrophobicity and durable resistance to thermolysis, radiolysis and biodegradation. The heterogeneous composition of the composite agglutinates and of the glassy components is shown to result from partial melting and instantaneous quenching in the atmosphere of mixed precursors of sedimentary and volcanic origin. The dispersion pattern at the ground and the imbrication of the polymer composites with the local soil/sedimentary components is interpreted to express the sudden pulverization at the earth's surface of electrically charged debris masses. The later would thus trace erratic formation of debris cloud and related enhanced lightning with severe effects at regional scales. The violence of the surface devastation expressed in the three studied records suggest that high energy processes most likely initiated by meteor airbursts in the atmosphere, without impact at the ground, would have been responsible for the formation of debris jet from aerosols and their pulverization at the Earth's surface.

These records express the complexity of triggering factors, processes, spatial extent and timing of mega-dust events that repeatedly occurred in the past. The integration of data collection from past records, experiments and modeling should help to improve the predictions of similar dust events for the near future in order to prevent their devastating effects.

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AFTER-TREATMENT SYSTEMS TO CONTROL THE EMISSIONS OF MARINE DIESEL ENGINE PARTICULATE MATTER

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Diesel particulate matter is a mixture of different kind of particles, some of which are associated to the insurgence of several pathologies and classified as carcinogenic of Class I from the World Health Organization [1, 2]. A portion of the particulate matter, known as black carbon, is a relevant climate-forcing agent having significant effects on the artic climate (e.g. [3, 4]). Commercial and military ships are responsible for large amounts of particulate matter emissions, having potentially severe and largely unrecognized effects on the populations living in coastal areas [2, 5]. However, particulate removal is not a conventional technique on-board ship and the removal of fine (diameter below 2500 nm) and ultrafine (diameter < 200 nm) particles is a challenging task even for stationary combustion plants [6].

This makes unreliable the application of dedicated environmental regulations on particulate matter on-board ships, although the MARPOL Annex VI Regulation 14 of the International Maritime Organization indicated that particulate matter removed is partially accomplished by reducing the fuels sulphur content or using a scrubber. However, this only encompass the coarser sulphate-based particles that are the most important in terms of mass emissions but also the less toxic ones.

This talk presents a comparison of the after-treatment systems for particles removal on board ships, including conventional units for gas cleaning (as scrubbers and selective catalytic reactors), and new units as the Diesel particulate filters and the wet electrostatic scrubbers. Considerations upon the specific fields of application for each technology are also reported.

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DUST EVENTS ON VATNAJÖKULL, ICELAND: COMPARISON BETWEEN MODEL RESULTS AND MEASUREMENTS

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Dust events in Iceland considerably influence the surface albedo and subsequently the energy balance of glaciers such as Vatnajökull. Here we study dust events on Vatnajökull based on model simulations and ground-based measurements. Possible sources of dust origin are proglacial areas and sandy deserts which cover more than 22% of Iceland. A newly developed scheme for dust mobilization is used to estimate dust emission from these sandy deserts. Driven with these emissions, a Lagrangian dispersion model, FLEXPART, is used to calculate dust concentration and deposition. The model simulations facilitate to distinguish main source areas of dust transported to the glacier. Meteorological conditions at the source locations as well as flows induced by topography will affect the spatial distribution of dust on the glacier, and not all are resolved by the meteorological data from ECMWF used to run FLEXPART (resolution 0.2 degrees or about 22 km). We aim to determine how important local effects are. Ground based data such as distributed snow samples from Vatnajökull with impurities were collected in October 2013 and 2015. Additionally, firn cores of about 8 meters depth from Brúarjökull (NE Vatnajökull), were taken in 2014 and 2015. The firn cores show pronounced dust layers in the years 2012, 2011, 2010 and 2008.These dust concentrations from firn cores and snow samples as well as time series of albedo measurements from automatic weather stations, were compared to model results. For this comparison we chose ablation seasons which are not influenced by volcanic eruptions. For these periods we explain variations in dust amounts and their spatial patterns.

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INCINERATION OF DIESEL PARTICULATE MATTER USING NONTHERMAL PLASMA

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The particulate matters (PMs) emitted from ship diesel engine exhaust during the combustion process have low resistivity and extremely small in the range of 70-120nm. These particles cause a various human health and environment impacts. After MARPOL 73/78 Annex VI entered into force on 1st of July 2010, shipping-induced NOx and SOx, PM emissions are regulated stricter. Many methods were applied to control mass concentration of PM from diesel exhaust gas. Many studies of ESP were reported to collect low resistive particles generated from diesel engine [1, 2].

Authors confirmed that a collection was possible in PM by a dielectric barrier discharge (DBD) type ESP [3]. In barrier discharge space, since non-thermal plasma (NTP) is formed, the particles which pass a charging section are charged in positive and negative polarity. Therefore, the collection of the PM is carried out to both of a high voltage and a grounded electrode. In the DBD type ESP, the PM is collected densely on the dielectric material compared with the corona discharge type ESP, there is almost no re-entrainment for the particles of the large diameter. Therefore, the re-entrainment phenomena are prevented due to the thin dust layer on electrode [4]. DBD is characterized by the presence of one or more insulating layers (dielectric barrier) in the current path between metal electrodes in addition to the discharge space. Discharges are initiated in discharge gap due to strong electric fields. Local electrical breakdown in narrow discharge gaps leads to micro-discharge formation and short current pulses. The neutral particle reactions in oxygen as well as in air show that mainly the electrons are important for ozone formation.

Authors have been developed NTP reactor for removal of PM emissions from a diesel engine [5, 6]. In the NTP reactor, the air is activated by discharge and produces ozone, oxygen radical and nitrogen radical, resulting the diesel particulates are oxidized under low temperature condition. Diesel PMs were perfectly incinerated by ozone produced in NTP. When the gas temperature is higher than 250^{o}C, NO in the flue gas is oxidized to form NO_2 by ozone and O radical, then carbon particles can be incinerated.

This research has been developed an after treatment system for removal of diesel PM from the ship exhaust. The PM was collected by ESP using NTP reactor. NTP was generated by a high-frequency DBD. In the incineration experiment, plasma was generated in the heater which carried out temperature adjustment. The weight of PM before and after the experiment was measured and incineration efficiency was determined. In the collection and incineration experiment, a diesel engine generator, displacement volume of 435cc, was used. The particle size-dependent number densities before and after the ESP was determined by the Scanning Mobility Particle Sizer (TSI, Model 3034) for the particle size ranged 20-800 nm and the particle counter (Rion KC-01E) for the particle size of 300-5,000nm, respectively. The gas velocity was 13m/s. The ESP using DBD were composed by a parallel plate electrode. Both electrodes were covered by the dielectric glass plate. The discharge gap length was 3.5mm. The discharge power was measured by Lissajous method. From the experimental result, PM incineration efficiency was 0.2mg/kJ at 27 ^{o}C, 0.8mg/kJ at 350 ^{o}C. It was confirmed that the collected particles were incinerated with ozone and NO_2 generated by DBD.

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CHLORINATED PARRAFFINS IN CANADIAN HOUSE DUST AND NIST SRM 2585 (ORGANIC CONTAMINANTS IN HOUSE DUST)

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Chlorinated paraffins (CPs) have been widely used as both flame retardants and plasticizers in rubbers and textiles, in paints and coating, in leather processing, and also as metal working fluids and sealants [1]. They can be roughly classified into three categories according to their carbon chain length: short-chain CPs (C_{10}-C_{13}, SCCPs), medium-chain CPs (C_{14}-C_{17}, MCCPs), and long-chain CPs (C_{18}-C_{30}, LCCPs). The worldwide production of CPs was estimated to be 916,000 tons per year [2]. Animal studies show that CPs (C_{12}, 60% chlorine content) are carcinogenic in rats and mice of both sexes [3]. Although the underlying mechanisms are not clear, the major target organs are the liver, kidney, and thyroid [3]. CPs have been classified as Group 2B - possibly carcinogenic to humans based on animal study results by International Agency for Research on Cancer [4]. Due to their wide use, CPs are ubiquitous in the environment and have been detected in air, soil, sediment, water, and house dust [5, 6].

House dust is a sink and repository of various contaminants including CPs; it has been recognized as an important source for human exposure, especially for children, to dust-bound contaminants via inhalation, dermal adsorption and unintentional ingestion. The objective of the current study was to develop a method for the determination of SCCPs and MCCPs in indoor dust samples collected under the Canadian House Dust Study (CHDS) [7]. The method was based on those reported by Reth et al. (2005) and Yuan et al. (2012) with some modifications [8, 9]. Dust sample (0.1 g, <80mm) was subjected to sonication extraction, cleanup by solid phase extraction (SPE) (Florisil cartridge topped up with acidified silica gel), and separation and detection by gas chromatography –mass spectrometry (GC/MS) operated in electron capture negative ionization (ECNI) mode. The method demonstrated good sensitivity, with the method detection limits (MDLs) down to 0.21 µg/g for SCCPs and 0.70 µg/g for MCCPs. The overall recoveries of the method were good, with 104±11% and 108±16% for SCCPs and MCCPs, respectively. SCCPs and MCCPs were detected in every sample (n=48), with median concentrations (range) of 6.2 (4.0-58) µg/g for SCCPs and 20 (5.9-900) µg/g for MCCPs. These are the first CP concentration data reported for Canadian house dust, which are relatively lower compared with those reported in other countries. On average, the percentages of SCCP congeners were 16.5%, 21.7%, 33.8%, and 28.0% for C_{10}, C_{11}, C_{12}, and C_{13}, respectively; the percentages of MCCP congeners were 48.6%, 25.8%, 15.8%, and 9.8% for C_{14}, C_{15}, C_{16}, and C_{17}, respectively. The method was also applied to the analysis of SCCPs and MCCPs in NIST standard reference material (SRM 2585, organic contaminants in house dust). To the best knowledge of the authors, this study was the first to report the CP concentrations in SRM 2585, with 7.58±0.43 µg/g for SCCPs and 16.4±2.1µg/g for MCCPs. These results could be useful for the comparison of the accuracy for CP analysis using different analytical methods.

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OBSERVED AND MODELLED ATMOSPHERIC VERTICAL PROFILES IN THE LOW TROPOSPHERE DURING A SAHARAN DUST ADVECTION OVER APULIA REGION.

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Apulia region is located in the south-eastern part of Italy, surrounded by the Mediterranean sea. In this region Saharan dust advections are very common. The present work aims to investigate meteorological main features associated to these advections and in particular to examine by means of both observed and modelled data whether these events affect PBL (Planetary Boundary Layer) height.

In particular, the work is focused on a case study for which there are available experimental data from LIDAR and radiosounding measurements, plus modelled vertical profiles and maps obtained by the WRF (Weather Research and Forecasting) model.

The LIDAR is a one-wavelength near-infrared CHM15K- Jenoptik ceilometer located in a highly polluted industrial site (the ILVA steel plant in Taranto). It operates continuously in automatic mode and produces vertical profiles in the range 0-15 km with temporal resolution of 30 sec and spatial resolution of 15 m. Ceilometer are recently becoming a suitable support for conventional meteorological observation systems [1].

Radiosounding data used in present work are from the Brindisi radiosounding station belonging to the WMO worldwide radiosounding network and providing data every 12 hours (00:00 and 12:00 UTC).

WRF [2] is a Limited Area Model (LAM) of atmospheric simulation giving outputs on domain up to 1 Km of resolution. For the present work the WRF domain was set at a horizontal resolution of 4 Km and a time resolution of 1 hour.

By LIDAR images a Saharan advection event was selected [3], characterized by several dust layers corresponding to different atmospheric pressure layers.

Online desert dust models have indicated that the selected event involved the whole Apulia region, allowing to exploit data retrieved from Brindisi radiosoundings station, 60 Km away from Taranto. These experimental data put in evidence the presence, among the various layers, of air masses with different thermodynamic features.

Given the above, the WRF model has been used to simulate those specific thermodynamic features over the area around the LIDAR site. It was found that the meteorological patterns associated to Saharan advection result in an impact on the typical diurnal cycle of PBL height.

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LEVELS AND SOURCES OF POLYCYCLIC AROMATIC HYDROCARBONS IN THE SOLUBLE FRACTION OF THE ATMOSPHERIC DEPOSITION IN CANTABRIA (NORTHERN SPAIN)

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Polycyclic aromatic hydrocarbons (PAHs) are harmful semivolatile organic compounds; some of them are classified as priority pollutants due to their carcinogenic character. PAHs are emitted in particulate and gaseous phases to the atmosphere. Gaseous PAHs are mainly emitted by volatilization of petroleum-derived fuels (i.e. petrogenic origin) while gaseous and particulate PAHs are mainly derived from the incomplete combustion of solid, liquid and gaseous fuels (i.e. pyrogenic origin) [1]. Traffic and domestic and industrial combustion are usually the main sources of atmospheric PAHs; however, some industrial activities such as iron foundries, ferroalloy manufacturing or carbon black production can have a significant contribution to PAHs emissions in local industrial areas.

Both the particle matter bound and the gaseous PAHs may reach the terrestrial and aquatic systems through wet and dry deposition. Thus, gaseous PAHs are scavenged by precipitation, and particulate PAHs are removed by precipitation and dry particle deposition [2]. The analysis of the water soluble fraction of the bulk atmospheric deposition may indicate the potential risk of such pollutants toward the ecosystems.

The aim of this work is to assess the levels of polycyclic aromatic hydrocarbons (PAHs) in the soluble fraction of the bulk atmospheric deposition in urban, industrial, rural and traffic sites of a small region located in Northern Spain (Cantabria). Bulk atmospheric deposition was sampled monthly for two years at an urban site (Santander), and for one year at an industrial (Maliaño), rural (Bárcena Mayor) and traffic (Cabezón de la Sal) sites. Sampling was based on UNE EN 15980 standard. Samples were filtered and the filtrate was extracted, concentrated, purified and analysed for 15 PAHs: acenaphthylene (ACY), acenaphthene (ACE), fluorene (FLU), phenanthrene (PHE), anthracene (ANT), fluoranthene (FLA), pyrene (PYR), benzo[a]anthracene (BaA), chrysene (CHR), benzo[b]fluoranthene (BbF), benzo[k]fluoranthene (BkF), benzo[a]pyrene (BaP), indeno[1,2,3-cd]pyrene (IcdP), dibenzo[a,h] anthracene (DahA), and benzo[ghi]perylene (BghiP).

The highest deposition fluxes of PAHs were found in the industrial site (Maliaño); the total PAH fluxes in the other sites were similar. Box plots of the PAH levels found in the literature in wet and bulk deposition samples were used to compare the values found in this work. FLA, BaA, PHE and PYR were the most abundant PAHs in the industrial site. In the urban and rural site the profile found in the deposition samples was similar: PHE>FLA>BaA>PYR. The traffic site showed a different profile: PYR>ANT>FLU>FLA.

A discussion about the limitations in the use of diagnostic ratios in PAHs source identification from deposition samples was performed. Based on this analysis, diagnostic ratios of some PAH isomers (FLA/(FLA+PYR) and BaA/(BaA+CHR)) were calculated and compared with the ratios found for the main PAH industrial and non-industrial sources. Thus, according to Yunker et al. [3], the FLA/(FLA+PYR) ratio found in the industrial site (0.6) is in the range of soil fuel combustion (>0.5), but in particular this high value is also characteristic of some industrial activities that are located in the vicinities of the sampling site: ferromanganese alloys production, iron foundries and carbon black manufacturing.

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CHARACTERISATION OF DUST EMISSION FROM ALLUVIAL SOURCES IN THE SAHARA

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The Sahara is the world's largest source of atmospheric dust. 55 % of the global dust emission can be linked to North Africa [1]. Thus, understanding the North African dust sources is of great importance to estimate their impact on the atmospheric dust content. However, the interannual variability in the frequency of dust emission and its connection to local weather conditions is still poorly understood. Alluvial dust sources are considered to have a great impact on dust export, especially in rugged terrain, where heavy rainfall can lead to strong surface runoff, the formation of ephemeral river systems, or flash floods [2]. Thereby, enormous amounts of sediments are carried downhill and are accumulated at the foothills of mountains. These alluvial fans are considered to be predestined for wind erosion. Despite their importance, alluvial dust sources have not been characterized very well in the past and are often underestimated in mesoscale and global climate models [2].

Here, we present results from a study characterizing alluvial sediments acting as dust source. They are analysed in three steps: (1) the surface runoff is estimated by determining the amount of precipitation using TRMM precipitation estimates and by identifying the catchment area of the ephemeral river system. (2) Dust emission subsequent to strong precipitation events is detected using satellite based AOD data and MSG SEVIRI's Dust Product with its very high temporal resolution. (3) Changes in the surface's sediment structure due to accumulation and erosion by water and wind are determined using time series of Landsat imagery. The implementation of an automatic land cover classification scheme on the Landsat imagery shows an increase of alluvial sediments downstream of ephemeral channels and on foothills of mountains due to strong precipitation events and a decline in their coverage after longer periods of drought. The disappearance of alluvial sediments can at least partly be related to wind erosion, especially since satellite based dust products eventually show dust plumes emitted from the considered area within the analysed time period.

The analysis represents a proof of concept of alluvial dust sources in Saharan mountains like described in [2]. It quantifies the connection between the amount of precipitation and the supply of potentially erodible sediments; the processes are put into a spatial and temporal scale. This will help to improve the representation of alluvial sources in climate and dust emission models.

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AMBIENT $PM_{2.5}$ AND PM_{10} MASS CONCENTRATIONS BASED ON URBAN AREA MONITORING DATA IN URBAN ATMOSPHERE, TURKEY

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Epidemiological studies have shown a significant impact of fine particles below 10 mm (PM10) on human health. Due to the increasing interest for the fine particles (PM2.5) the measurement programme of the network has been extended to include PM2.5 measurements into the measurement programme at several countries.

In this work, variations of mass concentration of fine ($PM_{2.5}$) and coarse ($PM_{2.5-10}$) during June 2015 to November 2015 has been investigated. A total of 163 samples were collected during this study period using Anderson Dichotomous sampler. The average mass concentration of $PM_{2.5}$ and $PM_{2.5-10}$ and PM_{10} was found as 25.13 µg/m^3, 11.05 µg/m^3 and 36.18 µg/m^3 respectively. The concentration of $PM_{2.5}$, and PM_{10} were higher in November than in June. As expected, the low temperature is an increase in the number of episodic events. This is a result of the extensive use of fuel during winter-time for heating purposes and also due to stagnant air masses formed because of low temperature and low wind speed over the study area.

Keywords: $PM_{2.5}$ and PM_{10} mass concentrations, urban areas, Çorlu, Turkey.

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GROUND-BASED CHARACTERISATION OF AEROSOL CHEMICAL COMPOSITION DURING THE SALTRACE CAMPAIGN

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Aerosol chemical composition was investigated during the Saharan Aerosol Long-range Transport and Aerosol Cloud Interaction Experiment (SALTRACE) which was conducted to investigate the transport of mineral dust and the effect of aerosol cloud interactions. Aerosol particles were collected at two stations separated by about 4000 km namely at the Cape Verde Atmospheric Observatory (CVAO) and at Ragged Point on the East coast of Barbados, respectively, to further investigate the changes in the aerosol chemical composition during the dust transport. Both size resolved (using a 5-stage Berner impactor) and bulk (using a high volume DIGITEL DHA-80 sampler) aerosol samples were collected at both stations in a 24 h sampling routine for a period of about 4 weeks. The filters were analyzed for inorganic ions, soluble and non-soluble trace metals as well as organic and elemental carbon (OC/EC).

Our observations show that despite the long range transport, the aerosol composition was dominated by mineral dust and sea salt which were mainly found in the coarse mode aerosol fraction at both stations. The aerosol mass did not show strong variation between the two stations with average mass concentrations of 23.58 ± 9.1 μg/m³ and 28.04 ± 11.1 μg/m³ at CVAO and Ragged Point, respectively. Higher dust concentrations and aerosol pH were observed at Ragged Point in comparison to CVAO. However, lower concentrations of sulfates, nitrates as well as organic matter were observed at Ragged Point in comparison to CVAO. These differences are related to differences in the air mass history at both stations with stronger continental European air mass influence at CVAO as compared to Ragged Point. Aerosol iron solubility did not show any strong increase due to the long range transport.

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POLYBROMINATED DIPHENYL ETHERS AND NOVEL FLAME RETARDANTS: ASSOCIATIONS BETWEEN DUST AND HUMAN MILK

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Besides diet, house dust has been recognized as an important exposure media for polybrominated diphenyl ethers (PBDEs) [1]. Our previous work showed significant associations between levels in dust and in human plasma, for the congeners BDE-28, BDE-47 and BDE-100 as well as for $\Sigma PBDE_{tri\ hexa}$ [2]. Recent results from Sweden indicated that dust was a significant source of exposure for the octa- to decabrominated congeners in particular [3]. Moreover, several novel flame retardants (NFRs) have been detected in dust some of which might be replacement products of PBDEs [4].

Building on these findings, the objectives were to study whether i) the associations observed for plasma also existed for human milk, ii) the PBDE profiles in dust and milk could provide insights into the bioavailability and bioaccumulation of individual congeners, iii) NFRs were measurable in human milk, and iv) infants were exposed to significant amounts of NFRs via breast feeding.

PBDEs were detected in all of the 40 milk samples analysed in this study. $\Sigma PBDE_{tri\text{-}hepta}$ ranged from 0.98-45.8 ng/g lw, with a median of 2.26 ng/g lw. The main congener in milk was BDE-153, accounting for 35% of $\Sigma PBDE_{tri\text{-}hepta}$. This is much higher than in dust collected in the same residences, but comparable to plasma and placenta [2,5]. BDE-99 on the other hand, had clearly lower percentages in human milk than in dust. BDE-209 had a median concentration of 0.64 ng/g lw, which was similar to that of BDE-47 and confirmed that BDE-209 was taken up by humans and, despite its shorter half-life, accumulates to the extent that exposure of infants can occur.

As for plasma, PBDE-levels in milk samples were significantly correlated with dust levels (Spearman rank), this was most pronounced for the lower brominated congeners like BDE-28 ($p=0.03$) and 47 ($p=0.006$). Large intercorrelation was also observed, e.g. BDE-47 in milk was significantly correlated with most other congeners, though not with BDE-209. In contrast to the plasma results, significant correlation of BDE-99 in milk and dust was also observed ($p=0.003$). One explanation for this may be the higher detection frequency of BDE-99 in milk compared with plasma (100% vs. 37%).

Hexabromocyclododecane and the NFRs bis(2-ethylhexyl)tetrabromophthalate (BEH-TEBP), 2-ethylhexyl-2,3,4,5-tetrabromobenzoate (EH-TBB), 1,2-bis(2,4,6-tribromophenoxy)-ethane (BTBPE), decabromodiphenyl ethane (DBDPE), 2,3-dibromopropyl-2,4,6-tribromophenyl ether (TBP-DBPE) and dechlorane plus (DDC-CO) have been detected in the same dust samples previously analysed for PBDEs and are currently being analysed in the corresponding human milk samples.

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NPC-INDEX APPLICATION FOR PM SOURCES APPORTIONMENT STUDY IN TWO MONITORING SITES OF SPAIN

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Particulate matter (PM_{10} and $PM_{2.5}$) is an important air pollutant for its high risks on human health and its diffuse adverse environmental impacts [1, 2]. In order to reduce the PM pollution, to make the better decisions for air quality management and to understand the potential source categories and their contributions, source apportionment studies are necessary [3, 4]. Over the past two decades, source apportionment of PM has attracted a growing interest of the scientific community in order to improve the efforts in reducing their concentration [2, 5]. In fact, the identification of types of emission sources and their relative contributions are very important to identify and quantify those sources that would be more effective to control.

Source apportionment procedures are based on multivariate statistical techniques such as Principal Component Analysis (PCA). PCA is generally used as an exploratory tool to identify the major sources of aerosol emissions and to statistically select independent source tracers. [6, 7].

In this study we show the results of a new multivariate statistical procedure for source identification and characterization, applied to PM data collected in two different sites of Catalonia (Northeast Spain), from 2002 to 2013. We propose an integrated application of PCA and synthetic multivariate index, Normal Principal Component Index (NPCI) [8, 9]. The Principal Component Analysis technique is recursively applied for each year and for both stations. Starting from PCA results, NPC-Index are employed to analyzed the chemical composition datasets, for assigning a standardized weight to each descriptor and to each monitoring site.

This index allows to exploit the information content of the descriptors and/or of the sites, as well as to compare the behaviour of the different elements in the correlation structures characterizing the investigated period. In this way it is possible to identify the role of each variable in the investigated period by means an only quantitative index. Consequently we may not only identify the different sources but also attribute their a weight. This method allows to establish a rank among the sources and to analyze the evolution of the multi-dimensional correlation structure as well as the occurrence of isolated elements. Furthermore for some sources, it is possible to analyze the temporal behavior of NPCI values for the different chemical elements that characterize the source. It may indicate a possible temporal evolution of the source profile, putting in evidence the effects of the application of specific reduction emission strategies.

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NESTED GRID SIMULATION OF THE CONTRIBUTION OF TWO BIG INDUSTRIAL SOURCES TO PRIMARY AND SECONDARY PARTICULATE MATTER

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Chemical Transport Models (CTMs) represent important tools to enhance our knowledge on chemical and physical processes affecting gas and particulate matter concentrations in the atmosphere and to support the development of efficient action plans aimed at reducing their levels [1][2].

The main goal of this study was to evaluate the contribution of two large industrial plants, located in the southern part of Apulia region, to primary and secondary particulate matter. These plants are respectively the largest integrated steel plant in Europe, located in the proximity of Taranto city, and a coal power plant, located in the municipality of Brindisi. The evaluation has been performed by means of the CTM FARM (Flexible Air quality Regional Model, [3]) that implements the SAPRC99 gas-phase chemical mechanism and the AERO3 aerosol module derived from CMAQ model. In particular, the AERO3 aerosol module includes ISORROPIA [4] and SORGAM [5] models for the calculation of secondary inorganic and organic aerosols. The simulations have been performed for the whole year 2013 considering a larger domain covering the Apulia region, with a horizontal resolution of 4 km, and two inner grids including the above industrial plants with a finer resolution (1 km). This nested approach permits to take into account the effect of both local and distant sources and to describe, more properly, the processes dominated by regional and local scales. individually. Vertically, the domains have been split into 14 levels from the ground to 5330 m. The emission data were derived from the regional INEMAR inventory, updated to the 2013 year, while the emissions from the neighbouring regions were taken from the Italian official inventory. Meteorological fields came from RAMS prognostic model [6], while chemical boundary conditions have been provided by FARM simulations performed at national scale. To discriminate the contribution of the above mentioned sources, three simulations have been carried out: a "base case" run considering all sources and two additional runs in which their emissions were alternatively turned off (e.g. "case 1" and "case 2" in which the emissions of respectively the Taranto steel plant and Brindisi coal power plant are switched off). The comparison between PM_{10} and $PM_{2.5}$ concentrations computed by the "base case" run by the two scenarios provided interesting insights on the contribution of these sources on primary and secondary PM levels and on the extension of the areas impacted by their plumes.

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EXPLOITING REMOTE SENSING OBSERVATIONS TO EVALUATE THE EFFECT OF DUST AEROSOL ON THE FORECAST SKILL OF NUMERICAL WEATHER PREDICTION MODELS

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Aerosols interact with marine and terrestrial ecosystems in various ways and on different scales. Their sources are as manifold as their impacts but mineral dust, which originates from arid and semi-arid regions, contributes most to the global atmospheric aerosol load. Mineral dust influences human health, can act as nutrient source, and impacts weather and climate, e.g. by changing cloud properties [1] and the radiation balance [2]. To investigate the dust impact on the performance of numerical weather prediction (NWP) models, we analysed and compared continuous long-term remote-sensing observations and NWP model results of cloud properties. The observations used in the study were from the LACROS supersite [3] in Leipzig (51.3° N, 12.4° E). LACROS comprises observations of lidar, 35-GHz cloud radar, microwave radiometer, which are processed within Cloudnet [4] to obtain information on the spatiotemporal distribution of clouds and their microphysical properties such as liquid water content, ice water content, cloud fraction, and precipitation rate. The observations have been performed semi-continuously since 08/2011. Interruptions in the dataset have occurred only when LACROS was operated at other research sites, which has been the case for a total of about 0.5 years within the time period until 12/2015.

In order to investigate the effect of dust on the NWP skill, the Cloudnet dataset was used to evaluate the forecast from ECMWF-IFS and COSMO, the regional NWP model of the German Weather Service (DWD), separately for low and high dust concentrations. According to the BSC-DREAM8b [5,6] Saharan dust forecast, a measurement day was categorized as dust-laden, dust-free, or intermediate, respectively. The Cloudnet data was scaled on the grid of the corresponding NWP system and statistically evaluated by means of the liquid and ice water content, cloud fraction, and precipitation rate.

In addition to the long-term evaluation, COSMO-MUSCAT model [7] runs are available for the time period March/April 2014. During this time a major dust outbreak originated in the Saharan region and reached up to northern Europe. COSMO-MUSCAT runs are available in different configurations: (1) all aerosol effects deactivated, (2) only direct aerosol effects activated, and (3) direct and indirect aerosol effects activated.

Overall, the evaluation of both, the long-term (ECMWF-IFS) and the COSMO-MUSCAT datasets reveal significant differences in the agreement between model and observations for the evaluated dust-laden and dust-free datasets, respectively. It needs to be investigated to which extent the differences result from actual aerosol effects or from the variability of model skills for different large-scale circulation patterns, considering that dust outbreaks are related to certain air flow regimes.

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FUGITIVE DUST EMISSIONS FROM INDUSTRIAL PROCESSES - SOURCE IDENTIFICATION, EMISSION FACTORS AND INFLUENCE ON AIR QUALITY AND DEPOSITION IN THE SURROUNDING AREA

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The particulate concentration present in outdoor air in urban areas today are in many cases harmful to human health and can cause, among other things, cardiovascular and respiratory problems. Particulate matter in outdoor air originates from both natural and anthropogenic sources. Fugitive dust emissions from industrial processes, such as rock crushers, industrial sieving machines, loading/unloading material and resuspension from vehicles associated with industrial activity, is one among other anthropogenic sources. However, the knowledge base concerning this type of dust emissions is deficient. Industries today are often required to know and report their total particle emissions and to implement measures to reduce these emissions. To be able to implement effective measures, in order to reduce the contribution of particles to the air from diffuse sources, it is important to know what the sources are, but also to have an understanding of how the intensity of the emissions from the source is affected by physical parameters such as the material moisture, particle fraction or vehicle weight.

Here the general methodology and preliminary results from an ongoing study into fugitive dust sources associated with industrial activity and the handling of materials will be presented. The scope of the study includes source identification, calculations of emission factors and assessing the influence of the dust emissions on the surrounding area. Additionally the effect of physical parameters, which may influence the intensity of the dust emission and the emission factors, are analysed as well as the effectiveness of various measures, such as watering or reducing vehicle speed. Using activity data and emission factors the overall fugitive dust emissions from the industry can be calculated and used as input for dispersion modelling.

The presentation will focus on describing the methodology of calculating emission factors for individual processes and how to apply a combination of in situ measurements and micro-scale wind field modelling to derive emission factors for industrial processes. The method and the calculated emission factors are thereafter compared to existing methods such as those put forth by the US EPA [1, 2].

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DUST EMISSIONS FROM THE DRY LAKEBED OF THE GREAT SALT LAKE AND POTENTIAL IMPACTS ON THE WASATCH FRONT URBAN AREA

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Dust storms occur frequently along the Wasatch Front urban area (Utah, USA) with potential negative impacts on air quality and human health. Regional dust sources include dry lakes and playas in the Basin and Range desert of western Utah. With water levels approaching historic lows, the recently exposed dry lakebed of Great Salt Lake (GSL) may be another important dust source that is located adjacent to the urban area. GSL dust may prove to be hazardous given high concentrations of salts and harmful metals in the lake. The purpose of this study is to evaluate the relative importance of dust emissions from GSL lakebed relative to other regional dust sources and characterizes the adverse effects of dust deposition along the Wasatch Front. Spatial variability in dust deposition will be characterized by placing four passive dust collectors in the urban area at Provo, Salt Lake City, Ogden and Logan during Fall 2015 and Spring 2016. Dust emissions will be characterized by placing BSNE samplers at multiple locations on the GSL lakebed and other regional dust source areas. Dust samples will be analysed for a suite of trace element concentrations and isotopic ratios ($\delta^{11}B$, $\delta^{34}S$, $^{87}Sr/^{86}Sr$, etc.) to "fingerprint" each source. These fingerprints will be compared with the composition of dust in the urban area to quantify the relative importance of dust emissions from GSL relative to other regional sources. This presentation will provide preliminary results from this study.

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FUGITIVE PARTICULATE MATTER EMISSIONS FROM LOOSE SOILS RICH IN CARBONATES

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Fugitive particulate matter (fPM) is a substantial source of airborne pollution in dry arid lands such as the Middle East Area (MEA) [1]. However, accurate determination of fPM emissions has been an ongoing challenge for the air quality research community because of the induced health effects and the large uncertainty on their determination [2, 3]. The objective of this study is to examine fPM emissions from loose soils rich in carbonates, and evaluate the accuracy of the existing emission factors to apply for dry and arid conditions. A two months field campaign was conducted at a construction site within the city of Doha (Qatar) to measure concentrations of fPM using two Grimm EDM365 Environmental Dust Monitors. The latter measures site specific meteorological parameters, and uses light scattering based techniques to measure particle number concentrations over a size range of 0.25-32 μm. One monitoring unit was placed at the construction site (the source) while the other at a background location, aiming to capture the net emissions generated by the source in comparison to background. The time period of the campaign was chosen deliberatively when the construction site was at rest, so we consider that Aeolian erosion of the loose soil was the only source of fPM. Fugitive Dust Model (FDM) was applied to calculate fPM concentrations and obtain their emission fluxes in an iterative procedure. The modeled emission fluxes were then plotted, based on their wind-velocity dependence, against the measured wind speeds to derive power law emission flux functions for different particle size fractions. The power factors were estimated as 1.87, 1.65, 2.70 and 2.06 for the four particles size classes ≤2.5, 2.5-6, 6-10 and ≤10 μm, respectively. Power factors fitted to the data were found to show a good adjusted R^2 that varied from 0.13 for the smaller particles and up to 0.69 for the larger ones. These power factors are in the same range of those reported in the literature for similar sources [4]. The derived power functions were used to re-run the FDM model and the resulted concentrations were plotted against the on-site measured concentrations for comparison. Although the modelled concentrations showed an overestimation of the measured ones, they were considered to be acceptable, and for PM_{10} mainly fall within the FAC2 (factor of two) statistical metric. We consider this study to be unique, as it focuses on fPM emission from loose, rich in carbonates, soils in construction areas, which are usually very close to, or within residential areas and has direct impact on the local air quality.

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REGIONAL MODELLING OF MINERAL DUST IN CENTRAL ASIA

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Central Asia is a hotspot of climate change, where mineral dust may play a potential role. Dust affects the climate directly by aerosol-radiation interactions or indirectly by modifying cloud properties, atmospheric dynamics, and the biogeochemical cycle. The dust load over Central Asia is influenced by long-range transport of Saharan, Arabian and Taklimakan dust, as well as by numerous local dust sources. The optical, chemical, and microphysical properties of the dust particles strongly depend on the actual source and may alter due to particle ageing and mixing with other aerosol types (biomass burning aerosol, urban pollutants). In the Central Asian region, however, little is know about the relative importance of input from long-range transport and local sources, as well as the impact of ageing and mixing processes.

In this study, simulations with the regional dust model COSMO-MUSCAT together with ECMWF-MACC reanalysis are used to provide a model-based assessment of the sources and transport pathways of mineral dust to Central Asia and to quantify direct and semi-direct dust radiative effects. For model evaluation, the results are compared against various standard observations. In addition, unique lidar and sun photometer measurements in Duschanbe/Tajikistan are available from the joint German-Tajik project Central Asian Dust Experiment (CADEX) since April 2015.

First initial results suggest an important contribution of Arabian dust and dust from a source in western Afghanistan to the local dust burden in Duschanbe in August 2015. In agreement with the lidar observations, the mineral dust is transported at heights of 2-3 km. Altogether, the outcome of this study will contribute to the understanding of varying source contributions and transport mechanisms in the Central Asian region.

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HOUR-BY-HOUR ANALYSIS OF UFP IN RELATION TO OTHER ATMOSPHERIC PARAMETERS OR WALPURGIS NIGHT REVEALED

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More than two-year measurements of particle number distribution in the range 10 to 800 nm (UFP) were performed in Ústí nad Labem (Northern Bohemia) since June 2012 in three size modes with time resolution of one hour: nucleation mode (10–30 nm), Aitken mode (30–100 nm) and accumulation mode (100–800 nm). Their seasonal and diurnal variations and dependencies on meteorological parameters were investigated in our previous papers by means of 3D temporal maps and correlational analyses [1], [2]. Regarding the conclusions we planned to use the outputs to determine specific episodes to study in details simultaneously with air pollution and meteorological data, measured with the identical time resolution at approximately the same place (PM_1–BC, NO, NO_2, NO_X, O_3, PM_{10}, SO_2, precipitation amount, air temperature, air humidity, sunshine duration, air pressure, wind direction and wind speed).

The most striking episodes of all three UFP modes occurred during relatively short period between 30 April and 11 May 2014, what allowed for their parallel analysis regarding synoptic meteorology, changing air masses and local meteorological conditions. The end of April saw at the Central Europe filling up of low pressure trough (synoptic situation B) characterized by low air flow, clearing of the sky and ground temperature inversion with unfavourable dispersion conditions. In the westerly control flow was the surface weather for the next few days dominated by north-eastern cyclonic situation (NEc) that was replaced by an anticyclone (Ap_2) by 5 May. After retreat of the anticyclone western cyclonic situation had been registered until the end of the period of interest. The inflow of cooler air strengthened the ground-level inversion in the Elbe river valley what prevented vertical mixing of the air and significantly limited the dispersion of particulate matter. Given the situation there was a significant diurnal pattern of relative humidity that came up to saturation at small hours. During the 9 May growing pressure gradient led to higher rate of control flow. At the end of the day the passage of cold front gradually restored the unstable thermal stratification even at the bottom of valley.

The city Ústí nad Labem is a regional centre on the border to Saxony state (Germany). The air quality is influenced by important chemical industry located downtown for historical reasons, by a number of major brown coal power plants inside the region and by the existence of main traffic junction of local and transit transportation. In the contrast the measuring point for UFP is located in the residential area with only minor traffic and industrial load.

The bursts of nucleation mode of UFP, recorded in the period 5–11 May (Monday to Sunday) exhibited strong diurnal behaviour with decreasing intensity towards the end of the interval. The peak particle number concentrations were as high as 90 000 particles/cm^3 just before local noon with the number concentration grow at the rate of several tens of thousands/cm^3/hour. No such event was registered for working days in the whole dataset. The Aitken mode behaved in similar way on smaller scale and slightly shifted towards the evening. The maximums of nucleation mode were preceded by the peaks of NO_X in less than two hours, what occurred at the very moment of saturation of the air by water vapour i. e. 100% relative humidity. The probable reason for the effect is the combination of anthropogenic air pollution with extremely pronounced daily course of unfavourable dispersion conditions due to local weather conditions at the bottom of river valley.

April 2014 turns into May by sunny, calm days with daily temperature maximums well above 20 °C. The inhabitants of Ústí nad Labem celebrated May Day and the night before at bonfires “burning the witches”. They were not aware of air pollution caused by this habit, what was clearly seen in the records of the measuring station. The averages of PM_{10} exceeded the daily limit of 50 μg/m^3 both days, the concentration of soot (PM_1–BC) during night and early morning was as high as 9 μg/m^3 and the accumulation mode of UFP reached its record value for the series at 14 000 particles/cm^3. This adverse impact of Walpurgis Night (traditional celebration of formerly pagan origin, known across Central and Northern Europe) was repeatedly described by Czech authors and led in the result to exclusion of the data of 30 April from environmental studies [3].

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ESTIMATING THE SENSITIVITY OF REGIONAL DUST SOURCES TO SEA SURFACE TEMPERATURE ANOMALY PATTERNS

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Investigating the impact of sea surface temperature (SST) anomaly patterns on local climate in major dust source regions can aid in understanding the sources of variability in the global dust cycle. Dust emissions are largely controlled by regional climate factors such as atmospheric stability, precipitation, soil moisture, and vegetation. Regional climates, particularly those within 30 degrees of the equator, are affected by teleconnections excited by sea surface temperatures. We therefore explicitly investigate the influence of SST anomalies on dust emissions and aim to explain the physical mechanisms by which SST anomalies affect seasonal dust emissions.

We explore the seasonal sensitivity of mineral aerosol emissions to SST anomaly patterns from the Bodélé Depression, West Africa, Sahel, Kalahari Desert, Arabian Desert and Lake Eyre Basin to help us understand variability in the global dust cycle. We estimate the sensitivity of dust emissions from these regions to SST anomaly patterns using the global teleconnection operator (GTO), which relates regional climate responses to SST anomaly patterns. The GTO is estimated for relevant climate variables in an ensemble of the National Center for Atmospheric Research Community Atmosphere Model version 5 forced by randomly perturbed climatological SST fields.

Variability in dust emissions are connected to SST anomaly patterns in the tropical oceans, particularly in the Indian and western Pacific Oceans. During the dust-emitting seasons, teleconnections excited by remote SST anomalies typically modify dust emissions via near-surface circulation changes that impact friction velocity. However, SST-driven changes in threshold friction velocity suggest that the impact of SST anomalies on surface conditions is also significant. Recognizing SST anomaly patterns as a component of internal variability in regional dust emissions helps to characterize the impact of human influences on the dust cycle as well as improve predictions of dust and its potential impacts on the climate system.

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METRO SUBWAY DUST COLLECTION BY MAGNETIZED WIRE MESH

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The public indoor space, Seoul metro-subway, is of great concern for the air quality including fine dust. A large portion of suspended dust is iron compounds. Magnetic filtration before ultimate cleaning in ventilation chambers has been proposed with pretreatment using permanent magnets [1, 2]. The present study utilized magnetic force filed formed in intersticies of ferromagnetic mesh wires. At this time, mesh screen weaving pattern has rarely been studied in particle collection by magnetic filters. Thus, wire weaving configuration was observed focusing on iron-containing particle capture.

Three weaving type of the magnetic filter mesh were designed and investigated by numerical simulation. The weaving patterns were : no warp weave (a), one warp weave (b), two warp weave (c) per unit structure cell. It showed that the weaving method makes the structure of the cell different from each other. Therefore, the flow distribution and magnetic field distribution were in disparity for the three types mesh. The performance of screens were compared under four velocities (0.15, 0.6, 1.05, 1.5 m/s) and four magnetic flux density (0.0012, 0.014, 0.026, 0.039 T) conditions. Screen performance in a unit cell increased along with the increasing magnetic field and decreased with the increasing flow field. Furthermore, in a high magnetic field with low velocity, the complex weaving structure improved the deposition of particles on the convex wires due to magnetic force played a major role. However, at a velocity of 1.5 m/s, particle collection efficiency decreased with the complexity of screen weave (from no weave to two warp weave). In high velocity area (diagonal left data without bold), because of the strong inertial interception, the simpler the weave structure, the higher the particle collection.

Keywords: Subway dust, Magnetic filter, Weaving method.

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LINK BETWEEN DUST-RADIATION INTERACTION AND ATLANTIC TROPICAL CYCLONE ACTIVITY

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THE IMPACT OF THE DUST-SHORTWAVE RADIATION EFFECT ON ATLANTIC HURRICANE ACTIVITY IN 2007

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Mineral dust particles play a vital role in climate and the Earth's energy budget and can have impact on weather as well. This research is to investigate the dust-radiation effect on Atlantic tropical cyclone (TC) activities. The first objective of the research is to follow the development of knowledge about the Saharan air layer (SAL). To investigate how the SAL and Saharan dust affect Atlantic tropical activities, tropical cyclone activities in 2005 and 2007 were studied and connected to environmental conditions, such as sea surface temperature (SST) anomaly, vertical wind shear, and aerosol optical depth (AOD). The 2005 hurricane season was very active, while the 2007 was a normal year. Compared to the normal year 2007, the 2005 hurricane season had a lower dust load, weaker deep shear and warm SST anomaly. The second objective of the research is to study the dust-radiation interaction on Atlantic seasonal TC activity in 2007 using a dust numerical model. Two numerical experiments were conducted. The dust short-wave radiation interaction was activated in one simulation (ON) and deactivated in the other one (OFF). Nine TCs formed in the ON experiment, while only two TCs formed in the OFF experiment through July to September. The results show that for a normal year the dust-radiation interaction reduces vertical wind shear over West Atlantic and thus increases the TC development over region, which is more comparable to observations. It is unfortunate that the model did not produce any TC over the main developing region in both experiments, while five TCs formed in reality.

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A NOVEL APPROACH TO DETERMINE THE HYGROSCOPICITY OF SINGLE ATMOSPHERIC AEROSOL PARTICLES BY ENVIRONMENTAL ELECTRON MICROSCOPY

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Hygroscopicity of atmospheric aerosol is a key parameter when it comes to aerosol cloud interactions. Traditional main methods of determining the aerosol hygroscopicity are bulk weighing methods under humid conditions or assessment by hygroscopic tandem differential mobility analysis. Disadvantage of the former is the unknown distribution of hygroscopic matter between the single particles, whereas the latter is restricted mainly to submicron particles. Here we present an application of environmental scanning electron microscopy to overcome these restrictions and assess the hygroscopic growth of collected aerosol particles under humid conditions in-situ in an electron microscope.

Samples were collected during the Saharan Aerosol Long-range Transport and Aerosol-Cloud-Interaction Experiment (SALTRACE) at Barbados from June 10 to July 15 2013. During this period, a mixture of marine and dust aerosol (supermicron particles) as well as combustion and secondary aerosol (submicron) was prevailing. Aerosol samples were collected at Ragged Point (13°9’54.4”N, 59°25’55.7”W) with a single round jet cascade impactor on nickel-substrates. Particles were analyzed with an Environmental Scanning Electron Microscope (ESEM) equipped with an energy-dispersive X-ray detector (EDX) and a cooling stage. In an initial automated run, information on particle size and chemical composition for elements heavier than carbon were gathered. Afterwards, electron microscope images of the same sample areas as before were taken during a stepwise increase of relative humidities (between 50 % and 92%), so that the hygroscopic growth of the droplets could be directly observed. That way, the hygroscopic growth can be correlated to the chemical composition of the respective particles. For the automated analysis of several hundred images of droplets an image processing algorithm in Python was developed. The algorithm is based on histogram equalization and watershed segmentation. Since SEM images can only deliver two-dimensional information, but the hygroscopic growth factor usually refers to the volume of a drop, Atomic Force Microscopy (AFM) was used to derive an empirical function for the drop volume depending on the apparent drop diameter from the electron images. A chlorine-sulfur index (S/(Cl+S), based on atom%) was used to determine different grades of sea-salt aging. Growth factors are in general the highest for sea-salt particles, while they decrease with increasing chlorine-sulfur index. Dust particles showed no significant hygroscopic behavior.

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REMOVAL OF PM EMISSION FROM SHIP EXHAUSTS USING HOLE-TYPE ELECTROSTATIC PRECIPITATORS

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Particulate matter (PM) pollution from ship exhaust has become one of the main pollution sources in marine environments. After MARPOL 73/78 Convention Revised Annex VI entered into force on 1st of July 2010, shipping-induced NOx and SOx, PM emissions are regulated stricter. Annex VI regulations include caps on sulfur content of fuel oil as a measure to control SOx emissions and, indirectly, PM emissions. In recent years, the black carbon in PM also attracts attention. It is thought that black carbon is the second major contributor to climate change after CO_2. The deposition of black carbon from ships and other sources on ice and snow in the Arctic accelerates ice melting by reducing the albedo effect.

One of the collection devices was to use the electrostatic precipitator (ESP). ESP has several advantages in terms of pressure drop, easy maintenance and low electric power consumption in comparison with diesel particulate filter. Many studies of ESP were reported to collect low resistive particles generated from diesel engine [1, 2]. However, the collection of low resistive particles generates from ship and automobile diesel engines have been known to be difficult by the conventional ESPs. The low resistive PMs are detached from the collection plate by repulsion force caused by induction charge. This phenomenon has been known as particle re-entrainment or resuspension, resulting in poor collection efficiency [3].

Authors have been studying the technology of the re-entrainment inhibition on ship exhausts. In the present study, a double cylinder type ESP is proposed to remove ship diesel exhaust particles [4]. The double cylinder type ESP has a grounded electrode with hole. This ESP was developed to minimize re-entrainment. The hole-type ESP utilizes the ionic wind, combined with electrostatic force to transport the charged particles effectively into the collecting zone through the hole of the grounding electrode. The collecting zones are designed as zero electrostatic fields, i.e., no electrostatic repulsion force acting on particles by induction charge, so that no re-entrainment takes place. Three-Dimensional Particle Migration in the flow interaction field between the primary flow and the secondary flow in the double cylinder ESP was analyzed by numerical simulation [5]. Furthermore, the influence of hole aperture ratio to the particle collection processes was investigated, the optimum hole diameter was determined by the time-dependent collection efficiency [6].

This research has been developed an after treatment system for removal of PM emissions from a diesel engine. The hole-type ESP was improved to the parallel plate type from double cylinder type. This is for utilizing an ion wind more effectively. The hole-type ESPs were investigated using a 435-cc engine. The particle size-dependent collection efficiency was obtained for three different waveform ESP operation using a Scanning Mobility Particle Sizer (SMPS TSI) with particle sizes in the range of 20–800 nm and particle counters (RION PC) with particle sizes in the range of 300–5000 nm. In order to confirm the re-entrainment inhibition effect, PM collecting characteristic of the hole-type ESP and the conventional ESP were compared. In particular, the geometric position of a discharge needle electrode and a hole was examined.

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PARTICLE SIZE AND COMPOSITION IN DRY DEPOSITION AND AEROSOL ON BARBADOS AND CAPE VERDE DURING SUMMER 2013 – AN ELECTRON MICROSCOPY PERSPECTIVE

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Mineral dust is frequently transported during summer time from the Saharan desert across the Atlantic Ocean to the Caribbean (Trapp et al. 2010). On its way, dust particles may in principle undergo ageing and acquire secondary materials like sulphate or organics or may mix with sea-salt particles. This ageing might be relevant for radiation transfer, deposition velocities as well as bio-availability of nutrients (e.g., marine ecosystems).

From June to July 2013, at Ragged Point, Barbados (N 13.165, W 59.432) dust dry deposition and aerosol samples were collected. Dry deposition was collected with modified 'flat plate' samplers (Ott et al. 2008), aerosol particles with different impactors. Emphasis for the ground-based sampling was also put on 'giant' (up to 30 µm diameter) particle sampling. In addition, onboard the Falcon aircraft of the German Aerospace Research Center, about 60 impactor samples were collected. Samples were analysed by electron microscopy with X-ray fluorescence detection (Kandler et al. 2009). As result, for each particle chemical composition, size and shape descriptors are available for approximately 60,000 particles.

Dust and marine occurred in the large (> 0.5 µm diameter) particle range at Barbados persistently, whereas for the smaller particles nearly no dust was present in the boundary layer; instead, mixtures of secondary aerosol with soot prevailed. In contrast, onboard the Falcon aircraft in the Saharan air layer, considerable abundances of dust particles smaller than 0.5 µm were observed. Dust particles observed in the Saharan air layer was very pristine und unmixed, whereas those at ragged point showed a considerably internal mixture with sea-salt and sulfate. Due to the persistent presence of dust at Barbados, dust deposition rates could not directly be linked to dust events identified by remote sensing. Instead, they were rather connected to variation in total deposition, showing the dominating influence of the wind speed on deposition velocity.

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COMPARISON OF ORGANIC AND ELEMENTAL CARBON MEASUREMENT DETERMINED BY THERMAL OPTICAL ANALYSIS PROTOCOLS

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Carbonaceous aerosol is generally classified into organic carbon (OC) and elemental carbon (EC) by thermal optical analysis. Both NIOSH (National Institute of Occupational Safety and Health) with high temperature (HighT) and IMPROVE-A (Interagency Monitoring of Protected Visual Environments) with low temperature (LowT) protocols are widely used. In this study, both protocols were applied for ambient PM2.5 samples (Daejeon, Korea) in order to underpin differences in OC and EC measurement. An excellent agreement between NIOSH and IMPROVE-A protocol was observed for total carbon (TC). However, significant differences between OC and EC appeared and the differences were larger for EC than OC. The main differences between two protocols are temperature profile and charring correction method. For the same charring correction method, HighT_OC was 10% higher than LowT_OC, while HighT_EC was 15% and 33% lower than LowT_EC for TOT (thermal-optical transmittance) and TOR (thermal-optical reflectance), respectively. This differences may be caused by the temperature of OC4 in He step and possibly difference in POC (pyrolized OC) formation. For the same temperature profile, TOT_OC was about 26% higher than TOR_OC. In contrast, TOT_EC was about 50% lower than TOR_EC. POC was also dependent on both temperature profile and the charring correction method, showing much distinctive differences for the charring correction method (i.e., POC_TOC to POC_TOR ratio is about 2). This difference might be caused by different characteristics between transmittance and reflectance for monitoring POC formation within filters.

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SENSITIVITY STUDIES ON GLACIGENIC DUST MOBILISATION IN GREENLAND WITH THE MESOSCALE MODEL COSMO

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Glacial outwash plains are a significant source of dust in high latitudes and cold climate zones. Aeolian dust transport associated with these sources has recently gained growing attention also in view of paleo-climate model simulations of glacial-interglacial cycles. Projections of glacier retreat in a warming climate motivate additional studies on the entrainment of glacigenic dust into the atmosphere.

We present results of sensitivity simulations with the non-hydrostatic mesoscale atmosphere model COSMO for Greenland. In a first step the modelled atmospheric circulation and winds, in particular katabatic winds, are validated against observations with respect to their relevance for dust uplift. Next, different assumptions for dust sources characterised by glaciofluvial sediments are tested using an off-line dust emission scheme. As initial and driving conditions atmospheric fields from the COSMO simulations are used.

Ultimately, results from this study will contribute to an enhanced representation of the global atmospheric dust cycle, including emissions from high-latitude dust sources that become of increasing importance in a changing climate.

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AN OPERATIONAL DUST FORECAST SYSTEM FOR THE ARABIAN PENINSULA

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The Arabian Peninsula is the second largest dust source in the world only after the Sahara Desert (Tegen and Fung, 1994; Ginoux et al., 2001; Prospero et al., 2002; Tanaka and Chiba, 2006; De Longueville et al., 2010). Every year dust storms affect various parts of the Arabian Peninsula with destructive effects in air quality and human health. In Saudi Arabia, dust storms are considered to be one of the most severe environmental problems (Pease et al., 1998; Alharbi, 2009; Badarinath et al., 2010). Immediate impacts of dust storms include: (a) reduction of visibility, (b) degradation of air quality, (c) increase in respiratory illness in people and livestock, (d) reduction of solar radiation and the efficiency of solar devices, (e) reduction of soil fertility, (f) damage to telecommunication and mechanical systems, (g) widespread dust deposition, and (h) damage to buildings, vehicles, and trees. Dust aerosols also play an important role in radiation budget by scattering and absorbing solar and terrestrial radiation and interacting with clouds, thereby impacting weather and climate at local and regional scales.

The Presidency of Meteorology and Environment (PME) in Saudi Arabia in collaboration with the National Center for Atmospheric Research (NCAR) has developed a high resolution dust prediction system with the goal of providing improved early warning forecasts in an effort to reduce the risk of these dangerous conditions. The dust prediction system is based on the Weather Research and Forecasting – Chemistry (WRF-Chem) modeling system. WRF-Chem is a fully coupled chemistry – forecast system based on the WRF model (Grell et al., 2005). WRF-Chem has been successfully used for a variety of research and applications for the prediction of weather, climate, air quality, dispersion of pollutants, and the prediction of dust.

The dust forecast system has been integrated into the operational WRF-data assimilation forecast system at PME. The model has been evaluated for several significant dust storm events. The evaluation of the case studies have demonstrated that WRF-Chem model is capable of simulating dust storms events in the region. The system will be useful for providing dust forecast guidance for PME operational forecasting activities. This presentation will provide an overview of the dust forecast system, highlight results from the case study analysis, and summarize future dust forecast development in Saudi Arabia.

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ESTIMATION OF DUST MASS AND COMPOSITION FROM ELEMENTAL ANALYSIS AND APPLICATION TO GREENLAND SNOW SAMPLES

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Atmospheric dust can be a major component of both fine ($PM_{2.5}$) and coarse ($PM_{10-2.5}$) particulate matter, and as such has implications for health, climate, and chemical processes in the atmosphere. While major crustal elements are known based on dust source studies and upper crust composition, estimating dust mass in ambient aerosol or deposited snow and ice samples, when specific dust source is not necessarily known and other particles are also present is less straightforward. Methodologies range from using one element, such as Ca, as a tracer, to summing various forms of multiple crustal elements, and choice of method merits careful consideration.

Related to mass estimation, the composition of atmospheric dust varies depending on many factors, including source region, size fraction, and aging and interaction with other aerosols during atmospheric transport. One important implication of this variability is corresponding differences in optical properties: mineralogy affects how strongly dust particles absorb radiation. Iron oxide minerals, namely hematite and goethite, are the most strongly absorbing major mineral present in dust and have been shown to drive the optical properties of dust, though this is also influenced by size distribution, mixing state, and fractions of other minerals, particularly light-absorbing clay minerals [1].

Mineralogy of dust particles has been studied, but is not always feasible for low levels of dust in other matrices (i.e. snow/ice), and is labor-intensive and mostly qualitative, requiring single-particle imaging and analysis. Elemental analysis using x-ray or inductively-coupled plasma techniques (i.e. XRF, ICP-MS, ICP-OES) can be conducted more easily and quantitatively on bulk samples, but translating this data to mineralogy is somewhat complex. It is unlikely that chemical analysis could be used for a comprehensive assessment of mineralogy; however, for the purposes of broadly estimating mineralogy and apportioning optically important elements, chemical techniques may be appropriate.

In order to address this need, we developed a simple linear mixing model to apportion dust mineralogy based on key crustal elements estimate dust mass to obtain mineral mass fractions, and applied it to 133 samples of Greenland snow where dust may contribute significantly to albedo changes. Based on mineralogical studies of dust in the literature, we identified quartz, calcite, clay minerals (illite, montmorillonite, kaolinite), and hematite as the major mineral species.[1] Key crustal elements used to estimate dust mass and represent components of major minerals include Si, Al, Ca, Mg, Ti, Fe, Mn, K, and Na; only particulate concentrations of K and Na were used to account for water-soluble biomass burning and marine contributions. Fe could be derived from both crustal and anthropogenic sources, and so we added As as a general tracer for anthropogenic sources and used data from a major pollution event in Beijing in winter 2013 [2]. Our goals for this application of the model were to (1) estimate dust mass and assess the use of different dust "tracers" in other estimations of dust mass, (2) determine what fraction of measured Fe is present as hematite, and (3) the fraction of hematite present in dust in these samples. We found that 83% of Fe (median) is present as hematite, and only 3% (median) contributed from anthropogenic sources, with the remainder present in clay minerals. We estimated dust mass by summing the common oxides of the major crustal elements listed above (e.g. SiO_2), and found that hematite constituted about 5% (median) of total dust mass. We used these results to tailor dust optical properties in the Snow, Ice, and Aerosol Radiation (SNICAR) albedo model and calculate albedo changes in these samples, as discussed elsewhere [3].

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THE EFFECT OF ASIAN DUST EVENTS ON VARIATIONS IN AIRBORNE BACTERIAL COMMUNITIES AT HIGH ALTITUDES OVER A DOWNWIND AREA, NOTO PENINSULA, JAPAN

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Asian dusts transport airborne microorganisms through free troposphere from the China desert areas to the downwind area in the East Asia [1] and can influence ecosystem dynamics, human health, and climate change. However, the variations of airborne bacterial communities in the free troposphere over the downwind area are poorly understood and there are a few of detail studies reporting on the effects of Asian dust event on the bacterial variations at high altitudes. In this study, the characteristics of airborne bacterial communities at high altitudes above the ground were investigated and the bacterial variations were compared between dust events and non-dust events.

Aerosols at altitudes of 1,200 m were sequentially collected during the Asian dust events and non-dust events over the Noto Peninsula, Japan, where the westerly winds carry aerosols from the Chinese continental areas. During Asian dust events, the air mass at high altitudes was transported from the Chinese desert region by the westerly winds, and lidar data indicated high concentrations of non-spherical particles, suggesting that dust sand particles were transported from Chinese continental area. Microbial particles at altitudes of more than 1,200 m maintained relatively high abundances at concentrations ranging from 1.2×10^6 to 6.6×10^6 particles/m^3. When air masses remained over Japanese areas for a few days and dust event disappeared, air mass predominantly included spherical particles and the microbial particles at altitudes of 1,200 m decreased to the concentrations ranging from 6.4×10^4 to 8.9×10^5 particles/m^3. MiSeq sequencing targeting 16S rRNA genes (16S rDNA) revealed that the bacterial communities at altitudes of 1,200 m during dust events were predominantly composed of terrestrial bacteria, such as *Bacillus* species [2]. In contrast, during non-dust periods, airborne bacteria at high altitudes sifted to different compositions that dominated by other terrestrial bacteria, such as *Actinobacteria* species, marine bacteria belonging to *Cyanobacteria* and *Alpha-proteobacteria*, plant-associating bacteria belonging to *Gamma-proteobacteria*. In addition, vertical bacterial distributions from ground level to free troposphere also changed in correspondence to Asian-dust event [3].

The origins of air masses and meteorological conditions contribute to the shifts of bacterial communities in downwind atmosphere. The ratios of terrestrial categories (*Bacillus* and *Actinobacteria*), marine categories (*Cyanobacteria* and *Alpha-proteobacteria* SAR clade) and plant-associating categories (*Gamma-proteobacteria*) would be influenced by the mixture levels of air-mass originated from the Chinese desert region, the Sea of Japan, and Japanese island. This study demonstrated that airborne bacterial communities at high altitudes significantly varied by air-mass sources and suggested that the taxonomic compositions in airborne bacteria might be used as air-mass tracers.

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AUTOMATED SINGLE-PARTICLE SEM/EDX ANALYSIS OF SUBMICROMETRIC SILICATE AND ALUMINOSILICATE DUST PARTICLES: MORPHOLOGY AND SULFUR CONTENT

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The aim of this study is to analyze submicrometric silicate and aluminosilicate dust particles using automated single-particle SEM/EDX analysis to characterize morphology and determine sulfur content. In order to achieve this, dust particles were collected using low-volume gravimetric sampler equipped with a PM1 cut-off inlet on polycarbonate filters. The collected samples were prepared by positioning the polycarbonate filter on aluminium stubs using carbon sticky tabs and were subsequently carbon coated. The prepared samples were analyzed using a Field Emission Scanning Electron Microscope equipped with an Energy Dispersive X-ray Spectrometer. The elemental composition characterization of particles was performed using Inca Energy 350 Suite software. The area, perimeter, length and breadth of the silicate and aluminosilicate dust particles were also determined. The sampling of dust particles took place on a pilot site in the Agri Valley which is close to the C.O.V.A. oil pre-treatment plant of the Europe's largest on-shore hydrocarbon reservoir. From a geological point of view, this site is characterized by a wide range of lithotypes, such as limestone, dolostone, radiolarites, siliceous argillites, calcilutites, marls, clayey marls silty clays and sandstones. The site has a mountain climate influenced by Mediterranean atmospheric circulation, resulting in dry summers, cold winters and relatively frequent dust episodes from North Africa [1].

Results show that silica particles (Si-particles), silicates (Si-X-particles) and aluminosilicates (Al-Si-particles and Al-Si-X-particles) were the most abundant mineral particles in the samples collected. They were mainly composed of silica and/or aluminium, with variable amounts of calcium, magnesium, sodium, potassium, iron and titanium (X=Na, Mg, Fe, K, Ti, P, Ca). The number of particles containing sulfur were calculated for the latter four groups. Silicate and aluminosilicate dust particles show a diverse sulfur content. The percentage of Al-Si-particles and Al-Si-X-particles containing sulfur were 2.6% and 7%, while Si-particles and Si-X-particles containing sulfur were 4.8% and 14%.

Furthermore, particle elongation ratio and circularity were evaluated in order to characterize particle morphology [2]. The circularity classified the silicate and aluminosilicate dust particles into two statistically different groups ($p<0.05$).

The silicate and aluminosilicate dust particles therefore show dissimilar characteristics with respect to their morphology and sulfur content. This ongoing study aims to identify any correlation between the morphological characteristics of the particles and their sulfur content.

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DUST MODELLING WITH LOTOS-EUROS: SEARCH FOR A GLOBALLY APPLICABLE APPROACH

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The LOTOS-EUROS model is a regional-scale chemistry-transport model of intermediate complexity, primarily aimed at modelling of air pollution (e.g. ozone, PM10). As part of its particulate matter (PM) it includes dust from road resuspension, agricultural activities and wind erosion of bare soils (deserts and agricultural land outside the growing season). The parameterization of the latter has been updated recently, based on a new combination of parameters available from literature. We aimed for a set-up that is universally applicable. The approach and results of this update will be presented.

The model should be applicable to any region in the world. Therefore we have a few requirements:

- the parameterization should be robust
- the input data should be globally available.

The first criterion means that the parameterization should stay close to first principles. The second criterion for example excludes the use of "potential source" areas as derived from METEOSAT, since they are only available for the Sahara, and a simple parameterization based on regional height differences was used.

The main challenge was to represent a large diversity of landscapes and with a limited set of input values. For example a constant roughness length per land cover category was used, albeit with a seasonal component for cropland.

Sensitivity tests were done with parameters in the range of the literature values, and values were chosen that were most universally applicable. With the final set were able to reproduce a diversity of cases: Saharan dust emissions as well as the incidental high dust loads stemming from agricultural land in the Ukraine (2007) and a small dust event in northern Germany, that caused a large accident on a motorway due to a sudden visibility reduction. Although the absolute dust emissions are still uncertain, the timing of the events and order of magnitude were in agreement with the available observations (PM10, AERONET, MODIS). AERONET data showed a good time correlation to modelled Saharan dust events, with correlation values around 0.5 for directly desert-related stations and around 0.7 for stations at larger distance to source areas.

Further improvements can be expected when roughness length and land cover maps which represent (large) regional and seasonal differences (e.g. local agricultural practices) would be used.

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NUMERICAL PHASE IDENTIFICATION ON SINGLE PARTICLE DATA FROM AUTOMATED SEM/EDX MEASUREMENTS

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Single particle data from automated scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDX) hold chemical information of every single detected particle. These data are not quantitative and therefore cannot be used to calculate absolute abundances directly, because of the non-ideal conditions for X-ray generation and distribution on small structures like particles. Quantitative measurements with this method require a flat surface and are limited in spatial resolution.

Nevertheless, it is possible to assign simple X-ray spectra signatures to common materials, such as minerals or artificial metallic compounds. Additional properties such as particle diameters (min/max) and the resulting shape factor can help distinguishing between different materials. This can be accomplished manually by looking up every particle type and assigning it to a phase or group, or it can be done numerically. Of course, the second method also needs manual input, depending on the sample type, preparation technique, etc.

In our approach, we worked on complex particle samples with particle sizes from 1 to 50µm in diameter (atmospheric dust from ambient air, lung dust, dust from biomass combustion and re-suspended volcanic ash) analysed with different microscopes with different measuring settings, and therefore we needed a tool, which is capable of handling all of these. For each sample, an individual algorithm was developed to find the closest match to the true composition, which was validated by other analytical methods, such as X-ray diffraction. From experiences gained during the evaluation of various individual datasets, we are developing an algorithm, which is capable of handling a wide range of data types. The tool allows the algorithm to learn with each new dataset processed.

The core feature of the algorithm is the development of a database of particle types and their interpretations, variation ranges and criteria for plausibility tests based on chemical composition as well as on physical shape factors.

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SIZE DISTRIBUTION AND CONCENTRATION OF AIRBORNE PARTICLES IN A TENEBRIO MOLITOR PRODUCTION UNIT

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European animal production systems are strongly dependent on protein imports (mainly soybean and fish meals). Moreover, these importations contribute significantly to the environmental burden placed on those systems. A very promising alternative source of protein could be insect proteins that have been little explored so far in Europe. The rearing conditions should however be improved and standardized before going to large-scale production systems. In order to assess the exposure of workers to particles, one objective of this study was to characterize the environmental conditions in a rearing room of *Tenebrio molitor*.

Size distribution and concentrations of particles were monitored using a Grimm Dust monitor () over 22 hours. Temperature and moisture were monitored simultaneously. In the rearing room (96 m^2), different instars of *T. molitor* were identified and a rough estimation of the numbers of batches per instar was made. Insects were produced on a diet composed of wheat bran and a mixture of flours obtained from several cereals.

Ventilation remained constant during the measurement cycle and the airflow in the room was weak (2.96±0.54 m/s). The $PM_{2.5}$ and PM_{10} concentrations were respectively 7.52±6.53µg/m^3 and 32.73±49.61µg/m^3. These concentrations values are lower than those measured in standard animal production given by Lai et al [1]. More than 95% of the particles were smaller than 0.5µm.

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CHARACTERIZATION OF DUST AEROSOL CYCLE AND IMPACT ON RADIATIVE FLUXES DURING FENNEC CAMPAIGN 2011-2012. ANALYZE OF MESO-SCALE SIMULATIONS AND OBSERVATIONS

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The Sahalien and Saharan zones are principal worldwide sources of dust aerosol emissions that play significant role in the climatic system. In the framework of FENNEC campaign, conducted during the summer 2011 and 2012, we focus on dust radiative effect and impact on the atmospheric dynamics and profile structure. We study the variability of the measured radiative parameters and model atmospheric dynamics during dust plume observations at the FENNEC sites, therefore, trying to understand the link between the Saharan heat low system and dust aerosols. With the meso-scale model RAMS, we simulate the dust cycle in order to find the contribution of the different emission sources, identify structure of plume's transport over an extended domain and describe the plume's size distribution. Several key cases of dust events, at the same days of June in 2011and 2012, are in particular studied. Results are a first indication about temporal variability of activated dust sources and wind fluxes over those regions. Then, coupling the radiative code (GAME) to RAMS, we calculate the radiative forcing of dust and compare it to the radiative flux observed and computed based on the AERONET observations. Validation of simulations is made using measurements from space-borne CALIOP lidar, SEVIRI and OMI satellites, AERONET ground-based stations and observations acquired onboard the SAFIRE Falcon 20 research aircraft. This study is also to test the capability of the model to describe the dynamic processes of dust plume in this region and to estimate the radiative impact of dust plume. Therefore, it will be applied to others cases much recently observed during SHADOW campaign (2014-2015).

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CIAO, THE CNR-IMAA ATMOSPHERIC OBSERVATORY: AN IDEAL EXPERIMENTAL SITE FOR DESERT DUST INVESTIGATION

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The CNR-IMAA observations for aerosol and water vapour started in 1993 within a National Research project (Progetto Sud INFM). Systematic lidar measurements of aerosol optical properties vertical profiles started in 2000. The current CIAO (CNR-IMAA Atomospheric Observatory) infrastructure (instruments and data) is the result of subsequent system upgrades, acquisitions of new instruments and quality control developments. This is a continuously evolving process carried on thanks to national and international projects and collaborations with scientific and industrial partners.

CIAO is located in Southern Italy on the Apennine mountains (40.60N, 15.72E, 760 m a.s.l.), less than 150 km from the West, South and East coasts. The site is in a plain surrounded by low mountains (<1100 m a.s.l.) and this location offers an optimal opportunity to study different kinds of weather and climate regimes.

The observatory operates in a typical mountain weather strongly influenced by Mediterranean atmospheric circulation, resulting in generally dry, hot summers and cold winters. In this location, phenomena like orographically-induced effects on cloud formation can be studied. The site is particularly interesting for studying aerosol properties because it is affected by a quite large number of Saharan dust intrusions per year and it is located 300 km far from the Etna Volcano.

The wide range of measurements provided at the facility makes it an ideal site for calibration and intercomparison campaigns. CIAO combines in an unique site multi-wavelength lidar for aerosol and water vapour vertical profiling performing systematic measurements with operational scanning cloud radar, microwave profiler, sunphotometers and ceilometers. In addition radiosoundings are performed systematically at CIAO, with at least 1 launch per week.

The laser ceilometers and the passive sensors are standard instruments and generally operate on a continuous basis and their data are available for scientific exchange. The lidar systems are unique research tools built by the scientific experts working at the facility.

CIAO provides quality-controlled data on the vertical profiles of clouds, humidity, temperature and aerosols. The availability of simultaneous measurements of aerosol and cloud properties makes the site optimal also for the investigation of aerosol-cloud interactions. The site is affected by typical mountain weather strongly influenced by Mediterranean atmospheric circulation. Phenomena like orographically-induced effects on cloud formation can be studied at this location. Moreover, the site is particularly interesting for studying aerosol properties in the Central Mediterranean region. This region is of great interest because affected by different types of aerosol: African desert dust, volcanic particles from nearby Etna volcano; anthropogenic aerosols produced by urban and industrial areas in continental and eastern Europe; biomass burning aerosols produced in forest fires; and of course maritime aerosol produced over the Mediterranean sea itself.

Long-term measurements for aerosols and clouds climatology are the main topics of the ground-based facility and have been performed following the EARLINET measurement protocols for lidar systems and cloud-radar as well as using low-cost operational active and passive instruments.

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IMPACT OF MARITIME AND PORT EMISSIONS ON THE AIR QUALITY IN PORTUGAL: PRESENT AND FUTURE SCENARIOS

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Particulate matter emitted from ship's exhausts contributes significantly to air pollution in coastal regions. In this scope the AIRSHIP project, funded recently by the Portuguese Scientific Foundation, aims to evaluate the impact of maritime transport emissions on the air quality in Portugal and, with greater detail, in the Porto urban area due to its proximity to the Port of Leixões. In order to achieve this goal, high resolution and precision detailed emission scenarios are required, together with the physical-chemical modelling of atmospheric processes.

At first, a detailed emission inventory for Portugal regarding shipping activities will be developed using updated activity data (ship movements) and appropriate emission factors for the fleet. The calculated emission data will be then compared with previous (EMEP) inventories and its differences analysed.

The mesoscale numerical modelling will be performed with the WRF-CHIMERE modelling system, already tested and validated for this region. The model will initially be applied at the regional scale, followed by its downscaling to the Porto urban area, using nesting techniques, at a high spatial resolution (1x1 km^2). Climate simulations already performed for Portugal (with WRF model) will be used with the aim of integrating climatic conditions (as well as emissions projections) in the assessment of future air quality.

Taking into account the obtained modelling results, strategies for the efficient mitigation of maritime transport pollution in this region will be investigated. Moreover, the project aims to elaborate and distribute guidelines for the implementation of such strategies.

This poster will allow the dissemination of the AIRSHIP project throughout the scientific community, including its objectives, methodology and preliminary results.

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DECOUPLING OF AIR MASSES IN THE WESTERN MEDITERRANEAN: SIMULTANEOUS AFRICAN DUST OUTBREAKS AND MEDITERRANEAN POLLUTED CONTRIBUTIONS IN SOUTHERN/SOUTH-EASTERN SPAIN

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Dust-laden African air masses reach frequently the Iberian Peninsula. We show that during most African dust outbreaks, southern/south-eastern Spain is under the influence of Mediterranean air masses at the lowest heights, while African flows arrive above the boundary layer primarily with southwestern pathways. The local and regional accumulation of aged pollutants in the western Mediterranean during the central months of the year, associated to recirculations within the coastal breezes reinforced by the local orography, contributes with anthropogenic aerosols and O_3. In particular, ozone concentrations are significantly higher under African episodes than on days with no episode. Concentrations increase when flows are traced-back from the Spanish coast to the Gulf of Lyon, which points out the contribution of continental polluted outflows. However, the maximum concentrations are found with no African episode, probably due to ozone depletion by dust particles.

We have made an analysis of back-trajectories at multiple heights over the southern and eastern Spanish coast for the period 2004-2012, to analyse the decoupling between the lowest troposphere and upper levels, and its influence during African dust events. Though mesoscale processes are not well represented in the calculated single-particle trajectories, and consequently they cannot be reproduced, the short Mediterranean trajectories are a clear signature of the low synoptic forcing associated to daily recirculations in the western Mediterranean. Similarly, the influence of the Atlas Mountains, which act in most of cases as a barrier, can be ascertained. The study is done in combination with meteorological data from the ERA-Interim database and radiosoundings from Gibraltar and Murcia, PM_{10} and O_3 concentrations at the ground level, and column-integrated aerosol properties and O_3 data.

This work provides insight on the vertical transport of African dust to the Iberian Peninsula. It also highlights that the contribution of Mediterranean polluted air masses, concurrent with African dust outbreaks, should be considered in the studies of the health outcomes of African dust episodes.

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IMPACT OF SAHARAN ADVECTION ON PLANETARY BOUNDARY LAYER OVER TARANTO (ITALY) BY LIDAR CEILOMETER

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Saharan dust strongly contributes to the atmospheric aerosol loading in Mediterranean region, thus affecting climate, precipitation cycle, and human health [1].

The use of LIDAR ceilometers is recently becoming a valid alternative to more sophisticated observation systems in order to detect the presence of a Saharan advection and follow its temporal evolution [2]. Indeed, ceilometers are robust, inexpensive and reliable systems that are suitable for continuous operation over long periods. They are able to provide useful information about the vertical profile of clouds and aerosol layers and to retrieve the height of the planetary boundary layer (PBL).

In this study, a ceilometer placed in a highly polluted industrial site (ILVA, the largest European integrated cycle steel plant) has been employed in order to confirm the presence of desert aerosol over the Apulia region in the month of September 2015. The LIDAR is a one-wavelength near-infrared CHM15K- Jenoptik ceilometer, that operates continuously in automatic mode and produces vertical profiles in the range 0-15 km with temporal resolution of 30 sec and spatial resolution of 15 m in the raw signals. The lack of a depolarizer unity makes the comparison with the output of online desert dust models (BSC-Dream and Hysplit for backtrajectories) necessary for the correct interpretation of the signal produced by the cielometer during the Saharan advection.

The steps of the analysis are described as follows: firstly, the daily profiles are qualitatively analyzed for the identification of the days affected by Saharan dust; secondly, the PBL height is evaluated using a semi-automatic algorithm exploiting three different methods (variance, threshold and gradient of range-corrected LIDAR signal [3]) for each day of the tested month.

Occurrences of Saharan dust advections are found to be associated to a relevant decrease of the maximum daily value of PBL height. Besides, the PBL height and the readings of in-situ PM10 concentration are found to show a negative correlation.

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MODELLING CONVECTION DUST STORMS IN LARGE-SCALE WEATHER AND CLIMATE MODELS

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Recent field campaigns have shown that convective dust storms – also known as haboobs or cold pool outflows – contribute a significant fraction of dust uplift over the Sahara and Sahel in summer. However, in-situ observations are sparse and convective dust storms are frequently concealed by clouds in satellite imagery. Therefore numerical models are often the only available source of information over the area. Here a regional climate model with explicit representation of convection delivers the first full seasonal cycle of convective dust storms over North Africa. The model suggests that they contribute one fifth of the annual dust uplift over North Africa, one fourth between May and October, and one third over the western Sahel during this season. In contrast, most large-scale weather and climate models do not explicitly represent convection and thus lack such storms.

A simple parameterization of convective dust storms has recently been developed, based on the downdraft mass flux of convection schemes. The parameterization is applied here to a set of regional climate runs with different horizontal resolutions and convection schemes, and assessed against the explicit run and against sparse station observations. The parameterization succeeds in capturing the geographical distribution and seasonal cycle of convective dust storms. It can be tuned to different horizontal resolutions and convection schemes, although the details of the geographical distribution and seasonal cycle depend on the representation of the monsoon in the parent model. Different versions of the parameterization are further discussed with respect to differences in the frequency of extreme events. The results show that the parameterization is reliable and can therefore solve a long-standing problem in simulating dust storms in large-scale weather and climate models.

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DISPERSION OF FLUE GAS FROM URBAN ENERGY PLANTS TO TALL RESIDENTIAL APARTMENT

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Expansion of cities becomes close to various industrial plants including energy facilities of power station which had usually been remote from the urban centre. The flue gas from power station stacks near the large and tall residential apartments has arisen significant public complaints. Thus, this study deals with theoretical effects of the exhaust from a local power station within 500 meters of the newly constructed residential area through the numerical simulation. Standard k-ε turbulence model was used to trace the flow pattern and corresponding dispersion of pollutants.

Dynamic behaviour of gas flow depends on the micrometeorological condition. It was found that the altitude and direction of the flue gas were determined according to the wind direction and intensity. In a day with no wind, a park and a hospital very near the power station received the dropping pollutants by downwash. Northeasterly wind higher than 2 m/s drove the flue gas into the floors 25th to 38th. In addition, several floors might face warm air approximately 2 to 4 °C higher than the background due to the exhaust at 100 °C. Little influence of NOx concentration appeared despite of the initial discharge, 50 ppm. It seems to be due to sufficient dilution and wide dispersion as soon as exiting the stacks.

Keywords: flue gas, urban pollution, numerical simulation, air dynamics

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MONITORING PARTICULATES IN URBAN AND RURAL UGANDA

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There is currently no systematic, continuous monitoring of particulates in Uganda, but isolated measurements in the largest two cities, Kampala and Jinja, have shown very high levels, with PM2.5 concentrations typically exceeding 100 μg/m^3 during the dry season [1,2]. Preliminary source attribution shows that roughly half of these particulates are crustal in origin, while the remaining major constituents are from biomass burning (both fuel and trash), vehicle exhaust, and industry.

The current study extends this work by measuring PM10 concentrations in three distinct environments: an urban center (Kampala), a small city (Mbarara) and a village location (Rubindi), both in the wet season and the dry season. Since the majority of Uganda's population is in rural areas, it is important to understand whether particulate concentrations are also high outside of urban areas. Additionally, measuring concentrations in different locations aids in source attribution. These concentrations are measured using gravimetric methods (SKC PEM with Teflon filters) and real-time optical methods (TSI SidePak). For most of the measurements, these two instruments are co-located, enabling both the comparison of the two data sets and the calibration of the optical measurements using local particulate distributions.

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USING A MULTI-WAVELENGTH AETHALOMETER TO STUDY THE PROCESSES AFFECTING THE VARIABILITY OF AEROSOL PROPERTIES

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For several decades optical properties of aerosols have been an important subject in atmospheric research. The radiative effects of black carbon (BC) cannot be neglected as it is dominant light-absorbing component of atmospheric aerosols.

The present study focuses on the evolution of the eBC (equivalent black carbon) concentrations at a suburban site of A Coruña measured by aerosol light absorption techniques and to try to identify mineral dust from these techniques. The sampling was carried out in a suburban area (43.3 N, 8.4 W, 45 m.a.s.l.), close to A Coruña, in the northwest of Spain. This site is characterized by an Atlantic climate, and the sea breeze is presented during all year. Light attenuation by the aerosol particles (deposited on a filter) was measured at 7 wavelengths (λ=370, 470, 520, 590, 660, 880, and 950 nm) using an Aethalometer (Magee Sci. Model AE33, Aerosol d.o.o., Slovenia) [1] during 2015 (January to November). The instrument was measuring at a flow rate of 5 $Lmin^{-1}$ with a membrane drier (AID, Magee Scientific, Aerosol d.o.o.). Data were recorded with a time-resolution of 1 minute. The AE33 incorporates the patented DualSpot™ method [1]. From the absorption light coefficient, b_{abs}, for atmospheric aerosols, it can be studied the relation between aerosol composition and the wavelength dependence of b_{abs} by means of the following empirical power law fit [2].

Monthly means of eBC concentration ranged from 0.43 to 1.13 μgm^{-3} and the hourly means varied between 0.023 and 15.5 μgm^{-3}, being the highest values found in January. During the May-July period the eBC mass concentrations were lower than in the other months. The eBC diurnal pattern in winter was typically different from that in spring indicating the seasonal variation of the atmospheric boundary layer height. The weekday/weekend difference was not strongly pronounced because the eBC concentrations are mainly affected by long-range transport or local sources. Temporal evolution and transport of eBC aerosols were interpreted by the air mass backward trajectory analysis in conjunction with the examination of the wavelength dependence on the Aethalometer data. Angstrom exponent values (α) have been calculated over the entire period, with a power law over all 7 wavelengths, and an average of 1.3 was found. The mean values of Angstrom exponent of the absorption coefficient (monthly means between 1 and 1.5) revealed that the eBC concentration observed over this area is influenced by submicron sized particles as a result of incomplete biomass combustion during the winter season. Also, several dust events were detected and analysed in order to compare α during these events with other similar found in the bibliography [3].

This work has been supported by Program of Consolidation and Structuring of Units of Competitive Investigation of the University System of Galicia (Xunta de Galicia) (references: GRC2013-047) and the Slovene JR-KROP grant 3211-11-000519.

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ENVIRONMENTAL CONSEQUENCES OF DESERT DUST DISPERSAL

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SEASONAL VARIABILITY IN MINERALOGY AND CHEMISTRY OF DEPOSITION DUST SAMPLES FROM AN ARABIAN RED SEA COASTAL LOCALITY

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The Arabian Peninsula is one of the Earth's major sources of atmospheric dust. Along with profound negative effects on human activity and natural processes in this region, dust is an important nutrient source for the oligotrophic northern Red Sea. From preliminary observations it is estimated that some 18-20 major dust storms per year over the Arabian Peninsula deposit about 6 Mt of mineral dust into the Red Sea. To better understand the optical characteristics, health, and ecological impacts of dust, we study the mineralogical, chemical and morphological properties of deposited dust samples collected at King Abdullah University of Science and Technology (KAUST), Saudi Arabia since December 2014 using "frisbee" type deposition samplers along the Red Sea coast. Sampling periods of one month are adopted. Sixteen deposited dust samples are analysed using X-ray diffractometry (XRD) to establish their mineral content. Elemental composition of dust samples is studied by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES), and their water-soluble ions by Ion Chromatography (IC). The deposition rates from the "frisbee" samplers varied between 3 and 43 gm^{-2} $month^{-1}$ and show a pronounced seasonal cycle. The mineralogical analysis shows the samples to contain major components of quartz and feldspars, variable amounts of halite and dolomite, and lesser amounts of gypsum, calcite, clays, micas, and gypsum.

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AEOLIAN DEPOSITS BEWEEN SANDY DESERT AND LOESS IN NORTHERN CHINA: INSIGHTS INTO LATE QUATERNARY VARIATIONS IN EXTENT OF CHINESE LOESS PLATEAU

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The Chinese Loess Plateau (CLP) is well-known for providing an important terrestrial record for broad paleoclimatic comparisons on various timescales. However, there are few studies concerning variations in the extent of the CLP over geological times and those dynamic linkages to climatic changes. As an intermediate aeolian deposition, aeolian deposits in the transitional zone between sandy desert and loess plateau in northern China can provide important information on desert expansion or retreats of the CLP. In this study, three outcrop sections of aeolian deposits from two sites along the desert-loess transitional belt in northern China were investigated. Based on the results of proxy analyses and optically stimulated luminescence (OSL) dating, we attempt to discuss variability of the extent of the CLP and its possible forcing mechanisms over the late Quaternary. The aeolian deposits are mainly composed of interbedded well-sorted sand, sitly sand, loess and/or palaeosol. At the site of Xiangshan, south of Tengger Desert, sedimentary disconformities are clearly identified exactly below the silty sand deposition in two sections. The disconformity surfaces are also depicted by abrupt increase in grain size and by geomorphic signs around the sections, suggesting occurrences of intense aeolian erosion prior to deposition of silty sand. A disconformity surface is also found in the section at the site (Kajia village) in the southeastern Gonghe Basin, but it was formed by a truncation due to riverine processes, as indicated by the deposits of sandy gravel in the upper part of this section. Well-sorted sand deposition occurring in the middle section may have resulted from the expansion of dune fields on the upwind Mugetan Plain, currently ~3 km away from the section. The loess layers in the aeolian sections have similar sedimentary characteristics to the typical loess deposits from the central CLP, strongly suggesting that a depositional environment of dust, similar to the modern landscape on the CLP, may have occurred at the marginal sites during some episodes of the past. A couple of OSL dates suggest that the loss deposition took place before 42.5 ka at the Xiangshan site and before 19.3 ka in the southeastern Gonghe Basin, probably as early as 382.8 ka. Although the studied aeolian deposits were interrupted by either the episodic deposition of aeolian sand/silty sand or sedimentary hiatuses (e.g. 42.5–19.1 ka in section Xiangshan), the most prominent change from a landscape of loess deposition to one characterised by aeolian activity occurred at around 19 ka at both sites, when silty sand and fluvial sandy gravel deposited at sections Xiangshan and Kajia, respectively. Our results suggest that the extent of the Chinese Loess Plateau may have fluctuated episodically at least before 19 ka. A northwestward expansion of loess depositional area could have resulted from shifts of bioclimatic zones in northern China induced by climatic changes, which appeared to occur even during some climatic optimums of Late Pleistocene. In contrast, the episodic retreats of the CLP would be caused by either intensive aeolian erosion [1] or fluvial processes. The variability of extent of the CLP may provide insights into past dust cycles in northern China.

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INVESTIGATING THE HETEROGENEOUS INTERACTION OF VOCS WITH NATURAL ATMOSPHERIC PARTICLES: ADSORPTION OF LIMONENE AND TOLUENE ON SAHARAN MINERAL DUSTS

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The heterogeneous interaction of limonene and toluene with Saharan dusts was investigated under dark conditions, pressure of 1 atmosphere, and temperature 293K. The mineral dust samples were collected from six different regions along the Sahara desert, extending from Tunisia to the western Atlantic coastal areas of Morocco, and experiments were carried out with the smallest sieved fractions, i.e. inferior to 100 μm. N_2 sorption measurements, granulometric analysis, and X-ray Fluorescence and Diffraction (XRF and XRD) measurements were conducted to determine the physicochemical properties of the particles. The chemical characterization showed that dust originating from mid-eastern Sahara has significant higher SiO_2 content (~82%) than dust collected from the western coastal regions where the SiO_2 relative abundance was ~50%. A novel experimental setup combining Diffuse Reflectance Infrared Fourier Transform spectroscopy (DRIFTS), Selected-Ion Flow-Tube Mass Spectrometry (SIFT-MS) and long path transmission Fourier-Transform InfraRed spectroscopy (FTIR) allowed to follow both the adsorbed and gas phases. The kinetic adsorption/desorption measurements were performed using synthetic dry air as bath gas exposing each dust surface to 10 ppm of the selective Volatile Organic Compound (VOC). The adsorption of limonene was independent of the SiO_2 content, given the experimental uncertainties, and the coverage measurements ranged between (10-18) × 10^{13} molecule cm^{-2}. Experimental results suggest that other metal oxides that could possibly influence dust acidity may enhance the adsorption of limonene. On the contrary, in the case of toluene, the adsorption capacities of the Saharan samples increased with decreasing SiO_2 content. However, the coverage measurements were significant lower than those of limonene and ranged between (2-12) × 10^{13} molecule cm^{-2}. Flushing the surface with synthetic dry air showed that VOC desorption is not a completely reversible process at room temperature. The reversibly adsorbed fraction and the rate coefficients of desorption, k_{des}, depended inversely on the SiO_2 relative abundance for both VOCs.

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IMPROVEMENT OF THE AGREEMENT OF MODELED AND EXPERIMENTAL DESERT DUST RADIATIVE FORCINGS BY THE REFRACTIVE INDEX OPTIMIZATION

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Closure studies between model-based and observational findings were addressed by several works (e.g. [1] and references therein) in order to improve the accuracy of some key parameters (mainly aerosol optical depth, single scattering albedo, and asymmetry parameter) in the model-based determination of the aerosol Direct Radiative Forcing (DRF). In this work, the sensitivity of a two-stream radiative transfer model (RTM) [2] to the desert dust refractive index values was studied to improve the agreement between model-based and experimentally-determined DRF values at the surface. To this end, downward and upward irradiance measurements, in the short-wave (SW, 0.3-2.8 μm) and in the long-wave (LW, 4.5-42 μm) spectral ranges, were used in combination with aerosol optical depths (AODs) collocated in space and time to experimentally determine the instantaneous and clear-sky aerosol DRF at the surface, during some desert dust outbreaks that affected the Central Mediterranean. A two-stream RTM was also used to simulate the SW (0.3-4 μm) and the LW (4-80 μm) radiative fluxes with and without aerosol particles and to reproduce the experimental DRF values at the surface. Input data included the columnar aerosol volume size distribution from AERONET (AEronet RObotic NETwork) sun/sky photometer retrievals. The used surface albedo values were experimentally determined from the SW irradiances measured at the surface. The aerosol vertical distribution was retrieved from LIDAR measurements. Air density and temperature, atmospheric pressure, and water vapour mixing ratio values at the surface were provided by local meteorological stations. The vertical profiles of these meteorological parameters up to 20 km of altitude were retrieved from radiosonde measurements. Summer and mid-latitudes standard atmosphere data provided by the Air Force Geophysics Laboratory (AFGL) were then used above 20 km of altitude. Vertical profiles of oxygen, ozone, and well-mixed trace gases were also taken from AFGL.

The sensitivity of the model results to desert dust refractive index values was investigated to optimize the agreement between simulated and experimental aerosol SW- and LW-DRFs at the surface during the analyzed events. To this end, the dust refractive indices available in literature were firstly tested. Then, it was shown that the use of the refractive indices retrieved from AERONET sun/sky photometer measurements during the analyzed desert dust events allowed improving the agreement between model-based and experimental DRF values. This outcome could be explained by noting that the literature refractive index values referred to pure dust particles and were time-independent. Conversely, the AERONET refractive indices varied with the time of the day and were representative of the monitored aerosol load. As it is well known, dust particles can interact and/or mix with other kinds of particles during their transport to monitoring sites that are several hundred kms away from the source area. However, we found that the AERONET refractive index values also needed to be optimized to further reduce the differences between experimental and model-based desert dust DRF because of their uncertainties.

In conclusion, we found that the used RTM allowed reproducing the experimental SW- and LW-DRFs, within experimental uncertainties, by using refractive indices better suited to the investigated monitoring sites.

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LATE PLEISTOCENE AEOLIAN DUST PROVENANCES AND WIND DIRECTION CHANGES RECONSTRUCTED BY HEAVY MINERAL ANALYSIS OF THE SEDIMENTS OF THE DEHNER DRY MAAR (EIFEL MOUNTAINS, GERMANY)

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The study presents the results of a heavy mineral analysis from a 38 m long record of aeolian sediments from a core section of the Dehner dry maar (Eifel Mountains, Germany). The record encompasses the period from 30 to about 12.5 ka. Heavy-mineral analysis of the silt fraction has been performed at a sampling interval of 1 m. Statistical analyses enabled the distinction of local and regional source areas of aeolian material and revealed pronounced changes in the amounts of different heavy mineral species and corresponding changes in the grain size index (GSI). The results indicate that during the early stages of MIS 2 (40 to 30m depth) aeolian sediments were supplied mostly from local sources. This period is characterized by a low GSI ratio resulting from a reduced mobility of material due to a vegetation cover. The climax of the LGM is characterized by a higher supply of heavy minerals from regional and more distant sources. Changes in the provenance areas are indicated in inverse relationships between zircon, rutile, tourmaline (ZRT) and carbonate particles. Shifts in the wind direction are documented in pronounced peaks of carbonate particles indicating easterly winds that have crossed the limestone basins in the Eifeler North South Zone. ZRT-group minerals on the other hand suggest a westerly source area and a supply from areas consisting of Paleozoic clastic sedimentary rocks. In the periods following the LGM the analyses indicate an increasing degree of mixing of heavy minerals from various provinces. This suggests the existence of a presumably incomplete, thin cover of deflatable loessic sediments that has been repeatedly reworked on the elevated surfaces of the Eifel.

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CHARACTERIZATION OF TOXIC TRACE METALS IN SIZE-SEGREGATED FINE AND ULTRAFINE PARTICLES WITHIN AN URBAN ENVIRONMENT

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Background and aims – Several works suggested correlations between particulate metals and pulmonary toxicity [1, 2, 3]. The particulate size and chemical composition of inhaled particles govern their potential impacts on human health and can mediate toxicity by the presence of specific toxic elements. The problem becomes even more critical when considering ultrafine particles, because of their higher surface area-to-mass ratio and the greater deposition efficiency in the alveolar region [4]. For health reasons, one of the main goal of the scientific research in this area is to understand if the mechanisms of particle toxicity are defined in specific size fractions and how the particulate elemental composition can affect it [5]. In this framework, the present study attempted to characterize the concentration and size-distribution of potentially toxic trace metals in size-segregated nano, ultrafine and fine particles collected in Como, Northern Italy.

Materials and methods – Atmospheric particulate samples were collected in a typical urban background site in Como, at ground level. A 13-stage Low Pressure Impactor (DLPI), equipped with high-purity polycarbonate filters (25-mm, no-holes), was used to collect size-resolved aerosol particles in the 0.03 - 10 µm size range. Before sampling, the collection substrates were coated with a thin layer of grease, to avoid particles' bounce and blow-off effects, and the sampling device was run at 30 L min^{-1} for 96h, to allow the determination of total metal contents in all PM size fractions. Weekly sampling campaigns were carried out from Monday to Friday morning, for a total of 10 monitored months. Minor and potentially toxic trace metals (e.g. Pb, Be, Ba, Mn, Co) were then directly analyzed via laser ablation (LA) in combination with inductively coupled plasma-mass spectrometry (ICP-MS) for each of the size-resolved particulate fractions.

Results – The metal composition measured in this study accounted for a small percentage of the total PM mass concentration, but results revealed greatly variations in the concentration levels of the investigated toxic metals, with values differing by one or more orders of magnitude from element to element and between the different sampling periods.

Obtained findings showed distinct differences for the analyzed elements, with different and characteristic size-distributions in the nano, ultrafine and fine fractions. The studied elements were variously enriched in the particulate sizes, suggesting that local emission sources may exist for these chemical species.

Conclusions – In the present work, some potentially toxic trace metals were analyzed in size-segregated nano, ultrafine and fine particles during a 1-year monitoring period. Although these chemical species played a minor role in the PM chemical composition, their importance in the assessment of toxicological impacts on humans of inhaled particles is crucial and these findings could enrich the local and still limited knowledge about this topic.

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PARTICLE MATTERS (PM) AIR POLLUTION IN THE METROPOLITAN AREA OF HAIFA, ISRAEL – CORRELATION WITH SYNOPTIC CONDITIONS AND CLIMATIC STRESS

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Relatively high Particle Matter (PM) concentrations, detected over the Middle East and Israel, are attributed to natural dust outbreaks as well as to local and remote anthropogenic sources. The spatio-temporal distribution of the pollution is highly dependent on the geographical characteristics of the region, such as the complex terrain of Haifa, the nearby bay structure and the atmospheric conditions determined by the combined meso-, local and synoptic-scale circulations. Yuval and Broday (2006) showed that while dust outbreak events are excluded, heavy traffic load is a main source for PM_{10} in the Haifa metropolitan area, though this area has major industrial plants, including the national petroleum refineries, petrochemical and agrochemical industries.

The research analyzes the role of synoptic conditions and summer climatic stress in the temporal and spatial distribution of PM_{10} and $PM_{2.5}$. The 'environment to circulation' approach is adopted, following Yarnal (1993), Yarnal et al. (2001) and Dayan and Tubi (2012). First, 'pollution potential' is defined, regarded as percentage of exceeding days for each of the regional synoptic type, using the semi-objective synoptic classification of Alpert et al. (2004). Second, for the summer season, characterized by persistent Etesian winds with no dust outbreaks, we hypothesize a potential correlation between the climatic stress and PM concentration. The new climatic stress index of Savir (2014) is used.

The database includes PM measurements of 9 monitoring stations and wind measurements of 5 stations, for 10 years. Analysis of the days in which the concentrations exceeded the Israeli standard (daily average of 130 $\mu g/m^3$ for PM_{10} and 37.5 $\mu g/m^3$ for $PM_{2.5}$) indicates that they are most frequent during the spring and winter seasons. The North African Low has the highest pollution potential (22% and 33% for $PM_{2.5}$ and PM_{10}, respectively) and second is the Cyprus Low (12% for both). However, the contribution of the Cyprus Low to the exceeding occurrences is 7 times higher due to its higher frequency. Moreover, the highest concentrations observed belong also to Cyprus Lows. The remaining synoptic systems, typically associated with static stability, have lower pollution potential, of <5% for PM_{10} and 5-10% for $PM_{2.5}$. It should be noted that in spite of the persistent stability and absence of rain during the entire summer season, there were no exceeding days for PM_{10} and only 4% for $PM_{2.5}$, attributed to exceptional events for this season. When excluding dust outbreaks, the summer becomes the most polluted in $PM_{2.5}$.

An increase in PM concentrations, especially of $PM_{2.5}$, together with the increase in summer climatic stress is well seen, indicating that severe discomfort conditions are associated also with higher PM pollution. Erel et al. (2007) showed that European atmospheric pollution is imported by the Etesian winds to the Eastern Mediterranean during the summer.

Defining and understanding the relations between synoptic-scale atmospheric variables and local pollution potential can be further evaluated for future conditions using outputs of climate models.

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ROLE OF DESERT DUST AS SPHERICAL AND SPHEROIDAL PARTICLES IN CLOSURE STUDIES FOR IN SITU AEROSOL MICROPHYSICAL-OPTICAL PROPERTIES

Mar Sorribas (1,2)*, Francisco Jose Olmo (1,2), Arturo Quirantes (1,2), Hassan Lyamani (1,2), Manuel Gil-Ojeda (3), Lucas Alados-Arboledas (1,2), Helmuth Horvath (4)

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VARIABILITY OF THE CONCENTRATION AND SIZE DISTRIBUTION OF SUB-MICRON AEROSOL IN THE MARINE BOUNDARY LAYER AT TENERIFE ISLAND DURING AMISOC CAMPAIGN

Mar Sorribas (1,2)*, Manuel Gil-Ojeda (3), Sergio Rodriguez (4), M. Isabel García (4), Jose Antonio Adame (3), Mónica Navarro (3), Olga Puentedura (3), Alfonso Saiz-Lopez (5)

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PARTICULATE MATTER SOURCE SIGNATURE USING SIMULTANEOUS MEASUREMENTS OF PM_{10}, $PM_{2.5}$ AND PM_1 TRACERS MASS CONCENTRATION

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This study looks at the identification of particular matter (PM) source signature using the ratios between tracers (Tr) mass concentration of PM_{10}, $PM_{2.5}$ and PM_1 (i.e. aerosol particles with aerodynamic diameters less than 10, 2.5 and 1μm, respectively). Studies presenting simultaneous measurements of PM_{10}, $PM_{2.5}$ and PM_1 tracers mass concentration were considered and corresponding ratios (i.e., $PM_{1(Tr)}/PM_{10(Tr)}$, $PM_{2.5(Tr)}/PM_{10(Tr)}$, $PM_{1(Tr)}/PM_{2.5(Tr)}$ and $[PM_{2.5(Tr)}\text{-}PM_{1(Tr)}]/[PM_{10(Tr)} - PM_{1(Tr)}]$ were calculated and displayed using a triangular diagram [1].

Results show that these ratios related to tracers such as Al, Si, Ca and Fe (mainly attributed to crustal material e.g. soil resuspension, desert dust) and tracers such as Na, Cl and Mg (from sea-salt and marine sources) [2] are mostly characterized by lower values of $PM_{1(Tr)}/PM_{10(Tr)}$ and $PM_{2.5(Tr)}/PM_{10(Tr)}$ ratios (i.e. <50%) and are displayed toward the bottom right of the triangular diagram. In this region, the tracer mass concentration of the coarse size fraction, $PM_{10(Tr)} - PM_{2.5(Tr)}$, is larger than the tracer mass concentration of the fine ($< PM_{2.5(Tr)}$) and submicrometric ($< PM_{1(Tr)}$) size fractions and the tracer mass concentration of intermodal size fraction ($PM_{2.5(Tr)} - PM_{1(Tr)}$) is limited.

The calculated ratios corresponding to tracers generally attributed to combustion related emissions (e.g. Ni, V) and transformations of gaseous species [3] are mostly characterized by higher values of $PM_{1(Tr)}/PM_{10(Tr)}$, $PM_{2.5(Tr)}/PM_{10(Tr)}$ ratios (i.e. >50%) and are displayed toward the top left of the triangular diagram. In this region, the tracer mass concentration of the fine and submicrometric size fractions is larger than the trace mass concentration of the coarse size fraction. The tracer mass concentration of intermodal size fraction can also contribute substantially to tracer mass concentration of fine size fraction ($PM_{1(Tr)}/PM_{2.5(Tr)} > 60\%$) and in some cases can be of comparable magnitude to the tracer mass concentration of coarse size fraction, in that $[PM_{2.5(Tr)}\text{-}PM_{1(Tr)}]/[PM_{10(Tr)} - PM_{1(Tr)}] \approx 50\%$.

The data corresponding to tracers with more than one characteristic source, such as K (interpreted as city dust, smelter emissions and biomass burning), Pb (attributed to vehicle exhaust and industrial related emission), SO_4^- (related to either secondary aerosols and long-range transport combined with NH_4^+ and NO_3^- or to combustion and industrial emissions combined with Ni and V [2]) may have very different places on the triangular diagram. This result may depend on the mix of the K, Pb and SO_4 emission sources. However, calculated ratios corresponding to these tracers are within the region of the triangular diagram characterized by values of $PM_{2.5(Tr)}/PM_{10(Tr)}$ ratios > 50%.

Therefore, by plotting the ratios between tracers mass concentration of PM_{10}, $PM_{2.5}$ and PM_1 on the triangular diagram, it is possible to group the tracers on the basis of their characteristic emission sources.

Keywords: PM, Tracer composition, Triangular diagram.

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POLYBROMINATED DIPHENYL ETHERS IN HUMAN BREAST MILK IN RELATION TO THE INDOOR ENVIRONMENT

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Polybrominated diphenyl ethers (PBDEs) are incorporated as flame retardant chemicals in consumer products such as electronics. However, these chemicals are able to leach out in the environment, resulting in human exposure through dermal absorption, and ingestion and inhalation of contaminated house dust. PBDEs have endocrine disrupting abilities and therefore are a possible source for disturbed child growth and behavioral development. PBDEs are lipophilic, accumulate in fatty tissues and are excreted in breast milk. Newborns are therefore especially at risk for exposure.

This study aims to determine the contribution of the indoor environment to the excretion of PBDEs in human breast milk.

Breast milk from 118 mothers from a Dutch birth cohort (LINC) was collected four to eight weeks after childbirth. Extraction was carried out using pressurized liquid extraction. Two non-destructive clean-ups steps were performed and the final extract was analyzed for PBDEs on gas chromatography coupled with high resolution mass spectrometry. Linear regression analyses were performed in a subset (N=40) to assess associations with the indoor environment.

PBDE concentrations of all congeners were found in human breast milk, although detection frequencies differed (N=118). BDE47 (mean=349.6 pg/g lw, standard deviation=584.3), BDE100 (83.5 (102.3)), BDE99 (138.7 (422.8)) and BDE153 (524.5 (247.6)) were detected in all samples. Detection percentages were respectively 97% for BDE28 (24.8 (38.4)), 56% for BDE183 (39.0 (31.7)), and under 50% for BDE66 (9.0 (10.0)), BDE154 (17.8 (27.0)) and BDE85 (18.7 (37.1)). BDE209 was only detected in 8% of the samples. Significant positive associations were found (N=40) between exposure to BDE28 and number of electronic devices (β=0.353 p=0.027), exposure to both BDE85 and BDE154 and size of the house (β=0.687 p=0.028; β=0.355 p=0.029). No associations were found for type of house and flooring.

We identified ten endocrine disrupting PBDE congeners in human milk, which may affect infant's health. We found positive associations for respectively the number of electronic devices and size of the house and certain congener levels. Further research needs to assess the effects of PBDE exposure through breast milk on behavioral development.

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REGIONAL MODELLING OF SAHARAN DUST IN THE CONTEXT OF RADIATIVE IMPACT AND ICE NUCLEATION

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Regional-scale models are useful tools to advance our understanding of processes involved in dust emission, transport and deposition, in addition to their essential role in forecasting dust storm occurrences. While the direct radiative effect of dust aerosol has been studied in detail in the past, the effects of dust on cloud properties, in particular on ice formation and the so-called semi-direct effect, has remain highly uncertain. A prerequisite of realistic simulation of dust events is the model's ability to realistically reproduce meteorological features that cause dust emissions. Atmospheric models with grid resolution of 3 km or less do not require parameterization of moist convection and are thus well suited to reproduce realistic wind events causing dust emission. However, such high model resolution cannot always be realised due to limited computer resources. In addition, soil properties in remote desert regions that are required as input parameters into dust emission routines embedded in transport models contain considerable uncertainties. A challenge lies in simulating the mineral composition of dust particles, which is of importance for describing their optical properties and efficiency as ice nuclei in the atmosphere. The regional model COSMO-MUSCAT is used to simulate dust concentrations during March and April 2014, when an exceptionally strong dust plume was transported from the Sahara over central Europe. The model computes emission, transport, dry and wet deposition of Saharan dust as well as the effect of dust radiative forcing on heating rates and ice nucleation, which in turn impacts stability and circulation patterns in regions affected by dust aerosol. The model results indicate that Saharan dust may impact on cloud and ice formation over central Europe.

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PM_1 MEASUREMENTS IN AGRI VALLEY – SOUTHERN ITALY: SOURCE CONTRIBUTIONS AND HEALTH RISK PRELIMINARY ASSESSMENT

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Particulate matter (PM) is one of the most challenging environmental issues due to its impact on air quality, human health and ecosystems [1] and for its important role in the global climate change [2]. The current interest of scientific and regulatory communities is moving to finer fractions - especially PM_1 (i.e, aerosol particles with an aerodynamic diameter less than 1.0 μm) - mainly due to their relevant implications on the human health.

As a consequence, the assessment of the PM_1 levels and chemical composition, the identification of its sources and the evaluation of the associated heath risks have become challenging issues, especially where significant anthropogenic sources, such as industrial plants, are located within a short distance away from urban centers.

In this view, a PM_1 sampling campaign has been performed in Agri Valley (Southern Italy) starting from December 2011. This is an area of international concern since it houses one of the largest European on-shore reservoir and the biggest crude oil pre-treatment plant (i.e., Centro Olio Val d'Agri – COVA) within an anthropized context. This plant involves several combustion processes emitting gaseous pollutants and particulate matter mainly in the fine and sub-micrometric size ranges which should represent a real problem for the surrounding environment, also posing health risks to the population living close to this plant [3]. In fact, several small towns (from 1700 to 5400 inhabitants) are located in the area surrounding the COVA.

During this campaign, daily PM_1 samples have been collected using a low volume (16.7 l min^{-1} flow rate) gravimetric sampler and their trace element content (e.g., Al, Be, Ca, Cd, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, P, Pb, Ti, S and Zn) has been determined by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) or Graphite Furnace Atomic Absorption Spectrometry (GFAAS).

Starting from the PM_1 chemical composition and by the integrated use of advanced statistical techniques, the main PM_1 emission sources have been identified. Moreover, a risk analysis has been performed in order to preliminary evaluate the possible occurrence of adverse human health effects posed by the inhalation of PM_1-bound trace elements measured in the area under study.

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EFFECT OF OPERATING CONDITIONS ON PM2.5 EMISSIONS DURING WOOD COMBUSTION IN DOMESTIC APPLIANCES HAVING HIGH ENVIRONMENTAL PERFORMANCE

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Although wood combustion is a renewable energy, it is well known that it is a source of fine particles ($PM_{2.5}$) and gaseous pollutants. In the last decade numerous studies were devoted to the evaluation of emission factors for gaseous compounds or PM from residential wood combustion appliances. Most of them have attempted to compare pollutant emissions as a function of the nature of the wood or the technology of the domestic heating appliances [1]. Investigations on the influence of the operating conditions of the devices and pollutants emissions are scarce.

Appliances used are an inset and a stove, both equipped with high technologies in order to optimize the combustion and decrease its environmental impact. Normative and realistic conditions of use, as well as different stages of operation (ignition load, normal, reduced or extended paces), nature of the flue (isolated or not) and depression (natural 35 Pa and imposed 12 Pa) were considered. Effect of all these parameters on $PM_{2.5}$ (in number), total suspended particles (TSP) (in mass) and gaseous compounds was evaluated.

Compared to normal pace, the ignition load generates concentrations in $PM_{2.5}$ and TSP in the fumes two and five times higher, respectively. It was shown that this rate of increase is independent of the operating conditions used, i.e. normative or realistic conditions. In contrary, the impact of the ignition load in CO and THC emission is more important in realistic conditions than in normative ones. Among the different parameters analysed during ignition and normal paces, it was shown that the most sensitive one, to particulate emissions, is the temperature of fumes. A linear relation between $PM_{2.5}$ concentration (p/Ncm^3) and the flue gas temperature was established while an exponential one is obtained for TSP (mg/Nm^3).

Reduced or extended paces are characterised by a progressively decrease of TSP and $PM_{2.5}$ emissions as a function of time.

Realisation, for three consecutive days, of a representative scenario of a real heating day at home allowed us to assess the daily average emission factors of pollutants in the fumes. The scenario is composed of an ignition load (~20min), followed by six normal phase (~40min each) and an extended one (4h).

Investigation on the contribution of the different daily operation conditions to the pollutant emissions reveals that the ignition load involved to a large extent in TSP emissions (20 to 30%). Normal paces are particularly responsible of NO (~45%) and $PM_{2.5}$ (40 to 60%) emissions. CO and THC are essentially emitted during the extended pace (75%).

This work was carried out in the framework of the ESPACE Bois project supported by the Agence De l'Environnement et de la Maitrise de l'Energie (ADEME).

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VOLCANIC ASH PLUME AND CLOUD TRAJECTORIES OF MOUNT ETNA WITHIN LAST TEN YEARS

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After one month of strombolian activity in the Voragine crater, the activity of Etna Volcano gradually increases at a very violent phase with lava fountains height of over one kilometre and ash injection up to 5-6 kilometres. The paroxysm of the eruption was between 03:20 and 04:10 UTC easily trackable on the satellite image as that provided by METEOSAT-8.

Although for Romanian airspace the volcanic ash hazard is not a common threat there is an existing possibility to experience such a menace as Eyjafjallajökull volcano demonstrated it in April-May 2010.

Therefore, the aim of this study is to evaluate the volcanic ash clouds dispersion provided by Etna eruptions since 2006.

The tools used are HYSPLIT Dispersion Model [1,2] and PlumeRise web-tool [3,4] to simulate trajectories and dispersion ash plumes for various situations as with or without wet/dry deposition. For the default values of the total mass ejected (those that are currently used from USGS archive) were used values obtained from the output of PlumeRise web-tool.

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HEALTH EFFECTS OF PARTICLES FROM BURNT BIOMASS TO LARGE URBAN AREAS

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The new global fire model SEVER-FIRE is a mechanistic model, which calculates number of human-induced and lightning fires as well as area burnt and carbon and particle emissions for both cases. The model operates at a daily time step and uses climate data (daily minimum/maximum temperature, daily precipitation/convective precipitation and daily short-wave radiation) as an input. The model works in interactive mode with a dynamic global vegetation model (DGVM), which provides fuel content and moisture and receives back amount of biomass burnt. SEVER-FIRE applies at a variable spatial resolution and for regional and global scale. This model was applied for simulation of wildfires near large urban areas at different continents.

We calculated smoke area and PM10 concentration for a case study of Indonesian fires of 1997 and Moscow fires of 2010 and found that the concentrations and exposure of population in Singapore (and Kuala Lumpur) were similar to the Moscow case. Using obtained extrapolations future projections of potential health risk in large cities due to aerosols emissions from wildfire for future climate change scenarios were estimated for such cities as Moscow, Los Angeles, Singapore, Kuala Lumpur and Sydney.

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TOWARDS THE QUANTIFICATION OF THE CONTRIBUTION OF FIRES TO THE NORTH AFRICAN DUST EMISSIONS

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Not only dust emissions from barren or unvegetated soil surfaces like deserts or uncultivated croplands are important sources of airborne mineral dust, also during fire events dust is entrained and appears to contribute noteworthy to the dust burden of the atmosphere. The underlying process, which drives dust entrainment during fires, is the so-called pyro-convection. High temperatures in the center of the fires result in an upward motion of the heated air. Subsequently, air flows towards the fire replacing the raising air. The resulting winds are able to mobilize soil and dust particles up to a size of several millimeters, depending of both the size and the strength of the fire. The particles are then mixed externally with the combustion aerosols into the convective updraft and were finally inject into altitudes up to several kilometers where they will be distributed and transported over long distances by the atmospheric circulation.

Several studies have shown that up to 80% of the mass fraction of the emitted particles during natural or prescribed fires is related to soil or dust particles [1, 2].

Here, we present a first estimate of fire-induced dust emissions for North Africa. In the first step, MODIS active fire and burned area products were analyzed and compared with MODIS land cover data in order to investigate the spatial-temporal distribution of frequently burned areas with regard to vegetation and land use. In the second step, observed atmospheric dust concentrations are linked to active fires. This includes the analysis of observation products like satellite- and ground-based measurements of the dust aerosol optical depth and their accordance with the fire activity in these regions.

Because of the high fraction of prescribed fires in North Africa (mainly during the cultivation season), pyro-convection must be considered as an important contribution to the non-natural dust burden of the atmosphere. As the quantity of dust emitted during fire events is still unclear, pyro-convection is a source of uncertainty in estimates of the aerosol-climate feedback, which requires further investigation.

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THE STRUCTURE OF ATMOSPHERIC BOUNDARY LAYER AND AIR POLLUTION IN ULAANBAATAR BETWEEN WARM AND COLD PERIODS

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Ulaanbaatar, the capital of Mongolia, has suffered a serious atmospheric pollution caused by airborne particulate matter in winter season for resent years. The air pollution in Ulaanbaatar represents a typical type of the urban atmospheric pollution, which is widely seen in developing countries. With the inadequate social infrastructure, the over-increased population caused by urban concentration brings the air pollution.

It is an important way to fix our eyes on the Atmospheric Boundary Layer (ABL) structure if we want to solve the problem of air pollution. However, there are quite few previous works that about Ulaanbaatar's air pollution using such a way. (Guttinkunda, 2007) (Nishikawa et al., 2011)

In this research we used AD-net LIDAR data, surface meteorological data, and radiosonde data to study on the ABL structure and air pollution in Ulaanbaatar between warm and cold periods. The LIDAR data and meteorological data were provided by National Institute for Environmental Studies, Japan (NIES) and Information and Research Institute of Meteorology, Hydrology and Environment of Mongolia. We chose October 2010 as a representative period in which the weather in Ulaanbaatar changes from the warm period to the cold one.

As the air temperature dropped down from the warm period to the cold one, the feature of ABL structure as well as the atmospheric environment near the surface significantly changed. During the first time that air temperature dropped from 15°C to about 0°C on 10 October, the airborne particulate matter was discharged in great volume (from 0.025~0.05mg/m^3) as citizens in Ulaanbaatar started heating. Then it came the second time of freezing on 21 October, which caused the lower temperature (above -15°C) and greater volume of airborne particulate matter (about 0.08mg/m^3). It was in this period that ABL came to be stable within the height of 300m, and the surface inversion layer started to present throughout the day and night.

The formation and domination of the surface Siberian High in this period straightly led to the decline of the temperature in October 2010. Finally after 26 October, under the absolute domination of Siberian High, the surface temperature in Ulaanbaatar kept under the line of -20°C and the daily average PM2.5 exceeded 0.05mg/m^3 almost every day throughout the whole wintertime.

As the effect of surface inversion layer, the airborne particulate matter concentrated at the low level of approximately 300 m or less above the ground, which increased PM2.5 during the last days of October. In Ulaanbaatar, there were non-spherical dust particles that always presented both in heating and non-heating periods in the urban area, which were mixed with spherical particles that indicate anthropogenic atmospheric pollution.

From 10 October to the end of this month, more than 3/4 of the wind blows in Ulaanbaatar was northerly or westerly, and the velocity is quite low (under 4m/s) throughout the whole month. There was a trend that the velocity of wind in October 2010 becomes greater in the morning, then reach a peak at about 14 LST, and decrease in the afternoon. Because of the Gel area, which is recognized as the main source of the air pollution, distributes mainly in the northwest, north and east of Ulaanbaatar City, it is suggested that the wind circulation in winter made the air pollutants concentrate in the urban area, as we known the air pollution.

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CHARACTERISTICS OF ASIAN DUST OBSERVED FROM 8-YEAR CALIPSO LIDAR MEASUREMENTS

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The Asian dust not only plays an important role in the radiative energy budget and hydrological cycle, but also is critical in global biogeochemical cycle. Knowledge of Asian dust aerosols in different source and long-range transport region is important for estimating their impacts on climate. In this study, we examines the vertical distribution, optical properties of Asian dust over the Taklamakan Desert, Gobi Desert and long-range transported regions using CALIPSO V3 aerosol layers, profiles, vertical feature mask, and cloud layers at a nominal resolution of 5 km along the track and covering a 6-year period from Dec, 2006 to Nov, 2014.

The results show that the Taklimakan and Gobi deserts are two major dust sources in East Asia with much more dust occurring in spring and summer, long-range transport mainly occurring in spring and winter. Vertical distribution of Optical properties of Asian dust aerosol indicate that much more irregular and larger dust aerosols near the surface. The average of dust particular depolarization ratio ranges from 0.25 to 0.35 at Taklamakan, Gobi and long-range transport region for different season. Dust optical properties diminish with distance from sources with different seasonal dependencies. They are indicative of a shift in aerosol bulk properties towards spherical and smaller particle types. Additionally, based on above threshold of layer depolarization ratio of dust and non-dust aerosol over different regions, we derived dust optical depth from CALIOP total backscatter, which is consistent to that from MISR at the Taklamakan desert where dust is dominating aerosol.

Keywords: Dust aerosol, Distribution, Ddepolarization ratio, Mass flux.

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EFFECTS OF STORNG WIND AND LAND SURFACE CONDITION ON DUST OUTBREAKS IN GOBI DESERT AND NORTHERN CHINA

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Gobi Desert and northern China are one of the main source regions for Asia Dust. Dust outbreaks that emitted from source regions have a widespread impact on dust events in the downwind regions, such as Japan and Korea. Dust outbreaks experienced inter-annual variations over the past decade. To clarify the recent trend of dust occurrence, the present study reports temporal and spatial characteristics of dust outbreaks in the Gobi Desert and northern China; and examined related factors of dust occurrence during springtime from 1999 to 2013.

During the study period, dust outbreaks occur the most frequently in the Gobi Desert and less frequently in the Loess Plateau, where the dry land surface is covered by sparse vegetation and snow. The occurrence of dust outbreaks is frequent in the years of 2000-2002 and 2006, and then significant decreasing in 2007-2013. Statistically significant correlations are found between dust outbreak frequency and strong wind frequency ($R=0.80$, $P<0.01$), and spring NDVI ($R=-0.67$, $P<0.01$). Thus, the inter-annual variations of dust outbreaks is primarily controlled by strong wind; while the occurrence of dust outbreaks can be suppressed by abundant spring vegetation. The effect of anthropogenic factors (e.g., grazing) on vegetation was discussed in Inner Mongolia. Results suggest that the expansion of fenced grassland areas and a stabilized condition of the cultivate areas and livestock population are related to the increased trend of NDVI, especially from 2007 to 2013, which induced the recent decline in dust outbreak frequency.

Acknowledgements: This study was supported by JSPS Core-to-Core Program (B. Asia-Africa Science Platforms).

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IONIC CHARACTERISTICS OF FINE PARTICLES AT A ROADSIDE SITE IN WUHAN, CHINA

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Wuhan is the capital of Hubei province, and is the most populous city in central China, with a residential population of 10,220,000 in 2013. Due to the high coal consumption, intensive steel manufacturing, and rapid motor vehicle growth, air quality in urban Wuhan is seriously deteriorated. However, research on air pollution is relatively scarce in Wuhan.

In this study, fine particles ($PM_{2.5}$) were collected on filters at a roadside site in Wuhan during March 2014 – January 2015, with around 10 samples collected in each month. After weighing the filter for mass concentrations, ions including Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}, Cl^-, NO_3^-, and SO_4^{2-} were determined by ion chromatography. During the sampling period, the overall average of mass concentration and standard deviation was 118.1±70.3 $\mu g \cdot m^{-3}$, which was higher than the 24-hour average standard value of 75 $\mu g \cdot m^{-3}$ as regulated in the Chinese National Ambient Air Quality Standard (GB3095-2013). In addition, the mean mass concentrations at this roadside site is slightly higher than the value of 106.5 $\mu g \cdot m^{-3}$ at an urban site and 114.9 $\mu g \cdot m^{-3}$ at a suburban site reported by the recently conducted monitoring campaign in Wuhan from August 2012 to July 2013, which indicated that the roadside environment was more polluted than non-roadside environment.

Total concentration of measured ions was 41.2±20.9$\mu g \cdot m^{-3}$, accounting for 34.9% of $PM_{2.5}$ mass. Among them, NH_4^+ (8.7±4.0 $\mu g \cdot m^{-3}$), NO_3^- (12.1±9.5 $\mu g \cdot m^{-3}$), and SO_4^{2-} (15.2±8.2 $\mu g \cdot m^{-3}$) were dominant, which accounted for 21%, 29%, and 37% of total ions measured, respectively. Estimation showed that they possibly existed in the form of $(NH_4)_2SO_4$ and NH_4NO_3. Concentrations differed greatly in different seasons, but seasonal variation pattern was not identical for different ions. Highest concentrations of NO_3^- and NH_4^+ occurred in winter and spring, respectively. On the other hand, SO_4^{2-} peaked in summer.

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ABRUPT CHANGE OF SANDSTORM FREQUENCY AND DUST OPTICAL PROPERTIES OVER CHINA ARID AND SEMI-ARID REGIONS

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Based on data of dust storm frequency of spring in Dunhuang, Minqin, Wuwei, Zhangye and Jingtai over China arid and semi-arid regions from 1958 to 2007, sliding t-Test and F-Test were used to search for possible abrupt changes in the mean value and get the intensity and reason of abrupt changes. The sliding t-test of abrupt changes in the mean value indicated that abrupt change frequency showed an increasing trend from the west to the east, so Jingtai got the higher abrupt change frequency; the abrupt increasing changes concentrated in the late 1960s and 1990s; the abrupt decreasing changes were found around 1983 and 2002; the intensity of abrupt increasing changes was higher than the abrupt decreasing changes. The sliding F-test indicated that the central-eastern Hexi Corridor has the much more decreasing changes test results of the frequency of dust storms in sprint by sliding t-Test and F-test. The abrupt changes of dust storm frequency in Hexi Corridor were closely linked with abrupt changes of surface wind speed, windy days, precipitation and average temperature. Furthermore, the optical properties of dust aerosol over Tengger Desert are analyzed. The results show that the extinction factor isn't very sensitive to extinction effect of huge dust particle, so that extinction method can retrieve better the spectrum distribution ranging from 0.1 to 5 um. The aerosol size distribution was very similar to a Junge distribution. In the dust weather, big dust particles ($0.1<r<1.0$ um) and huge dust particles ($r>1.0$um) remarkably increased, and its number concentration was lager than several magnitude that of in the clean weather.

Keywords: Dust storm, Abrupt change, Size distribution.

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PARTICULATE MATTER AND SO_X REMOVAL IN AN ELECTROSTATIC PRECIPITATAOR FOR MARINE DIESEL

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Diesel particulate matters (DPM), SOx in the exhaust gases emitted from marine diesel engines cause serious problems in human health and coastal environments. In 2008, to overcome this problem, the International Marine Organization (IMO) adopted the MARPOL 73/78 Convention Revised Annex VI [1]. The regulation typically requires the use of low-sulfur fuel to reduce the sulphate portion of PM emissions and SOx emissions. To reduce PM and SOx emissions, the Annex stipulates that the global sulphur fuel limit should be lowered to 3.5 % in 2012 and further down to 0.5 % in 2020 or 2025. Alternatively, it is also permitted to use an exhaust gas cleaning after-treatment system or similar machinery that can reduce emissions to the levels that should be achieved by using a low-sulfur fuel.

Seawater scrubbers [2] for reduction of DPM and SOx have begun to be installed on ships. However, there are still unsolved problems, such as the need for an extensive installation area on ships and a large amount of seawater. On the other hand, it is known that DPM includes Dry soot, sulphate and soluble organic fraction (SOF) [3]. Electrostatic precipitators (ESP) have been developed for the removal of DPM [4]. The reductions of DPM and SOx using plasma and chemical technologies have been investigated [5].

In this study, a novel DPM and SOx removal system for marine engines is proposed. Experiments were carried out to collect DPM by an electrostatic precipitator (ESP) and reduce SO_2 by corona discharge in the ESP and water condensation in a gas heat exchanger. The experimental system consists of a water-cooled 4-cycle diesel engine (DA-3100SS-IV, manufactured by Denyo Co., Ltd; cylinder volume, 400 cc; output, 5.5 kW), a heat exchanger and an ESP. In the experiment, Bunker A (ENEOS LSA fuel oil; sulphur content, 0.09 %) was used as a test fuel oil. The exhaust gas at a temperature of 180 ^oC was cooled to 20 ^oC using the gas heat exchanger, whereby mist particles were generated due to water condensation. The DPM concentrations, which were included dry soot and sulphate and SOF, were measured using a low volume air sampler, a soxhlet extraction and an ion chromatograph. SO_2 concentration was measured by an SO_2 monitor.

As a result, DPM collection efficiency in the ESP significantly improved due to increasing collection efficiencies for sulphate and SOF with decreasing the gas temperature. SO_2 removal efficiency increased with decreasing the gas temperature, and achieved approximately 20 % at 20 ^oC due to absorbing SO_2 into mist particles. Furthermore, SO_2 of 10% was removed by a corona discharge in the ESP, because SO_2 was converted into H_2SO_4 due to reactions with OH, O_3 and H_2O.

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NOTICE. THE NAMES OF SOME OF THE AUTHORS WERE NOT ERRONEOUSLY OMITTED BUT THEY WERE NOT AVAILABLE SINCE THEY HAD NOT BEEN INSERTED DURING THE ABSTRACT SUBMISSION PROCEDURE.