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III International Conference on Atmospheric Dust

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LIVING IN A WORLD OF DUST: AN INVESTIGATION OF OZONE UPTAKE ONTO TITANIUM MINERALS AND URBAN ROAD DUST

Maya Abou-Ghanem* (1), Zhihao Chen (1), Stephanie R. Schneider (2), Ming Lyu (1), Brett Wickware (1), Andrew J. Locock (3), Sarah A. Styler (1)

(1) Department of Chemistry, University of Alberta, (2) Department of Chemistry, University of Toronto, (3) Department of Earth and Atmospheric Sciences, University of Alberta

Each year, 1600 Tg of mineral dust is lifted into the atmosphere from arid regions [1]. Once aloft, mineral dust can undergo long-range transport to polluted urban areas, where it can affect air quality, health, and climate [2–4]. Dust serves as a site for adsorption and/or chemical reaction of trace gases, and can therefore alter the composition of our atmosphere [5]. Previous studies have shown that the uptake of gaseous pollutants onto mineral dust is enhanced upon illumination [6]. It is currently thought that semiconducting materials, including titanium and iron oxides, are responsible for the photoreactivity of dust [7]. This has led to the use of commercial titanium dioxide as a mineral dust proxy in studies of dust–pollutant photochemical interactions [8–10]. However, the reactivity of commercial titanium dioxide may not reflect that of naturally occurring titanium dioxide; moreover, titanium dioxide is not the only form of titanium that exists in mineral dust. Here, we present results from coated-wall flow tube studies of heterogeneous uptake of ozone onto a wide variety of titanium minerals. We find that the magnitude and time dependence of the photoenhanced uptake of ozone by titanium minerals display a strong substrate dependence, which highlights the importance of using natural minerals when investigating trace gas uptake.

Cities unaffected by desert dust emissions may still be affected by emissions of road dust, which contains not only crustal materials but also non-exhaust vehicular emissions, including particles from abrasion of brakes, tires, and roads [11]. Although many studies have investigated the composition and toxicity of road dust [11,12], no studies to date have investigated trace gas uptake onto road dust surfaces. Here, we discuss observations of ozone chemistry and photochemistry at the surface of road dust collected in Edmonton, Alberta. Our results show that road dust is more reactive toward ozone than is mineral dust. In addition, the reactivity of road dust is enhanced at elevated relative humidities. These results suggest that road dust chemistry has the potential to influence ozone concentrations in urban areas.

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THE EFFECT OF ATMOSPHERIC WEATHERING ON THE ICE NUCLEATING ABILITY OF K-FELDSPAR AND QUARTZ

Mike Adams* (1)

(1) University of Leeds, Institute of climate and atmospheric science

The formation of ice in supercooled water droplets in our atmosphere plays a central role in regulating important cloud properties such as cloud radiative properties and the generation of precipitation. While this process only becomes kinetically favourable at temperatures below -33C for cloud sized droplets (Herbert et al., 2015), certain particles, known as ice nucleating particles can catalyse the freezing process at much high temperatures (Murray et al., 2012). Globally, a component of mineral dusts, K-feldspar, has been shown to be an important source of Ice Nucleating Particles (INPs) around the world (Atkinson et al., 2013). While it is known that reactions of feldspar with acids modify its surface properties, the extent to which atmospheric processing of feldspars by common environmental acids (a process known as “weathering”) affects its ice nucleating abilities is largely unknown. Similarly, quartz has also been shown to be an effective INP (Harrison et al., 2016) and may compete with K-feldspar under certain circumstances such as when mineral dust is transported over a large distance and exposed to persistent atmospheric weathering, as quartz is expected to be less affected to weathering due to its relative chemical inertness. Given that large burden of mineral dusts in our atmosphere, understanding how this weathering process affects its ice nucleating abilities is of first order importance to improving our current knowledge of how mineral dusts contribute to the total INP loading around the globe (Vergara-Temprado et al., 2017).
In this study we show the effects of chemical weathering by sulphuric acid on the ice-nucleating activity of K-feldspar and Quartz. We further show the effects of different concentrations of acid and different time dependences with regards to the mixing of solution and acid.

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VARIABILITY AND CLIMATE IMPACTS OF NORTH AFRICAN DUST

Samuel Albani* (1), Natalie Mahowald (2)

(1) LSCE/IPSL, France, (2) Cornell University, USA

Modern observations and paleoclimate records offer the possibility of multiple, complementary views on the global dust cycle, and allow to validate and/or constrain the numerical representation of dust in climate and Earth system models. We present our results from a set of simulations with the Community Earth System Model for different climate states, including present and past climates such as the pre-industrial, the mid-Holocene and the Last Glacial Maximum. A set of simulations including a prognostic dust cycle was thoroughly compared with a wide set of present day observations from different platforms and regions, in order to realistically constrain the magnitude of dust load, surface concentration, deposition, optical properties, and particle size distributions. The magnitude of emissions for past climate regimes was constrained based on compilations of paleodust mass accumulation rates and size distributions, as well as based on information on dust provenance. The comparison with a parallel set of simulations without dust allows estimating the impacts of dust on surface climate. We analyze impacts of dust on the mean and variability of surface temperature and precipitation in each climate state, as well as the impacts that changing dust emissions had in climate transitions.

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A PALEODUST DATABASE FOR THE LAST GLACIAL-INTERGLACIAL CYCLE

Samuel Albani* (1), Gisela Winckler (2), Thomas Stevens (3), Yves Balkanski (1), Natalie Mahowald (4), Valter Maggi (5)

(1) LSCE/IPSL, France, (2) LDEO/Columbia University, USA, (3) Uppsala University, Sweden, (4) Cornell University, USA, (5) University of Milano-Bicocca, Italy

Changing climate conditions affect dust emissions and the global dust cycle, which in turn further affects climate and biogeochemistry.
Natural archives show that the dust cycle experienced considerable variability in the past in response to global and local climate change. The growing number of paleodust archives and the inclusion of the dust cycle in climate models has promoted synthesis efforts in the compilation of global dust data sets. In particular the DIRTMAP project formalized the compilation of dust mass accumulation rates, a quantitative metric that allows inter-comparison among different sites, among different kind of natural archives, and between models and paleodust observations.
We review our most recent efforts in reconstructing the past global dust cycle with model simulations and in the compilation of a paleodust database based on dust mass accumulation rates and particle size distributions for the Holocene. We also give a perspective on ongoing work aimed at providing adequate tools for paleoclimate model validation over the full last glacial-interglacial cycle, considering that the representation of the dust cycle will be an option in the upcoming PMIP4-CMIP6 experiments. We will analyze the potential to validate both time slices over key periods such as the mid-Holocene and the LGM, as well as rapid transitions such as the last deglaciation, and also in relation to other climate variable such as carbon dioxide, to address leads and lags in the climate system.

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ROAD DUST EMISSIONS: IMPACT ON AIR QUALITY AND HEALTH AND POSSIBLE MITIGATION

Fulvio Amato (1), Elio Padoan* (2)

(1) Institute of Environmental Assessment and Water Research (IDÆA) Spanish National Research Council (CSIC), (2) DI.S.A.F.A. - Chimica Agraria - Università degli Studi di Torino

Road dust is one of the main contributor to urban PM10 levels worldwide. Nowadays, about half of the traffic emissions has been calculated to derive from non-exhaust processes, such as road dust suspension due to vehicle-induced turbulence and wind. However, the attention of research has been focused mostly on motor exhaust emissions, limiting the actual knowledge on the impact of road dust both in terms of PM10 levels and health endpoints.
The health impact of road particles can be very different, as these particles can derive from diverse sources, such as wear processes of brakes, tires and road pavement, but also fugitive contributions from construction and roadside soils, plant materials and atmospheric deposition.
Moreover, the information on effective mitigation strategies to reduce air quality impact of road dust is scarce.
This talk will present an overview of the current knowledge on this field, and state-of-the-art methodologies to assess these knowledge gaps.

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DISTANCE-CONTROL GRAIN SIZES OF DUST RESULT IN DETERMINE SOIL PRODUCTIVITY AND IMPACT CIVILIZATION AROUND THE MEDITERRANEAN.

Rivka Amit* (1), Yehouda Enzel (2), Onn Crouvi (1)

(1) Geological Survey of Israel, (2) Institute of Earth Sciences, The Hebrew University of Jerusalem, Israel

Soils in the Mediterranean region are primarily controlled by incoming dust. Two main dust sources have been identified in this environment: (a) local regional dust derived mainly from abraded dune fields that contribute proximal coarse to medium silt, and (b) distal sources, bringing only fine silt and clays from thousands of kilometers away in Sahara and Arabia. This distance-dependent dust size have long term impacts on soil formation. We studied the silicate components in soils at similar geological positions on top of carbonate mountain terrain in Crete, Malta and across south to north transect in Israel, i.e. across isohyets of 100 mm to 800 mm. Soils developed on similar landforms, but are impacted only by distal fine dust without local coarse silt sources as in the Upper Galilee, Crete, and Malta are thin and shallow non- productive lithosols. In contrast, proximity to a distinct source of coarse silt, as dune fields, results in thicker accretion of soil profiles suitable for intensive agriculture. Contrary to expectations, thick soils and well developed profiles are located at the desert fringe zone at the semi-arid climatic region, whereas shallow, less developed soils are formed in more humid areas of the Mediterranean as the Upper Galilee or Crete. It was found that precipitation amount and rock weathering rates are not the main factors in the process of soil formation in Mediterranean carbonate terrains; accretion rates of incoming dust are. Moreover, the mountainous area in the eastern Mediterranean and in Mediterranean islands, without massive coarse silt (loess) influx, is practically bare of soils. This is not a matter of soil erosion or limited weathering, but of formation of cumulic soils controlled by the spatio-temporal distribution of silicate grain size and their influx rate. With no dune activity triggering massive loess formation and distribution it would not be able to define eastern Mediterranean as one of the civilization cradle - the “Land of Milk and Honey”.

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INDUST: INTERNATIONAL NETWORK TO ENCOURAGE THE USE OF MONITORING AND FORECASTING DUST PRODUCTS

Sara Basart (1), Slodoban Nickovic (2), Vassilis Amiridis (3), Pavla Dagsson-Waldhauserova (4), Hesham El-Askary (5), Isadora Christel (1), Adam Durant (6), Stelios Kazadzis (7), Lucia Mona* (8), Alexandra Monteiro (9), Anca Nemuc (10), Ina Tegen (11), Ana Vukovic (12), Bernadett Weinzierl (13), Gyorgy Varga (14), Enric Terradellas (15)

(1) Earth Sciences Department, Barcelona Supercomputing Center, BSC, Barcelona, Spain, (2) Republic Hydrometeorological Service of Serbia, Belgrade, Serbia, (3) National Observatory of Athens, Athens, Greece, (4) Agricultural University of Iceland, Reykjavik, Iceland, (5) University of Alexandria, Alexandria, Egypt, and Chapman University, USA, (6) Aeroanalytica Ltd., Cambridge, United Kingdom, (7) Physikalisch-Meteorologisches Observatorius Davos, World Radiation Center, Switzerland, (8) Instituto di Metodologie per l'Analisi Ambientale, Consiglio Nazionale delle Ricerche, Tito Scalo, Italy, (9) CESAM, University of Aveiro, Aveiro, Portugal, (10) National Institute of R&D for Optoelectronics, Bucharest, Romania, (11) Leibniz Institute for Tropospheric Research, Leipzig, Germany, (12) Faculty of Agriculture, Belgrade, Serbia, (13) University of Vienna, Vienna, Austria, (14) Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences, Hungary, (15) Spanish Meteorological Agency, AEMET, Barcelona, Spain

Sand and Dust Storms (SDS) are extreme meteorological phenomena that generate significant amounts of airborne mineral dust particles. SDS play a significant role in different aspects of weather, climate and atmospheric chemistry while they represent a serious hazard for life, health, property, environment and economy. Understanding, managing and mitigating the risks and effects of SDS requires fundamental and cross-disciplinary knowledge.
Over the last few years, numerical prediction and observational products from ground- and satellite platforms have become prominent at different research and operational weather centres as a result of growing interest from diverse stakeholders, such as solar energy plant managers, health professionals, aviation and policymakers. Current attempts to transfer tailored products to end-users are not coordinated, and the same technological and social obstacles are tackled individually by all different groups. The usage of data is therefore slow and expensive.
The EU-funded COST Action InDust has an overall objective to establish a network involving research institutions, service providers and potential end users on airborne dust information. Airborne dust transport has multi- and trans-disciplinary effects at local, regional and global scales; InDust involves a multidisciplinary group of international experts on aerosol measurements, regional aerosol modelling, stakeholders and social scientists. Moreover, InDust searches to coordinate and harmonise the process of transferring dust observation and prediction data to users as well as to assist the diverse socio-economic sectors affected by the presence of high concentrations of airborne mineral dust.
Cooperation with institutions from near-neighbouring and international partner countries in Northern Africa and the Middle East will be essential and of mutual benefit, because dust concentrations are markedly higher while the adverse effects more severe near the sources than far downwind. Moreover, the participation of South African, American and importantly Asian partners brings the possibility of extending the application of the developed products, protocols and tools well beyond the European borders, including areas like Asian regions where dust particles play a significant role in the air quality and meteorological processes.

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PHYSICAL AND CHEMICAL CHARACTERIZATION OF FINE AND ULTRAFINE PARTICULATE MATTER AT ROADSIDE IN DIFFERENT HIGHWAY ENVIRONMENT.

Asma Beji (1), Karine Deboudt* (2), Marc Fourmentin (2), Pascal Flament (2), Elena Maters (2), Salah Khardi (1), Bogdan Muresan (1)

(1) IFSTTAR, (2) ULCO/LPCA

Road traffic is one of the main causes of poor air quality in European cities. This is despite improvements in combustion engine technology, in-vehicle pollutant reduction systems, advanced power-train technologies, improved aerodynamics and development of alternative fuels. Based on today's technology advances, a future increasing use of electric and hybrid vehicles can reduce greenhouse gases, especially NOx and CO, in urban areas. The reduction of coarse (PM10) and fine (PM2.5) particulate matter will nevertheless be limited. This is due to the high contribution of non-exhaust emissions (e.g., dust from abrasion of brakes, tyres and roads) from overall road traffic including electric car fleet. In this context, our goal is to increase knowledge of the physico-chemical properties of non-exhaust particles (NEP) emitted by light-duty vehicles and identify the key parameters controlling these emissions. This is a challenging objective due to the wide variety of NEP and their interactions with ambient particles, as well as with gaseous pollutants, in the urban environment. For that reason, the size distribution, morphology and chemical composition of particles collected at roadside during a field campaign in March 2017 were determined by various techniques including Scanning Electron Microscopy associated with Energy Dispersive X-ray Spectrometry (SEM-EDX), Ionic Chromatography (IC) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS). The in-situ size distribution of atmospheric particles was also investigated by an optical particle counter and electrical mobility sizers (SMPS). This campaign was performed in different urban and suburban driving locations. Concentrations of PM at roadside were found to be well correlated to the loading of the local background, with a high contribution of sub-micrometer PM. On average, the mass-size distributions were bimodal, centered on 400 nm and 2 μm. Iron-containing particles were distributed among iron oxide particles coated with organic matter probably resulting from brake wear, and aluminosilicate particles enriched in calcium and iron induced by soil resuspension. Roadside particles were furthermore compared to particles collected in a controlled laboratory environment from isolated sources such as brakes, tyres and road wear. The expected results will contribute to the European Sustainability Agenda (regulation strategy), in particular the “Smart, green and integrated transport” priorities, which target objectives for air quality impact reduction aiming to accelerate the Vehicle Clean Innovations concept link to a green mobility.

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SEASONAL PATTERNS OF SAHARAN DUST DETECTED OVER THE CENTRAL MEDITERRANEAN BASIN, AT THE HIGH-ALTITUDE MONTE CURCIO GAW STATION

Mariantonia Bencardino* (1), Virginia Andreoli (1), Jessica Castagna (1, 2), Francesco D'Amore (1), Valentino Mannarino (1), Moretti Sacha (1, 3), Naccarato Attilio (1), Tassone Antonella (1, 4), Sprovieri Francesca (1), Pirrone Nicola (1)

(1) Institute of Atmospheric pollution Research (CNR-IIA), (2) Department of Physics, University of Calabria, Rende, Italy, (3) Department of Physics, UNICAL, Rende, Italy, (4) Department of Physics, UNICAL, Italy

The High-altitude Monte Curcio station is part of the Global Mercury Observations System (GMOS) as well as of the Global Atmospheric Watching (GAW) networks within which, since 2015, it produces quality controlled and high-temporal resolved data on atmospheric mercury, greenhouses gases and the physical-chemical properties of aerosols [1]. Located within the Sila National Park (39.2° N 16.2°E; 1780 m a.s.l.) the station is not influenced by local anthropogenic sources being instead able to intercept long-range transported air masses [2]. These last may include industrial pollutants from continental Europe, sea spray from the surrounding Mediterranean sea, volcanic ashes from the nearby Etna and Stromboli volcanoes as well as mineral dust from the Saharan desert. Among various atmospheric monitoring instruments, the station is equipped with the SWAM Dual Channel Monitor by which, based on the β-ray attenuation method, 24-h PM10 and PM2.5 samples were simultaneously collected. In total, about 300 samples have been gained, for both the finer and coarser size fractions of PM, and then analyzed by the thermo-optical method to quantify their Organic and Elemental Carbon concentrations (OC and EC). Starting from April 2016 until June 2017, an extensive and quite continuous data series on PM levels and its carbonaceous content was thus obtained for the first time at the most southern part of Italy as representative for the regional area of the central Mediterranean basin [3,4,5] . The new dataset together with the study of air-mass origin and the aerosol optical depth allowed to identify the occurrence of dust outbreaks and to assess their influence in terms of physical-chemical modification of PM. Over than 10% of our collected samples resulted to be affected by Saharan intrusions with a concurrently increase in PM levels, particularly relevant for the coarser aerosol fraction. Mean values of 5.6 ± 3.0 and 9.0 ± 6.0 μg/m3 were recorded over background conditions for PM2.5 and PM10, respectively, while the same reached the averaged levels of 13.7 ± 8.4 and 43.3 ± 32.4 μg/m3 in conjunction with dust outbreaks. A seasonal pattern was identified revealing the spring period like the one characterized by a major emphasis of Saharan intrusions in terms of both frequency and intensity, differently from the winter time during which not even a dust occurrence was observed. Synoptic and local wind fields were analyzed and discussed in terms of the observed PM seasonal variability. The availability of the carbon content provided insights about the possible association of OC to mineral dust contrarily to the EC component that was instead more influenced by wildfire events, widely occurred during summertime. The comparison of carbon species and their share between the fine and coarse PM fractions resulted useful in discriminating the prevailing sources at our monitoring station.

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PARTICLE-INDUCED OXIDATIVE DAMAGE FROM EXPOSURE TO AIRBORNE PM2.5 COMPONENTS IN THE VICINITY OF HONG KONG LANDFILLS

Kelly Ann BeruBe* (1), Timothy Peter Jones (2), Rachel Adams (3), Shelley-Ann Evans (3), Kin Fai Ho (4)

(1) School of Biosciences, Cardiff University, Museum Avenue, Cardiff, CF10 3AX, Wales, UK, (2) School of Earth and Ocean Sciences, Cardiff University, Main Building, Park Place, Cardiff, CF10 3AT, Wales, UK, (3) Cardiff School of Health Sciences, Cardiff Metropolitan University, Llandaff Campus, Western Avenue, Cardiff, CF5 2YB, Wales, UK, (4) The Jockey Club School of Public Health and Primary Care, Faculty of Medicine, Hong Kong, The Chinese University of Hong Kong, China

Landfills are an essential component of Hong Kong's waste management strategy. With a geographically small size and a large population it is inevitable that many residents will live proximal to landfill sites, and this has raised public concerns about landfill emissions causing low birth weights, cancer, neurological diseases, nausea, and hospitalization of diabetics. This project has collected, physico-chemically characterise, and determined the potential bioreactivity of landfill-derived PM2.5 particulates.

Many studies have demonstrated the health risks posed by landfill sites (Koshy et al., 2009), but unfortunately there is lack of investigation in the bioactivity of PM2.5 from municipal landfill sites in Hong Kong. This study has investigated the physicochemical characteristics of PM2.5 samples collected from locations near Municipal Solid Waste (MSW) landfill sites. We determined the oxidative stress of PM2.5 samples from their generation of reactive oxygen species. We determined the relationship between physical and chemical characteristics of PM2.5 and their bioreactivity from particles collected near to the landfill sites and in downwind urban sites.

Five sampling sites were selected for this study. Two sites adjacent to the landfill areas, Two urban sites in a mixture of residential and commercial areas, and one sampling site is in a remote area far removed from any anthropogenic activities. The PM2.5 samples were collected simultaneously at all sites with URG PM2.5 samplers. Wind and real-time PM2.5 monitors were installed at two locations in proximity to the landfill sites in order to determine diurnal variations of particulate level, wind speed and direction. Twenty-four hours integrated PM2.5 samples were collected in winter (December to March, 2014-15) and summer (July to November, 2015) in every 3 days intervals. Samples were weighed to a 1 μg precision for the mass concentration measurements. Field emission scanning electron microscope (FESEM) analysis was used for particle imaging. Total metal concentrations were analysed using inductively coupled plasma mass spectrometry (ICP-MS). Ion chromatography (IC) was employed for water-soluble inorganic ions analysis. Organic carbon (OC) and elemental carbon (EC) were analysed by thermal optical reflectance. Thermal desorption-gas chromatography-mass spectrometry (TD-GC/MS) was used for polycyclic aromatic hydrocarbons (PAHs) analysis. A plasmid scission assay (PSA) was used to determine the capability of each sample to induce plasmid DNA damage. Statistical analysis was performed using SPSS 21.0 software. The average PM2.5 concentrations were generally higher in winter than summer at all locations and significant differences between seasons were observed at the landfill sites. The average concentrations of most chemical species demonstrated summer minimum and winter maximum. The contributions of OC and EC in PM2.5 in winter are in a range of 17.2-29.1 and 4.4-5.0%, respectively. However, the contributions of OC is lower in summer. The NO3-, SO42- and NH4+ are the three most abundant inorganic ions, with sulphate contributed in a range of 6.6-42.3 % in PM2.5 in winter. The amount of damage to the plasmid DNA induced by PM2.5 varied in a range of 24-92 % and 27-96 % in winter and summer, respectively. The DNA damage in summer were higher than winter in all locations

High PM2.5 levels were observed during daytime downwind from landfills. Significant associations were observed between DNA damage and heavy metals/PAHs in summer. Emissions from landfill-related machinery are potential important particle sources. No significant associations were observed between DNA damage and landfill particles, which indicates that PM2.5 loading from other regional sources was an important factor for DNA damage.

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SUITABILITY OF THE LOW-COST SDS011 PARTICLE SENSOR FOR URBAN PM MONITORING

Matthias Budde* (1), Thomas Müller (2), Bernd Laquai (3), Norbert Streibl (3), Almuth D. Schwarz (4), Gregor Schindler (1), Till Riedel (1), Michael Beigl (1), Achim Dittler (4)

(1) Karlsruhe Institute of Technology (KIT), Pervasive Computing Systems / TECO, (2) Leibnitz Institute for Tropospheric Research (TROPOS), World Calibration Centre for Aerosol Physics (WCCAP), (3) Independent Researcher, (4) Karlsruhe Institute of Technology (KIT), Gas Particle Systems Group

In Particulate Matter (PM) monitoring, a paradigm shift towards incorporating distributed sensing approaches using low-cost sensors has begun [1]. In past research, early generations of low-cost particle sensors based on IR light scattering have been compared with official measurement stations, showing that these sensors can in principle capture the dynamics of ambient PM levels [2,3], but may suffer from low calibration stability [2], are unable to differentiate size classes [3], and may be susceptible to other sources of error [4]. Current low-cost sensor generations that rely on laser scattering claim to exhibit a better level of stability and feature internal digital processing in order to achieve more accurate results. While they are mostly designated as PM2.5 sensors, some also output values for PM10 and/or PM1.

As a representative of this class of sensors, we examine the SDS011 laser-scattering PM sensor [5]. It is already widely used in deployments around the world, e.g. in the German grassroots citizen science project “luftdaten.info” (http://www.luftdaten.info), in which volunteers have deployed hundreds of these sensors in urban areas. In previous work, co-location measurements between the SDS011 have already been performed [6], the results of which indicate that the sensor delivers adequate correlation under typical conditions (relative humidity of 20-50% and PM10 mass concentrations < 20 µg/m³) but performs less well under other ambient conditions, especially high humidity. To further explore the sensor's data quality in-depth, we present the key influencing factors on measurement uncertainty of the low-cost sensor, along with a series of experiments to appropriately assess its potential and limitations:

• Investigation of the humidity influence and possibilities for its compensation.
• Comparison of the SDS011 sensor and a Welas2100 monitor using monodisperse aerosol of different sizes.
• Characterization of the mass distributions the SDS011 can capture, based on experiments with different generated particle spectra and using the Grimm 1.108 aerosol spectrometer as reference.
• Longer-term comparison (days) of 13 SDS011 and a Scanning Mobility Particle Sizer (SMPS) exposed to (1) ambient air, (2) artificial aerosol (ammonium sulfate) levels, and (3) black carbon/soot.

From the results of these experiments, we present the causes of the sensor's measurement uncertainty in our talk. We show that the sensor generally does not capture PM10 satisfactorily and discuss under which conditions PM2.5 readings reflect the ambient air quality adequately.

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PROJECT SMARTAQNET: COMBINING EXISITING DATASETS AND A MOBILE MEASUREMENT STRATEGY INTO A SMART URBAN AIR QUALITY NETWORK

Matthias Budde* (1), Klaus Schäfer (2), Till Riedel (1), Josef Cyrys (3), Stefan Emeis (4), Thomas Gratza (5), Hans Grimm (6), Markus Hank (7), Stefan Hinterreiter (6), Marcel Köpke (1), Erik Petersen (8), Andreas Philipp (8), Johanna Redelstein (8), Johannes Riesterer (1), Jürgen Schnelle-Kreis (9), Duick Young (4), Volker Ziegler (7), Michael Beigl (1)

(1) Karlsruhe Institute of Technology (KIT), Pervasive Computing Systems / TECO, (2) Atmospheric Physics Consultant, (3) Helmholtz Zentrum München, German Research Center for Environmental Health - Helmholtz Zentrum München GmbH, Institute of Epidemiology II, (4) Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research, Department Atmospheric Environmental Research, (5) City of Augsburg, Environmental Agency (Umweltamt), (6) Aerosol Akademie e.V., (7) GRIMM Aerosol Technik Ainring GmbH & Co. KG, (8) University of Augsburg, Institute of Geography, Chair for Physical Geography and Quantitative Methods, (9) German Research Center for Environmental Health - Helmholtz Zentrum München GmbH, Cooperation Group of Comprehensive Molecular Analytics

Air quality and the associated subjective and health-related quality of life are among the important topics of urban life in our time. In the past years, a paradigm shift towards integrating mobile PM monitors to form distributed sensing networks has begun in air quality sensing [1]. In addition to new and promising measurement approaches, large-scale basic data is becoming available as well.This potentially enables the collection of fine-granular data and the development of information on causal chains.

The" SmartAQnet" research initiative [2] focuses on the subject of data access and data-based applications. Central to this is the development and utilization of partial, already existing (but not yet combined) data on the one hand and the collection and integration of relevant missing data on the other hand. This includes the integration of third-party sources and the development of novel measuring devices, as well as an improvement of the overall data quality and theidentification and implementation of meaningful interfaces between devices, databases and the end user. SmartAQnet creates a novel measurement and analysis concept within the model region of Augsburg, Germany. The project is funded by the German Federal Ministry of Transport and Digital Infrastructure (BMVI).
It connects open data, such as weather data or development plans, remote sensing of influencing factors, and new mobile measurement approaches, such as...

- distributed and/or participatory sensing with low-cost sensor technology (e.g. [3],[4]),
- so-called “scientific scouts” (newly developed autonomous, mobile smart dust measurement devices that are auto-calibrated to a high-quality reference instrument within an intelligent monitoring network) and
- demand-oriented measurements by light-weight UAVs

In addition to novel analytics, a prototypical technology stack is planned which, through modern analytics methods and Big Data and IoT technologies, enables application in a scalable way. On the data, new applications will be implemented. For this entire data-driven software chain, also new methods are explored. Specifically, these are big data analyses for quality improvement and model validation, as well as novel algorithms, e.g. for distributed calibration.

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A DECADE OF INFRARED DUST AEROSOL CHARACTERISTICS (AOD AND MEAN LAYER ALTITUDE) RETRIEVED DAILY FROM IASI

Virginie Capelle* (1), Alain Chédin (1), Marc Pondrom (1), Cyril Crevoisier (1), Raymond Armante (1), Laurent Crepeau (1), Noëlle Scott (1)

(1) CNRS/Ecole polytechnique

Aerosols represent one of the dominant uncertainties in radiative forcing, partly because of their very high spatiotemporal variability, a still insufficient knowledge of their microphysical and optical properties, or of their often complex vertical distribution. In this context, observations from space offer a good opportunity to follow, day by day and at high spatial and spectral resolution, dust evolution at global scale and over long time series. Currently, satellite remote sensing of aerosols is mostly based on radiance measurements in the visible; however observations in the infrared are a necessary complement to solar measurements. First of all, the two spectral domains are not sensitive to the same ranges of particle size: the coarse mode (>1 micron), typical of dust mineral aerosols, is preferentially observed in the infrared, whereas both coarse mode and fine mode (0.1–1 micron), also typical of pollution or fires, are observed in the visible, making distinction between the two modes difficult. Observations in the infrared also allow night-time measurements, necessary to constrain the diurnal cycle and therefore to correctly estimate the total amount of dust release in the atmosphere and can provide useful observations above bright surfaces such as desert, assuming a suitable treatment of surface properties. Finally, having channels sensitive to different levels of the atmosphere, infrared thermal sounders offer the possibility of determining the dust layer mean altitude. Moreover, a recent study (1) shows that over bright surfaces such as desert, absorption of longwave radiation emitted by Earth's surface is the determinant factor that controls the sign of the radiative imbalance at the top of the atmosphere.
In this study, a physical method based on offline computed Look-Up-Tables (LUTs) is used to retrieve 10 micron dust AOD and mean dust layer altitude from the Infrared Atmospheric Sounder Interferometer (IASI) observations from July 2007 to June 2017. The atmospheric state observed is retrieved in a first step and, in a second step, the 10 micron AOD, the aerosol layer mean altitude as well as the surface temperature are determined simultaneously. A particular attention has been given to the validation of the IASI-retrieved AOD through comparisons with the Spectral Deconvolution Algorithm (SDA) 500nm coarse mode AOD observed at 70 ground-based Aerosol RObotic NETwork (AERONET) sites. Comparisons between IASI aerosol mean layer altitude and the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) dust mean altitude for one year of data have also been carried out. Results of these comparisons will be presented here, as well as examples of intense dust events observed by IASI.

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ATMOSPHERIC PARTICLE MATTER-INDUCED DECAY OF PAINTINGS (SEMI)EXPOSED TO THE URBAN AIR OF GRANADA CITY (SPAIN)

Carolina Cardell* (1), Paloma Cariñanos (2), Maria Elena Pulido (3), Agustín Herrera (1), Natalia Navas (4), Guerra Isabel (5), Kerstin Elert (1), Csquero_Vera Juan Andrés (6), Lyamani Hassan (6), Titos Gloria (6), Alados-Arboleda Lucas (6), Olmo-Reyes Francisco José (6)

(1) Dept. Mineralogy and Petrology, Faculty of Science, Univ. Granada, 18071 Granada, Spain, (2) Dept. Botany, Campus Cartuja, Univ. Granada, 18071 Granada, Spain, (3) Dpt. Botany, Campus Cartuja, University of Granada, 18071 Granada, Spain, (4) Dept. Analytical Chemistry, and Biomedical Research Institute of Granada (IBIG), Univ. Granada, 18071 Granada, Spain, (5) Scientific Instrumentation Centre, Univ. Granada, 18071 Granada, Spain, (6) Dept. Applied Physics, Univ. Granada-Andalusian Institute Earth System Research (IISTA-CEAMA), Granada, Spain

At present, decay and related color change of painted cultural heritage exposed to polluted areas and cities is a social and economic issue of major concern, exacerbated by climate change. Consequently, preventive conservation of open-air paintings is becoming a major strategy to guarantee their long-term conservation. To this end, source identification and characterization of atmospheric particulate matter (APM) and its adverse impact on such outdoor-exposed artwork is being performed by researchers [1,2]. Much effort should be made to promote multidisciplinary investigations that shed light on the origin of APM (dust and biological material), related paint decay mechanisms and unaesthetic damage effects, since APM concentrations have increased considerably, and often exceed international air quality values in (sub)urban areas [3].

To explore these topics the Spanish government has funded (2012-18) two pioneering research projects (AERIMPACT-CGL2012-30729 and EXPOAIR-P12-FQM-1889) to evaluate the effects of polluted urban air (gases and APM) and climate change on color of outdoor historical paintings, and analyze interactions at the artwork-exposure interface. Here, paint dosimeters were long-term exposed in pilot monuments (different urban air scenarios) in the city of Granada (Spain). Field campaigns measured APM, black carbon (BC) and biological particulate matter (BPM), and accelerated aging tests (APM and gases) were done to relate field- and lab-aging tests. A multidisciplinary research team used an array of analytical techniques and strategies.

Paint dosimeters (pigment-binder binary mixture) were 3-years exposed at 8 pilot sites (ca. 2000 samples), including the Alhambra monumental complex. Their color changes, composition and textural features were periodically examined [4,5]. BC campaigns were done at a city center monument and at the Alhambra on a hill ca. 200m above downtown, to analyze different urban air scenarios and their impact on paint decay. BPM were also measured and their sources identified. Then, a novel study characterized the BPM (pollen grains mainly) deposited on paints, its affinity to paintings according to composition, and possible biodeterioration.

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URBAN DUST AND CENTRAL OHIO PRECIPITATION-AN UPDATE

Anne Carey* (1), Susan Welch (1), W. Berry Lyons (1)

(1) The Ohio State University

In an on-going study of urban dust and precipitation, we examine both the mineralogical and chemical composition of dry dust and the solubility of dust collected during a long-term study of the stable isotopic composition of precipitation in Columbus, Ohio, the 14th 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. Dry dust collection and analysis occurred during 2018, and rain and snow were collected over a five-year period during 2014-2018 and analyzed for major cations (Na+, Ca2+, Mg2+, K+) and anions (Cl- and SO42-) by ion chromatography. SEM analysis of dust shows a complex mixture of inorganic and biogenic materials ranging in size from submicron to 100s of microns. Inorganic particles in dust were frequently embedded in a larger organic matrix. Shale particles observed are composed of micron-sized illite-muscovite, quartz and pyrite. Etched texture of particles in wet deposition indicates preferential dissolution of carbonates. Dissolved chloride concentrations in precipitation are low, ranging from <1 μM L-1 to 550 μM L-1, and are not correlated to the total Ca2+ whose concentrations ranged 1-280 μM L-1. Cation concentrations were corrected for seawater aerosol contribution using the chloride data. Soluble, sea salt-corrected Ca2+concentrations ranged from 1.3 to 280 μM L-1 and demonstrated a strong positive correlation to the time elapsed since the antecedent precipitation event. It remains unclear whether the soluble calcium in wet deposition 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 Ca2+ deposition to the Midwestern US between 1994 and 2010[1]. Possible calcium sources include sea-salt aerosols, forest fires, industrial emissions, wind erosion of soils, and the weathering of Ca-bearing minerals. This latter source is deemed most likely due to the carbonate bedrock underlying the local environment. SEM analysis of dry-deposition collected separately from precipitation is used to determine mineralogy of dust input to our samples and the possible source of the dissolved calcium observed.

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THE ATMOSPHERIC IMPACT OF VOLCANIC ACTIVITIES IN THE MEDITERRANEAN SEA INVESTIGATED DURING A MEASUREMENTS CRUISE CAMPAIGN

Jessica Castagna (1, 2), Mariantonia Bencardino* (1), Marcella Capua (2, 3), Francesco D'Amore (1), Giulio Esposito (1), Valentino Mannarino (1), Sacha Moretti (1, 2), Attilio Naccarato (1), Jenny Orbe (2, 4), Antonella Tassone (1, 2), Francesca Sprovieri (1), Nicola Pirrone (1)

(1) Institute of Atmospheric Pollution Research (CNR-IIA), (2) Department of Physics, University of Calabria, Rende, Italy, (3) Istituto Nazionale di Fisica Nucleare (INFN), Cosenza, Italy, (4) Facultad de Ciencias - Escuela Superior Politécnica de Chimborazo

The Mediterranean Sea is a geologically young area with structures tectonically active, where the emissions from numerous volcanic activities are influencing the ecosystem. Moreover, the volcanic ashes and the gases emissions are troubling also for the human health, causing problems going from cancers until the people deaths at very high concentrations [1,2]. The goal of the measurements cruise campaign "Minerva 2017", organized by the Institute of Atmospheric Pollution of the National Research Council (CNR-IIA), was to investigate in a unique expedition the natural influence of several active volcanoes present in the Mediterranean Sea. The route of the campaign, which was performed aboard the Research Vessel "Minerva Uno" during the summer of 2017 (18th of August to 7th of September), included some marine sampling stations near to volcanoes, as well as, the Mount Etna (Sicily, South Italy), Stromboli and Vulcano belonging to the volcanic archipelago of the Aeolian Islands (Italy), and near to the Solfataras of the Phlegraean Fields (near to Naples, Italy). During the campaign, the Particulate Matter was sampled as Total Particulate Matter (TPM) and into two different size fractions, PM2.5 and PM10, collecting them on quartz filters through the Echo PM - Instruments (Tecora). The filters had been conditioned at 50% RH and 25°C for 24 hours before and after sampling, hence the gravimetric mass was deduced. The mean values recorded for PM2.5, PM10, and TPM, were respectively 11.4 ± 3.1 μg m-3, 17.5 ± 5.1 μg m-3, 21.6 ± 5.7 μg m-3. Moreover, the measurements of radioactivity were performed by the SM200 AB (OPSIS) which, by the beta mass technique, provided the information about the beta-emitter radon daughters [3]. The radon, a natural gas released by the crustal surface and magmas, has been considered like a geochemical tracer indicating that the source of the monitored air masses were the volcano and/or the land [4,5]. This cruise campaign has been also useful to perform preliminary studies on the possibility to include in our research measurements, in samples of air and marine water, of radon concentration of activity as a function of various marine, geological and environmental parameters. Furthermore, to better establish the volcanic source, the behavior of chemical gases (O3, NOx, and SO2) and meteorological parameters had been jointly discussed, highlighting the SO2 which, among the others, represents a marker for volcanoes [6].

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ELEMENTAL CHARACTERIZATION OF PM2.5 AND PM10-2.5 IN DENSE TRAFFIC AREAS IN TORONTO AND VANCOUVER, CANADA

VALBONA CELO (1), EWA DABEK-ZLOTORZYNSKA* (1)

(1) Analysis and Air Quality Section, Air Quality Research Division, Environment and Climate Change Canada, 335 River Road, Ottawa, ON K1A0H3, Canada

Road traffic is known to make a large contribution to emissions and chemical composition of total particulate matter (PM). Elevated concentrations of metals in urban areas and exposure to PM from vehicular emissions has been demonstrated to have detrimental impacts on human health. PM emissions from road vehicles include emissions from the tailpipe and emissions due to wear and tear of vehicles parts, such as brakes, tires and clutch, and re-suspension of dust [1]. This results in elevated metal concentrations, which can pose an important risk to human health.
In this study, we report the elemental composition of PM2.5 and PM10-2.5 collected at near-road monitoring stations in Toronto and Vancouver. The 24-hour integrated PM samples were collected every third day from July 2015 to December 2016 following the procedures used in the National Air Pollution Surveillance program. Data at these locations were compared to the nearby urban background sites. Additionally, the water solubility of PM2.5-bound metals, a surrogate for bioavailability, was studied. The major sources of trace elements identified by factor analysis are also presented.

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TOTAL SUSPENDED PARTICULATES MASS CONCENTRATION IN A SUBURBAN AREA IN BARBADOS

Rebecca Chewitt-Lucas* (1), Andrea Sealy (1)

(1) Caribbean Institute for Meteorology and Hydrology

Air quality in the Caribbean is greatly impacted by Saharan Dust all year round. While the quantitative impact of Saharan Dust on the health of the region is inconclusive at this time, some studies have indicated strong links between Saharan Dust and human health. Saharan dust significantly impacts the PM2.5 and PM10 concentrations in the Eastern Caribbean and could possibly impact the concentration of Total Suspended Particulates (TSP). The Caribbean region has developed industrially and economically over the last fifty years, thus TSP sources from anthropogenic activities would also impact TSP concentration.

During the summers of 2015, 2016 and 2017, TSP samples were collected at the Caribbean Institute for Meteorology and Hydrology (CIMH), Husbands, St. James Barbados situated in a suburb of the capital city Bridgetown. Daily mass concentrations measured ranged from 6 to 316 µg m-3 in 2015, 3 to 1094 µg m-3 in 2016 and 32 to 1781 µg m-3 in 2017 with some of the daily TSP concentrations measured over the three sampling periods exceeding the United States Environmental Protection Agency (260 µg m-3) and World Health Organisation (120 µg m-3) 24-hour mean guidelines.

Examination of the Saharan Air Layer (SAL) and the summer sampling periods indicates: (i) Summer 2015 TSP concentrations and SAL levels were generally low; (ii) Summer 2016 TSP concentrations were high while SAL levels were relatively low and (iii) Summer 2017 TSP concentrations were very high for most of the sampling period while SAL levels were generally low. The objective of this study is to further examine if there is a correlation between the TSP concentrations, the daily meteorological parameters, the Saharan Dust transport over the region and possible local sources.

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MULTIDECADAL VARIABILITY OF DUST SOURCES, TRANSPORT, AND DEPOSITION: EVIDENCE FROM OBSERVATIONS AND ANALYSIS WITH A GLOBAL MODEL

Mian Chin* (1), Bian Huisheng (2, 3), Kim Dongchul (4), Yu Hongbin (1)

(1) NASA GSFC, (2) NASA Goddard Space Fligth Center, (3) NASA GSFC/UMBC JCET, (4) NASA GSFC/USRA

We present an analysis of changes of dust aerosols over major dust source regions in Africa (Sahara, Sahel) and Asia (Middle East, Central/South/East Asia) and trends of dust transport/deposition from the source to neighboring oceans and downwind continents from 1995 to 2015. We use several satellite data (SeaWiFS, MISR, MODIS, POLDER, CALIOP) and simulations from the NASA GEOS-5/GOCART model to examine the dust aerosol variability and to understand the key parameters determining the emission strengths, transport efficiency, and deposition amount. We will also assess the possible effects of climate variability on the change of dust loading and deposition, which is indicated by the changes of sea surface temperature, precipitation, land cover, wind strength, and atmospheric circulation. We will also discuss the implications.

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VERTICAL VARIATION OF BLACK CARBON AND BROWN CARBON IN BANGKOK AEROSOL

Parkpoom Choomanee* (1, 2), Thunyapat Thongyen (3), Surat Bualert (1, 2), Wladyslaw W. Szymanski (4), Thitima Rungratanaubon (1), Narita Fakkeaw (1, 2), Juthapas Saiohai (1, 2)

(1) Department of Environmental Science, Faculty of Environment, Kasetsart University, Thailand, (2) The Monitoring of Microclimate and Air Pollution in Thailand Project, Kasetsart University, Thailand, (3) Department of Environmental Technology and Management, Faculty of Environment, Kasetsart University, Thailand, (4) Faculty of Physics, University of Vienna, Austria

Black carbon (BC) and brown carbon (BrC) are most important light absorbing species in atmospheric aerosols. Rather recently BrC (light-absorbing organic carbon) attracts increasing interest as a possible substantial contributor together with BC to radiative transfer and climatic effects [1,2]. Of particular interest is the strong absorptivity of BrC in ultraviolet wavelengths. However, in many climate models, organic particulates are still considered as only light scattering aerosols. This is mainly due to a rather limited experimental data.

Consequently, this research aims to study vertical variation of BC and BrC concentrations at different highs and seasons in Bangkok, Thailand. Particulate matter (PM10) was collected by area dust monitor (Mod. ADR1500) at heights level above ground 30, 75 and 110 m at the Microclimate and Air Pollutants Monitoring tower at the Kasetsart University (KU) (Latitude: 13.854529N, Longitude: 100.570012E). Multiple measurements during various seasons at daytime and nighttime in 2016 were performed. The samples were analyzed by Magee Scientific Sootscan (Mod. OT21), which uses optical transmittance method at two wavelengths: 880 and 370 nm. Analysis of data shows that the annual average values of BC at the observation height of 30, 75 and 110 m were 1.72±0.56, 1.68±0.47 and 1.59±0.38 µg.m-3, respectively. BrC concentrations at the observation height of 30, 75 and 110 m were 13.89±5.89, 17.84±6.31 and 13.22±4.66 µg.m-3, respectively. The concentrations of BC and BrC were found to decrease with altitude, and follow the trend: winter > summer > monsoon. In the monsoon season, BC and BrC value were rather low due to the washout by rainfall. The highest concentrations were observed in winter season also due to typically lower boundary depth. The seasonal dependence of BC and BrC concentrations are influenced by seasonal variation in emission intensities and meteorological factors. The main sources of BC and BrC were likely from traffic and biomass burning. The preliminary results of this study indicate that they can utilized as a guideline for control and management of BC and BrC in Bangkok aerosol and could contribute an input to optical aerosol models.

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TRANS-ATLANTIC DUST OBSERVED FROM NOAA JPSS ENTERPRISE AEROSOL DETECTION PRODUCT

Pubu Ciren* (1), Shobha Kondragunta (2)

(1) IMSG & NOAA/NESDIS/STAR, (2) NOAA/NESDIS/STAR

Dust influences weather and climate, air quality, hydrological cycle, and ecosystems. To understand these effects, monitoring its global distribution routinely including sources and transport is crucial. Remote sensing from space provides an unprecedented capability to monitor the spatial and temporal variability of dust. NOAA Joint Polar Satellite System (JPSS) Enterprise Processing System (EPS) aerosol detection algorithm was developed to detect aerosol type including dust based on the distinct spectral signature of dust in both deep-blue and IR wavelengths. The JPSS aerosol detection algorithm has been applied to VIIRS observations on-board Suomi National Polar Partnership (NPP) since 2011 and will be applied to VIIRS observations on-board recently launched NOAA-20. In this paper, we present the characteristics of temporal and spatial distribution of the transatlantic dust derived from the NOAA-20 Aerosol Detection Product (ADP). Comparisons of correlative measurements from other satellites such as MISR, OMI and CALIOP will be presented to demonstrate that the probability of correct dust detection is ~80%. Additionally, the potential for dust detection product to quantify transatlantic dust transport will be presented.

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EFFECT OF BIOSECURITY PROCEDURES ON DUST LEVELS IN PIG FARMS

Costa Annamaria* (1), F.M. Tangorra (1), S. Nava (1), M. Lazzari (1)

(1) Department of Health, Animal Science and Food Safety (VESPA), Faculty of Veterinary Medicine, Università degli Studi di Milano, via Celoria 10, 20133 Milan, Italy

Pollutants in animal facilities are mainly dust, ammonia and greenhouse gasses. They originate from animals and manure. Bio-aerosols in animal houses are emitted in considerable quantities into the environment by ventilation systems and consequently can also affect the respiratory health of people living close to livestock enterprises (IPCC, 2000). Pollutants levels in animal houses are variable and depends mostly on the species, its behavior (Costa, 2009; Costa et al., 2017), stocking density, feeding and littering strategies, and climate conditions inside the barn (Liao et al., 2001). Dust can derive from feed (mostly by dry feed), from manure that can be re-suspended by ventilation and by animals walking on the dirty floor.
The aim of this study was to compare the concentrations and emissions of PM10 in two identical farrowing rooms, classified as BAT, evaluating the efficacy of the biosecurity procedure applied.
The farrowing rooms measure 10.95 m per 17.30 m. The rooms are mechanically ventilated through a control system (FANCOM) based on a free running impeller, for continuous, real-time monitoring of the ventilation rate. Air entered from the roof through a pierced PVC ceiling, two exhaust chimneys guarantee air exchanges (7666 m3 h-1 and 7566 m3 h-1). Thirty sows were housed from 3 to 6 days before farrowing to 21 days after delivery. Each sow was assigned 12 piglets after parturition. The measurements were taken for 27 days totally for two farrowing cycles, from the entrance of sows in the room to the piglets' displacement to the weaning room.
One of the farrowing room was not washed after the end of the production cycle, the other one was completely washed, as the pit (both rooms are equipped with vacuum system) according the biosecurity protocol usually applied in the farm. During the trial, dust was measured through a GRIMM Portable Laser Aerosol Spectrometer Model Mini-LAS 11-R. Swab samples were performed on a weekly basis, on 7 points in each room to evaluate airborne bacteria as potential piglets mortality causes. The sanitary status of sows and piglets was evaluated by the vet.
Data were processed through variance analysis (Proc GLM, SAS 9.2 2017) to test the biosecurity procedure effect on dust concentration and emission considering all the recorded variables (temperature, humidity, ventilation rate). A correlation procedure (Proc CORR, SAS 9.2 2017) was performed to evaluate the interdependence between the considered variables.
Environmental quality in the two rooms resulted significantly affected by the biosecurity procedure in agreement with Costa et al.(2014) and Hernandez et al. (2000), for dust concentrations (108 µg/m3 vs 321 µg/m3, $P<0.001$) and emissions (13 mg h-1 animal-1 vs 31 mg h-1 animal-1; $P<0.01$) relative humidity affected dust concentration that resulted inversely related to ventilation rate ($r=0,37$, $P<0.01$). No differences in airborne bacteria were detected in the two rooms, the higher mortality rate of piglets in the untreated room (+4 %) room was caused by the infection of Clostridium perfringens, probably for the unremoved manure from the cages during the production cycles.

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CONTRIBUTION OF A BURNED FIELD TO THE AEOLIAN DUST IN PATAGONIA

Augusto Crespi-Abril* (1, 2), Antonella De Cian (2), Gaspar Soria (1), Rodrigo Gonçalves (1), Elena Barbieri (1), Flavio Paparazzo (1), Claudio Lóppez-Moreno (3)

(1) Laboratorio de Oceanografía Biológica (LOBio). Centro para el Estudio de los Sistemas Marinos (CESIMAR-CENPAT-CONICET), (2) Universidad Nacional de la Patagonia San Juan Bosco, (3) Laboratorio de Gestión Ambiental. ALUAR Aluminio Argentino S.A.I.C.

Fire activity in the Patagonian region of Argentina (39ºS-45ºS) is frequent in summer due to the high temperatures and dry weather. In the northern region of Patagonia (742º20'S – 65ºW) a fire took place on December 22nd 2015 and continued for four days. In this period, at least 40 thousand hectares were burned. The diminution of vegetation coverage after this fire exposed the soil to aeolian erosion and particles removed were transported long distances to the Argentinean shelf. The aim of this research is to estimate the dust deposition in a burned region in Patagonia, to study its temporal evolution, and to analyze the elemental composition of dust particles. Four passive collectors were installed in the burned region and four on a control (unburned) region in January 8th 2016 and were monitored during a complete year. Collected dust was carefully removed from the collector monthly and was weighted on the laboratory using an analytical scale (precision 0.001 mg). A sample of dust was collected and analyzed using Energy-dispersive X-ray spectroscopy mounted on a Scanning Electron Microscope to determine the elemental composition. The deposition rate in the burned region decreased from February to May (from 73 to 12 mg /day, respectively), afterward the values remained constant around 10 mg/day. The deposition rate in the control region was significantly lower (0.19 mg/day) and remained constant throughout the year. The elemental composition of the collected dust was mainly Si and O both in burned and control region. However, a peak of C was detected in the burned region but not in the control region. These results show that the burned region in Patagonia represents a source that emits a significant amount dust due to the reduced vegetation coverage. Also, this region represents an input of carbon to the sea that would affect the marine productivity.

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DUST CONCENTRATION IN THE PATAGONIAN SHELF (ARGENTINA).

Augusto Crespi-Abril* (1, 2), Antonella De Cian (2), Gaspar Soria (1), Rodrigo Gonçalves (1), Elena Barbieri (1), Flavio Aparazzo (1), Claudio López-Moreno (3)

(1) Laboratorio de Oceanografía Biológica (LOBio). Centro para el Estudio de los Sistemas Marinos (CESIMAR-CENPAT-CONICET), (2) Universidad Nacional de la Patagonia San Juan Bosco, (3) Laboratorio de Gestión Ambiental. ALUAR Aluminio Argentino S.A.I.C.

Patagonia is the major source of aeolian dust into the southern part of the Atlantic Ocean and Argentinean shelf. However, few measurements of dust concentration were conducted over the ocean in these regions. The objective of this study is to analyze the spatial distribution of dust concentration over the Argentinean continental shelf on the northern Patagonia (43ºS-48ºS). Dust concentration was measured on 74 stations on an oceanographic survey conducted on board of the O/V Puerto Deseado between October 28 and November 8 of 2017. Measurements were conducted with a particle counter (PCE-PCO 1) and the concentration (number of particles per liter of air: p/l) was estimated in six classes of particle sizes: 0.3um, 0.5um, 1.0um, 2.5um, 5.0um and 10um. Additionally, complementary data of relative humidity and air temperature were measured. Particle concentrations varied inversely of particles sizes: the highest concentration was observed for smaller particles and the lowest concentration was observed for higher particles (mean concentration for 0.3um: 18500 p/l; 0.5um: 7030 p/l; 1.0um: 1750 p/l; 2.5um: 390 p/l; 5.0um: 80 p/l; 10um: 44 p/l). Regarding the spatial distribution, the highest concentration of particles was measured in the southern part of the studied area, between 46ºS and 48ºS, while the lowest concentration was measured in the northern part between 43º30’S and 45ºS. Based on these results, the southern part contributed with more dust particles to the Argentinean shelf than the northern part.

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THE ROLE OF DUST IN MODULATING MONSOON DYNAMICS IN MPI-ESM

D'Agostino Roberta* (1), Egerer Sabine (1), Niemeier Ulrike (1), Bader Juergen (1), Jungclaus Johann (1)

(1) Max Planck Institute for Meteorology

The mid-Holocene (ca. 6,000 years ago) is a climate period, in which the change of the orbital conditions determined more summer insolation in the Northern Hemisphere than present-day. This had lead to a dramatic change in the vegetation cover, especially in North Africa and a strengthening of the West African Monsoon (WAM). During the mid-Holocene, the Sahara was covered mainly by grassland and savanna and this resulted also in a drastic reduction of the Saharan dust load. However, model experiments are unable to fully reproduce the actual strengthening and expansion of the WAM in the mid-Holocene if they do not account simultaneously for vegetation change and dust reduction. While many modelling groups have integrated interactive dynamic vegetation in different earth system models (ESMs), the dust cycle is computationally extremely expensive for paleo-simulations. Dust reduction can be, however, prescribed in ESMs. Here, we present preliminary results from two different simulations performed with the Max Planck Institute ESM (the MPI-ESM). In the first simulation, the dust has been prescribed by reducing the pre-industrial aerosol optical depth by 80% over the Sahara. In the second simulation, we prescribed the dust using the mid-Holocene resulting dust field obtained by an interactive dust simulation made by ECHAM6 (the atmospheric model of the MPI-ESM) coupled with HAM module for aerosols. This hybrid solution avoids the high computational cost of an interactive dust paleo simulation and at the same time, uses a more reliable dust pattern than the pre-industrial. The comparison of the simulated WAM changes with reconstructions based on proxy data provides an indication on the importance of including interactive dust in paleo-simulations.

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COMPREHENSIVE CHEMICAL COMPOSITION OF PM2.5 AND ASSOCIATED GASEOUS POLLUTANTS AT NEAR ROADWAYS AND URBAN BACKGROUND SITES: A CASE STUDY OF TORONTO AND VANCOUVER

Ewa Dabek-Zlotorzynska* (1), Valbona Celo (1), Luyi Ding (1), Michal Suski (1)

(1) Analysis and Air Quality Section, Air Quality Research Division, Environment and Climate Change Canada, 335 River Road, Ottawa, ON K1A0H3, Canada

A growing number of health studies identifying adverse health effects for populations spending significant amounts of time near large roadways has increased the interest in monitoring air quality in this microenvironment. Emissions due to road traffic are known to make a large contribution to particulate matter (PM) concentrations in urban areas arising from multiple vehicle-related processes, including both exhaust and non-exhaust (abrasion and re-suspension) sources. Thus, understanding long-term, temporal and spatial variability and levels of PM and its chemical composition in the near-road environment is important to researchers and decision-makers evaluating exposures and risks for near-road populations; identifying locations for future near-road monitoring sites; and determining the viability and effectiveness of mitigation strategies.
This work will focus on the assessment of the chemical composition of fine PM (particles <2.5 μm in diameter; PM2.5) from a study conducted near roadways in Toronto and Vancouver over a 2 year period (July 2015-March 2017). In Toronto, two near-road monitoring stations were established, one beside a major arterial road in downtown and the second beside Highway 401. The Vancouver near-road monitoring station was selected based on the high traffic volume experienced, the truck route designation of the roadway and dense population of the surrounding neighborhood. The 24-hour integrated samples were concurrently collected at the roadside and the nearby urban background sites following the procedures used in the National Air Pollution Surveillance program.
Measured chemical components included inorganic and organic ions, total and water-soluble elements, carbonaceous compounds (OC, EC, biomass burning markers), and gas-phase species (HONO, HNO3, SO2 and NH3). Differences between near roadway and background urban sites were identified by evaluating temporal and spatial variations in the measured pollutants. Chemical mass reconstruction was evaluated to determine the relative contributions of different compound classes to PM2.5 mass during the sampling period

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CHEMICAL AND OPTICAL PROPERTIES OF VOLCANIC ASHES: LABORATORY MEASUREMENTS AND REMOTE SENSING APPLICATIONS.

Alexandre Deguine* (1, 2), Denis Petitprez (2), Lieven Clarisse (3), Hervé Herbin (1)

(1) Univ. Lille, CNRS, UMR8518 - LOA – Laboratoire d'Optique Atmosphérique, F-59000 Lille, France., (2) Univ. Lille, CNRS, UMR 8522 - PC2A - Physicochimie des Processus de Combustion et de l'Atmosphère, F-59000 Lille, France., (3) Laboratoire de Chimie Quantique et Photophysique, Université Libre de Bruxelles, Brussels, B-1050, Belgium

During a volcanic eruption, a huge amount of aerosols are emitted into the atmosphere which can be transported over long distances. By absorbing and scattering radiation, volcanic ashes influence strongly the Earth radiative budget. These particles may also affect human health and for some intense events may perturb or interrupt air traffic [1].

Aerosols can be detected by remote sensing using in particular from infrared spectrometers. These instruments record the extinction signal of a mixing gas and aerosols contribution. From these observations, the main objective is to estimate the chemical composition, the size and the number concentration of the particles. However, the retrieval of these parameters needs to use the appropriate complex refractive indices m, which are mainly unknown and are, up to now, one of the main sources of uncertainty for studying aerosols from infrared remote sensing instruments.

For this purpose, a new methodology has been applied in order to retrieve complex refractive indices in a large spectral range from the measurement of the extinction spectra of various sampling aerosols. Volcanic ashes powder was dispersed by a mechanical agitation in a flow of nitrogen (5 L min-1) within a glass container. Then the aerosol flow is directed through two spectrometers recording the extinction spectra from UV-visible (MAYA 2000 PRO, Ocean Optics 200 to 1100nm) to Infrared (Antaris IGS Analyser, Thermo Scientific 2,5 to 25 micrometers) and finally to an aerodynamic particle sizer (TSI APS 3321) to record the size distribution in the range 0.5-20 micrometers. A combination of experimental data, Kramers-Kroning relationship and optimal estimation method is used to determine both the real n and imaginary k parts of the complex refractive index.

This methodology has been successfully applied for five volcanic ashes samples collected from Chile (Cordon Caulle, Chaiten, Calbuco) and Iceland (Grimsvötn, Eyjafjallajökull). Moreover, a chemical analysis has been performed for each sample using X-ray diffraction (XRD) to establish the link between chemical and optical properties of materials. These results are then use to retrieve volcanic aerosol parameters from IASI/MetOp satellite instruments.

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CONDENSATIONAL GROWTH PROCESSES TO IMPROVE THE PERFORMANCES OF WET SCRUBBING TECHNIQUES

Francesco Di Natale* (1, 2), Claudia Carotenuto (3), Francesco La Motta (1), Amedeo Lancia (1)

(1) University of Naples "Federico II", Department of Chemical, Material and Production Engineering, Napoli, Italy, (2) National Council of Research, Institute of Applied Sciences & Intelligent Systems (ISASI) "E. Caianiello", Via Campi Flegrei 34, 80078 Pozzuoli, Naples, Italy, (3) University of Campania "Luigi Vanvitelli", Department of Industrial and Information Engineering, Aversa (Caserta), Italy

Recent studies clarified that the submicron particles, those with diameter lower than 1 μm (indicated as PM1) are among the most dangerous pollutants for both humans and the environment. Among them, some of the most risky particles are the ultrafine/nanometric particles (PM0.2) produced by incomplete combustion of fuels (soot), and pathogenic microorganisms, as bacteria and viruses. A significant fraction of diseases and hospitalizations are related to these particles, and diesel soot is a recognised carcinogenic agent. Assessments on the exposure risks related to the production and the utilization of nanoparticles suspended in gas streams are under scrutiny.

In spite of the recognised toxicological effects, there are still a few regulations pertaining the control of submicron particle concentration in the air, either in terms of emission control in the atmosphere, or air quality in workplaces and indoors. Emission control systems were voluntary adopted by the automotive sector, while air quality control systems were developed for surgery rooms or for microbiology laboratories.

The main reason for the absence of a reference regulation for submicron particles is the substantial absence of adequate technologies for their abatement, especially at large scale. Indeed, for small scale indoor applications, filters (HEPA, ULPA etc.) are the standards technologies, while for car diesel engines catalytic filtrations as DPF and DOC are the devices selected to comply with Euro 6 regulations, although concerns on their regeneration are emerging in the literature. For larger scale units, from thousands up to millions of Nm3/h, several potential solutions are proposed (Electrostatic precipitators, agglomerators, filters, wet electrostatic precipitators, Venturi scrubbers, etc) but their ability to capture PM0.2 is under scrutiny.

This work will show the results of experimental studies aimed to investigate the effects of a condensational growth pretreatment on the capture of submicron and ultrafine particles by means of wet scrubbing techniques as Venturi Scrubbers, Bubble Columns and Wet Electrostatic Scrubbers.

Experiments were carried out with a gas at ambient temperature and pressure polluted with calibrated polystyrene nanoparticles (Thermo Scientifics - OptiBind 0.1, 100 nm nominal size). The laboratory scale equipment included the sequence of a growth tube and either a bubble column or a model wet electrostatic scrubber. In the growth tube, the heterogeneous condensation of water vapour took place over the particles, producing a liquid-solid aerosol of size larger than the parent particles. Experiments showed that the condensational growth pre-treatment gave rise to a significant improvement of the removal efficiency in both the bubble columns and wet electrostatic scrubbers. Greater improvements were observed for the bubble column, whose efficiency increased by a factor 3.5. Numerical estimations indicated that also the performances of a Venturi scrubber unit can be improved by condensational growth. The experiments also suggest that the particles removal efficiency is also improved thanks to the change of interfacial properties of the aerosol due to the water coverage induced by condensational growth.

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GEOCHEMISTRY OF MINERAL DUST, MCMURDO DRY VALLEYS, ANTARCTICA: REVISITED

Melisa Diaz (1), Berry Lyons* (1), Byron Adams (2), Susan Welch (1), Alia Khan (3), Diane McKnight (3), Craig Cary (4)

(1) The Ohio State University, (2) Brigham Young University, (3) University of Colorado, (4) University of Waikato

At the 2014 DUST meeting some of the first geochemical data of aeolian materials from the McMurdo Dry Valleys (MDV), Antarctica were presented. The MDV is the largest ice-free area in Antarctica, and the transport and deposition of windblown materials are thought to play an important role in landscape connectivity, which in turn has important ecological consequences. The previous work was on samples collected only 30cm off the ground and probably represents material transported primarily by saltation. In this study, we have collected samples at multiple heights, including at 100cm above the ground surface. Samples were collected during two different periods during 2013–2015. Bulk samples were analyzed by XRF techniques for major, minor and some trace elements. In addition, four samples were analyzed for 87Sr/86Sr ratios. With the major oxide data, the chemical index of alteration (CIA) was determined and compared to that of the major bedrock types in the region. The CIAs of the aeolian material indicate little chemical weathering, and the values varied little with respect to height above the surface. The least weathered material comes from the highest elevation valley, where liquid water is thought to be less available for chemical weathering to occur. These data are similar to those reported for the original, 30cm height samples, and are most similar to the local Ferrar Dolerite. Using the geochemistry of the four major bedrock types in the region and a simple mixing model, our analyses indicate that materials from the two lowest elevation valleys fall between the bedrock mixing lines. However, material from the two higher elevation valleys fall just outside the mixing lines, suggesting the potential of an additional unknown source of material. In addition, the 87Sr/86Sr data from these higher elevation valleys were more radiogenic that other materials in the MDV, also suggesting an additional source. The possible location of this additional material will be discussed in context of the regional geology.

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OPTICAL DETERMINATION OF TIRE-ABRASION PARTICLES IN AIR SAMPLES BY AUTOMATED TRANSMITTED-LIGHT MICROSCOPY

Volker Dietze* (1), Frank Sommer (2), Stefan Gilge (1), Reto Gieré (3)

(1) Air Quality Department, Research Center Human Biometeorology, German Meteorological Service, 79104 Freiburg, Germany, (2) Institut for Earth and Environmental Sciences - Geology, Albert-Ludwigs-Unversität, (3) Department of Earth and Environmental Science, University of Pennsylvania, PA 19104-6316, USA.

Particulate matter (PM) pollution in urban areas not only has an impact on morbidity and mortality (e.g., PM2.5, PM10, PM10-2.5) of their population, but it could severely affect vegetation and ecosystems. Especially the deposition of larger particles (PM10-80) onto vegetated surfaces, soil, rivers and lakes affects the diversity of ecosystems. In congested areas with highly frequented traffic routes, suspension and re-suspension of tire-wear particles contributes substantially to the PM10-80 and airborne road dust concentrations.

Optical single-particle TLM (= transmitted-light microscope) analysis is a cost effective and efficient approach for PM analysis. By taking into account the evaluation area and the exposure period of an acceptor plate, this method allows for the determination of a number particle settling rate of the "total" atmospheric particle load (PM10-80), with subsequent calculation of the total ambient aerosol mass concentration [1]. Furthermore, it allows for the differentiation by particle type (e.g., opaque vs. transparent), which is then used for the calculation of the size-fractionated mass concentration of these particles [2]. The obtained results provide information on the distribution of different particle sizes over a given period and sampling site. They also permit distinction between, and first estimation of anthropogenic (e.g., tire-abrasion particles) vs. natural particles (e.g., minerals) in an air sample.

Weekly PM samples were analyzed by an automated real-color image processing system and digital optical microscopy with transmitted illumination. Two optically distinguishable main components were determined, i.e. transparent particles and opaque, mostly elemental carbon-containing particles. Particles were discriminated from the brightly illuminated background of the translucent substrate by adaptive thresholding. Geometric equivalent diameter and mean optical density (grey value) of the projected particle area were determined as object-specific main parameters. The mean grey value was used to distinguish between opaque and transparent particles, and various shape parameters (e.g., elliptical axis, circular form factor, roughness) were used for a more detailed particle characterization and final tire-wear particle classification.

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CHARACTERIZATION OF DISTRIBUTION OF DESERT DUST PROPERTIES BASED ON PARASOL AEROSOL DATA RETRIEVED BY GRASP ALGORITHM

Oleg Dubovik* (1), Pavel Litvinov (2), Tatyana Lapyonok (1), Li Lei (1), Chen Cheng (1), Derimian Yevgeny (1), Henze Daven (3), Chin Mian (4), Fuertes David (2), Ducos Fabrice (1), Lopatin Anton (2), Huang Xin (2), Torres Benjamin (1), Descloitres Jacques (5), Vass Johannes (6), Aspetsberger Michael (6), Federspiels Christian (6)

(1) Univ. Lille, CNRS, UMR8518 - LOA – Laboratoire d'Optique Atmosphérique, F-59000 Lille, France., (2) GRASP-SAS, Villeneuve d'Ascq, France, (3) Department of Mechanical Engineering, University of Colorado, Boulder, Colorado, 80309, USA, (4) SSAI, NASA Goddard Space Flight Center, (5) ICARE, CNRS, University of Lille, Villeneuve d'Ascq, France, (6) Catalysts GmbH, High Performance Computing, Linz, Austria

The distribution of desert dust properties have been analyzed based on PARASOL/GRASP aerosol retrieval product. GRASP (Generalized Retrieval of Aerosol and Surface Properties) is an algorithm of new generation developed for retrieval of aerosol from diverse remote observations (Dubovik et al. 2014). The algorithm is designed to provide enhanced aerosol retrieval especially from advanced observations as those by multi-angular polarimeters such as POLDER/PARASOL. GRASP searches in continuous space of solutions and uses statistically optimized fitting that includes several original features such as multi-pixel retrieval concept (Dubovik et al., 2011). As a result, GRASP/PARASOL provides reliable retrievals of aerosol properties that are traditionally difficult to obtain from remote sensing, such as spectral aerosol absorption and index of refraction. At present, whole PARASOL archive of 9 years of data has been processed with GRASP. The large number of retrieved parameter allows clear identification of aerosols of different type including desert dust. Correspondigly, the new data provide valuable information about spatial and seasonal variability of desert dust properties. In addition, the newest options of GRASP retrieval has been designed and applied to provide the information on optically distinct aerosol components including mineral dust, iron oxide, black and organic carbon, water fraction, etc. The obtained results from applying this retrieval of component suggest notable modifications of transported aerosols and specifically desert dust. In addition, the GRASP/PARASOL data were used for characterization of aerosol emissions using inverse modeling approach based GEOS-CHEM adjoint developments. The obtained results indicate global overestimation of desert dust emission by 30-40%. This and other results will be illustrated and discussed.

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PASSIVE DUST SAMPLERS – EFFECTIVE TOOL TO ASSESS TRAFFIC RELATED POLLUTION LEVEL

Sylwia Dytłow* (1), Beata Górka-Kostrubiec (1)

(1) Institute of Geophysics, Polish Academy of Sciences

Traffic related pollution is recognized to have strong impact on the environment and to be dangerous for human health. Magnetic study of street dust combined with evaluation of heavy metals contents and electron microscope observations is an effective approach to determine spatial distribution, the level of heavy metal pollution and to identify the sources of pollution. Traffic related pollution contains iron oxides and heavy metals highly concerning because of their toxicity and non-degradability. Numerous studies demonstrated link between concentration of magnetic particles and heavy metals. Street dust is often exploited as an effective study material for pollution impact assessment and monitoring. The disadvantages of street dust could be divided in two categories related to: geology of investigated area (1) and initial properties (2). The purpose of this study was to design the tool -"passive dust samplers" effectively accumulating the pollution that are mainly emitted by traffic sources.

The study was divided in two stages: testing and validation. The goals of testing stage was to find the mixture effectively accumulating traffic pollution and to find the procedure of passive sampler preparation. Drainage pipes of 20cm length and the diameter of 10cm were used to construct the passive samplers. In order to obtain the mixture effectively accumulating the pollution sand (coarse and fine) and peat in different proportions were tested. The passive samplers were installed at crossroad with high traffic intensity, where the dominant source of pollution is exhaust and non-exhaust particulate matter from road traffic. The best accumulation properties showed mixture containing coarse sand and peat in a 1:1 ratio for which the value of total magnetic susceptibility χ (total)=449·10-8 m3kg-1. Therefore, this filling of sampler as the most effectively accumulated pollution was used in the next stage.

The second stage covered the validation and confirmation of effectiveness of passive samplers in field and comparison their accumulation properties with street dust collected in the same sites. The 24 locations in Warsaw (Poland) were selected based of knowledge of traffic density, speed of vehicle, the presence of traffic lights and even landform along the road. Addidionally, we supported our choices by analysis of map of spatial distribution of magnetic susceptibility (χ) for the collection of 248 street dust samples from Warsaw.

The depth distribution of χ in samplers showed good ability to accumulate the anthropogenic magnetic particles, but it was also important to find the link between χ and depth distribution of heavy metals concentrations. This link could be used as a proxy of heavy metal pollution level.

The concentration of Fe, Zn, Pb, Al, Cd, Co, Cr, Ni, As, Ba and Mn showed the same decreasing trend with depth as χ. These associations could be indicative of an anthropogenic origin of the magnetic carrier, revealing that magnetic particles and heavy metals coexist in passive samplers. Moreover, the correlation between χ and PLI index expressing collective concentrations of heavy metals confirms the effectiveness of developed filling of passive samplers.

Linear correlation between of χ of samplers and χ of street dust for the same locations with the Pearson`s regression coefficient R=0.66 confirmed good accumulation capacity of samplers recommended as a tool reflecting the level of pollution.

The results confirms that passive samplers reflects the degree of pollution and overcomes the street dust disadvantages. We designed, accomplished, optimized and validated a new tool effectively used as a proxy to assess the pollution level. Additionally, we developed effective preparing strategies and experimental protocols for conducting a study using mixture of sand and peat as natural pollution collector.

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CONTEMPORARY DUST STORMS AS KEY FOR UNDERSTANDING PALEO-SYNOPTIC CONDITIONS IN THE LEVANT

Yigal Erel* (1)

(1) Institute of Earth Sciences, The Hebrew University, Jerusalem, Israel

The Levant area is located at the northern fringe of the vast Sahara-Arabian desert belt, which is a globally important source of late Quaternary and modern dust. Combining satellite images, back trajectory analysis and chemical and isotopic analyses of contemporary dust storms with Sr-Nd isotopes and chemical analysis of dust archives, we are able to relate changes in sources to shifts in wind patterns and delivery synoptic systems. The compositions of loess deposits from the Negev, fine detritus deposited in the central and northern Red Sea, and lacustrine deposits from the center and margins of the Dead Sea, reflect mixing between several end members: Proterozoic Sahara Shields, the late Proterozoic Arabian Nubian Shield (ANS), and to a lesser extent, Neogene-Quaternary basaltic-derived material.

The relative fraction of each of the source end-members in the final sinks reflects the configuration of atmospheric-synoptic systems and their delivery efficiencies, which in turn, are related to regional changes in climate. Sharav cyclones and Cold depressions are the main systems that deliver dust from the Sahara comprising mixture of both ANS and Saharan fine detritus, while the Red Sea trough is associated with the delivery of fine detritus also from the Arabian Peninsula. Hence, the latter is responsible for bringing more material derived from ANS rocks. These climate-provenance associations are used to reconstruct past climate conditions and will be presented in the talk.

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NUMERICAL MODELLING OF A WET ELECTROSTATIC SCRUBBER FOR SUBMICRON PARTICLES EMISSION CONTROL

Martina Esposito (1), Francesco Di Natale* (1, 2), Claudia Carotenuto (3), Amedeo Lancia (1)

(1) University of Naples "Federico II", Department of Chemical, Material and Production Engineering, Napoli, Italy, (2) National Council of Research, Institute of Applied Sciences & Intelligent Systems (ISASI) "E. Caianiello", Via Campi Flegrei 34, 80078 Pozzuoli, Naples, Italy, (3) University of Campania "Luigi Vanvitelli", Department of Industrial and Information Engineering, Aversa (Caserta), Italy

Particles belonging to the Greenfield gap size range (100-2000 nm) are hardly captured by conventional systems based on hydrodynamic forces or filtration media. Wet electrostatic scrubbing is emerging as a useful technique to reduce these particles concentration in polluted gas streams and applications to marine and industrial fields are under scrutiny. The wet electrostatic scrubbing consists in contacting the particle laden gas with an electrified spray in a suitably designed scrubber. Optionally, the gas can be exposed to a corona source in a particle charging unit (PCU) before entering the device. In recent times we carried out some of the first known experiments on diesel soot particles in the range from 10 to 500 nm. These experiments, carried out both in lab scale and in pre-pilot scale plants, showed that removal of more than 80% of 15 nm particles can be achieved using 1.1 kg of charged water per Nm3 of gas and with an energy consumption of about 25 mW per Nm3/h of treated gas [1].
Modelling of wet electrostatic scrubbing is an intricate problems involving quantification of spray electrohydrodynamic properties, electromagnetic interactions between the swarms of charged particles and droplets and actual physics of particle interiorization in the collecting droplet.
This work presents the results of a numerical modelling aimed to describe experiments on wet electrostatic scrubbing of soot particles in a prototype unit described by our group in a former paper [1].
The model is based on the use of a CFD code used to describe the spray hydrodynamics starting from experiments and numerical data on spray and gas patterns are implemented in a dedicated Matlab® file that implement the stochastic scavenging model developed by Carotenuto et al. [2] and Di Natale et al. [3]. The model provided an accurate description of experimental data once the particles charge is suitably addressed. Indeed, the experimental data were used to calibrate particle charges, whose values were consistent with the data on total aerosol charge levels at the exit of the PCU that available from the experimental tests.

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MONITORING ASH/DUST EVENTS FROM SPACE BY MEANS OF TWO SPECIFIC CONFIGURATIONS OF THE RST MULTI-TEMPORAL APPROACH

Alfredo Falconieri* (1), Carolina Filizzola (1), Francesco Marchese (1), Nicola Pergola (1), Valerio Tramutoli (2)

(1) Institute of Methodologies for Environmental Analysis (IMAA), National Research Council (CNR), (2) University of Basilicata, School of Engineering

The RST-ASH [1] and RST-DUST [2] algorithms are two specific configurations of the RST (Robust Satellite Techniques) [3] multi-temporal approach developed to detect volcanic ash and to identify dust plumes, respectively. Those algorithms have been tested over different geographic areas also for comparison with some well-established literature methods. In this study, we present some recent results achieved implementing RST-ASH and RST-DUST on both polar and geostationary satellite data. A number of test cases, concerning the identification and tracking of volcanic ash and the monitoring of Saharan dust events, are investigated here by using AVHRR, SEVIRI and HIMAWARI 8 data. Among those events, the recent eruptions of Agung Volcano (Bali, Indonesia) of November 2017, which caused the evacuation of the local residents together with an air traffic disruption, are preliminarily analysed in this work, assessing RST-ASH performance in monitoring space-time evolution of ash clouds in real time, by exploiting the high temporal sampling (10 minutes) of Himawary-8 data.
The work shows that the two RST configurations mentioned above may represent a useful tool for studying ash/dust events from space, supporting activities aiming at mitigating impact of those phenomena on both social and economic human activities.

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PERDUS: MINERAL DUST FORECASTS USING ICON-ART

Jochen Förstner* (1), Andrea Steiner (1), Vanessa Bachmann (1), Thomas Hanisch (1), Florian Filipitsch (1), Ali Hoshyaripour (2), Frank Wagner (2), Heike Vogel (2), Bernhard Vogel (2), Bodo Ritter (1), Detlev Majewski (1)

(1) Deutscher Wetterdienst, (2) Karlsruhe Institute of Technology

Traditional weather forecasts are challenged by the increasing shares of renewables in our electricity mix. There are critical weather situations during which forecast errors arise due to known deficiencies in numerical weather prediction (NWP) models. Saharan dust outbreaks represent such a challenge, because mineral dust particles are not explicitly considered in conventional NWP models. The aim of the project PerduS is to improve weather and PV power forecasts during Saharan dust episodes with an emphasis on the region of Germany. Therein, the global NWP model system ICON-ART (Rieger et.al 2015) is used in order to generate, study and improve daily mineral dust forecasts (Rieger et. al 2017, Gasch et al. 2017).
This contribution will summarize findings and experiences from the first half of the PerduS project and present the current status in more detail.
Starting with stand alone runs, several adaptions had to be made to be able to run daily mineral dust forecasts within the framework of our experimental system NUMEX. This allowed for multiple studies concerning e.g. the resolution and soil moisture dependency of the mineral dust emission, the washout of mineral dust or the dust optical properties (introduction of non-spherical particle shapes). Since November 2017, ICON-ART is operated in the so called “EnVar” mode, which means that we also run a data assimilation cycle. Therein, a deterministic 3DVar including ICON-ART assimilation forecasts of mineral dust and its interactions with the atmosphere (radiation feedback) is combined with the global Kalman filter based ICON ensemble data assimilation at DWD. The used configuration runs on a global 40 km grid and a larger 20 km nest covering Europe, North Africa and the North Atlantic region (the so called “ICON-EU-NA2 nest”). The benefit of considering prognostic mineral dust in the model will be evaluated by comparing the ICON-ART cycle to a pure NWP reference cycle of ICON on the same domain configuration but without dust atmosphere interactions.

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LOESS-PALEOSOL SEQUENCES AS STRATIGRAPHIC MARKERS RECORDING ENVIRONMENTAL CONDITIONS AND TECTONIC ACTIVITY AT THE PO PLAIN

Chiara Frigerio* (1), Franz Livio (1), Alessandro Maria Michetti (1), Andrea Zerboni (2), Naomi Porat (3), Rivka Amit (3)

(1) Università degli Studi dell'Insubria, (2) Università degli Studi di Milano, (3) Geological Survey of Israel

Loess represents one of the main paleoenvironmental archives recording Quaternary environmental changes. In Italy, and in particular at the Po Plain Loess Basin (PPLB), loess accumulation and conservation was promoted by local environmental conditions during the Upper Pleistocene. The cold and dry climate of glacial periods led to loess generation and deposition; whereas, the wetter and warmer conditions typical of the interglacial/interstadial periods promoted pedological processes on loess deposits, resulting in loess-paleosol pedosedimentary sequences. In the PPLB, loess sequences are generally thin and seldom outcropping. Recent studies demonstrate that the most developed loessial sequences are preserved in association with morphotectonic structures, such as isolated hills, uplifted terraces, and topographic highlands formed due to tectonically-induced drainage diversion. These landforms represent the surface expression of the complex interplay between the Pleistocene climatic changes and the compressional active tectonics which characterize the Po Plain foredeep. Morphotectonic features emerge a few meters above the surrounding fluvial plain because their moderate tectonic uplift rates are higher than regional denudation and sedimentation rates. For this reason, isolated hills and uplifted terraces acted as sedimentary traps for aeolian sediments, and preserved them. Therefore, the preservation of loess-paleosol sequences in correspondence of morphotectonic landforms allows using loess as a tool suitable to investigate not only the Quaternary climate changes, but also the recent tectonic activity and paleoseismology of the Po Plain. We present four well dated key loess-paleosol sequences preserved in setting controlled by active compressional tectonics (Monte Netto, BS; Pecetto di Valenza, AL; Solero, AL; Rivarone, AL). The study of the interaction between aeolian sedimentation and active tectonics allowed to constrain and reconstruct the Late Quaternary paleoenvironmental evolution and the deformation history of each site. This interdisciplinary study reconstructs the environmental conditions and tectonic activity of the Po Plain.

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ATMOSPHERIC DEPOSITION OF COSMIC DUST STUDIED BY MOSS ANALYSIS

Marina Frontasyeva* (1), Vladimir Tselmovich (2), Eiliv Steinnes (3)

(1) Joint Institute for Nuclear Research, (2) Shmidt Institute of Physics of the Earth, RAS, (3) Norwegian University of Science and Technology

It is a well established phenomenon that extraterrestrial dust particles (micrometeorites) survive atmospheric entry and reach the Earth's surface. Collection of extraterrestrial dust for research focuses on the environments where terrestrial sedimentation rates and input of artificial particles of anthrogenic origin is minimal, including deep-sea sediments, Antarctic ice and snow, as well as natural planchettes of mosses and peat-bog cores. Experimental observations of particles considered as cosmic dust in moss samples (Sanionia uncinata) collected in King George Island [1], highlands of Georgia [2], lowlands of Belarus and Tver Region of Russia are presented. Microanalysis of moss samples showed the presence of clastic, anthropogenic particles and particles of cosmic dust. The results from Georgia are compared with those for moss samples collected in pristine areas of Norway [3]. The identification of particles as micrometeorites is achieved on the basis of their compositional, mineralogical, and texture analyses using microscopy of (SEM and EDAX techniques) and neutron activation analysis (NAA). The majority of particles undergo melting during their passage of the atmosphere. Most abundantly, particularly at large sizes, cosmic spherules, i.e. completely melted droplets, were observed. These spherical particles provide a useful proxy for the total flux of dust because they are relatively easy to identify. They are the background magnetic component of cosmic dust, mainly micro-spheres and particles of native metals. Most often, it was possible to detect native Fe, Fe-Ni and Fe-Cr minerals.

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ATMOSPHERIC AEROSOLS OF NORTH AREA OF SANTIAGO, CHILE. USE OF NON-DESTRUCTIVE METHODS OF ELEMENTAL ANALYSIS

Raúl Fuentealba* (1), Luís Muñoz (2), Margarita Préndez (1)

(1) Universidad de Chile, Facultad de Ciencias Químicas y Farmacéuticas, Santiago, Chile, (2) Comisión Chilena de Energía Nuclear, Departamento de Aplicaciones Nucleares, Santiago, Chile

Atmospheric pollution of Santiago, Chile, has been for decades related to adverse effects on public health and environment. Particulate matter (PM) and tropospheric ozone are the major pollutants [1]. Since the early 70's some groups of scientists, have analyzed their chemical, physical, and thermodynamic characteristics and their temporal and spatial in various environmental matrices [2-5]. Public policies since the mid 90's have been focused in decreasing the concentration of PM to accomplish national standards and international recommendations. The applied policies in the city, constantly expanding, had produced a decreasing of the annual concentrations of PM10 and PM2.5, but not a total adjustment to current regulations.

In this work, PM2.5 collected during austral spring of 2013 was studied. Gent SFU and Partisol samplers were located at the North Campus of the University of Chile, 100m east of the official air quality monitoring station (TEOM sampler). Samplings were divided in daytime (5-21h) and night-time (21-5h), with a total of 32 samples of PM2.5. Local time is UTC-4. Also, 21 samples of urban dust, deposited on streets, were collected around Campus. Elemental composition of PM2.5 was determined using multi-elemental non-destructive techniques PIXE and INAA (Al, As, Br, Ca, Cl, Co, Cr, Cu, Fe, K, La, Na, S, Sb, Sc, Si, Sm and Zn). Elemental composition of urban dust was determined with portable XRF (pXRF) as screening (As, Ca, Cu, K, Mn, Ni, Pb, Rb, Sb, Sr, Ti and V) and INAA for rare earths elements.

Gravimetric results show that the 24h-concentrations for PM2.5 did not exceed the national standard (50 μgm-3), but the annual standard (20 μgm-3) were exceeded 25% of the opportunities. The analysis of the back trajectories, the quantifiable elements and the statistical tools used allowed the identification of the main local and/or regional day and night sources, some of them located around 100 kilometers from the monitoring site. Preliminary results of the PIXE/INAA analysis of the PM2.5 of the night-time show that the elements As, Br, Cl, Cr, Cu, S, Sb and Zn are from anthropogenic origin while Al, Ca, Co, Fe, K, La, Na, Sc, Si and Sm are from natural origin. The urban dust show a contribution of critical elements such as rare earths Ce, Eu and La associated to some new technologies related to the development of catalytic converters of vehicles

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SYNTHESIS OF DUST RECORDS, VEGETATION RECONSTRUCTIONS AND SPELEOTHEM GROWTH FOR EIGHT KEY AREAS OF THE GLOBAL CLIMATE SYSTEM DURING THE LAST 60 000 YEARS

Florian Fuhrmann* (1), Frank Sirocko (1)

(1) Johannes-Gutenberg-University, Mainz, Germany, Department of Geoscience

Published literature on the dust content in terrestrial and marine sediment cores is synchronized with terrestrial and marine pollen data and speleothem growth phases on a common time scale for eight selected key areas of the global climate system during the last 60 000 years. Records have different time resolution and are dated by different methods, but still are brought to a synthesis for each of the eight regions. All regions shows speleothem growth during the early MIS3, sometimes continued into the middle MIS3, but sometimes confined to interstadial times only. Dust is common during the entire MIS2, but dust deflation in some regions start in the middle MIS3. It is not always apparent if the dust deflation is confined to stadial phases only, because the time resolution is often not sufficient to resolve the stadial / interstadial phases precisely. A major problem for the middle and early MIS3 are the limitations of 14C dating. Finally, we detect only three regions where a MIS3 synthesis of dust, vegetation and speleothem growth results in coherent pattern. These regions are central America, central Asia and central Europe. For central Europe, we do not use the published ELSA Dust Stack 2009, but a new time series from the dry maar of Auel, where we examine the sand fraction with a multifocal microscope to differentiate aeolian, fluvial and reworked sand fraction. The new ELSA-Dust-Stack 2018 reveals major grainsize changes between stadials / interstadials.

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ELEMENTAL COMPOSITION AND SOURCE APPORTIONMENT OF AEROSOLS NEAR A FREEWAY IN SWITZERLAND

Markus Furger* (1), Pragati Rai (1), Francesco Canonaco (1), Jay G. Slowik (1), Urs Baltensperger (1), André S.H. Prévôt (1)

(1) Paul Scherrer Institut

The bulk composition of airborne particulate matter consists of organic and inorganic compounds, and trace elements contribute only a few percent to the total mass. The composition of dust differs significantly, and crustal elements Si, Al, Ca and their oxides can make up more than 80 % of the particulate matter (PM) mass.
We report on field measurements near a freeway in Switzerland made during the summer of 2015. An online XRF spectrometer sampled PM10 with 1-h time resolution and analysed 24 elements. The data were compared to standard analysis techniques (ICP-MS) based on 24-h filter samples to assess the quality [1]. Positive Matrix Factorisation (PMF) based source apportionment was then performed on the dataset to determine the sources that contribute to the aerosol composition. The high time resolution of the measurements proved advantageous for a refined source apportionment.
The 23-day field campaign showed typical summer concentrations, except for the National Day weekend, where extensive fireworks were burnt, which showed a very distinct aerosol composition (mainly K, S, Cl, Fe, Ba). During the normal days, the elements Si, S, Cl, K, and Fe made up 95 % of the total analysed elemental mass, indicating the importance of re-suspended dust in the overall PM mixture at this traffic-influenced site. Source apportionment yielded eight different sources, among them two different dust sources: road dust and background dust. These two sources contributed about 18 % to the total analysed mass.

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METALS IN ATTIC DUST AS AN INDICATOR OF HISTORICAL ATMOSPHERIC POLLUTION IN URBAN AREAS: MARIBOR CASE STUDY

Martin Gaberšek* (1), Gosar Mateja (1)

(1) Geological Survey of Slovenia

Attic dust represents a very good sampling medium to assess historical air pollution with potentially harmful elements (PHE) [1, 2, 3, 4]. It is a type of dust, which is deposited in uninhabited attics. Attic dust originates mostly from external sources, both natural (e.g. soil dusting, volcanoes) and anthropogenic (e.g. fuel combustion, ore smelting, metal industries), and less from household activities [1]. Airborne particles with PHE can enter into the attics through small openings in the roof construction, cracks, windows, doors and other openings. There they are accumulated and preserved, since they are not influenced by weather conditions and inhabitant's activities [1, 2]. Continuous and undisturbed depositing of attic dust over a long period of time is its main advantage against some other types of urban dust, like road dust, which can easily be re-suspended into the atmosphere or washed away [3]. Its long-lasting stability enables indirect determination of average atmospheric pollution from the time of construction of building to the present days. On the other hand, attic dust could also be a source of contamination in case of renovation or demolition of old buildings [4].

Maribor is the second largest Slovenian town, with approximately 95,000 inhabitants. It was one of the most important industrial centres of Slovenia and also the former state of Yugoslavia in the past. The most significant industrial sectors were metal and textile industry. There were foundry, truck and bus factory, factory of automotive batteries and many others. The industrial sector is in decline in the past 25 years. To assess air pollution in the past and identify possible sources of PSE, 19 elderly houses (older than 60 years) with uninhabited and abandoned attics were chosen for the sampling throughout the whole town area. Attic dust samples were collected by brushing wooden construction (i.e. beams). Samples were dried at 35 °C and sieved to a fraction below 0.063 mm, using nylon sieves. Their chemical compositions were determined by ICP-MS, following the aqua regia digestion.

Preliminary results of concentrations of ten metals (Cd, Cr, Cu, Hg, Mo, Ni, Pb, Sn, W, Zn) in attic dust from the town of Maribor will be presented. Significant differences in concentrations of some metals between different parts of the town were observed. It looks like that these differences are caused by different types of industry; e.g. the highest Cu (2115 mg/kg) and Zn (6269 mg/kg) concentrations were determined in the area near foundry, and the highest Cr, Mo, Ni, W concentrations were detected near former truck and bus factory. Selected samples were analysed with SEM/EDS to gain additional information about attic dust particles.

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SOURCE APPORTIONMENT OF AMBIENT FINE PARTICULATE MATTER IN DUBLIN, IRELAND: A NEW APPROACH USING TARGETED CHEMICAL FINGERPRINTS OF MAJOR PM2.5 SOURCES.

Meabh Gallagher* (1), Bidroha Basu (1), Aonghus McNabola (1), Balz Kamber (2), Laurence Gill (1), Ghosh Bidisha (1)

(1) Department of Civil Structural and Environmental Engineering, Trinity College Dublin, Ireland., (2) Department of Geology, Trinity College Dublin, Ireland.

Particulate matter is one of the most problematic air pollutants globally, and recently the associations between exposure to ambient particulate matter (PM2.5) and adverse health outcomes have been more firmly established. Exposure to unhealthy concentrations of PM2.5 has been connected to increased respiratory and cardiovascular illness [1]. Diesel vehicles in particular are known for their significant contribution to overall emissions of PM2.5 in the atmosphere, and therefore constitute a significant threat to public health and the environment. Owing to the recent growth in private diesel vehicles in Europe in the past 10 years [2], this vehicle category represents a significant pressure on the quality of the urban environment. Determination of the proportion of total PM2.5 concentration in urban areas, which has originated from diesel vehicle emissions using source apportionment techniques, is invaluable in assessing the impact of diesel emissions on population exposure.

We are generating evidence on the impact of diesel vehicles in Ireland on the exposure of the population to PM2.5, through both field measurement of ambient PM2.5, and direct sampling of major PM2.5 sources. Here we present a large dataset of 24hr samples of ambient PM2.5 collected at residential and roadside microenvironments in Dublin between 2017 and 2018, which were chemically characterized using a single analytical technique; laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). Here we present results from a source apportionment technique known as Positive Matrix Factorization (PMF), which quantifies the major sources of ambient PM2.5 at these two locations in the greater Dublin area. Additionally, we have collected targeted chemical fingerprints of major sources of PM2.5, which include a wide variety of vehicular exhaust emissions, chimney smoke from a variety of the most commonly used solid fuels used for residential heating, and local sea-spray samples collected from Dublin bay. The low detection limits of LA-ICP-MS allows us to distinguish between emissions from combustion of solid fuels and diesel, which are difficult to separate with data from conventional techniques. Our aim is to estimate the contribution of PM2.5 that can be attributed to these various sources, using the end-member fingerprints to aid us in interpreting the results from the PMF source apportionment model. Thus, we can quantify the impact of diesel vehicles in Ireland on the exposure of the population to PM2.5.

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DUST CHARACTERIZATION IN PM10 SAMPLES COLLECTED IN A SUBURBAN SITE IN SOUTH ITALY

Alessandra Genga* (1), Maria Siciliano (1), Tiziana Siciliano (2), Simona Rella (1), Daniela Fico (2), Giuseppe De Benedetto (2), Cosimino Malitesta (1)

(1) Department of environmental and biological sciences and technologies, University of Salento (It), University of Salento, (2) DEpartment of cultural heritage, University of Salento

PM10 and PM2.5 samples simultaneously collected at a costal site of south eastern Italy have been analysed with the main aim of determining the atmospheric dust contribution and investigating the dust source impact. Low volume (2.3 m3 h_1) samplers were used to collect 24-h PM10 and PM2.5 samples on 47-mm-diameter quartz fibre substrates, pre-heated for 1 h at 600 °C, and Teflon fibre substrates. Organic and elemental carbon, inorganic ions, and selected metals were measured in the collected samples. EC and OC were determined by thermal optical transmittance technique (Sunset Carbon Analyzer) using the NIOSH5040 protocol in a 1.5 cm2 punch of the filter samples (1). Soluble ions (SO42-, NO3-, NH4+, Cl-, Na+, K+, Mg2+ and Ca2+) were analysed via High Performance Ion Chromatography (HPIC, Dionex DX-500 System). Eight trace elements (Ni, Cu, V, Mn, As, Pb, Cr, Sb) were analyzed via Graphite Furnace Atomic Absorption Spectroscopy (GF-AAS, Perkin Elmer Analyst 600 System). Four trace elements (Fe, Al, Zn and Ti) were analysed by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES, Varian Liberty 110 spectrometer). Moreover, ATR-FTIR analysis were performed on samples of Saharan Dust event and samples characterized by air mass transported from NE Europe. ATR-FTIR analysis let identify organic functional groups including non-acid organic hydroxyl C-OH group (eg sugars, anhydrosugars, and polyols) and carbonyl C=O group, carboxylic acid COOH group, aromatic and aliphatic unsaturated C=C-H group, aliphatic saturated C-C-H group, and amine NH2 group. Some inorganic ions have also been identified: carbonates, sulfate, silicate and ammonium. In this work, the X-ray photoelectron spectroscopy (XPS) has been used to investigate surface chemical composition of particulate matter.
The mass closure analysis have been applied to the chemically speciated PM10 and PM2.5 samples to identify main natural and anthropogenic sources and determine the atmospheric dust contribution. Analytical back trajectories combined with statistical analyses and satellite true colour images were used to know about the location of potential source regions and to determine the contribution of long range transported air masses (2). In particular the effect of Sahara dust outbreak on PM composition was evaluated.

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ARE THERE ANY TOXICOLOGY ACTIVITY IN THE POLLEN OF CRYPTOMERIA JAPONICA (THUNB.) AND SOME OTHER FRUITS?

Gennady Glazunov (1), Yoshiharu Fujii (2), Nikolai Kolodkin* (1)

(1) Lomonosow Moscow state university, (2) Tokyo University of Agriculture and Technology

Asian dust is a complex mixture of dusts from various sources. Especially negative influence of Asian dust is in cities where are enough negative factors for human health and plant development, such as automobile and industrial exhausts, road dust. Significant contribution to the bioactivity of the Asian dust is extinguished by natural sources of dust - such as massive flowering plants. In this study, the pollen of a number of trees that make a big contribution to the atmospheric dust of Tokyo was studied. Our main interest is in Cryptomeria japonica (Thunb.), because it has the biggest dissemination in Japan, and active producer of high-allergenic pollen. Other trees - Amygdalus persica L., Prunus salicin, Prunus Bretschneider, Prunus avium Japan, Prunus avium China, Malus pumila, Amygdalus persica L., Prunus salicina, Prunus bretschneideri, Prunus armeniaca, Prunus bretschneideri 1 type, Prunus bretschneideri 2 type, Prunus avium are also form massive plantings and produse a lot of pollen. In our pilot study, a possible pollen toxicological effect was determined on the root germination of the model plant Lactuca sativa (sort – Kaiser, Takii seed corporation, Kyoto, Japan).
Analysis of the experimental material was carried out using an analytical model derived from conservation laws, mechanics, chemical and biochemical kinetics of reactive living systems using the concepts of continuous medium, similarity theory and dimensional analysis. Particular points of the model found by analyzing the first-, second- and third-order derivatives separate the entire range of pollen exposure to gaps with intrinsic kinetic characteristics. Within the limits of the model it was found that the effect of increasing doses of pollen leads to a regularly increasing positive response of plants, which, after reaching a maximum, is replaced by a regularly increasing negative response, thus, pollen in small doses has a stimulating effect, and in large doses, a depressing effect. The maximum point is the minimum used dose of pollen - 2 mg, or the closest range of values obtained using the analytical model.

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TOPSOIL POLLUTION LEVEL NEAR THE STANISŁAW SIEDLECKI POLISH POLAR STATION IN HORNSUND, SVALBARD, EVALUATED BY DISTRIBUTION OF MAGNETIC SUSCEPTIBILITY AND MICROSCOPIC OBSERVATION

Beata Górka-Kostrubiec* (1), Tomasz Gonet (2), Beata Łuczak-Wilamowska (2)

(1) Institute of Geophysics, Polish Academy of Sciences, Księcia Janusza 64, 01-452 Warsaw, Poland, (2) Faculty of Geology, University of Warsaw, Żwirki i Wigury 93, 02-089 Warsaw, Poland

The study concerns the assessment of topsoil pollution in the vicinity of Stanisław Siedlecki Polish Polar Station (PPS) in Hornsund, Svalbard. For evaluation of topsoil magnetic methods supplemented by chemical element analysis and microscopic observations were applied. Analysis of magnetic parameters enabled to evaluate the concentration, magnetic mineralogy and grain size distribution of anthropogenic magnetic particles occurring in the area. Microscopic observations (SEM) equipped with Energy-Dispersive X-ray Spectrometer (EDS) were performed to evaluate the shape, morphology, and chemical composition of the magnetic particles.
Heavy metal pollution in the PPS area originates primarily from local sources. Anthropogenic spherical, magnetite-like particles were recognised in the topsoil near the PPS. In contrast, the unpolluted topsoil is devoid of such grains. The magnetite and goethite are the primary magnetic phases in the whole investigated region. However, in the polluted areas the amount of magnetite is relatively higher. Magnetic fraction of polluted topsoil is predominated by the mixture of single-domain and multi-domain grains, while the unpolluted topsoil contains relatively smaller grains. Results show a clear correspondence between Pollution Load Index and magnetic susceptibility anomalies, and that the area extent of PPS impact on the environment has not expanded significantly since 2004, although a new contamination source, the scrap yard, is now present. A comparison of topsoil magnetic susceptibility with heavy metal contents indicates that magnetic methods can be used as a rapid, inexpensive, non-invasive and sensitive tool for the evaluation of the level of topsoil pollution.

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PRESENCE OF METALLIC IRON IN AN URBAN DUST DETECTED BY MAGNETIC METHODS, MICROSCOPIC OBSERVATIONS AND MöSSBAUER SPECTRA

Beata Górka-Kostrubiec* (1), Tomasz Werner (1), Sylwia Dytłow (1), Iga Szczepaniak-Wnuk (1), Maria Jeleńska (1), Aneta Hanc-Kuczkowska (2)

(1) Institute of Geophysics, Polish Academy of Sciences, Księcia Janusza 64, 01-452 Warsaw, Poland, (2) Institute of Materials Science, Silesian University, 75 Pułku Piechoty, 41-500 Chorzów, Poland

The study presents thermomagnetic measurements of samples collected in different environments such as indoor dust, outdoor dust, street dust and dust from air filters of cabin cars. The temperature changes of magnetic susceptibility K(T) were determined in the temperature range of 30-700 °C. The induced magnetization M(T) were obtained with applied magnetic field of 500 mT in the wider range of 30-800 °C.
The curve of K(T) revealed the Curie temperature (Tc) of magnetite which confirms the presence of magnetite as the primary magnetic phase. The "tail" i.e. substantial decreasing value of K, visible on the heating curves between 600 °C and 700 °C was the attribute of second magnetic phase with Tc above 700 °C. The curve of M(T) revealed also the Tc of magnetite and the second magnetic transition at 760 °C characteristic for metallic iron and/or iron-based alloys.
The presence of metallic iron fraction in the non-heated samples was confirmed by the microscopic observation, energy-dispersive X-ray spectroscopy and by Mössbauer spectroscopy. The magnetic extract of dust from different environments revealed the elongated shaving-like particles comprised of metallic iron. The measurements of hysteresis properties for a few samples at high temperatures and after step-wise annealing indicated the process of oxidation of iron to magnetite.
The "tail" appearing on the heating curve of K(T) between 600 °C and 700 °C are often interpreted as the presence of hematite. The study of M(T) in the wider temperature range up to 800 °C combined with transmission Mössbauer spectra revealed the significant amount of strong magnetic iron in non-heated samples. Probably in other studies that phase is not recognized as iron due to limit of heating up to 700 °C. Our study shows that heating up to 800 °C and measuring magnetic properties is the effective method to distinguish between hematite and metallic iron in dust.

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CLIMATE-HYDROLOGY-DUST FEEDBACKS DURING THE MID-HOLOCENE DECLINE OF MEGALAKE CHAD

Nicholas Graham (1), Dirk Verschuren* (2)

(1) Hydrologic Research Center, San Diego, USA, (2) Limnology Unit, Ghent University, Gent, Belgium

During the mid-Holocene, Megalake Chad (MLC) covered more than 400,000 km2 of central North Africa, spanned 8° of latitude and was more than 150 m deep. Paleohydrological reconstructions based on its sedimentary record of past lake-level change suggest that MLC first receded slowly ~6.5-5.0 ka BP and then began a rapid decline with remnant Lake Bodélé apparently reaching a minimum level sometime between ~4.5-4.0 ka BP, in the process exposing vast areas of long-submerged lakebed. The lake recovered partly during subsequent centuries but fell dry by ~2.4 ka BP. Today these dry northern lakebeds form the Bodélé Depression, the world's largest single source of dust, their productivity owing to the extensive diatomaceous deposits which had accumulated under mid-Holocene megalake conditions.

We examine the remarkable mid-Holocene evolution of MLC using a coupled hydrology / lake water-balance model with parameterizations both for lakebed dust production and for the effects of these regional dust emissions on catchment rainfall. The results support quantitative inferences concerning changes in regional rainfall and lake geometry, findings relevant to the much-discussed termination of the 'African Humid Period' and the interpretation of paleo-records from different settings within the basin. Further, we find that even with modest sensitivity of catchment rainfall to regional dust emissions, dust-rainfall-runoff feedbacks operating in a 5th Millennium BP hydroclimatic setting can produce intense coupled climate 'events' of 200-300 years in duration. During these 'events', catchment rainfall, runoff and lake level plummet in response to heavy dust production from newly exposed areas of lake bottom. Given that the 5th Millennium lowstand of Lake Bodélé appears contemporaneous with the much-debated '4.2-kyr event', we suggest that Bodélé dust emissions may have played a dual role by enabling the regional "drought" via dust-climate feedback and by causing the distinctive global climatic impacts indicated by proxy records.

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LINKING DUST OPTICAL PROPERTIES TO SOURCE REGIONS OVER AFRICA AND THE MIDDLE EAST

Schuster Greg* (1), Kim Dongchul (2), Liu Zhaoyan (1), Mian Chin (3), Kerstin Schepanski (4)

(1) NASA Langley, (2) NASA GSFC/JCET/UMBC/USRA, (3) NASA GSFC, (4) TROPOS

The mineralogical composition of atmospheric dust varies substantially over north Africa and the Middle East. For instance, coastal ship measurements indicate that airborne concentrations of illite and hematite are greater over the northwest portion of the African Sahara than the concentration of these minerals along the southern and eastern coasts of the Sahara. This mineralogical variability has a substantial impact on the refractive indices of dust in those regions, which causes substantial variability in the scattering and absorption optical properties. We have developed a technique for inferring the refractive indices of dust associated with seven potential source areas (PSAs) located in north Africa and the Middle East. We use the GOCART model to ``tag'' dust emitted from each PSA, which allows us to compute PSA mixing ratios at 19 AERONET sites every day from June 1, 2006 until Dec 31, 2016. We screen the AERONET refractive index retrievals for ``pure'' dust, considering only Level 2.0 retrievals with fine volume fractions less than 0.05 and linear depolarization ratios at the 532 nm wavelength greater than 0.25, obtaining 1388 retrievals after the screening process. The 1388 retrievals and the GOCART PSA mixing ratios allow us to implement an over-constrained Generalized Matrix Inversion of the refractive indices at the 7 PSAs.

Our inversion indicates that northwest Africa and the Bodele Depression have the lowest real refractive indices, with values of 1.47--1.48 at the 532 nm wavelength, whereas northeast Africa has a real refractive index of 1.56; the imaginary refractive index also varies from 0.0012--0.0034 for the 7 PSAs. We attribute this refractive index variability to the different mineralogies of the various source regions. These mineralogical differences also impact the regional lidar ratio, which varies from 41 to 61 sr^{-1}.
Accordingly, we discuss the ramifications using a single refractive index for all dust aerosols in global aerosol models.

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PARTICULATE EMISSIONS DURING 23 MAJOR INDUSTRIAL FIRES AND THE IMPLICATIONS FOR SHORT-DURATION EXPOSURE GUIDELINES FOR HUMAN HEALTH PROTECTION.

Simon Griffiths (1), Philip Chappell (2), Jane Entwistle* (1), Frank Kelly (3), Michael Deary (1)

(1) Northumbria University, UK, (2) Environment Agency, UK, (3) King's College London, UK

Public exposure to significantly elevated levels of particulate matter (PM) as a result of major fires in urban areas is of growing worldwide concern. This presentation reports on the United Kingdom's Air Quality in Major Incidents (AQinMI) programme. AQinMI is one of the first civilian projects of its type to provide real-time fire effluent plume concentration data for use by incident managers to allow an informed public health response based on concentrations of PM that populations may be exposed to in major incident fires.

We present the monitoring data for PM10, PM2.5, and PM1, collected by the AQinMI teams using standard OSIRIS laser light scattering monitors and deployed to 23 major incident industrial fires between 2009 to 2016. Incident-averaged concentrations ranged from 38 to 1450 µg m-3 for PM10 and 7 to 258 µg m-3 for PM2.5. For several incidents, 15-minute averaged concentrations reached in excess of 6,500 µg m-3 for PM10 and 650 µg m-3 for PM2.5, although such excursions tended to be of relatively short duration. In the absence of very short-term (15-min to 1-hour) guideline values for PM10 and PM2.5, we have analysed the relationship between the 1-hour and the 24-hour threshold values as a predictor of longer-term exposure.

We also consider: i) the accuracy of the data provided, ii) the human health impacts of short-term exposure to significantly elevated, especially fine, PM concentrations, and iii) the appropriateness of current short-term guideline values in providing suitable information to incident managers to determine the appropriate public health response.

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CONTRIBUTION OF ATMOSPHERIC WET CALCIUM DEPOSITION TO SOIL PROVISIONAL ECOSYSTEM SERVICES

GR Groshans (1), EA Mikhailova* (1), CP Post (1), MA Schlautman (1)

(1) Clemson University

Soil provisional ecosystem services are significantly impacted by the atmospheric input of calcium (Ca^{2+}) ions. Annual atmospheric deposition of Ca^{2+} ions furthers the liming of soil; however, deposition spatially varies in the United States. This study ranked the provisional value of soil ecosystem services of atmospheric wet Ca^{2+} deposition from 1994 to 2003 within the continental United States by soil order. The total provisional ecosystem value of atmospheric calcium deposition was almost $25M (i.e., 25 million U.S. dollars) based on an average 2014 price of $10.42 per U.S. ton $CaCO_3$ lime in the U.S. Top five soil orders with the highest total average value were: 1) Mollisols ($8.90M), 2) Alfisols ($6.41M), 3) Entisols ($2.97M), 4) Aridisols ($2.20M), and 5) Inceptisols ($1.82M). The top five soil orders with the highest area-normalized total average annual value were: 1) Alfisols ($4.98), 2) Mollisols ($4.88), 3) Histosols ($4.79), 4) Vertisols ($4.50), and 5) Spodosols ($3.45). Mollisols and Alfisols are both agriculturally significant soil orders for crop production and ranked the highest in total average and area-normalized total average values. The results of this study begin to provide an estimated value of the importance of atmospheric wet deposition when assessing ecosystem services. The potential impacts on society from this research include adding wet deposition into the ecosystem services framework for the United Nations (UN) Sustainable Development Goals.

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CHANGES IN THE MIXING STATE AND SIZE DISTRIBUTION OF AEROSOLS DURING THE URBAN TRANSPORT OF INDUSTRIAL PLUMES

Sarah Guilbaud* (1), Karine Deboudt (1), Pascal Flament (1), Patrick Augustin (1), Marc Fourmentin (1), Hervé Delbarre (1)

(1) Laboratoire de Physico-Chimie de l'Atmosphère

The impact of atmospheric aerosols on climate, biogeochemical cycles and human health (via inhalation and/or ingestion) was largely demonstrated. In this context, this work focuses on atmospheric particles emitted by plants located in the Dunkirk Harbour industrial area. These particles are released in the low troposphere by high-temperature processes (predominantly for steelworks and metallurgy) and their physical and chemical characteristics can rapidly change (Marris et al., 2012). Many different aerosol sources were located in the vicinity of the studied area, in addition to steelworks and other industrial plants. Urban areas and the North Sea were all located less than 5 km away, and could possibly influence the plumes behaviour, depending on the wind direction.

In this context, our goal is to study the evolution of the aerosol mixing state during aging of industrial plumes. For that, particles were collected inside the plumes, in particular during sea-breezes, using a balloonborne platform, at increasing distances from the industrial zone (5000-10000m). A LIDAR (Light Detection And Ranging) was used to determine the vertical and horizontal dispersion of aerosols and to follow the plumes.

To observe the evolution of the size distribution and chemical composition of particles during the plumes aging, an optical particle counter (OPC) and a Sioutas impactor were implemented in the platform, in particular for cryo-electron microscopy (cryo-TSEM-EDX) analyses, a technique limiting the loss of non-refractory fine particles during observations.

Combining single-particle analysis by cryo-electron microscopy and global analyses by ICP and ionic chromatography, a mixing state index (Riemer and West, 2013) was calculated for each sample. In this way it was possible to quantify the evolution of particles during plumes aging, between the source (i.e. the industrial zone) and a receptor site located a few kilometres away. This evolution was pronounced when the wind was coming from the northeast and the industrial plumes mixed with emissions from the adjacent urban area and marine air masses.

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EVALUATION ON THE EFFECTIVENESS OF STREET VACUUM CLEANER FOR REMOVING RESUSPENDED FINE PM FROM PAVED ROADS IN SEOUL METROPOLITAN AREAS

Sehyun Han* (1), Jong-Sang Youn (1), Yong-Won Jung (1), Ki-Joon Jeon (1)

(1) Inha University

Fugitive dust arising from the resuspension of deposited materials on paved roads by vehicle travel has been regarded an important contributor to ambient particulate matter(PM) in the large urban areas around the world (Amato et al., 2010; Han et al., 2011; Han and Jung, 2012). Recently, these cities have practiced the enhanced street cleaning program as a means of controlling PM10 emissions from paved roads. The effectiveness of street cleaning on ambient fine PM, however, has not been clearly investigated thus far. In the Seoul metropolitan areas, dry-type vacuum street cleaner with dust filter has been introduced and operated to reduce ambient PM10 concentration. The ultimately aim of our study is to evaluate the quantitative effectiveness of street cleaning program for reducing PM10 emissions from paved roads. In this study, in order to evaluate the removal effectiveness of road resuspended fine PM(PM10, PM2.5), two test methods were applied. In one method, silt loadings of test roads before and after street cleaning were measured by using the real-time silt loading measurement system, which has been developed for estimation of resuspended dust emissions from paved road by our research team(Han and Jung, 2012). In the other method, we measured the concentration and size distributions of fine PM at the suction inlet and outlet of vacuum cleaner using real-time dust monitor(Grimm #1.109) and evaluated the dust removal efficiency of the cleaning equipment in actual operation.

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HEALTH COMPLAINTS IN A VIENNESE SCHOOL: HIGH ORGANOPHOSPHATE CONCENTRATIONS IN HOUSE DUST

Hutter Hans-Peter* (1), Tappler Peter (2), Damberger Bernhard (2), Lemmerer Kathrin (3), Moshammer Hanns (1), Wallner Peter (1)

(1) Department of Environmental Health, CPH, Medical University Vienna, Austria, (2) Austrian Institute for Healthy and Ecological Building, Vienna, Austria, (3) Department of Environmental Health, CPH, Medical University of Vienna, Austria

Background: School children and teacher complained about health effects like eye irritations, sore throats and some unspecific symptoms. They were concerned that chemicals might cause these adverse health effects. An external working group was appointed to investigate indoor air pollution and to suggest measures to improve the situation.
Methods and material: After a visual inspection air samples and floor dust samples for the analysis of organic compounds were collected in 6 classrooms according to standardized procedures. Fifty target VOCs (Volatile Organic Compounds) were selected for analysis of air samples. Dust samples were analyzed for semivolatile to nonvolatile organic compounds including biocides (e.g. PCP, lindane, pyrethroids), phthalates, trisphosphates, PAHs, and polychlorinated biphenyls.
Results: Overall the concentrations of VOC (50 to 150 µg/m³); and formaldehyde (0.016 to. 0.027 mg/m³) were fairly low. In dust samples high levels of tris(2-butoxyethyl)-phosphate (1300 to 2300 mg TBEP/kg) were detected. All other compounds (semivolatile to nonvolatile organic compounds) were below limit of detection.
Discussion: The coating of the floor tiles was identified as the source of TBEP. Based on our experiences with this chemical in indoor environments it is likely that acute irritative effects may occur especially if unfavorable indoor climate factors (low humidity) are associated with exposure to high TBEP concentrations. Due to the neurotoxic and carcinogenic of TBEP potential measures had to be taken to reduce the exposure of children and adolescents in the classrooms resp. in the school building.
Conclusions: As organophosphate flame retardants and plasticizers have been used in large quantities in building-related products, more attention must be paid to these chemicals especially in schools.

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BURIED AND RELICT SANDY SOILS ALONG IN THE CENTRAL COASTAL PLAIN, ISRAEL AND FINE AND COARSE DUST TRENDS AWAY FROM THE SINAI DUNE FIELD

Maayan Harel (1), Rivka Amit (2), Onn Crouvi (2), Naomi Porat (2), Yehouda Enzel* (1)

(1) Hebrew University, (2) Geological Survey of Israel

Dust from three main sources have been incorporated into the surfaces of stabilized coastal dunes as part of pedogenesis in the Israeli Coastal Plain in the eastern Mediterranean. These sources are: (a) the proximal active dune fields of northern Sinai that under intensified, late Pleistocene, glacial-time winds, generated by abrasion, coarse to fine quartzo-feldspathic silts and some finer grains; in turn, these grains accreted into the soils that present a pronounced fining trend of coarse to fine silts northward and away from the dunes. (b) A nearby, local, eastern Mediterranean continental shelf source possibly contributing dust directly from exposed silts and active dunes during low eustatic sea levels. These sediments have been recorded at specific mid-Pleistocene sites and were unable to musk the late Pleistocene northward trend. (c) Distal sources, bringing only finest silt and clay fraction from Sahara and Arabia.

The relative contribution from these sources of dust results in different soil profiles. We focus here on the coarse and fine silts in a south-north direction along the eastern Mediterranean coast based on the additions to sand parent material. We examined both buried and relict sandy soils in sandy aeolian Quaternary deposits exposed along the central Coastal Plain of Israel, with at least some chronological control. We distinguish between long-distance transported fine dust (finest silts and clays) that affected the entire region, and the proximal dust (coarse silt) accumulated in sandy soils along the coast and in the prehistoric Tabun Cave, Mt. Carmel, which presents a window to middle Pleistocene accretion of aeolian sediments. The interval of soil development and silt and clay accretion was determined by OSL ages of the dunes underlying and overlying the buried soils.

Our results indicate that the majority of the additions to the soils is the coarse fraction of the dust in the southern coastal sandy soils is similar to the coarse fraction composing the loess in the Negev; i.e. the source for both is in the abraded sand of the Sinai-Negev erg. The fining trend toward north also supports such a proximal source. Soils exposed since ~100 ka present the two grain-size distribution modes of fine and coarse silt, characteristics of the Negev loess to the south that was generated by long- and short-distance transport of dust, respectively. This pattern characterises almost all soils of the last 200 ka. In contrast, buried soils dated to >200 ka practically lack the coarse fraction; the soils contain only the fine fraction. The source for the Tabun Cave sediments (>200 ka) present coarse silts but point at a local dust source just off-shore during eustatically lower sea levels. The regional lack of coarse fraction in soils and loess >200 ka, point to the youth of the their main source- the Sinai-Negev erg.

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PULMONARY INFLAMMATORY RESPONSES TO ACUTE METEORITE DUST EXPOSURES – IMPLICATIONS FOR HUMAN SPACE EXPLORATION

Andrea Harrington* (1), Francis Mccubbin (1), Kathleen Vander Kaaden (2), Jasmeet Kaur (3), Alexander Smirnov (4), Karen Galdanes (5), Martin Schoonen (6), Lung-Chi Chen (5), Stella Tsirka (3), Terry Gordon (5)

(1) NASA Johnson Space Center, (2) Jacobs, NASA Johnson Space Center, (3) Stony Brook University, (4) Lone Star College, (5) New York University, (6) Brookhaven National Laboratory

New initiatives to begin Lunar and Martian human surface operations within the next few decades are illustrative of the resurgence of interest in human space exploration. However, as with all exploration, there are risks. The previous manned missions to the Moon highlight a major hazard for future human exploration of the Moon and beyond: surface dust. Not only did the dust cause mechanical and structural integrity issues with the suits, the dust 'storm' generated upon reentrance into the crew cabin caused "lunar hay fever" and "almost blindness [1-3].". It was further reported that the allergic response to the dust worsened with each exposure [4]. Due to the prevalence of these high exposures, the Human Research Roadmap developed by NASA identifies the Risk of Adverse Health and Performance Effects of Celestial Dust Exposure as an area of concern [5].

As a direct response to this deficit, the present study evaluates the role of a particulate's innate geochemical features (e.g., bulk chemistry, internal composition, morphology, size, and reactivity) in generating adverse toxicological responses. This highly interdisciplinary study evaluates the relative toxicity of six meteorite samples representing either basalt or regolith breccia on the surface of the Moon, Mars, and Asteroid 4Vesta. Terrestrial mid-ocean ridge basalt (MORB) is also used for comparison. All material is fully characterized and evaluated for geochemical reactivity (e.g. iron solubility and acellular reactive oxygen species (ROS) generation). Both in vitro and in vivo toxicological techniques are used to determine the cardiopulmonary inflammation caused by acute exposure.

The MORB demonstrated higher geochemical reactivity than most of the meteorite samples but caused the lowest acute pulmonary inflammation (API). Notably, the two Martian meteorites generated some of the highest API but only the basaltic sample is significantly reactive geochemically. Furthermore, while there is a correlation between a meteorite's soluble iron content and its ability to generate acellular ROS, there is no direct correlation between a particle's ability to generate ROS acellularly and its ability to generate API. However, assorted in vivo API markers did demonstrate strong positive correlations with Fenton metal content and the ratio of Fenton metals to silicon.

In summary, this comprehensive dataset allows for not only the toxicological evaluation of celestial materials but also clarifies important correlations between geochemistry and health. Furthermore, the utilization of an array of celestial samples from Moon, Mars, and asteroid 4Vesta enabled the development of a geochemical based toxicological hazard model that can be used for: 1) mission planning, 2) rapid risk assessment in cases of unexpected exposures, and 3) evaluation of the efficacy of various in situ techniques in gauging surface dust toxicity.

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AIR POLLUTION BY FINE PARTICLES IN 5D DIAGRAMS

Libor Hejkrlík* (1), Helena Plachá (1), Dáša Richterová (1)

(1) Czech Hydrometeorological Institute

Number concentrations N of fine particles had been measured by SMPS in 7 channels (10–20 nm, 20–30 nm, 30–50 nm, 50–70 nm, 70–100 nm, 100–200 nm, 200–800 nm) with time resolution of one hour since June 2012 to December 2015 at a background urban site in Northern Bohemia (Hejkrlík et al, 2016). At the same measuring station of the National air pollution network operated by the Czech Hydrometeorological Institute hourly means of two pollutants had been measured (mass concentrations of SO2 and PM1 – black carbon). At two nearby climatological stations one-hour values of three meteorological elements were available (air temperature Th, relative air humidity Hh and global radiation Rh).

The whole period of observations covered 1309 days, periodically involving all of the seasons of the year with no respect to weekdays or rush hours. Night hours (Rh=0) were excluded even though they amounted to more than one half of available data. Th varied between 11,2 °C and 36,1 °C, for Hh it was between 21% and 100% and Rh reached its extremes between 0,2 and 940,5 W/m2. The maximum of mean concentration of SO2 slightly exceeded the level 20 mcg/m3/hour and the value for PM1 was in most cases less than 14 mcg/m3/hour. Resulting number of analyzed rows of 5 variables was approximately 14 000. The database was thoroughly checked for missing values which was extremely important especially for data measured by SMPS.

The nearly-continuous combinations of meteorological data were transformed into three-dimensional matrix where Th, Hh and Rh were assigned only few discrete values (48, 13 and 13 respectively). In the resulting 8112 cells of the 3D matrix mean concentrations of the modes of fine particles were calculated. To clarify the whole picture only the cells containing at least 15 values of N were taken into account. The results were displayed in the form of XYZ bubble graph, diameters of the spheres being the fourth dimension. GrapherTM 11 (Golden Software, LLC) enables colouring of the bubbles regarding specific key, in this case one of four classes of mean hourly concentration of SO2 in corresponding cells. The colour of the spheres may be regarded as the fifth dimension.

The nucleation mode of nanoparticles (10–20 nm) demonstrate strong proliferation (N~104/cm3/hour) under extreme both temperature and solar radiation while air moisture remains moderate (Hejkrlík et al, 2017). Highest quantities of these particles correlate with elevated concentrations of sulphur dioxide registered at the same time. The picture gradually fades out for the ultrafine particles in the 20–50 nm size categories probably due to advancing nucleation of sulphuric acid formed from the atmospheric oxidation of SO2.

The overall picture changes for fine particles with diameter up to 800 nm. Their concentrations are one order less, the maximum values show considerable affinity to periods of low visibility and high humidity where there are registered events with higher levels of SO2. They are possibly primary particles of anthropogenic origin; this is also supported by practically identical graphs for numeric concentrations of particles with diameter 200–800 nm and for mass concentrations of PM1, obtained by MAAP instrument.

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IMPACTS OF DUST DERIVED AIRBORNE MICROBES ON THE SE MEDITERRANEAN SURFACE SEAWATER

Barak Herut* (1), Adina Paytan (2), Eyal Rahav (1)

(1) Israel Oceanographic and Limnological Research, Haifa, Israel, (2) Institute of Marine Science, University of California, Santa Cruz, USA

Dust events function as an external supplier of atmospheric nutrients (N, P, Fe and other trace metals) and airborne microbes (e.g. bacteria, archaea, diazotrophs, viruses) that possibly remain viable during transport. On-board microcosm and land-based mesocosm experiments suggest a significant impact of dust/aerosols on ambient microbial populations, triggering an increase in several rate and state parameters such as bacterial production and abundance, primary production rates and chlorophyll-a (or other phytopigments), abundance of certain pico and nanophytoplankton groups and dinitrogen (N2) fixation rates (Herut et al., 2016). We will present here observations on airborne microbial diversity, activity and function from representative dust storm events in the SE Mediterranean Sea (SEMS) and their potential impact upon deposition into the Low Nutrient Low Chlorophyll (LNLC) SEMS (Rahav et al., 2016ab). We show that: 1) aerosols over the SEMS carry high diversity of microbes, some remain viable, 2) airborne bacteria contribute to nutrient fixation via bacterial and primary production and nitrogen fixation and 3) airborne viruses may infect ambient Prochlorococcus populations resulting in decreasing cyanobacterial abundance. Warmer atmosphere in the future may increase dust emissions and oligotrophic areas, thus accelerating the above processes.

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THE PMF PROJECT; TOWARDS MAGNETIC AND CHEMICAL CHARACTERISATION OF AIRBORNE PARTICLES FROM URBAN PM SOURCES AND ASSOCIATED EARLY-HEALTH EFFECTS

Jelle Hofman* (1), Castanheiro Ana (1), Moretti Serena (2), Nuyts Gert (3), Joosen Steven (4), Lebeer Sarah (2), Blust Ronny (4), De Wael Karolien (3), Lenaerts Silvia (5), Samson Roeland (1)

(1) Environmental and Urban Ecology Lab, Department on Bioscience Engineering, University of Antwerp, Belgium, (2) Applied Microbiology and Biotechnology, Department of Bioscience Engineering, University of Antwerp, Antwerp, Belgium, (3) Antwerp X-ray Analysis, electrochemistry & Speciation (AXES), Department of Chemistry, University of Antwerp, Antwerp, Belgium, (4) Systemic Physiological and Ecotoxicological Research (SPHERE), Department of Biology, University of Antwerp, Antwerp, Belgium, (5) Sustainable Energy, Air and Water Technology Purification (DuEL), Department of Bioscience Engineering, University of Antwerp, Antwerp, Belgium

Air pollution is now the world's largest single environmental health risk. Nonetheless, current air quality networks obtain poor spatial monitoring resolution due to high investment and maintenance costs. Especially in heterogeneous urban environments, spatial monitoring resolution is generally too limited. Biomagnetic monitoring has previously shown to be a promising monitoring approach for capturing spatio-temporal variation of particulate air pollution (Hofman et al. 2017; Rai 2013; Matzka and Maher 1999; Maher et al. 2008); for both air quality monitoring and modelling applications, on both spatial (e.g. Hofman et al. 2013) and temporal (e.g. Hofman et al. 2014; Mitchell et al. 2010) resolutions. Nevertheless, lacking information on source-dependent magnetisable composition and health-relevancy of atmospheric particles impedes the general application of biomagnetic monitoring in environmental air quality assessments. This ongoing Particulate Matter Fingerprinting (PMF) project, therefore, aims at evaluating atmospheric PM, originating from different sources (road and railway traffic, shipping, industry and background location) for its chemical composition, association with co-emitted pollutants (heavy metals, black carbon, ultrafine particles and PAHs), magnetic properties and early health responses (pro-inflammatory potential), combining a range of analytical techniques (SEM-EDX, ED-XRF, HR-ICP-MS, GCxGC-TOFMS and Coriolis). For each PM source, we combined source-targeted sampling and atmospheric sampling from conventional 24h pumped-air filters (Leckel SEQ47/50; EN12341 standard) and passively-deposited leaf biomonitoring. First results already identify source-specific metal and magnetic “fingerprints” from the loaded filter and leaf samples, with discriminating pro-inflammatory potential. This research hereby contributes to chemical source characterisation, its potential for source attribution in urban areas, and the health-relevancy of biomagnetic monitoring. While the magnetic mineralogy, grain size and concentration will reflect PM source-contributions, associations with heavy metals and/or elemental carbon might emphasize biomagnetic monitoring as a novel health-related PM proxy.

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CYCLIST EXPOSURE TO BLACK CARBON, ULTRAFINE PARTICLES AND PARTICLE-BOUND METALS: FROM IN-SITU MOBILE MONITORING NEAR TWO COMMUTING ROUTES TO INHALED POLLUTANT DOSE

Jelle Hofman* (1), Roeland Samson (1), Joosen Steven (2), Blust Ronny (2), Lenaerts Silvia (3)

(1) Environmental and Urban Ecology Lab, Department on Bioscience Engineering, University of Antwerp, Belgium, (2) Systemic Physiological and Ecotoxicological Research (SPHERE), Department of Biology, University of Antwerp, Antwerp, Belgium, (3) Sustainable Energy, Air and Water Technology Purification (DuEL), Department of Bioscience Engineering, University of Antwerp, Antwerp, Belgium

Urban environments typically exhibit large atmospheric pollution variation, in both space and time (Hofman et al. 2016; Klompmaker et al. 2015; Amato et al. 2011; Hofman et al. 2013; Zauli Sajani et al. 2018). In contrast to traditional monitoring networks, suffering from a limited spatial coverage, mobile platforms enable personalized high-resolution monitoring, providing valuable insights into personal atmospheric pollution exposure, and the identification of potential pollution hotspots. This study evaluated personal cyclist exposure to nanoscale particles (UFPs), black carbon (BC) and particle-bound transition metals along two commuting routes near Antwerp, Belgium, by performing mobile measurements with wearable BC and UFP instrumentation. While one commuting route ran along road traffic, the other followed a bicycle highway along railway traffic. Loaded AE51 microaethalometer (Aethlabs, US) filterstrips were chemically analysed through HR-ICP-MS and the inhaled pollutant dose determined from the exhibited heart rate. Considerable spatial pollutant variation was observed between and along the travelled routes, with distinct contributions from spatial factors (e.g. traffic intersections, urban park and market) and temporary events. On average 300% higher BC, 20% higher UFP and changing elemental concentrations are observed along the road traffic route (RT), when compared to the bicycle highway route (BH). Although the overall background pollution determines a large portion of the experienced personal exposure (in this case 53% for BC and 40% for UFP), cyclists can influence their personal atmospheric pollution exposure, by selecting for a proper commuting route. Our results, hereby, strengthen the body of evidence in favour of further policy investments towards isolated bicycle infrastructure.

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USING SATELLITE OBSERVATIONS TO ESTIMATE DUST TRANSPORT AND DEPOSITION INTO TROPICAL ATLANTIC OCEAN

Yu Hongbin* (1)

(1) NASA Goddard Space Fligth Center

Massive dust emitted from deserts and semi-arid regions in North Africa can transport long distances across the tropical Atlantic Ocean, reaching the Americas. Dust deposition along the transit adds essential nutrients to marine and terrestrial ecosystems, which could increase the productivity of the ecosystems and CO2 uptake, modulate biogeochemical cycle, and influence climate. Assessment of the dust-biogeochemistry–climate interactions has been in part hindered by the paucity of dust deposition measurements, particularly in open oceans, and large uncertainties associated with representing dust processes in models. Currently there are several remote sensing capabilities of measuring aerosol optical depth (AOD) and particle size and shape properties (e.g., fine-mode fraction from MODIS, non-spherical fraction from MISR, depolarization ratio from CALIOP), which can be used to distinguish dust from other types of aerosol. Atmospheric infrared sounders such as IASI and AIRS with high spectral-resolution thermal channels can measure dust but not combustion aerosol. In this study, we combine CALIOP 3-D distributions of dust with dust optical depth (DOD) from MODIS, MISR, and IASI to quantify dust transport and deposition over the tropical Atlantic Ocean. On the basis of 2007-2014 average, the estimated yearly dust deposition is 89-117 Tg and 22-40 Tg into tropical Atlantic Ocean and Caribbean Basin, respectively. The dust deposition shows large inter-annual variability, which shows a negative correlation with prior-year Sahel rainfall anomaly to some extent. The satellite observations also yield an estimate of regional dust loss frequency of 0.056 ~ 0.086 d^-1. The GEOS-5 and AeroCom models simulate a much more efficient dust removal, although the models substantially overestimates small dust particles but underestimates large dust particles. Future effort needs to investigate model parameterization of size-dependent dust emission and removal processes.

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SATELLITE OBSERVATIONS AND MODEL SIMULATIONS OF AEOLIAN DUST AND COMBUSTION AEROSOL: CONSISTENT INTER-ANNUAL VARIABILITY AND TREND IN MAJOR OUTFLOW REGIONS IN RECENT DECADES

Yu Hongbin* (1)

(1) NASA Goddard Space Flight Center

Aeolian dust from wind erosion processes and combustion aerosol from burning of fossil fuels and biomass can transport long distance from continental source regions to oceans and other continents, exerting far-reaching impacts on air quality, human health, radiation budget, biogeochemical cycle, and climate. Sources of Aeolian dust and combustion aerosol have been changing on a regional basis in response to changes in meteorological conditions and environmental regulations. This study characterizes inter-annual variability and trend of Aeolian dust and combustion aerosol in major outflow regions over the 2000-2016 period using both satellite observations and model simulations. Because of great spatial and temporal coverage, satellites are an ideal platform for characterizing the aerosol long-range transport phenomena and assessing their consequences. A more than decade-long record of aerosol over global ocean, dust and combustion aerosol separately, has been recently derived from both MODIS-Terra (since 2000) and MODIS-Aqua (since 2002) Collection 6 aerosol products. This MODIS dataset has been used to examine the inter-annual variability and possible trend of Aeolian dust and combustion aerosol over more than a dozen major continental outflow regions. We have also used the satellite-observed inter-annual variability and trend to evaluate aerosol historic simulations by the Community Atmospheric Model - version 5 (CAM5), in which a tagging technique is implemented to trace combustion aerosol to 14 source regions. Our analysis shows a consistency between the satellite observations and the model in the inter-annual variability and trend of Aeolian dust and combustion aerosol. The MODIS-based characterization of dust inter-annual variability is corroborated by observations from other satellite sensors including MISR, CALIOP, and IASI.

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COMBINING LC-MS AND GC-MS MEASUREMENTS TO ANALYSE HOUSE DUST FOR PHTHALATE BASED PLASTICIZERS, ORGANOPHOSPHORUS FLAME RETARDANTS AND ALTERNATIVE PLASTICIZERS

Maria Hoppe* (1), Ludwig Gruber (1)

(1) Fraunhofer IVV

House dust is a very complex matrix. Likely main constituents are human skin cells and furniture abrasion or small soil particles, but also dust mite fecals, insect fragments, and air-delivered pollen and mold. These particles serve as absorption surface for a huge amount of artificial compounds which are present in various objects of every day life. We developed a method to analyse house dust for 34 compounds from the groups of phthalate based plasticizers, organophosphorus flame retardants, synthetic musk substances and alternative plasticizers for GerES (German environmental health study of children and adolescents) carried out by Germany's central environmental authority. [1]

The difficulty here was to create a robust and reliable analytical routine to analyse house dust from different house holds for all these compounds. We chose a combination of GC-MS and LC-MS with a number of different control points between these two methods. To validate our approach we carried out an inter-laboratory comparison with several independent laboratories.

The methodological approach was the following: A sieving was performed to get the < 63 µm fraction of the dust sample, which was collected by a vacuum cleaner. Extraction procedures with different solvents revealed complete extraction.[2] Acetonitrile was chosen for preparation of LC-MS samples, whereas n-hexane was used to prepare GC-MS samples of the house dust. Highly volatile low molecular weight substances were analysed with GC-MS, low volatile high molecular weight substances were analysed using LC-MS. Some substances could be analysed with both methods and were chosen to constantly cross-control points between the two analysis approaches. We used five internal standards for quantification and recovery control.
For the inter-laboratory comparison a mixed house dust sample from eight individual samples was mixed. These samples showed high concentrations in DIBP, DBP, BBP, DEHP, DPHP, DEHA, ATBC, TEHTM and TBEP with DEHP and DPHP as the most abundant compounds with 240 – 1240 µg/g and 239 – 941 µg/g, respectively. Although a low number of laboratories took part in these the study we revealed that the statistical determined analyte concentrations might represent the real concentrations.

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DRY LAKE BEDS RETRIEVAL AND DETECTION OF DUST EMISSION FROM DESERT STEPPE USING REMOTELY SENSED DATA

Buho Hoshino* (1), Yuta Demura (2), Kenji Baba (1), Christopher McCarthy (3), Yuki Sofue (4), Kenji Kai (5), Purevsuren Tsedendamba (2), Jun Noda (6), Katsuro Hagiwara (6), Keita Shima (1)

(1) Department of Environmental Symbiotic College of Agriculture, Food and Environment Sciences, Rakuno Gakuen University, (2) Rakuno Gakuen university, (3) Graduate School of Global Environmental Studies, Kyoto University, Japan, (4) Graduate School of Science, Chiba University, (5) Graduate School of Environmental Studies, Nagoya University, (6) School of Veterinary Medicine, Rakuno Gakuen University

The influence of climate change on inland Asia is primarily dryness and desertification. Long drying caused many rivers and lakes to dry up and the dry river basin and dry lake beds are hotspots of dust emission. In the Mongolian Plateau, the desert steppe, rocky mountains and dry lakebeds surfaces may affect the process of dust storm emissions. Among the three surface types, dry lake beds are considered to contribute a substantial amount of global dust emissions and to be responsible for “hot spots” of dust outbreaks. The land cover types in the study area were broadly divided into three types such as desert steppe, rocky mountains, and dry lake beds by a classification based on Normalized Difference Water Index (NDWI) calculated from MODIS Terra satellite images, and Digital Elevation Model (DEM). This dry lake beds extracting method using remote sensing offers a new technique for identifying dust hot spots and potential untapped groundwater in the dry lands of the Gobi region. In the study area, frequencies of dry lake beds occurrence were calculated during the years 2001 to 2014. The potential dry lake area corresponded well with the length of the river network based on hydrogeological characterization ($R2 = 0.77$, $p < .001$). We assume that precipitation during a dry period and precipitation during a wet period influence the frequency of dry lake occurrence. Precipitation is one of the most important factors for growth of plants especially in arid and semi-arid regions. In this study, we show that vegetation in the arid and semi-arid Gobi region is sensitive to the dynamics of precipitation. Using satellite imagery we analyzed the space-time features of seasonal vegetation evolution and anomaly patterns from 1985 to 2013. Cross correlation analysis was used to evaluate the response of vegetation to precipitation. We found that vegetation in low precipitation areas such as around Gansu in China was degraded than that in high precipitation areas.

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INTERANNUAL VARIABILITY AND LONG-TERM TRENDS OF AEROSOL LOADING OVER NORTH AFRICA BASED UPON AEROSOL PRODUCTS FROM SEAWIFS, MODIS AND VIIRS

Christina Hsu* (1), Andrew Sayer (2), Jaehwa Lee (3), Vincent Kim (3)

(1) NASA GSFC, (2) NASA GSFC/USRA, (3) NASA GSFC/ESSIC

The impact of natural and anthropogenic sources of mineral dust has gained increasing attention from scientific communities in recent years. Indeed, mineral dust not only perturb Earth's radiative energy balance by interacting with solar and terrestrial radiation, but also could have adversary effects on air quality and human health. With the launch of SeaWiFS in 1997, Terra/MODIS in 1999, Aqua/MODIS in 2002, and NPP/VIIRS in 2011, high quality comprehensive aerosol climatology is becoming feasible for the first time. As a result of these unprecedented data records, studies of the radiative and biogeochemical effects due to tropospheric aerosols are now possible. In this study, we will demonstrate how this newly available SeaWiFS/MODIS/VIIRS aerosol climatology can be useful in estimating the trends and interannual variability of aerosol loading over North Africa. The monthly averaged aerosol optical thickness from SeaWiFS will be compared with the recently released MODIS C6.1 as well as VIIRS Deep Blue products to investigate if any systematic biases may exist between SeaWiFS, MODIS C6.1, and VIIRS products for trend analysis. Finally, the effect of atmospheric dynamics in modulating the interannual variability of mineral dust loading over this region will be discussed.

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INFLUENCE OF PARTICLE SIZE ON WATER UPTAKE ON NATURAL MINERAL DUST AEROSOLS

Sara Ibrahim (1), Manolis Romanias (1), Laurent Alleman (1), Mohamad Zeineddine (1), Giasemi Angeli (2), Pantelis Trikalitis (2), Frederic Thevenet* (1)

(1) Institut Mines Telecom Lille Douai, (2) University of Crete

The interaction between dust particles and water molecules is a subject of interest for the atmospheric community. However, the influence of particles size on the hygroscopicity of mineral particles is poorly evaluated. In the current study, Diffused Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS) is used to study in-situ the adsorption of water molecules on natural Arizona Test Dust (ATD) particles.

Five ATD dust grades are used with different size ranges, 0-3, 5-10, 10-20, 20-40 and 40-80 micron, corresponding to the whole range of uplifted mineral particles in the atmosphere (<100 micron). N2 sorption measurements, particles size distribution and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) analyses are performed to determine the physicochemical properties of the samples. The water adsorption experiments are conducted in an optical cell under flow conditions at room temperature and under the relative humidity (RH) range from 2 to 90 %. Experimental results are simulated with the modified 3-parameter Brunauer-Emmet-Teller (BET) equation.

Water monolayers (ML) are found to be formed at 13%, 17%, 22%, 25% and 28% RH respectively for ATD 0-3, 5-10, 10-20, 20-40 and 40-80 micron respectively. Additional water layers are formed at higher RH conditions. Besides, the standard enthalpies of water adsorption onto the various ATD samples are determined. Thorough comparisons point that smaller particles adsorb water more efficiently. To better assess the impact of size on water uptake, a series of desorption experiments are performed at room temperature. The water desorption follows 2nd order kinetics, the results are fitted to determine desorption rate coefficients for each dust grade.

As a conclusion, results evidence that particle size is a key factor influencing water uptake onto mineral dust. Thus, it is a determining factor of mineral dust hygroscopic properties and it directly impacts the aerosol heterogeneous physics and chemistry.

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A HOT-AIR BALLOON OBSERVATIONS OF SOOT, PM1, PM2.5, AND PM10 VERTICAL DISTRIBUTION IN URBAN BOUNDARY LAYER: A CASE STUDY OF THE SILESIAN METROPOLITAN AREA (POLAND)

Mariola Jablonska* (1), Janusz Janeczek (1), Natalia Ziola (1), Miroslaw Szczyrba (1)

(1) Faculty of Earth Sciences, University of Silesia, Poland

The Silesian Metropolitan Area (SMA) is one of the largest European industrial and densely populated (1620 people/km2) urban centers inhabited by 3 million people. Many households still relay on coal-burning for heating and cooking. As a result coal-burning for domestic purposes accounts for 59% and 68% of PM10 and PM2.5 emission, respectively [1]. On-road transportation and industry are additional major sources of air pollution in the SMA. Combination of high emission of air pollutants with unfavorable meteorological conditions, i.e. windless and dry periods, low temperature and temperature inversion, often leads to severe smog during the so-called heating season, i.e. between mid-October and late-March. As a result, all pollution limits are significantly exceeded. The aim of this preliminary study is to determine the vertical extent of soot and particulate matter within the urban boundary layer by using hot air balloon as a measurements platform. Observations were made during two flights on November 16 and December 19, 2017. Results of measurements are summarized below:

Altitude [m a.g.l.]	PM10 [µg/m^3]		PM2.5 [µg/m^3]		PM1 [µg/m^3]		SOOT [ng/m^3]	
	Nov.*	Dec.**	Nov.*	Dec.**	Nov.*	Dec.**	Nov.*	Dec.**
2	155	114	97	81	74	68	12709	13277
250	75	62	55	44	42	35	7797	6867
550	1.5	33	0.89	30	0.46	35	94	1192
750	-	2	-	2	-	1.2	-	50

*November 16. Temperature and humidity at 2 m above ground level (a.g.l.) 8.3°C and 58%; at 500 m a.g.l. 12.4°C and 40%, respectively.
** December 19. Temperature and humidity at 2 m above ground level (a.g.l.) -0.1°C and 85%; at 750 m a.g.l. -4.3°C and 78%, respectively.

The concentration of particulate matter decreased with the height almost linearly, regardless of particles size fraction. However, there is a significant difference between observations in November and December. While in November, the amount of particulate matter at the altitude of 550 m was around 1% or less of the ground level value, in December concentrations at that height were still high (soot: 10%; PM between 28% and 51% of the ground level pollution). Concentrations in the range of 1-2% of the ground level values were recorded at 750 m a.g.l. The differences in both PM and soot vertical distributions between November and december observations can be explained by different meteorological conditions. During November flight there was a persistent temperature inversion ($\Delta T = 4^oC$) and low wind (<4km/h) resulting in a suppressed convection. That led to the accumulation of air pollutants in the first ca. 100 m-thick air layer and gradual decrease in PM above smog blanket. In December the vertical temperature gradient was normal ($\Delta T = -4^oC$) and upward transport of PM was undisturbed. As a result, PM and soot were transported to higher altitudes than in November. The vertical extent of air pollutants is important because it may affect their lateral extent due to advective transport.

[1] http://powietrze.katowice.wios.gov.pl

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IDENTIFICATION OF SPECIFIC SOURCES OF ANTHROPOGENIC PARTICULATE MATTER IN AN URBAN ENVIRONMENT BY A COMBINED MINERALOGICAL AND METEOROLOGICAL ANALYSES: A CASE STUDY FROM UPPER SILESIA, POLAND

Janusz Janeczek* (1), Mariola Jablonska (1), Mieczyslaw Lesniok (1)

(1) Faculty of Earth Sciences, University of Silesia, Poland

Specific industrial point sources of PM10 were identified by combining meteorological observations and mineralogical examination (XRD, SEM, TEM) of individual particles collected during six individual week-long sampling campaigns in 2011 in the most industrialized region of Poland. Major (>20 vol.%) and subordinate components of PM10 (soot, quartz, gypsum, aluminosilicates, Fe-oxides, dolomite, and Pb-chloride) occur in different proportions season-depending and are of limited use in the identification of the emission point sources. Some minor components (particles of Cd- and Tl-bearing ZnS, and of iron, steel, and Cu-Sn-Zn alloys) related to meteorological conditions enabled identification of a large zinc refinery (ca. 35 km NW of the sampling site) and two steelworks located close to (ca. 10 km NE) and relatively far (ca. 80 km SW) from the sampling site as the most probable emission point sources. Unusually high concentrations of ammonium chloride in PM10 observed on soot particles during smog episode in December 2011 can either be attributed to the release of ammonia and NOx from the nearby (ca. 10 km) coking plant or to the inefficient coal-burning for domestic purposes in the vicinity of the sampling site. Combination of meteorological data and mineralogical investigation of airborne individual particles can be helpful in identification of emission point sources using site-specific mineral tracers. It also enables distinguishing between sources of similar mineral tracers located in different sectors of wind rose. Mineralogical observations of PM not supported by meteorological data can only be used for assigning individual particles to the emission source category.

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HETEROGENEOUS OXIDATION OF SO2 AND NOX IN THE PRESENCE OF MINERAL DUST PARTICLES: CHAMBER STUDIES AND MODELLING

Myoseon Jang* (1), Zechen Yu (1)

(1) Department of Environmental Engineering Sciences, University of Florida, Gainesville, Florida 32611, USA

The surface of dust particles can act as an important sink for atmospheric trace gases such as NOx, SO2, O3, and organics. The photocatalytic ability of airborne mineral dust particles was known to heterogeneously promote atmospheric oxidation of SO2 and NOx, but prediction of this process was not fully taken into account by current models. Most research on dust photochemistry has been limited to qualitative studies and lacks kinetic mechanisms that promote the development of a predictive model. The Atmospheric Mineral Aerosol Reaction (AMAR) model was developed to capture the influence of air–suspended mineral dust particles on the formation of sulfate and nitrate in ambient environments. In the model, the oxidation of SO2 and NOx proceeds in three phases including the gas phase, the inorganic–salted aqueous phase (non–dust phase), and the dust phase. Dust chemistry begins with the adsorption–desorption kinetics (gas–particle partitioning) of SO2 and NO2. The reaction of adsorbed species occurs via two major paths: autoxidation in open air and photocatalytic mechanisms under UV light. The kinetic mechanism of autoxidation of tracers was first leveraged using controlled chamber data in the presence of mineral dust [i.e., Arizona Test Dust (ATD) or Gobi Desert Dust (GDD) particles] without UV light, and then extended to photochemistry. SO2 photooxidation was promoted by surface oxidants (OH radicals) that are generated via the photocatalysis of semiconducting metal oxides (electron-hole theory) of dust particles. This photocatalytic rate constant was derived from the integration of the combinational product of the dust absorbance spectrum and wave–dependent actinic flux for the full range of wavelengths of the light source. The suitability of the AMAR model was tested against sulfate formation in a large outdoor smog chamber (UF–APHOR) using natural sunlight. Based on model simulations, the formation of sulfate was sensitive to dust chemical characteristics (i.e., photo-activation capacity, buffering capacity, and hygroscopicity) as well as meteorological variables including temperature, humidity and sunlight intensity. At high NOx (>50 ppb with low hydrocarbons/NOx ratio), sulfate formation was significantly suppressed by the competition between NO2 and SO2 that both consume the dust–surface oxidants (OH radicals or ozone). Both the model and chamber data showed that dust particles were rapidly titrated by nitric acid and sulfuric acid under the typical urban environments and pass buffering capacity. The AMAR model of this study will vastly improve the prediction of sulfate and nitrate formation in regional and global scales where dust emissions are influential.

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VALIDATION OF EYE ONLY EXPOSURE CHAMBER FOR THE IDENTIFICATION OF ENVIRONMENTAL EYE DISEASE CAUSED BY PARTICULATE MATTER

Ki-Joon Jeon (1), Jong-sang Youn* (1), Sehyun Han (1)

(1) Inha University

An environmental disease is a disease that occurs due to environmental factors such as physical, chemical, and biological factors, and it is recognized that there is a correlation between environmentally harmful factors and disease through epidemiological investigation. Among them, environmental eye diseases are diseases caused by atmospheric environmental factors such as yellow dust and fine particles, and they cause dry eye syndrome and allergic conjunctivitis. Recent studies have shown that the incidence of environmental eye disease tends to increase gradually, but most of the studies are mainly based on statistical analysis using correlation analysis between pollutants and eye diseases. In the case of respiratory diseases, nonclinical studies using animal test chambers as well as statistical analysis have been performed. The purpose of this study is to investigate the effect of air pollutants on ocular diseases using animal test chambers (OECD Guideline 403/412, EPA OPPTS 870.1300.) to identify the mechanism and biomarker of environmental eye diseases.
The conventional ophthalmic toxicity assessment method is an eye dropping method, which is different from actual exposure. To compensate for this, a chamber-based eye disease model is constructed similar to the exposure method. Fine particles (PM10, PM2.5) should be concentrated in the eye and external exposure (respiratory, skin) should be minimized. The restraint equipment restricts the movement of the test animal and exposes only the eye area. The separate test space into clean/dirty zones supply clean air from the clean zone to breathe, and supply air containing fine dust in the dirty zone to shut down the external factors of the test. The uniform flow of the clean/ dirty zone was confirmed by the flow analysis inside the test chamber.

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INVESTIGATING WATER ADSORPTION ONTO NATURAL MINERAL DUST PARTICLES: LINKING DRIFT SPECTROSCOPY AND BET THEORY

Nitesh Joshi (1), Manolis Romanias* (1), Veronique Riffault (1), Frederic Thevenet (1)

(1) IMT Lille Douai, Université de Lille, SAGE, Département Sciences de l'Atmosphère et Génie de l'Environnement, 59000 Lille, France

The adsorption of water molecules on natural mineral dusts was investigated employing in-situ Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS). The natural dust samples originated from North and West Africa, Saudi Arabia and Gobi desert regions. Furthermore, the hygroscopicity of commercially available Arizona Test Dusts (ATDs) and Icelandic volcanic ash were examined. N2 sorption measurements, X-ray fluorescence and diffraction (XRF and XRD), as well as Inductively Coupled Plasma Mass Spectrometry (ICP-MS) analyses were performed to determine the physicochemical properties of the particles. The water adsorption experiments were conducted in an optical cell, at room temperature under the relative humidity (RH) range of 1.9 - 95%. Results were simulated using a modified three-parameter Brunauer-Emmett-Teller (BET) equation. Water monolayer (ML) was formed in the RH range of 15–25%, while additional water layers were formed at higher RH. Besides, the standard adsorption enthalpies of water onto natural mineral dust samples were determined. A thorough comparison of two commercially available ATD samples indicated that size distribution and/or porosity should play a key role in particle hygroscopicity. Regarding the natural mineral particles, Ca/Si ratios, and to a lesser extent Al/Si, Na/Si, Mg/Si ratios, were found to impact the minimum RH level required for water monolayer formation. These results suggest that the hygroscopic properties of investigated African dusts are quite similar over the whole investigated RH range. Furthermore, one of the major conclusions is that under most atmospheric relative humidity conditions, natural mineral samples are always covered with at least one layer of adsorbed water.

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DEVELOPMENT OF AN INNOVATIVE TECHNOLOGY FOR SEED DRESSING WITHOUT ABRASION OF ACTIVE INGREDIENTS

Christoph Kämpfer* (1), Dieter Von Hörsten (1)

(1) Julius Kühn-Institute, Institute for Application Techniques in Plant Protection, Braunschweig, Germany

Seed dressing is a highly efficient method of protecting the seed and germinating plant from fungal and animal pests and offers many advantages compared to spray applications. Since the seed dressing process applies the crop protection products directly to the grain, the contact area with the environment is significantly smaller. Thus, the seed dressing also reduces the negative influence on the environment and non-target organisms. At the same time, however, the necessary protection is achieved where it is needed. Seed dressing is therefore the preferred method for protecting the crop in germ and youth development. Therefore, the process represents a key position in the production of high-quality food, feed and renewable raw materials in modern agriculture [1].

However, in the last few years it has been shown that dust abrasion from the seed dressing layer can have a negative impact on the environment. For this reason, various efforts were made to reduce the abrasion of seed dressing dust containing active ingredients from plant protection products. However, even today it is still possible to detect the active ingredient in very small amounts of dust, which can have a negative influence on non-target organisms such as bees or aquatic organisms. One reason is that the seed is stressed mechanically and physically during, transport and sowing, which leads to the abrasion of dust particles from the dressing layer [1], [2], [3], [4]. These abrasion sources are difficult to influence by the seed treatment facilities and authorities. This means that even with high-quality dressed seeds from professional treatment facilities there is a danger of dust generation in the further processing chain.

Therefore it is necessary to improve seed dressing technology in order to prevent the release of seed dressing dust which contains active ingredients.

This goal can be achieved by different strategies. This research project aims at improving the adhesion of the dressing agent to the grain by improved adjuvants and by developing a new active substance-free covering layer for the dressed cereal seed. On the one hand, this is intended to reduce the abrasion of dust and, on the other hand, to ensure that the dust does not contain any residue of active ingredients. At the same time, germination and behaviour in the seed drill must not be negatively influenced and should be improved if possible.

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CONCEPT FOR EVALUATING THE DUST EMISSION OF INDIVIDUAL SOWING COULTERS ON UNIVERSAL PNEUMATIC SEED DRILLS

Christoph Kämpfer* (1), Dieter Von Hörsten (1), Dirk Rautmann (1)

(1) Julius Kühn-Institute, Institute for Application Techniques in Plant Protection, Braunschweig, Germany

It has been known for some years that dust abrasion from dressed seeds can have a negative impact on the environment if it is released uncontrolled during seeding [1]. Pneumatic seed drills are considered critically in this context when seed dressing dust particles are transported and emitted via the pneumatic conveying system. While pneumatic precision seed drills with vacuum system have been technically modified and improved in the past few years to reduce the dust drift, universal seed drills with pneumatic conveying systems have rarely been examined [2]. In practice, however, this type of machine is state of the art in many companies. Large working widths can be realized with the pneumatic conveying system, as the seed can be transported from the seed tank to the coulters via a light tube system. However, it is difficult to separate seed dressing dust particles from the system with the assistance of filters, since seed and seed dressing dust particles use the same transport route up to the sowing coulters. As a result, seed dressing dust particles are mainly emitted from the sowing coulters of this type of machine, on the assumption that the rest of the transport system is free of leaks.
For this reason, the dust emission of individual sowing coulters should be examined on an indoor test bench. It should be tested whether the direction and quantity of dust emission depends on the type of coulter used and whether specific modifications of the coulter geometry can influence the direction and quantity of dust emission.
For this purpose, a Suffolk coulter, a disc coulter and a modified disc coulter were compared with each other. The coulters were mounted individually and stationary in the indoor test stand and the conveying air was enriched with a tracer substance. During operation, the test bench generated a perpendicular vertical air flow to the working direction of the coulter, with which the ejected tracer particles were transferred to a filter fleece (0.9 m x 1.5 m) attached to the bench. The filter fleece was divided into three vertical and five horizontal segments in order to make statements about the direction and quantity of the dust emission by determining the weight difference.
First results indicate that with the chosen method, differences between individual coulters can be found with regard to their dust emission. In the coulters examined, it was also possible to show that the Suffolk coulter emits the conveying air and dust particles very close to the soil. Due to its geometry, the disc coulter emits the dust particles to the top filter segments. However, a targeted modification for air deflection of the disc coulter makes it possible to redirect the conveying air and particle emission into the lower filter fleece segments. The relevance of these findings on the dust drift in field tests must be demonstrated by further studies.

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XMED-DRY – A CROSS-MEDITERRANEAN DRY DEPOSITION MEASUREMENT NETWORK: FIRST RESULTS

K. Kandler* (1), J. De La Rosa (2), R. Torres-Sanchez (2), M. Aviles (2), A. M. Sanchez De La Campa (2), A. Alastuey (3), N. Perez (3), C. Reche (3), X. Querol (3), M.-D. Loye-Pilot (4), M. Scerri (1, 5), M. Nolle (5), P. Ielpo (6), F. De Tomasi (7), K. Eleftheriadis (8), V. Vassilatou (8), I. Stavroulas (9), M. Pikridas (9), A. Maisser (9), J. Sciare (9), K. Schneiders (1), T. Dirsch (1)

(1) Applied Geosciences, Technische Universität Darmstadt, (2) CIQSO, University of Huelva, (3) IDAEA-CSIC, Barcelona, (4) CERES, Ecole Normale Supérieure, Paris, (5) Environment and Resources Authority, Malta, (6) Institute of Atmospheric Sciences and Climate of CNR, Lecce, (7) Dipartimento di Matematica e Fisica, Università del Salento, (8) Nuclear Radiological Sciences & Technology, Energy & Safety, Agia Paraskevi, (9) EEWRC, The Cyprus Institute, Nicosia

Dry deposition is one of the two major pathways for aerosol particles to be removed from the atmosphere and be transferred into another compartment. Depending on the precipitation pattern and thus, locality, it can dominate then total aerosol flux. Still, measurements of dry deposition with sub-weekly time resolution are rare, as usually the mass collected during this period is too low.
For XMed-Dry, a set of seven new dry deposition-only collectors were installed at different locations across the Mediterranean (Huelva, Barcelona, Spain; Île-Rousse, France; Gozo Island, Malta; Lecce, Italy; Athens, Greece; Nicosia, Cyprus) to capture spatial and temporal variability. Sampling was performed on a 3-times-per-week schedule. Particles deposited on a 25 mm pure carbon adhesive protected from wet deposition by a shelter and an active closing mechanism during rain. The carbon adhesive was subject to electron microscopy with energy-dispersive X-ray analysis to obtain size, shape and elemental composition of single particles. Several hundred to several thousand particles were analyzed for each sample.
First results show that deposition consists of a highly variable mixture of sea-salt, sulfate, mineral dust, metal oxides and biological material, depending on location, season and meteorological situation. Moreover, different state of ageing of sea-salt was detected by the single particle analysis. Statistical back-trajectory analyses allowed for the discrimination of potential source regions for different compounds. The latter showed that particles of similar chemical composition, but different size can have different origin, e.g., in Gozo large ($d>4\mu m$) iron-rich particles (possibly fly-ashes) have probably SE European origin, whereas small iron-rich ones originate from the Saharan desert. Also, for the same receptor location, S-rich sea-salt particles were originating from Italy and SE Europa, while the more pristine ones were produced locally or coming from the Atlantic Ocean.

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DETERMINING MIXING STATE AND AGING OF SAHARAN DUST TRANSPORTED ACROSS THE ATLANTIC OCEAN BY MEANS OF ELECTRON MICROSCOPY

K. Kandler* (1), M. Hartmann (1), K. Schneiders (1), M. Prass (2), C. Pöhlker (2)

(1) Institute for Applied Geosciences, Technical University Darmstadt, DE-64287, Darmstadt, Germany, (2) Max Planck Institute for Chemistry, Multiphase Chemistry Department, D-55128 Mainz

Mineral dust aerosol particles become the focus of increasing scientific attention mainly due to their effect on the radiative budget and impact on biogeochemical cycles. African 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 sulfate 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 and during August 2016, at Ragged Point, Barbados (N 13.165, W 59.432) aerosol dry deposition was collected. Dry deposition was collected with a modified 'flat plate' sampler (Ott et al. 2008). With this type of sampler, aerosol particles larger than 0.5 µm diameter can be collected. Samples were analyzed by electron microscopy with X-ray fluorescence detection (Kandler et al. 2009) with a focus on the size range of 1 µm to 16 µm, which covers most of the deposited aerosol mass. As result, for each particle chemical composition, size and shape descriptors are available for approximately 63,000 particles.
Determining the mixing state from particles collected on a substrate should regard on-substrate mixture by coincidental particle deposition. A model was developed for simulating this coincidental mixture by a Monte Carlo approach, based on the unmixed particle abundances and their size distribution.
Dust, sea-salt and sulfates occurred at Barbados persistently in different proportions. Dust sources could be tracked back to African source areas by back-trajectory analysis, while as expected no distinct source area could be determined by this technique for the non-mineral components. An anthropogenic finger print of certain iron-rich particles was observed, when the air masses were crossing South America. Internal particle mixtures were found between dust and sea-salt, as well as between dust and sulfate. In June/July 2016, sea-salt mixtures were more frequent, in contrast to August 2016, when sulfate mixture prevailed. A distinct source region could not be identified, leading to the conclusion that internal particle mixture occurs at the end of the long-range transport, when dust from the Saharan Air Layer is mixed down to the surface with the marine boundary layer. This is corroborated by the still pristine nature of dust found in the Saharan Air Layer (Weinzierl et al. 2017).

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INDOOR AIR STUDY OF DUSTFALL FLUXES ON THE FOLIAR SURFACES OF SELECTED PLANTS AND THEIR EFFECTS IN DELHI

Ankita Katoch* (1), Umesh Kulshrestha (1)

(1) Jawaharlal Nehru University

Mineral dust is a predominant air pollutant in the Asian and African regions. High loadings of atmospheric dust lead to high levels of particulate matter in the air in these areas. Atmospheric dust not only affects atmospheric processes such as visibility, air quality, atmospheric chemistry and clouds, but it also poses a severe risk to human health when levels go higher than prescribed limits. Green plants are known to improve the quality of our environment by trapping and absorbing pollutants including dust. In urban areas, plants act as a sink for detoxifying air pollutants and also serve as dust platform. Dust retention on the foliar surface depends on the factors like plant height, canopy, leaf structure, leaf inclination and geometry, morphological characters such as hair, epicuticular wax, trichomes, cuticle etc. The present study includes three plants namely Ficus lyrata, Ficus elastica, and Schefflera, growing in polluted locations of Delhi (India). This study aims to find the average and seasonal dustfall fluxes (using gravimetric method) and the effects of this dustfall deposition on the surface morphology and other biochemical parameters related to the overall health of the plant. This study will help in characterising the tolerant species which survive better among the selected plants in heavily polluted environment. Such knowledge is crucial to mitigate particulate pollution in the urban areas especially in the indoor environment.

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DUST STORMS AND PM DISTRIBUTION AT THE CITY SCALE

Itzhak Katra* (1), Krasnov Helena (1), Yizhaq Hezi (2), Friger Michael (3)

(1) Department of Geography and Environmental Development, Ben-Gurion University, Israel, (2) Department of Solar Energy and Environmental Physics, BIDR, Ben-Gurion University, Israel, (3) Department of Public Health, Faculty of Health Sciences, Ben-Gurion University, Israel

The east Mediterranean is subjected to frequent dust storms and thus air pollution events. Several studies indicate on a trend of increase in the strength and frequency of dust-raising activity in this region during the last years. The predicted climate changes are expected to amplify this trend. Other studies in this region have shown clearly the impact of natural dust events on human health. Gaps remain in our knowledge about the distribution of dust-related PM concentrations at the city scale and inside buildings. This study focuses on dust analyses in urban environments in the northern Negev, Israel. Data were collected in-situ by set of mobile monitors and analysed for both dust days and non-dust days. The database was constructed using Geographic Information System and includes distributions of PM that were derived using statistical methods. A spatial analysis at the city scale showed significant variability in PM distributions during dust events. During the peak time of dust storm the differences in PM concentration between locations in the city can reach 400 μg m-3. An average daily net contribution of dust to PM10 of 122 μg m-3 was calculated for the entire study period. Real-time measurements inside buildings 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. The results serve to improve our understanding of dust storm behaviour with implications for air quality in urban environments and health issues. In addition, this study conducted in a semi-arid area that may serve as a case study for climate change scenarios, in which more (non-arid) regions will be subjected to frequent dust events.

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NUMERICAL MODELING OF CONCENTRATIONS IN AIR OF RADIOACTIVE AEROSOLS (PM10) FOLLOWING DUST EMISSIONS FROM CONTAMINATED TERRITORIES AROUND OBJECTS OF STORAGE OF RADIOACTIVE WASTE.

Aleksander Kchalchenkov* (1, 2), Ivan Kovalets (1, 2), Tatiana Lavrova (3), Sergey Todosienko (3)

(1) Institute of Mathematical Machines & Systems Problems NAS of Ukraine, (2) Ukrainian Centre of Environmental & Water Projects, (3) Ukrainian Hydrometeorological Institute

In this work we present the model of atmospheric transport of pollutions and model of source of radioactive aerosols which were created for assessment of radiation pollution from the contaminated territories of the former Pridneprovsky Chemical Plant (PChP) [1].
The simulation of source of radioactive aerosols was carried out by using empirical formula for PM10 flux depending on wind velocity [2]. This formula describes direct aerodynamic raising of fine particles (PM10) in the conditions of high humidity in the absence of a saltation of coarse particles, what corresponds to the main way of dust emission in the conditions of the PChP. Additional multipliers to consider properties of a covering have been added to a formula [3]. Territories of tailings and surrounding areas were divided onto elementary subsources and for each elementary subsource time dependent resuspension rate was estimated.
For calculation of atmospheric transfer we used diagnostic meteorological model CALMET and model of atmospheric transfer CALPUFF [4]. The CALMET meteorological preprocessor calculated spatially and temporally distributed meteorological fields on a computational grid required by ADM (including fields of micrometeorological parameters such as Monin-Obukhov Length) based on using measured meteorological data. For the calculation of atmospheric transport following release from an arbitrary quadrangle area source, CALPUFF used the semi-analytical 'Industrial Source Complex Short Term' (ISCST) algorithm. Calculation of the aerosols dry deposition had been carried out using parameterizations available in CALPUFF for PM10.
The results of simulations were compared to the averaged measurements of Ra-226 and U-238 concentration data. Atmospheric transport model with new model of source was able to reasonably reproduce average concentration of radionuclides. Results of calculations are suitable for an assessment of risks of the population and the developed methodology could be adapted and used for estimation of the influence of contaminated territories on air pollution due to resuspension

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MINERAL DUST SIZE DISTRIBUTIONS OBTAINED FROM BALLOON-BORNE OPTICAL PARTICLE COUNTER, AIRCRAFT AND REMOTE-SENSING MEASUREMENTS IN THE EASTERN MEDITERRANEAN

Maria Kezoudi* (1), Helen Smith (1), Alexandra Tsekeri (2), Joseph Ulanowski (1), Holger Baars (3), Bernadett Weinzierl (4), Matthias Tesche (1)

(1) University of Hertfordshire, UK, (2) National Observatory of Athens, Athens, Greece, (3) Leibniz Institute for Tropospheric Research, Leipzig, Germany, (4) University of Vienna, Vienna, Austria

Measurements of the size distribution of atmospheric aerosols and cloud particles are fundamental not only for understanding the physical processes governing aerosol-cloud interactions but also to gain statistical insight into their microphysical properties. The Universal Cloud and Aerosol Sounding System (UCASS) is a balloon-borne open-path optical particle counter developed at the University of Hertfordshire. In spring 2017, UCASS measurements of mineral dust particles have been performed from Crete and Cyprus during two campaigns in the eastern Mediterranean. Five soundings have been performed on coordination with lidar and sun photometer measurements during an outbreak of dust from western Africa that arrived at Cyprus between 20 and 22 April 2017. Dust mass concentrations of up to 1200 μg/m3 were observed during a UCASS launch from Limassol on 21 April 2017. Lidar measurements showed a dust layer height of 7 km with a dense filament of dust at 3 km height. The dust size distributions from UCASS soundings will be compared to coinciding independent measurements with research aircraft as well as to the ones retrieved by combining data from sun photometer and lidar using state-of-the-art retrieval algorithms such as GARRLiC, LiRIC, the AERONET inversion and POLIPHON. This allows to evaluate the performance of UCASS within different aerosol layers and to assess whether UCASS could be used as an affordable alternative to research aircraft for in-situ profiling of the size distribution of coarse aerosol particles.

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CHEMICAL PROCESSING AND NITRATE FORMATION IN HIGH-DUST ENVIRONMENT AT A HIGH- ALTITUDE SITE, MANORA PEAK, IN THE FOOT-HILLS OF THE CENTRAL HIMALAYA

Ram Kirpa* (1)

(1) Institute of Environment and Sustainable Development Banaras Hindu University

Mineral dust is one of the major components of atmospheric aerosols and contributes to nearly 30-50% of PM10 concentrations. However, the contribution of mineral dust could be even higher during a few episodic dust outbreaks. The heterogeneous reactions with acidic species can change the morphology and hygroscopic properties of mineral dust and more importantly, climate by changing optical properties due to change in mixing state of aerosols. A few recent studies have investigated on the changes in chemistry, chemical composition, morphology and hygroscopic properties of mineral dust on the heterogeneous reaction of single particles of CaCO3 with NO2 (in the presence of H2O) using various techniques such as Raman microscopy etc. However, real-time field observations and studies related to the heterogeneous reaction on mineral aerosol surface and changes in aerosol chemical composition are rather sparse. In this study, we provide a direct evidence of particulate NO3- formation on the mineral aerosol surfaces during a dust storm event at Manora Peak in June 2006, a high- altitude site in the foot-hills of the Central Himalaya. The abundances of TSP and carbonate carbon (CC), all indicator of presence of mineral dust, show a similar increasing trend for the samples collected during the dust storm days. In addition, a similar increasing trend was observed for Ca2+ and NO3- during the dust storm event which may be attributed to heterogeneous reaction of nitric acid (HNO3) with mineral dust and formation of calcium nitrate (Ca(NO3)2 in high-dust condition. The chemical processing enhances the solubility of mineral dust and thus, its ability to act as cloud condensation- and ice nuclei.

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CHALLENGES IN MONITORING PM10 CONCENTRATION CAUSED BY ATMOSPHERIC WATER VAPOUR

Gyula Kiss* (1), Kornélia Imre (1), Ádám Tóth (2), Ágnes Molnár (1)

(1) MTA-PE Air Chemistry Research Group, 8200 Veszprém, Hungary, (2) Department of Earth and Environmental Sciences, University of Pannonia, 8200 Veszprém, Hungary

Air pollution is a serious issue in cities but very often also in the countryside. The respirable fraction of atmospheric aerosol (particulate matter with aerodynamic diameter <10 μm, PM10) is one of the most hazardous air pollutants. Exposure to elevated concentrations of PM10 may lead to illnesses of - among others - the respiratory and circulatory systems.
According to the regulations of the European Commission operative at present the daily average of PM10 concentration should not exceed 50 μg m-3, while the upper limit for the yearly average is 40 μg m-3. In case the measured concentrations exceed the alert threshold special measures are taken in order to reduce the level of pollution (smog alert) that affect the way of life of the population as well as the economy. Although regulation is based on daily and annual average PM values, there is often need for PM data with higher temporal resolution, e.g., during air pollution episodes with high PM mass concentrations. The biggest uncertainty in the measurement of the PM mass concentration is caused by the fact that atmospheric water may significantly influence the mass of the aerosol particles as well as it can be adsorbed on and desorbed from the filter material used in PM monitors.
The objective of this research was the quantification of the error in the determination of PM mass concentration caused by the uptake of water vapour of the aerosol particles and the filter material itself. Quasi continuous PM10 monitoring was performed with a Thermo FH62C14 type particulate monitor working on the principle of beta attenuation while 24-hour average PM10 concentrations were obtained by using a Digitel DHA-80 high volume sampler and applying the reference gravimetric method. It was found that hourly PM data may be strongly distorted by the adsorption and desorption of atmospheric water vapour onto and from the filter used in the monitor. The measurement error in hourly PM10 readings arising from the interaction with water were found in the range of -53% …+69 % (Kiss et al., 2017). The 24-hour average PM10 concentrations obtained with the reference gravimetric method were also biased by 2-11% depending on the season and meteorological conditions.
In the presentation the bias in both hourly and 24-hour PM10 concentrations caused by water vapour will be shown and the relationship among the magnitude of the bias, the meteorological conditions and the chemical composition of the aerosol will be discussed. Possible solutions to reduce this error will also be overviewed.

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ELECTROSTATIC PRECIPITATION AIR CLEANING OF DUST EMISSIONS FROM ANIMAL PRODUCTION FACILITIES – A REVIEW

Reyna Knight (1), Lingying Zhao* (1)

(1) The Ohio State University

Animal production facilities are a significant emission source of dust, also called particulate matter (PM), aerosols, or bioaerosols. Dust emissions from animal facilities absorb odorous gases and carry microorganisms, and therefore are of both health and environmental concerns. Various mitigation technologies and management practices have been applied to control dust emissions from animal facilities, among which electrostatic precipitation shows great potential in effectiveness and feasibility. Electrostatic precipitation based air cleaning technologies have been effectively used in many industries that are inherently involved with particles, such as energy production, coal mining, painting, etc. The technology has also recently been developed for air cleaning of dust emissions or mitigation of microbial transmission to and from animal production facilities. Preliminary prototypes of electrostatic precipitation based air cleaning technologies in the literature include electrostatic space charge systems (ESCS), electrostatic precipitators (ESP), and electrostatic scrubbers (ESS). ESCS devices function by ionizing the air near points of ventilation and/or recirculation to create a significant space charge throughout the room, electrically charging dust particles to allow their collection on walls, floors, and other grounded surfaces. The ESCS system demonstrated limited effectiveness in large production facilities due to the lack of well controlled collection surfaces and entrainment of dust particles after losing their charges on the collecting surfaces. ESP systems work similarly to ESCS, but collect dust particles using collection plates with opposite charge. ESS systems charge spray droplets and use them to capture dust particles with a natural opposite charge. Spray droplets and dust particles collide and drop out of the air stream. Since agricultural dust particles are mostly organic and biological active, their collection requires much different designs and operations than that of electrostatic technologies used in other industries. Currently, the ESCS, ESP, and ESS dust control technologies are being developed and improved for effective dust control at animal production facilities. The preliminary prototype tests showed varied effectiveness in different animal production facilities depending on PM characteristics and local environmental conditions. This paper presents a comprehensive review of the state-of-the-art of the electrostatic dust control technologies and their applications in animal production facilities, in terms of design and modeling of electrostatic precipitation based air cleaning processes and systems, optimization techniques to improve PM collection efficiencies, effectiveness of applications in various facility types, economic analysis of electrostatic precipitation air cleaning technologies, and future research needs to address existing knowledge and technology gaps.

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PREDICTION OF MOBILIZATION AND SEDIMENTATION OF NATURAL AND ANTHROPOGENIC DUST ON THE EXAMPLE OF MOSCOW TERRITORY

Nikolai Kololodkin* (1), Gennady Glazunov (1)

(1) Lomonosow Moscow state university

Dust atmosphere pollution has a special way affects in megacities, reducing air quality, reducing the transparency of the atmosphere, changing the temperature background, has a negative impact on human health and toxicology on plants. Currently, when more than half of humanity live in cities, identifying sources, predicting the mobilization, transfer and sedimentation of dust is one of the key moments in the cities' ecology. We investigated the feasibility of using the theory of wind erosion created in the framework of the laws of mechanics of multiphase media by Gendugov V.M., Glazunov G.P., in modeling the prediction of dust mobilization / deposition, using the example of urban environments in Moscow city. To conduct the study, a new instrument was created-a portable cyclone aerodynamic device. During this work were determined the values characterizing the mobilization activity of possible dust sources - Uk min, r*, K**, f and Uk, α, Bk. Where Uk min, r*, K**, f - the fundamental indicators of the anti-deflation resistance of soils and grounds and Uk, α, Bk - parameters of zero-model of soil and grounds blowing in an air-dry state. It was first time determination of these parameters for soils and grounds at Moscow territory. Dust sites were identified, the duration of periods of active dusting of these sites was determined and their dependence on such factors as seasonal and weather (rain) changes, on the direction, duration and strength of the winds. In the the study, the dependence of the size of the mobilizing fractions on the strength of the wind was determined. The potential of natural filling of the atmosphere by the dust of soils and other land sources in Moscow has been determined. A map-scheme of dust areas, sources of dust is compiled with reference to them, which allow to predict the emission of dust (kg/m2/c).
Thus, within the framework of the work, a dust mobilization / precipitation model for large cities has been tested, which allows to predict the emission of dust depending on the types of dust sources, wind characteristics and climatic parameters.

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CELL PHONES AS DUST COLLECTORS - DUST POLLUTION SURVEY IN TWO POLISH CITIES: GDANSK AND KRAKOW

Piotr Konarski* (1), Katarzyna Olszewska-Czopik (1), Aleksander Zawada (1, 2), Maciej Miśnik (1, 3), Janusz Hałuszka (4), Bartosz Balcerzak (4), Monika Ścibor (4)

(1) Instytut Tele- i Radiotechniczny, (2) Military University of technology, Warsaw, Poland, (3) Gdansk University of Technology, (4) Institute of Public Health, Collegium Medicum, Jagiellonian University

Stationary dust collectors are commonly used to monitor dust pollution in the urban environment. However, monitoring dust pollution in the immediate vicinity of urban residents is not sufficiently developed. One solution is to use portable and personal dust monitors [1].
In the presented work, we use cellular telephones as dust collectors [2]. Samples of dust were extracted from internal parts of housings of used mobile phones. We collected samples from 273 used phones of different brands and models from residents of two Polish cities of Gdańsk (234 samples) and Kraków (39 samples). These two cities differ greatly in terms of air pollution.
We tested dust samples using the inductively coupled plasma mass spectrometry (ICPMS) technique using Quadrupole ICP-MS Elan DRC II, Perkin Elmer after mineralisation of samples with Milestone ETHOS Plus in 69% HNO3 (Merck) + 10% vol. of 36% H2O2. The results of this study allowed to determine the concentration of 39 elements from Li to U.
Some of the samples were also tested by the secondary ion mass spectrometry (SIMS) using SAJW-05 [3] and Hiden Workstation spectrometers. The SIMS technique allows for mapping of dust particles deposited on the high purity indium substrate. This technique allows also for the removal of subsequent atomic layers from the surface of individual particles. The obtained results allow to compare the elemental composition of the surface of particles with the elemental composition of the cores of particles, that is, they allow for the analysis of “core-shell” structure of dust particles.
In the presented study we also compared dust samples collected in the urban environment of the two cities using traditional methods. Dust samples were collected on the surface of quartz filters of stationary municipal monitoring stations and on teflon surfaces of the portable dust meters.
The results of comparisons will be discussed in the presented work.

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Atmospheric Dust - DUST 2018

CITY DUST (PM10) COMPOSITION AS AN IMPORTANT TOOL OF PLANNING A TOWNS ENVIRONMENT: MINERALOGY, LEAD-ISOTOPE AND PAH-COMPOSITION IN VIENNA

Martin Kralik* (1)

(1) University of Vienna

The air-quality including the quantity and sort of fine dispersed particles are important for the well being and the prosper development of inhabitants of major cities. The knowledge about the composition and source of emitted fine dust (<PM10) are important for planning and managements of large towns.
Due to improved filtering techniques the coarse dust emission was reduced considerably in cities in Central Europe. However, the very fine grained (<10 μm) and more dangerous dust emission has been reduced less or even increased in some places. Because of their small size as well as their shape and composition, dust particles may be harmful to the human respiratory system. High concentrations of some minerals themselves (asbestos, quartz etc.) or high heavy metal content as well as carcinogenic organic compounds (e.g. PAHs) frequently attached to them have noxious affects.
The most important natural and manmade particle sources in urban environments are materials eroded by wind (e.g. soils, plants and construction materials etc.), as well as industrial and traffic emissions. Speculation about their sources are frequently based on chemical data only. Very little is known about their mineral and organic phases. To improve the interpretation about the physical properties of the particles, their environmental behaviour and the health risks they may pose in future, the combined information of chemistry and mineralogy is essential.

The very fine-grained particles have been collected on “low blank” cellulose nitrate and glass fibre filters in a high-volume sampler or in a cascade impactor. Mineralogical composition was analysed by x-ray diffraction, Fourier Transformed Infra-Red analysis (FTIR) and Scanning Electron Microscopy (SEM). The trace elements and Pb-isotope composition were obtained by dissolving parts of the filters and subsequent analysis with ICP-MS. Glass fibre filters were extracted with supercritical CO2 and PAHs were analysed with GC-MS.

The dust samples consist of calcite, dolomite, quartz, organic matter (+soot), and gypsum as major phases, whereas illite-mica, chlorite and feldspar are minor phases (< 5%). Magnetite, goethite, brushite and epsomite were detected as well. Winter samples are more enriched in calcite, dolomite and gypsum. Summer samples are more enriched in particulate organic matter (POM). The mineral composition is partly influenced by geology (limestone or flysch sandstones) surrounding the sampling site. The considerable enrichment in As, Cd, Pb and Zn compared with the mean crustal crustal composition, as well as the lead isotope-ratio (207/206) indicate a fair mixture of emission from heating and gasoline combustion. In summer the gasoline emission dominates. The PAH-pattern supports the conclusion drawn from the heavy metal analysis.

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A THEORETICAL MODEL OF DUST LIFTING BY ATMOSPHERIC DUST DEVILS

Michael Kurgansky* (1)

(1) A.M. Obukhov Institute of Atmospheric Physics, Russian Academy of Sciences

Dust devils are thought to play an important role in the terrestrial and, especially, Martian environments due to their capacity of dust lifting into the atmosphere. Hereafter, the combined Rankine vortex model is applied to describe the radial profile of azimuthal velocity in atmospheric dust devils, and a simplified model version is proposed of the turbulent surface boundary layer beneath the Rankine vortex periphery that corresponds to the potential vortex. The consideration of the vortex periphery is important, since it is by its peripheral part that the dust-devil vortex at the first place sweeps out the ground surface. Based on the results [1], it is accepted that the radial velocity near the ground in the potential vortex greatly exceeds the azimuthal velocity, which makes tractable the problem of the surface shear stress determination, including the case of the turbulent surface boundary layer. The constructed model explains exceeding the threshold shear velocity for aeolian transport in typical dust-devil vortices both on Earth and on Mars [2].

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ASSESSMENT OF DUST DIRECT RADIATIVE EFFECTS IN THE MEDITERRANEAN REGION THROUGH CALIPSO SATELLITE MEASUREMENTS (2006-2017)

Tony Christian Landi* (1), Simone Lolli (2), Paolo Cristofanelli (1), Angela Marinoni (1), Paolo Bonasoni (1)

(1) CNR-ISAC, (2) CNR-IMAA/NASA-JCET

Aerosols play a fundamental role in the earth-atmosphere system radiation budget, especially in the Mediterranean, a region frequently exposed to dust outbreaks originating from Sahara desert. In this study we evaluate the dust direct radiative effects computed by the Fu-Liou-Gu atmospheric radiative transfer model, adequately adapted for lidar measurements, both at surface and at the top-of-the atmosphere. The dust direct radiative effects were computed respectively using the retrieved lidar extinction from Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP), the lidar on-board of Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO in the Mediterranean (46N-33S, 0E-20E) with 1x1 spatial resolution. The analysis put in evidence which spots are more prone to dust net forcing and their variability from 2006 to 2017. Starting from this point of view, the results of this study will serve as basis for future investigation to assess how dust presence in atmosphere is affecting cloud formation and lifetime.

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OZONE UPTAKE BY CLAY DUST UNDER ATMOSPHERIC CONDITIONS

Jerome Lasne* (1), Manolis Romanias (1), Frederic Thevenet (1)

(1) Institut Mines Telecom Lille Douai

Ozone (O3) plays a major role in the atmosphere of Earth. As a strong oxidant, tropospheric O3 is a threat to the health of living beings. During its journey in the lower layers of the atmosphere, O3 can encounter dust particles lifted by winds or storm events. Clays are widespread at the surface of Earth, and represent about half of atmospheric dust loading and fluxes [1]. Assessing the heterogeneous interaction of O3 with the surface of clay dust is therefore of crucial importance to comprehend the budget of tropospheric O3. The quantification of O3 uptake by dust is required to understand the global ozone cycle and also to implement models with laboratory data dealing with heterogeneous processes.

To this aim, we have investigated in the laboratory the heterogeneous interaction of O3 with natural clay dust surfaces of montmorillonite and kaolinite. A Coated-Wall Flow Tube reactor, recently developed in our group, was used to determine the uptake coefficient of O3 by clay dust surfaces in a broad range of O3 concentration (20 to 200 ppb), relative humidity (RH, 0 to 93%) and temperature (from -23 to 80 °C). Determined values of the uptake coefficient (< 10^-7) of O3 by clay dust surfaces are compared with literature data obtained using different experimental procedures, and their relevance is discussed. The uptake of O3 decreases on montmorillonite with increasing RH, but it is constant on kaolinite. These contrasting behaviours are discussed in connection with the structure and morphology of the clay samples. An increase of the uptake with temperature is observed on both surfaces. The results are presented and discussed with the perspective of their relevance to the atmosphere.

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INFLUENCE OF HUMIDITY AND UV-IRRADIATION ON SO2 UPTAKE BY VOLCANIC DUST

Jerome Lasne* (1), Manolis Romanias (1), Frederic Thevenet (1)

(1) Institut Mines Telecom Lille Douai

Volcanic eruptions release large amounts of dust in the atmosphere, accounting for up to 10% of the total primary aerosol emission. The accompanying outgassing emits mostly water, carbon dioxide and sulfur dioxide (SO2). During eruptions, SO2 concentrations can reach 1 ppm locally [1]. In this environment, SO2 can interact with volcanic dust (v-dust) in the presence of water vapour, and under UV light during the day. Assessing the heterogeneous interaction of SO2 with the surface of v-dust under UV-irradiation is therefore of crucial importance to comprehend its budget. Moreover, the quantification of SO2 uptake by v-dust is required to understand the global SO2 cycle and also to implement models with laboratory data dealing with heterogeneous processes [2].

To this aim, we have investigated in the laboratory the heterogeneous interaction of SO2 with the surface of natural Icelandic v-dust samples. A Coated-Wall Flow Tube reactor, recently developed in our group, was used to determine the uptake coefficient of SO2 by v-dust surfaces in a broad range of concentration (13 to 250 ppb) and relative humidity (RH, 0 to 72%). The impact of typical solar UV-irradiation on SO2 uptake was also investigated. Determined values of the uptake coefficient of SO2 by v-dust surfaces are lower than 5 × 10^-7. In spite of the fact that the steady-state uptake values are not modified by UV-irradiation, the total number of SO2 molecules taken up is greatly enhanced under simulated solar illumination. The results are presented and discussed with the perspective of their relevance to the atmosphere. Reaction mechanisms for SO2 uptake in presence of H2O and under UV-irradiation are proposed and discussed.

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A STUDY ON THE PERFORMANCE EVALUATION OF AIR CLEANER IN EDUCATIONAL FACILITIES

Hye-Won Lee* (1), Ji-Hoon Seo (1), Dong-Gun Lee (1), Hyun-Woo Jeon (1), Jong-Ryeul Sohn (1)

(1) Korea University

Schools where children spend most of their time are high density spaces with occupancy rates as high as 5 times that of the office and 8 times that of the house, and it is difficult to manage the indoor air quality because of the inflow of fine dust due to the activities of the students and their use of the schoolyard. So the government is supporting the installation of air cleaners in schools to reduce fine dust in schools.
Nowadays many kinds of air cleaners are being used in school. However studies to evaluate air cleaning performance of cleaners are essential to ensure air cleaners that are appropriate for school air purifying. Therefore this study evaluated the fine dust reduction efficiency by applying the wall mounted air cleaner in the classroom.
In this study PM10 and PM2.5 were measured before and after operating air cleaner using Grimm 1.108 at two elementary schools, one child care center from August 7 to september 8, 2017. It was measured at student's main activity time(09:00am~5:00pm). In the case of the elementary school, the measurement was performed at the care class, because period was the measurement period corresponded to the vacation. Statistical analysis was also performed using IBM SPSS Statistics 21 to ensure the statistical significance of the measurement data. Statistical significance was determined $p < 0.05$.
When the air cleaner was not operated in elementary school 1, the concentration of PM10 was 55.01 ± 10.47 μg/m3, and 19.14 ± 11.95 □/m3 when the air cleaner was operated. So the removal efficiency was 65%. In the case of PM2.5, the concentration was 32.48 ± 2.97 μg/m3 when the air cleaner was not operated and 4.90 ± 2.40 μg/m3 when it was operated. Removal efficiency was 85%. As a result, statistical analysis showed that the concentration difference between PM10 and PM2.5 before and after the operation of air cleaner was significant($p < 0.05$). So it was confirmed that the use of air cleaner is effective in reducing fine dust.
In elementary school 2, the concentration of PM10 when air cleaner was not operated was 16.88 ± 10.03 μg/m3, and 9.53 ± 6.57 μg/m3 when the air cleaner was operated. It shows 43% lower fine dust concentration than usual when the air cleaner was used. The concentration of PM2.5 before operating the air cleaner was 6.76 ± 2.37 μg/m3, and 2.92 ± 0.88 μg/m3 after the operation. It also showed 57% lower fine dust concentration than usual. The concentration difference of PM10 and PM2.5 was also statistically significant ($p < 0.05$).
Background concentration of PM10 in child care center was 72.10 ± 17.94 μg/m3, which is quite high. When air cleaner was operated, concentration of PM10 showed 43.59 ± 18.57 μg/m3 which is 40% lower than before. But also this value was highest among three facilities. Background concentration of pM2.5 was 33.98 ± 5.80 μg/m3, which is also high value. After the operation, concentration was 11.51± 2.90 μg/m3, 66% lower than before. But it was also highest value among three facilities. The operation of the air cleaner in the child care center was also effective in removing fine dust ($p < 0.05$).
The difference of PM10 and PM2.5 concentration was significant in all three facilities, and was confirmed that air cleaner is effective in removing fine dust in the classroom. However, because measurement was performed in care class due to the period of measurement, the lifestyle during the semester and vacation is different. And cause of the lack of numbers of school due to limitations of the study period, there is a problem in the representativeness and reliability. So the additional intensive evaluation is required.

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PM CHARACTERISATION IN A PILOT SITE IN THE AGRI VALLEY (BASILICATA, SOUTHERN ITALY)

Antonio Lettino (1), Rosa Caggiano (1), Antonio Speranza (1), Vito Summa* (1)

(1)) Istituto di Metodologie per l'Analisi Ambientale, Consiglio Nazionale delle Ricerche, Tito Scalo, Italy

The elements characterization of PM was performed on a pilot site in the Agri Valley which is close to the oil pre-treatment plant (C.O.V.A) of Europe's largest on-shore hydrocarbon reservoir. The pilot site was chosen also close to a urbanized areas, making it a representative site with respect to the potential risks of PM for human health and the environment [1]. The study measured a number of elements such as Al, Si, Sr, Ca, Ti, Fe Mg, etc. and characterized mineralogical and petrographical composition, relating to possible sources affecting the PM mixture. Moreover, key meteorological parameters were also considered such as atmospheric pressure, temperature, relative humidity and precipitations to monitor the sampling conditions. Results showed that the measured elements of PM could be grouped in characteristic sets, which were representative of different natural and anthropogenic sources affecting the PM in the Agri Valley.

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RELATIONSHIPS BETWEEN RAINWATER AND PARTICULATE MATTER IN THE VAL D'AGRI VALLEY (SOUTHERN ITALY): THE CONTRIBUTION OF MINERAL DUST AND ANTHROPOGENIC ACTIVITIES

Antonio Lettino (1), Giovanni Mongelli (2), Michele Paternoster (2), Rosa Sinisi (2), Antonio Speranza (1), Vito Summa* (1)

(1)) Istituto di Metodologie per l'Analisi Ambientale, Consiglio Nazionale delle Ricerche, Tito Scalo, Italy, (2) Dipartimento di Scienze, Università della Basilicata, Viale dell'Ateneo Lucano 10, 85100 Potenza, Italy

The understanding of the relationship between ambient particulate matter and rain water chemistry is a subject of growing interest mainly because they have adverse impacts on the environmental equilibrium of the planet, air quality and human health. In general, the chemical composition of rainwater is used to comprehend the source of dissolved chemical constituents and the local and regional dispersion of pollutants and, in addition, to evaluate the potential impact of these constituents on ecosystems. The mineralogy and geochemistry of single particles, their coatings and aggregation states may provide useful information on the relationships between size, composition and origin of the particulate matter [1]. In many cases, these information are also indicative of natural or anthropogenic source and are useful to estimate the elemental bioavailability and bioaccessibility. Regarding to this topic, we have conducted a study to assess the chemical characteristics of both aerosols and rainwater of the Agri Valley (Basilicata, southern Italy) in order to gain a better understanding of the contribution of different local sources. The Agri Valley is an area of international concern since it houses one of the largest European onshore reservoirs and the biggest oil/gas pre-treatment plant (Centro Olio Val d'Agri-COVA) within an anthropized context. The major element (Na^+, K^+, Ca^{2+}, Mg^{2+}, NH_4^+,Cl^-, NO_3^-, SO_4^{2-}) and trace element (Zn, Fe, Mn, Pb) concentrations of bulk precipitation from five different sampling sites within the study area were determined between November 2016 and March 2017. In the same time samples of airborne particulates with an aerodynamic equivalent diameter of 10 μm or less (PM10) were analyzed by means of a field emission scanning electron microscope (FESEM) equipped with an energy dispersive spectrometer (EDS) to characterise airborne particulates. These data were finally integrated with meteorological information (wind intensity and direction, air temperature, humidity, rainfall) and air-mass back trajectory analysis (500 m above mean sea level) based on HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory) model for aerosols. Our preliminary results suggest a possible geogenic source for the analysed elements mainly related to the silicate and carbonate mineral phases of the air-particles. However, in some samples an anthropogenic signal can not be excluded.

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CRYCONITES AS A SENSITIVE INDICATORS FOR RADIOACTIVE CONTAMINATION IN ARCTIC GLACIERS

Edyta Łokas* (1), Piotr Zagórski (2), Ireneusz Sobota (3), Krzysztof Zawierucha (4), Łukasz Pawłowski (5), Shiv, Mohan Singh (6), Wiesław Ziaja (7), Paweł Gaca (8)

(1) Institute of Nuclear Physics PAS, Krakow, Poland, (2) Marie Curie Sklodowska University, Lublin, Poland, (3) Nicholas Copernicus University, Toruń, Poland, (4) Adam Mickiewicz University in Poznań, Poznań, Poland, (5) University of Wroclaw, Wroclaw, Poland, (6) Earth System Science Organisation, National Centre for Antarctic and Ocean Research, India, (7) Jagiellonian University in Kracow, Kraków, Poland, (8) University of Southampton, Southampton, United Kingdom

Cryoconites are aggregates of mineral and organic substances on surfaces of glaciers, which are able to accumulate large amounts of airborne pollutants by binding them to extracellular polymeric substances secreted by microorganisms. The cryoconites are common in the ablation zones of glaciers, particularly those located at high latitudes and high altitudes. They accumulate dust eluted from the atmosphere by dry or/and wet precipitation. Because of their low albedo (Takeuchi 2002), cryoconites facilitate melting of ice leading to formation of holes on the glacier surface. The development and fate of cryoconites and cryoconite holes are closely interrelated with meltwater generation and with run-off on glacier surfaces. The cryoconite holes are less frequent in steep ablation-prone parts of glaciers where, due to the high volumes and energy of run-off, they cannot develop or have short lifespan (MacDonell and Fitzsimons 2012). The research was carried out in five areas of Spitsbergen (Kongsfiord, Kaffiøyra, Bellsund, Hornsund, Sorkapland). The cryoconites were collected from the western and southeastern Spitsbergen coast. Measurements conducted in such a variety of localizations influenced by different environmental conditions provide an opportunity to study the impact of glaciological characteristics on contaminant accumulation in cryoconites. In this study the contents of airborne radionuclides (137Cs, Pu isotopes, 210Pb) in cryoconites were determined. Cryoconites collected from two glaciers reveal the highest activity concentrations of the anthropogenic (137Cs, 238,239,240Pu) and natural (210Pb) radionuclides. Activity concentrations of the fallout radionuclides reach 4500 Bq/kg, 14 Bq/kg, 179 Bq/kg for 137Cs, 238Pu and 239+240Pu, respectively. Activity ratios of 238Pu/239+240Pu, 239+240Pu/137Cs are commonly used to identify and distinguish between global and regional sources of these radionuclides. The average activity ratios for 238Pu/239+240Pu are 0.060 suggesting contributions from other than the global fallout sources of plutonium. Global fallout of radionuclides from the atmospheric nuclear weapons testing was characterized by the 238Pu/239+240Pu activity ratios (for year 1973) of 0.025. The 239+240Pu/137Cs activity ratios are close to the value of 0.018 and are much lower than the decay-corrected value of ~0.06 expected for the year 2017. This points to possible other sources of 137Cs in these area. This study also reports the results of 240Pu/239Pu atomic ratio measurements in the cryoconites. The average atomic ratio of 240Pu/239Pu change within wide range - between 0.117 and 0.229 with the mean value of 0.144. The results are higher and lower values of 240Pu/239Pu atomic ratios than 0.180 expected for the global fallout (Mitchel 1997), indicating some regional influences on the Arctic fallout. Activity concentrations of the airborne radionuclides in cryoconites from Spitsbergen were higher than in the soils of Spitsbergen. The main source of anthropogenic radionuclides in the Arctic is the global fallout from atmospheric nuclear weapon tests and a local fallout from tests conducted at Novaya Zemlya. 210Pb in cryoconites is derived mainly from the atmospheric deposition and its activity concentrations reach high values, up to 13000 Bq/kg. Occurences of seemingly cryoconite-derived material with high radionuclide contents in the glacier forefront indicate that the cryoconite granules can be retained on glacier surface and deposited at the terminus after ice melts out (Łokas et al., 2017).

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AIR QUALITY MONITORING WITH A HIGH-RESOLUTION SPACE-TIME NETWORK

Nicoletta Lotrecchiano (1), Daniele Sofia* (2), Aristide Giuliano (1), Diego Barletta (2), Massimo Poletto (2)

(1) Sense Square, (2) University of Salerno

The increase in the anthropic burden in urban areas, including many activities which produce emissions in the air, such as vehicular traffic, domestic heating and industrial activities make it necessary to keep the concentration of some pollutants under control. Accurate measurements of the concentrations of these pollutants are important not only from an environmental point of view, but also for economical reasons, since a part of taxation may be dependent on the emission values [1] [2]. The monitoring networks defined by national regulations may not be sufficient to have a space defined and immediate picture of the state of the air in towns and to discriminate between sources. Therefore, it is becoming necessary to increase the number of measuring points and to make the instrumentation simpler and cheaper. In fact, low-cost sensors can allow the collection of a large amount of temporal and spatial data. Furthermore, a public handling of information from this sort of networks has the potential to bring citizens closer to the problem of air pollution [3].

In this work, data of 10 μm particulates taken from three monitoring stations located in three different positions in Salerno, a seaside town in southern Italy, were taken into consideration. Locations were chosen in order to address relevant human activities [4]. Criteria to validate of the a system for the monitoring of air quality monitoring system are proposed, with particular reference to the necessary characteristics of space intensity in the urban fabric. A model accounting for the main atmospheric phenomena was used to simulate the pollutant movements and, in particular the PM10 concentration in the monitored area. The model employes a Gaussian dispersion scheme for the prediction of 10 μm particulates concentrations. This model was compared with the experiments to check if it is able to describe the experimental observations. It turned out that that it is possible to successfully apply the model to correlate measurements.

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HEAVY METAL CONTAMINATION AND SOURCE APPORTIONMENT IN RE-SUSPENDED ROAD DUST FROM A TYPICAL MEDIUM-SIZED INDUSTRIAL CITY IN NORTHWESTERN CHINA

Xinwei Lu* (1), Dongqi Shi (2)

(1) Shaanxi Normal University, (2) Baoji University of Arts and Sciences

Dust is an important environmental medium in urban area. It often contains elevated heavy metals due to the influence of anthropogenic activities, such as fossil fuel combustion, metal smelting activities, construction activities, and traffic emission etc. The finer than 100 μm particles in road dust, also be known as re-suspended road dust, have more serious environmental detriment and health risk than coarser urban dusts. To know the contamination characteristics of heavy metals in the re-suspended road, the content, pollution level and source of heavy metals were determined in this work. The re-suspended road dust samples were collected from Baotou, a typical medium-sized industrial city in northwestern China and the contents of heavy metals Pb, Cu, Zn, Cr, Co, Ba, Mn and Ni were analyzed using X-ray fluorescence spectrometry. The pollution levels of the heavy metals were assessed using single pollution index and integrated pollution index. Their sources in the re-suspended road dust were determined by multivariate statistical analysis and multiple liner regression of absolute principal component scores. The results indicated that the contents of Ba, Co, Cr, Cu, Mn, Ni, Pb and Zn in the re-suspended road dust from Baotou ranged from 501.7 to 1873.5, 28.4 to 92.5, 132.7 to 510.5, 17.7 to 56.4, 381.7 to 938.7, 17.0 to 30.8, 26.2 to 127.0 and 21.7 to 137.8 mg/kg, with the mean of 1003.3, 54.2, 245.5, 31.6, 592.2, 24.0, 62.8 and 79.3 mg/kg, respectively. The mean contents of all heavy metals except for Ni and Mn measured in the dust were higher than their background values in local soil. The heavy metals presented different pollution levels in the dust. Co, Cu and Pb were high pollution, while Ba, Cu, Mn and Zn were middle pollution, and Ni was low pollution. The integrated pollution index of heavy metals in the re-suspended road dust ranged from 1.7 to 3.4 with the mean of 2.5, showing high pollution. Source analysis results indicated that Ba, Pb and Zn mainly originated from traffic source; Mn, Ni, Cu and Cr mainly came from the mixed source nature and industrial emission; and Co mainly originated from construction source. The contributions of traffic source, natural and industrial mix source, construction source and unknown anthropogenic source are respectively 45.5%, 39.0%, 3.7% and 11.8% to heavy metals in the re-suspended road dust. The study indicated that traffic and industrial activities had a predominant influence on local environment.

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THE WET DUST SAMPLER - EVALUATION OF A WATER-BASED METHOD FOR ROAD DUST SAMPLING

Joacim Lundberg* (1, 2), Göran Blomqvist (1), Mats Gustafsson (1), Sara Janhäll (3), Ida Järlskog (1)

(1) Swedish National Road and Transport Research Institute (VTI), (2) KTH - Royal Institute of Technology, (3) RISE - Research Institutes of Sweden

Emissions of PM is a well-known problem, with great impact on human health. One of the largest contributors is the road traffic. Due to stricter regulations for exhaust emissions, the relative importance of non-exhaust emissions is increasing. Abrasion wear of both pavements, tyres and brakes contribute to non-exhaust emissions. These particles are both directly emitted but also accumulated on the road surface as road dust load. This road dust is suspended through the road surface and tyre interaction as well as the turbulence introduced by the vehicle.

To allow for studies of the emission potential for road dust, the road dust load must be quantified. To quantify the total available dust load, a measurement device, the Wet Dust Sampler (WDS) [1] was developed. The WDS has since its development been used extensively for measurements in Sweden and has since then been updated. This updated version has also recently been exported to Norway and Finland.

The WDS basic principle of operation is to perform high pressure washing of a defined road surface area. This washing can be performed using regular water, or to allow for chemical analyses, distilled water. The sample is transferred into a storage container by the means of compressed air.

The evaluation of the WDS is done through several studies, including how different settings impact on the cleaning and sampling efficiency such as e.g. washing time, pressure settings etc. Of interest is also studies regarding the repeatability, surfaces texture influence on sampling efficiency, particle size cut-off, particle size distribution after sampling as well as investigating the possible retention of dust in the sampling system after sampling. Several initial studies have been performed with promising results. Examples are sampler settings' and pavement surface properties' impact on sampling efficiency. Initial results show that for three different surface types (Stone Mastic Asphalt, SMA, with maximum nominal size of 16, 8 and 6 respectively) less than 10% of the dust load is retained on the sampling surface.

The initial tests mentioned will be extended and presented in further detail.

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HEALTH EFFECTS OF AMBIENT PARTICULATE MATTER COMPONENTS

Chen Lung-Chi* (1), Harrington Andrea (2)

(1) NYU, (2) NASA

Particulate matter, an ambient air criteria pollutant, is a complex mixture of chemical components. We conducted four studies as part of HEI's integrated National Particle Component Toxicity (NPACT) Initiative research program. Data from the Chemical Speciation Net- work (CSN) enabled us to conduct a limited time-series epidemiologic study of short-term morbidity and mortality; and a study of the associations between long-term average pollutant concentrations and annual mortality. We also conducted a series of 6-month subchronic inhalation exposure studies (6 hours/day, 5 days/week) of PM2.5 concentrated 10X from ambient air (CAPs) with apolipoprotein E–deficient (ApoE-/-) mice (a mouse model of atherosclerosis). The CAPs studies were conducted in five different U.S. airsheds (New York City; Tuxedo, NY; East Lansing Michigan; Seattle Washington; Irvine, California); we measured the daily mass concentrations of PM2.5, black carbon (BC), and 16 elemental components in order to identify their sources and their roles in eliciting both short- and long-term health-related responses. In addition, from the same five airsheds we collected samples of coarse (PM10–2.5), fine (PM2.5–0.2), and ultrafine (PM0.2) particles. Aliquots of these samples were administered to cells in vitro and to mouse lungs in vivo (by aspiration) in order to determine their comparative acute effects.
Overall, the studies have demonstrated that the toxicity of PM is driven by a complex interaction of particle size range, geographic location, source category, and season. Across all studies, fossil-fuel combustion source categories were most consistently associated with both short- and long- term adverse effects of PM2.5 exposure. The components that originate from the Residual Oil Combustion and Traffic source categories were most closely associated with short-term effects; and components from the Coal Combustion category were more closely associated with long-term effects.
The results of these complementary studies, and the overall integrative analyses, provide a basis for guiding future research and for helping to determine more targeted emission controls for the PM components most hazardous to acute and chronic health. Application of the knowledge gained in this work may therefore contribute to an optimization of the public health benefits of future PM emission controls.

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IMPACT OF THE DIFFERENT LIDAR TECHNIQUE/DATA PROCESSING IN AEROSOL DUST DIRECT RADIATIVE EFFECT CALCULATIONS

Fabio Madonna (1), Simone Lolli* (2), Marco Rosoldi (1), James Campbell (3), Ellsworth J. Welton (4), Gelsomina Pappalardo (1)

(1) Institute of Methodologies for Environmental Analysis (IMAA), National Research Council (CNR), (2) CNR-IMAA/NASA-JCET, (3) Naval Research Lab, Monterey, CA, USA, (4) NASA Goddard Space Fligth Center

Since ten years lidar instruments, both from ground and from space, are more and more employed to retrieve aerosol and cloud atmospheric profiles of their optical properties. Recently, multi-yearly lidar retrieved extinction profiles are used as input in the atmospheric radiative transfer models to compute the aerosol and cloud direct radiative effect. Those results are of particular importance as they will partially help to reduce the uncertainty in temperature raise predictions of the climate change models. In this study we quantify for the first time how the different lidar technique (e. g. Raman vs. elastic) and data processing influence the result on dust direct radiative effect calculations through the Fu-Liou-Gu 1-D radiative transfer model. This is important in view of the new (GALION) or existing ground-based networks (e. g. EARLINET and MPLNET) and space missions (e. g. CALIPSO; EarthCARE) involving lidar instruments.

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INTERCOMPARISON OF MULTI-WAVELENGTH RAMAN LIDARS, AUTOMATIC LIDARS AND CEILOMETERS IN THE FRAME OF INTERACT-II

Madonna Fabio* (1), Rosoldi Marco (1), Lolli Simone (1), Amato Francesco (1), Vande Hey Joshua (2), Dillon Ranvir (2), Pappalardo Gelsomina (1), Zheng Yunhui (3), Bretelle Mike (4)

(1) Istituto di Metodologie per l'Analisi Ambientale, Consiglio Nazionale delle Ricerche (CNR-IMAA), (2) University of Leicester, Leicester, UK, (3) Sigma Space Corporation, Lanham, MD, US, (4) Campbell Scientific

Since a few years, the scientific community is working to understand to what extent automatic lidars and ceilometers (ALCs) are able to provide an estimation of the aerosol geometric and optical properties and fill in the geographical gaps of the existing advanced lidar networks. To this purpose, intercomparison experiments must be designed to assess the performances of commercial systems with respect to advanced multi-wavelength lidars and to ensure comparability between different instruments, measurements and retrieval techniques. Within this scenario and in continuity the effort spent during the INTERACT (INTERcomparison of Aerosol and Cloud Tracking) campaign (Madonna et al., 2015), the INTERACT-II campaign used multi-wavelength Raman lidar measurements to assess the performance of an automatic compact micro-pulse lidar (MiniMPL) and two ceilometers (CL51 and CS135), respectively, to provide reliable information about optical and geometric atmospheric aerosol properties. The campaign took place at CIAO, the CNR-IMAA Atmospheric Observatory (760 m asl, 40.60° N, 15.72° E), in the framework of the ACTRIS-2 (Aerosol Clouds Trace gases Research InfraStructure) H2020 project. Co-located simultaneous measurements involving a MiniMPL, two ceilometers, and two EARLINET (European Aerosol Research Lidar NETwork) multi-wavelength Raman lidars were performed from July to December 2016. During this period, various pure or mixed aerosol types have been observed at CIAO in the both the boundary layer and the free troposphere, such as mineral dust, biomass burning, continental, rural and pollution (Madonna et al., 2017).
The comparison between the MiniMPL and the CIAO EARLINET lidars showed an agreement within 10-15 % in the values of the Range-Corrected signal, with a good stability of the MiniMPL during the whole duration of the campaign. The CL51 ceilometer showed a much better performance than the previous generation of Vaisala ceilometers. The CL51 appeared to have the capability to detect the molecular signal in the free troposphere over an integration time of 1-2 hours. Nevertheless, signal distortions can have a large effect on the molecular calibration even after dark current subtraction. The CS135 showed improvements compared to the prototype tested during INTERACT-I. Its performance was similar to the CL51 in the region below 2.0 km asl (within 20-30% of the MUSA/PEARL attenuated backscatter). Both the ceilometers were corrected for the effect of the water vapor absorption bands at their operating wavelengths.
The experience gained during INTERACT-I and INTERACT-II confirms that ceilometers' good performances in the qualitatively monitoring of aerosols in the boundary layer with enhanced profiling capabilities in the free troposphere only for the most advanced models. Nevertheless, the retrieval of aerosol attenuated backscatter (and of any related optical properties) appears to be often affected by the instrumental issues which must be improved by the manufacturers in cooperation with the scientific community. Compared to automatic (backscatter) lidars, more expensive but more powerful, the capability of ceilometers to fill in existing observational gaps within lidar networks is in continuous growth but it is still limited.

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INDOOR DUST DIRECT EXAMINATION (E.D.P.A.®) AND AGRI-FOOD PRODUCTIVE CHAIN

Gabriele Mannucci* (1), Simona Principato (2), Iolanda Moretta (3), Mario A. Principato (3)

(1) Landini Giuntini Spa, Città di Castello (PG)- Italy, (2) Urania Research Center, Perugia (Italy), (3) Department of Veterinary Medicine, University of Perugia (Italy)

The E.D.P.A. ® (Indoor Dust Direct Examination) is an innovative method for detecting traces of insects and mites in the dust of confined environments (1,2). Its usefulness in the search for environmental pathogenic arthropods has been known for some time, while little is known about its application in the industrial field, particularly in the agri-food productive chain. Reported herein is our experiment with the systematic use of E.D.P.A.® in the research for arthropods in a pet food factory, in a ham factory and in a dairy factory , in order to evaluate , objectively, the advantages of its application. In the pet food factory a fortnightly monitoring was carried out for one year, collecting environmental dusts from 17 fixed points of the production premises. The samples were soon examined through E.D.P.A.® in order to detect the possible presence of pests. In the ham and in the dairy factories, two kinds of sampling were carried out: one on the environment (in the maturing cells) and the other one on the food products, in two different times: two months before the end of the food maturing period and after the corrective measures were applied by spraying the ALISTAG™ protective food coating agent. The monitoring carried out in the pet food factory gave as a result the identification of larval outbreaks of some pests, such as Plodia interpunctella, Ephestia kuehniella, Tribolium confusum, Oryzaephilus surinamensis, Stegobium paniceum, revealing also a pest of recent spread in Italy, Necrobia rufipes. Where the infestation was low, no corrective action was taken; where the infestation was high and in the sites where the larval outbreaks were found, a targeted treatment was performed using pyrethroids. In the ham factory and in the dairy factory the examination of samples was useful to identify the species of the pest: Tyrophagus putrescentiae in the ham factory and Acarus siro in the dairy one. Moreover the infestation rate could be checked, which was strongly lowered after the application of ALISTAG™. The results emphasize how the use of E.D.P.A.® in the agri-food productive chain can allow to have the following advantages: 1) to identify the infesting species and their development outbreaks; 2) to monitor the infestation after the corrective actions carried out specifically; 3) to reduce the use of biocides; 4) to control the frequency of disinfestation and treatment sites; 5) to reduce the risk of infestation and damages to food products and raw materials; 6) finally, but not less important, to identify also the possible presence of pathogenic arthropods (e.g.Glycyphagus domesticus, Lepidoglyphus destructor, Cephalonomia gallicola) that can be responsible for occupational diseases, in particular entomodermatosis, in the sector operators. The systematic use of E.D.P.A.®, therefore, has shown not only an immediate effectiveness in identifying the infesting species and the rate of environmental infestation, but also a long-term efficacy, highlighted by a reduction of the infestation as a result of highly targeted corrective actions with the consequent reduction of the risks of expensive damages to goods and humans.

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CHEMICAL KINETICS OF THE UPTAKE OF ATMOSPHERIC TRACE GASES ON VOLCANIC ASH AND DUST: AN OVERVIEW

Elena Maters (1, 2), Pierre Delmelle (3), Michel J. Rossi* (4)

(1) Université Catholique de Louvain, (2) université du littoral côte d'Opale, (3) Université Catholique de Louvain La Neuve, (4) Paul Scherrer Institute

This talk will provide an overview on the chemical kinetics of uptake of gases on dust substrates using a Knudsen flow reactor. The used substrates span a large range from mineral dust and its laboratory models to volcanic ash and its proxies such as volcanic glasses. Specifically, calcium carbonate (CaCO3) as well as other proxies such as Kaolinite, Limestone, Arizona Test Dust, TiO2 and Saharan Dust deposited on the Capverdes have been used as substrates in uptake experiments of atmospheric trace gases such as CO2, HCl, HNO3 and SO2. Another aspect of heterogeneous interaction of gases with the interface of suspended atmospheric solids such as TiO2, volcanic ash and its proxies is to monitor uptake of different probe gases in order to characterize the molecular composition of the interface. Typical probe gases are trimethylamine, hydroxylamine, HCl, trifluoroacetic acid, NO2, O3 and others. The talk will highlight the role of adsorbed H2O and CO2 in heterogeneous reactions and the fact that these reactions are observed under reduced pressure. In conclusion, adsorbed H2O is not a limiting factor for gas uptake owing to its significant affinity to the investigated polar substrates and build-up of strongly-bound H2O. The low-pressure studies are in direct competition with aerosol flow tube studies that are cumbersome and offer limited insight into heterogeneous chemical mechanisms.

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COAL DUST FROM COAL TRAINS IN VANCOUVER, CANADA: NOVEL OBSERVATIONS WITH MINI-MICROPULSE LIDAR

Ian McKendry* (1), Kevin Akaoka (2), Julie Saxton (3), Paul Cottle (1)

(1) University of British Columbia, (2) EcoFish, Vancouver, (3) MetroVancouver

Transport of coal by train through residential neighbourhoods in Metro Vancouver, British Columbia, Canada may increase the possibility of exposure to particulate matter at different size ranges, with concomitant potential negative health impacts. This pilot study identifies and quantifies train impacts on particulate matter (PM) concentrations at a single location. Field work was conducted during August and September 2014, with the attributes of a subset of passing trains confirmed visually, and the majority of passages identified with audio data. In addition to fixed ground based monitors at distances 15 and 50 m from the train tracks, an horizontally pointing mini-micropulse lidar system was deployed on three days to make intensive backscatter measurements in an attempt to identify the zone of influence of train-generated PM. Ancillary wind and dustfall data were also utilized. Trains carrying coal are associated with a 5.3 (54%), 4.1 (33%), and 2.6 (17%) µgm-3 average increase in concentration over a 14 minute period compared to the average concentrations over the 10 minutes prior to and after a train passage ("control" or "background" conditions), for PM3, PM10, and PM20, respectively. In addition, for PM10 and PM20, concentrations during train passages of non-coal-carrying trains were not found to be significantly different from PM concentrations during control conditions. Presence of coal dust particles at the site was confirmed by dustfall measurements. Although enhancements of PM concentrations during 14 minute train passages were generally modest, passing coal trains occasionally enhanced concentrations at 50 m from the tracks by ~100 µgm-3. Results showed that not every train passage increased PM concentrations, and the effect appears to be highly dependent on wind direction, local meteorology and load related factors.

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JOINT ORIGIN OF TERRA ROSSA AND KARST, CLAY-FOR-LIMESTONE REPLACEMENT, AND EOLIAN DUST: NEW EVIDENCE

Enrique Merino* (1)

(1) Indiana University

Both the “residual” and the “sedimentary” theories of origin of terra rossa have problems. New field, petrographic, and paleomagnetic evidence indicates that terra rossa and bauxite form by _replacement_ of limestone by authigenic clay at a downward-moving reaction front (refs 1,2). The red clay’s major chemical elements, Al, Fe and Si, reach the reaction front in aqueous form and come from dissolution of clayey eolian dust deposited at the earth’s surface. The isovolumetric mass balance for the clay-for-limestone replacement releases acid which immediately leaches additional limestone and increases its local porosity/permeability, which accelerates further replacement. This triggers a reactive infiltration instability (ref 4) that should, theoretically, convert the downward moving reaction front into a self-organized set of wormholes, which merge into funnels, which merge into sinks, which merge into tower karst. This is the very morphology that in nature does contain the terra rossa itself, and beautifully explains why terra rossa and karst are associated worldwide.
Reaction-transport calculations of the dynamics of the replacement reaction front (ref 3) suggest that the front “sinks” into the underlying limestone at a rate of a few meters per million years. This agrees with paleomagnetic dating (ref 2) of the Bloomington, Indiana, terra rossa, and with plausible estimates of eolian dust deposition. Terra rossa may be easily eroded, uncovering the karst it has carved. A particular terra rossa formation, if not eroded, is to be regarded as the authigenic equivalent of a roughly similar amount of eolian clay dust that settled at the earth’s surface over a large time span.

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ARE LICHENS AND MOSSES BOTH GOOD BIO-MONITORS OF AIRBORNE DUST?

Jerzy Mietelski* (1), Katarzyna Szufa (1), Anna Cwanek (1), Maria Olech (2, 3)

(1) Institute of Nuclear Physics, Polish Academy of Sciences, Radzikowskiego 152, 31-342 Krakow , Poland, (2) Institute of Botany, Jagiellonian University, Zdzisław Czeppe Department of Polar Research and Documentation, Kopernika 27, 31-501 Krakow, Poland, (3) Institute of Biochemistry and Biophysics, Polish Academy of Sciences, Pawinskiego 5, 02-106 Warsaw, Poland

Lichens and mosses of various species are both usually considered a good passive bio-monitors for airborne dust since all are collecting fallout particles from air and are not supposed to uptake nutrients from substrate. Typically its considered that both are very conservative in terms that no release of trapped dust happened with time. In our studies conducted in polar environment (both Arctic and Antarctic) a differences in proportion between isotopes of different radioactive elements (namely 137Cs/239+240Pu activity ratio) are observed between lichens and mosses. Data from Antarctic (Tab. 1) shows, that mosses and lichens are not both conservatives in the same time in preserving information on atmospheric dust precipitation: it can be said that effectively cesium carried particles are less effectively trapped than plutonium-carries particle in lichens while compare to mosses or that mosses uptakes at least some cesium from soils. In course of many years of our studies the proportion remains almost constant. However, data from Arctic (Tab.1) suggests revers feature: relatively higher values of Cs/Pu are for lichens then for mosses. It seems, that one cannot assume that both lichens and mosses are equally good as bio-monitors for airborne dust fallout. Apparently the dust accumulation properties are different for different species (and thus different morphology) and might also depend on environmental conditions.

Table 1. 137Cs/239+240Pu mean activity concentration ratios determined for lichens and mosses samples collected in years 1980-2015 from Antarctic or Artctic environment (dacay corrected to day of sampling). In brackets SE for mean and number of samples n.

ANTARCTIC			
Year of sampling	Lichens	Mosses	Reference
1980-1988	12.5 (3.0, n=4)	29.0 (-, n=1)	[1,2]
1996-1998	8.4 (2.2, n=3)	36.0 (7.2, n=4)	[1]
2002	5.8 (1.1,n=4)	27.2 (8.0,n=8)	[2,4]
2006-2015	6.3 (2.1, n=7)	15.1 (3.8, n=7)	[3,4]
ARCTIC*			
2012-2013	281(61,n=40)	115(40, n=15)	[5]

*Excluded are samples affected by Fukushima fallout distinguished by presence of 134Cs.

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SOURCE ASSESSMENT OF AIRBORNE POLLUTANTS IN INDOOR DUST FROM PB-POLLUTED AREA BASED ON STABLE SULPHUR AND LEAD ISOTOPES

Miloš Miler* (1), Mateja Gosar (1)

(1) Geological Survey of Slovenia

The study is focused on the assessment of origin of sulphur- and lead-bearing material in attic and household dust from the area of Žerjav (northeastern Slovenia) by means of stable sulphur and lead isotope analyses. The Žerjav area was characterised by more than 500 years of Pb-Zn mining and smelting of primary sulphide Pb-ore and in the last 20 years by recycling of Pb-based waste and used Pb-acid batteries. Mining and Pb-ore smelting ceased in 1995, but recycling continued. In addition, there is a large mine waste deposit, which is currently being exploited for construction material. All these past and present-day activities have significantly contributed to contamination of various environmental compartments, including indoor dust, with sulphur dioxide and potentially toxic elements. Our objective was therefore to assess, which of these activities contributed the most to air pollution.

The most appropriate environmental medium to study past air pollution is dust accumulated in the attics of houses as it provides a historical record of different emission sources. Airborne pollutants are also well preserved in attic dust and protected from direct atmospheric conditions. Household dust reflects short-term pollution from currently active emission sources, however, it strongly depends on pathways and modes of introduction of pollutants into indoor environment.

At three sampling points in Žerjav, two composite samples of attic dust were collected from roof beams of old houses using a nylon scrub brush and two samples of household dust were collected from vacuum cleaner bags, used for vacuuming the surfaces in living spaces. Samples were dry-sieved to a fraction <0.125 mm, from which three density fractions were prepared using iodomethane, bromoform and methylene iodide: lighter fraction (mostly gypsum), intermediate fraction (mostly anhydrite) and heavy fraction (mostly Pb sulphates and sulphides).

Stable sulphur isotope analyses of sulphates and sulphides were performed at the G.G Hatch Stable Isotope Laboratory (University of Ottawa, Canada) using Delta XP isotope ratio mass spectrometer. Pb isotope analyses were performed at Bureau Veritas Minerals (Vancouver, Canada) using quadrupole-based ICP-MS and Queen's Facility for Isotope Research (Kingston, Canada) using a multicollector ICP-MS.

δ34S values confirmed that metallic sulphides and non-metallic sulphates (gypsum, anhydrite) in attic dust result predominantly from past primary Pb-smelting of original local sulphide ore, while those in household dust originate directly from local mine-waste material. Pb isotope ratios also confirm that Pb-bearing phases in attic and household dust mostly originate from mining and primary smelting of local Pb-ore. Active Pb-recycling has contributed only negligible amount of material so far.

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COMPARISON BETWEEN DESERT DUST DAY BEHAVIOR IN GUADELOUPE AND IN FRENCH GUYANA

Jack Molinie* (1), Lovely Euphrasie-Clotilde (1), Marie-Line Gobinddass (2), Tony Feuillard (1), Kathy Panechou-Pulcherie (3), France-Nor Brute (1)

(1) Université des Antilles/Large, (2) Université de Guyane/UMR espace Dev, (3) Observatoire Regional de l'Air de Guyane

Due to its impact on air quality, desert dust is the major pollutant affecting human health in the Caribbean Region and the Guyana basin. The presence of particles coming from Africa, lead to high mass concentrations of particle matter with diameter less than 10 µm (PM10). Using statistical analyses of air quality network data, performed with TEOMs and AOD values, Desert Dust Days (D3) have been defined for both areas.
A climatological study of dust events along the year has been done. The mean monthly number of D3 behavior of the Caribbean Island and the northern part of South America, of course reflect the dust seasonality difference of the two studied areas. Earlier in the year the D3 appears more numerous in French Guyana. This region is impacted by outbreaks related to Bodele activation by Harmattan winds. At the same time, the dust activity over Guadeloupe is very weak with small number of D3. During spring season, a transition is operated where D3 observed in the Caribbean take the lead and reach its mean maximum number in June-July.
Day to day back-trajectories of high D3 seasons have been drawn for both regions. Two preferential corridors of transportation over the Atlantic Ocean have been determined for the desert dust and compared with the seasonal average AOT provided by satellite images from MODIS.
The preferential corridors of transportation show a difference between the desert dust predominantly observed over Guadeloupe and over French Guyana. Taking into account the dust major source locations, this difference probably can be found in its mineral and chemical composition.

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

Jeffrey Munroe* (1)

(1) Department of Geology, Middlebury College, Middlebury, VT 05753, USA

Modern dust accumulating in the Uinta Mountains, a prominent sub-range of the Rocky Mountain system in the western United States, has been studied intensively since 2011. In October 2015, the original network of 4 passive dust samplers was expanded to 8. All samplers are a variation on the established marble dust trap design, specifically configured to work in this high precipitation environment. The collectors are located above modern treeline, at elevations from 3330 to 3800 m. Each sampler is emptied twice per year: a collection in early summer (June) represents winter dust, and a second collection in the fall (October) represents summer dust. Dust accumulation rates averaged 3.1 g/m2/yr in the winter of 2015-16, 7.5 g/m2/yr in the summer of 2016, and 2.2 g/m2/y in the winter of 2016-17. Thus, rates of dust deposition in the summer are roughly 3-times greater than during the winter. Ground-based temperature data loggers, co-located with the dust collectors, document that the collectors experience varying degrees of snow cover. The most exposed collector was covered just 10 days in the winter of 2016-17. In contrast, the most sheltered collector was snow-covered for 196 days. However, there is no relationship between the amount of dust accumulating in each collector and snow cover, suggesting that dust trapped within the snowpack still accumulates in the collector during snowmelt. X-ray diffraction analysis reveals a consistent mixture of quartz, feldspar, and illite in dust at all sites. Geochemical analysis with ICP-MS reveals that the rank order of major elements by mean abundance is Al (7.2%) > Fe > K > Mg > Ca > Na (1.1%). Si was not quantified. Modern dust is clearly enriched in mining-related elements relative to standard values in the universal crustal composite. The most enriched elements are Sn (19x), Cd (17x) and Zn (11x). Cu, Sb, and As are enriched ~5x. Certain elements exhibit unique enrichment patterns. For instance, Sn is most enriched in collectors at the east end of the range. Cd is enriched at the east and west ends relative to the central parts of the range. Zn is enriched in collectors on the south flank. Cu abundance is highest in the two west-most collectors, closest to a major copper mine. Values of Cd are highest at one particular collector in the southeast part of the range. Seasonal contrasts are also apparent. For example, Sn is more abundant in summer dust and is inconsistent in winter dust: values in winter 2016-17 were ~2x greater than in winter 2015-16.

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EVIDENCE OF LONG RANGE AEOLIAN TRANSPORT TO THE WESTERN AMAZON BASIN THROUGH THE HOLOCENE

Juliana Nogueira* (1, 2), Heitor Evangelista (1, 3), Claudio Valeriano (4), Abdelfettah Sifeddine (5, 3), Carla Neto (4), Gilberto Vaz (4), Luciane Moreira (3), Renato Cordeiro (3)

(1)) Laboratório de Radioecologia e Mudanças Globais - LARAMG, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, 20550-900, Brazil., (2) Programa de Pós Graduação em Geoquímica, Departamento de Geoquímica, Universidade Federal Fluminense, Rio de Janeiro, 24020-150, Brazil., (3) Departamento de Geoquímica, Universidade Federal Fluminense, Rio de Janeiro, 24020-150, Brazil., (4) Laboratório de Geocronologia e Isótopos Radiogênicos - LAGIR, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, 20550-900, Brazil., (5) Institut de Recherche pour le développement (IRD) Bondy, France.

Isotopic and Geochemical proxies determined in sediment core retrieved from a remote Amazon site (Pata Lake, located at the Seis Lagos Hill, in the State of Amazonas/Brazil) allowed to reconstruct the paleoclimate along the last ~7.5 kyr before the present, aiming identify potential atmospheric source in Holocene sediment deposits. This lake is located above a 300m hill in which the amount of water comes only from the local precipitation, being isolated from any drainage basin. Its geographic location is such that, depending on the season, can remain below the indirect influence of the Intertropical Convergence Zone – ITCZ (receiving low influence of NE trade winds) or under the indirect influence of ITCZ receiving, in theory, part of the dust flow coming from the Sahara region as the literature suggests. The mineral dust can be used as a proxy for atmospheric transport patterns over time, by tracing its source region using radiogenic isotopes rations (87Sr/86Sr and 143Nd/144Nd) [1]. Many authors suggest that the Amazon Basin receives great amounts of African dust coming from the Sahara region [2,3], although most of this conclusions are based in satellite images observations and air-mass trajectories models. Core length was 118 cm long, sliced in 1 cm layers and dated for 14C method. After that, we separated 27 samples to the radiogenic analysis of Sr and Nd. Samples were previous treated for the organic matter removal and chemistry separation of the isotopes of interest for further insertion at the Thermal Ionization Mass Spectrometer (TIMS). In order to identify most typical advections to Pata Lake, we analyzed backward air mass trajectories using the HYSPLIT model (“Hybrid Single Particle Lagrangian Integrated Trajectory” hosted at NOAA/NASA website). A database of most likely aeolian dust sources, as well as the rock that forms the lake, were computed for the radiogenic isotopes domains considering the ratios 87Sr/86Sr and 143Nd/144Nd. Lastly, we calculated the ITCZ average latitudinal positioning over the Atlantic Ocean for the last 10 years using the data for Interpolated Outgoing Longwave Radiation at the Equatorial Atlantic (NOAA data base). The theoretical data suggests that the trajectory pattern follows the temporal dynamics of the ITCZ position along the year, indicating that the origin of the trajectories that arrive at Pata Lake are modulated by the ITCZ position. Pata Lake receives exclusive influence of North African trajectories by December to April (southern ITCZ), while in May to September it receives influence of trajectories coming from Southern South America and Southern Africa (northern ITCZ) and October and November it receives mix influence of Northern Africa and Southern Africa. The radiogenic isotopic ratios showed mixed contributions from the local rock (weathering), Southern Africa and Southern South America (mainly from the Southern Volcanic Zone - SVZ), instead of, surprisingly, the Saharan region. These results points to a different aeolian dust source reaching at Western Amazon: although the observational data, based on satellite imagery and trajectories models, suggests a huge contribution of the Saharan dust to the Amazon, we propose that maybe this influence is more valid to the Eastern Amazon due to the humid deposition along the way above the continent.

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A MODEL FOR ATMOSPHERIC DUST ON PLANET MARS

Per Nørnberg* (1)

(1) Aarhus University

Neither from Earth nor from Martian orbit by e.g. ESA, Mars Express or NASA, MRO has it been possible to do spectroscopic observations which could selectively determine the mineralogical or chemical composition of the dust on the surface of Mars. Even in surface soil sampling detailed chemical or mineralogical information about the Martian dust cannot be separated from the soil. Remote spectroscopic data contain a mixture of mineralogical components which do not provide any specific information on the dust. Information about chemical composition and mineralogy of the Martian airborne dust was derived from APXS and Mössbauer data from the MER rovers by Goetz et al. (2005). This paper concluded that magnetite and not maghemite is the magnetic phase of the dust, and also that the presence of olivine indicates that liquid water did not play a dominant role in the formation of atmospheric dust. The dust is most likely formed by mechanical comminution comparable to the fine fractions of dust in dune sand on Earth (Nørnberg, P. 2002).
The particle size of the Mars dust is known from the Viking mission, and recalculated Viking data (Pollack, J.B. et al. 1995) gives particle radius of 1.52 – 1.85 μm depending upon the atmospheric situation. This is not substantially different from the first estimates in 1977, and not very different from the radius of 1.0 μm for much of the atmospheric dust < 40 km given by Guzewich, S.D. et al. (2014).
We suggest a Mars dust model consisting of particles (2-3 μm) that inside consists of primary minerals which are either oxidized down to tenths of nm below the surface or have captured electrically charged nanoparticles of hematite on the surface giving the dust its red colour. Experiments done by Merrison, J.P. et al. (2010) showed that mechanical tumbling (abrasion)of a mixture of 10g quartz and 1 g magnetite in a dry abrasion process in a Martian atmosphere transformed magnetite into hematite. This experiment supports the dry comminution process indicated by Goetz et al. (2005).
The XRD analyses on the NASA, MSL are done on a mixture of soil material in which the dust accounts for only a minor part. However, if dust could have been captured separately from the atmosphere e.g. by magnets on the MSL and taken off by e.g. tape or another mechanism that could be transferred into the target holder of the XRD diffractometer on the rover, it could by Rietveld analyses have provided valuable quantitative information on the mineral content of the dust.
So we still do not know whether the dust particles consist of primary minerals that are oxidized down to a certain depth in a dry oxidation process, or if the oxidation has taken place under influence of UV radiation. A third possibility is that the primary particles due to electrification of the dust have captured a coating of nano size particles of hematite.
We could come closer to a solution to these central questions by relatively simple modifications of future rover instrumentation.

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MINERALOGICAL AND CHEMICAL ANALYSIS OF ROAD SEDIMENT IN PHILADELPHIA, PA

Michael O'Shea* (1), David Vann (1), Sarah Haber (1), Reto Gieré (1)

(1) University of Pennsylvania, Department of Earth and Environmental Science, USA

Urban road sediment consists of accumulated particles on a metropolitan roadway derived from natural and anthropogenic sources (1). While road sediment from natural sources is commonly from soils and the surrounding geologic material, road sediment of anthropogenic origin typically originates from road traffic and construction materials (2). Road sediment can act as both sink and source of pollutants through the deposition and resuspension of the sediment, making it a potential indicator of urban environmental pollution (3,4). As road sediment is often enriched in heavy metals and other harmful substances, exposure poses a potential health hazard (5). People interact with road sediment through a combination of ingestion, epidermal contact, and inhalation (6). We sampled and characterized road sediment at 30 sites in Philadelphia, PA. The sites were chosen to determine the effect of varying levels of average annual daily traffic, proximity to industry, and location in the city on the mineralogical and chemical compositions of the road sediment at the sample sites. To analyze the samples, we utilized X-ray powder diffraction (XRD), loss on ignition, and inductively coupled optical emission spectrometry (ICP-OES) to determine mineral phases present, organic content, and elements present, respectively. XRD results demonstrate that quartz (SiO2), dolomite (CaAl2Si2O8), hematite (Fe2O3), anorthite (CaAl2Si2O8), and magnetite (Fe3O4) are present at a majority of the sample sites. Additionally, over 40 different mineral phases were discovered only once at various sample sites, showing that there is significant mineralogical variability in the road sediment studied. ICP-OES results indicate that there are nine sample sites at or above the EPA safety threshold for Pb in soil that children interact with (400 ppm). Philadelphia is an old industrial city with many potential Pb sources including smelters, Pb-based paint in buildings built before 1978 and sundry industrial activity. Compared to studies of Chinese, European, and Middle Eastern cities, the concentration of metals found in Philadelphia's road sediment has similar median Pb and Cr values but higher Zn and Cu levels (1-7) than road sediment from the international studies. Through a Pearson correlation of the metals present in Philadelphia, we found a statistically significant ($P<0.5$) correlation between Pb and Zn, Ti and V, Cu and Cr, Cu and Fe, Cr and K, and Fe and Ca. Through varimax rotated principal component analysis of the metals present in the road sediment, we found that five components explained over 95% of the variance in metals. The first three components are likely associated with anthropogenic activity, specifically traffic, because they include components driven by V and Ti as well as Pb and Zn. These metals are often associated with tire abrasion and traffic. The final two components are likely related to natural sources such as local geologic formations. Therefore, the majority of the variation in composition from site to site is likely due to differences in traffic. The Pearson correlations may confirm this. Furthermore, sites located closer to industrial activity contained higher levels of Zn, Ti, and Cr. Much of the observed mineralogical variation is likely due to the complex combination of various natural and anthropogenic sources throughout the city.

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CHEMICAL AND MINERALOGICAL ANALYSES OF CEMENT-KILN-DUST (CKD) AND ITS POTENTIAL IMPACT ON THE ENVIRONMENT

Rotimi Oduola* (1)

(1) Dept. of Civil & Environmental Engineering, University of Lagos, Akoka, Lagos, NIGERIA

Cement-kiln-dust (CKD), a by-product of cement production, is generated and disposed off in piles at different cement factory sites in Nigeria, and this have been raising environmental concerns. About 25% of every tonne of raw materials fed into the kiln during cement production results in CKD waste in Lafarge cement plants. A number of actions such as dust recycling have been taken in the past by many cement plants in the country to curtail their environmental effects but despite these efforts large quantities of the wastes are still being produced. The wastes are suspended in air as particulates during dry weather causing air pollution particularly around the factories and also often deposited on plants and roofs of buildings. The dusts are also washed into surface and groundwater during rains thereby polluting the water sources. An intensive study is currently being conducted to find a productive use for this waste in civil engineering construction and this paper presents the results of chemical and mineralogical analyses of CKD with a view of determining their impact on the environment. Tests conducted on samples of CKD collected from Lafarge cement Plant Shagamu, Nigeria were chemical analysis using X-ray Flourescence (XRF), microstructural analysis using Scanning Electron Microscopy (SEM) and mineralogical analysis using X-ray Diffraction (XRD). From these analyses, results showed that the CKD contained lime, CaO, as the predominating elemental oxide among the major oxides present with a value of 68.44% while silica oxide, aluminium oxide and ferric oxide were 12.80%, 5.90% and 4.01% respectively. The SEM analysis showed the presence of fine and dense crystalline microstructure of mineral particles. XRD results showed that minerals present were antigorite, mordenite, christobalite, sanidine, etc. The high lime content indicate that soil, surface and groundwater sources will have a high pH values and which may have both short-term and long-term implications on both plants and animals in the affected areas. Further studies are still on-going to know the environmental implications of these chemical and mineralogical contents and the results will be reported soon.
(KEYWORDS: cement-kiln-dust, chemicals, mineralogy, pollution, environment)

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AN ATMOSPHERIC SIMULATION CHAMBER TO INVESTIGATE DUST-BORNE MICROBIOTA COMPOSITION AND VIABILITY

Maddalena Oliva* (1), Silvia Danelli (2), Dario Massabò (3), Antonio Comite (1), Camilla Costa (1), Andrea Di Cesare (4), Elena Gatta (5), Franco Parodi (2), Luigi Vezzulli (4), Paolo Prati (3)

(1) Dip. Chimica e Chimica Industriale, Università degli Studi di Genova, (2) INFN - Sezione di Genova, (3) Dip. Fisica e INFN, Università degli Studi di Genova, (4) Dip. Scienze della Terra dell'Ambiente e della Vita, Università degli Studi di Genova, (5) Dip. Fisica, Università degli Studi di Genova

Dust stormsfrom the desert areas, in particular from the Sahara, are the principal source of dust in the atmosphere, capable of dust dispersion and transport over very long distances [1].
Dust clouds may contain high concentrations of microbiota, e.g. fungal spores, plant pollen, algae, bacteria. Bioaerosols associated with dust events can spread pathogens over long distances [2-4] and can impact ecosystem equilibria, human health and yield of agricultural products. For many microorganisms long-range and high-altitude transport in the free atmosphere can be very stressful due to strong ultraviolet radiation, low humidity (inducing desiccation), too low or too high temperatures, and complex atmospheric chemistry (e.g. presence of radicals or other reactive species) [5, 6]. Only specially resistant organisms are able to survive, so microbiota population composition can change during the long airborne transport to the final site of deposition [7].
In this work we summarize the first results on the use of ChAMBRe (Chamber for Aerosol Modelling and Bio-aerosol Research), an atmospheric simulation chamber designed and implemented at the Physics Department of the University of Genoa, in cooperation with INFN (National Institute of Nuclear Physics) to investigate bioaerosol evolution and transformation under different atmospheric conditions [8]. ChAMBRe is the first Italian facility of this type, specifically conceived to study the mechanisms of interaction between bioaerosols and other particles or chemical compounds usually present in the atmosphere. We describe the experimental setup and the protocols to inject, monitor, analyze and extract Gram-positive and Gram-negative model bacteria, bacillus subtilis and escherichia coli respectively.
In this initial stage we focused primarily on crucial operational aspects such as growth and injection of suitable amounts of bacteria, measurement of the average lifetime inside the chamber, extraction and sampling, identification of the steps involving the major stress for the microorganisms under investigation.

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NOVEL TECHNIQUES FOR CHARACTERIZATION OF ORGANIC COMPOSITION OF PARTICULATE MATTER

Jürgen Orasche* (1), Uwe Käfer (1), Bendedikt Weggler (2), Ralf Zimmermann (1)

(1) Joint Mass Spectrometry Centre of the University Rostock and the Helmholtz Zentrum München, Germany, (2) Pennsylvania State University, Dept. of Biochemistry and Molecular Biology, USA

In recent years a range of analytical methods, instruments and tools have been established for characterization of chemistry of carbonaceous aerosols and source apportionment. Important developments are the Aerodyne Aerosol Mass Spectrometer (AMS), the Thermal desorption Aerosol Gaschromatography MS/FID (TAG) or Positive Matrix Factorization (PMF). Here we present other novel techniques for characterization of organic composition of fine dust. First the In-situ Derivatization Thermal Desorption (IDTD) followed by GC Time-Of-Flight Mass Spectrometry (GC-TOF-MS) which allows derivatization of organic compounds directly on the filter [1]. The main advantage of IDTD-GC-MS is the possibility of determination of highly polar organic compounds like water soluble organic compounds (WSOC), namely sugars, anhydrous sugars and threitols. We applied it also for identification and quantification of many biomass burning tracers like phenols (guaiacols and syringols) and abietic acids.
For a better separation of the complex mixture of organic compounds contained in atmospheric dust, combustion aerosols, etc. we combined now the IDTD with GCxGC-TOF-MS. This technique might be an upcoming additional tool for source apportionment – combined with other useful tools like PMF. The complexity of wood combustion aerosols can be easily visualized by 2D-contour chromatograms. Each is showing several thousand compounds emitted depending on the source. In a first approach we compared different wood types (birch, beech and spruce) combusted in a masonry heater [2]. Univariate and multivariate chemometric tools, such as analysis of variance (ANOVA), principal component analysis (PCA), and ANOVA simultaneous component analysis (ASCA), were used to reduce the data to highly significant and wood type-specific features. This novel approach reduces comprehensive data sets to a minimum of significant compounds which are necessary for source apportionment and essential to investigate the different causes of different health effects of different aerosols.
As GC separation is limited by the size of molecules we applied also a Direct Inlet Probe (DIP) to evaporate sensitive and large molecules within high vacuum atmosphere. By coupling the DIP with a high resolution time-of-flight mass spectrometer (HR-TOF-MS) from LECO, USA, we got structural information about the content of different compound classes. The higher oxygen content of highly cross link beech wood lignin was clearly visible when comparing it to spruce wood. This method is an extremely fast method to distinguish between different aerosol sources. It is also a useful tool for observing formation of secondary organic aerosols due to oxidation and nitration with nitrate radicals. Again the structural information from the DIP-HR-TOF-MS can be very useful in combination with IDTD-GCxGC-TOF-MS.

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DUST RESEARCH UNDER EXTREME CONDITIONS – PERSONAL SAMPLING AND CHEMICAL CHARACTERIZATION OF AEROSOLS IN A PLATINUM MINE

Jürgen Orasche* (1), Vesta Kohlmeier (1), George Constantin Dragan (1), Gert Jakobi (1), Patricia Forbes (2), Ralf Zimmermann (1)

(1) Joint Mass Spectrometry Centre of the University Rostock and the Helmholtz Zentrum München, Germany, (2) Department of Chemistry, Faculty of Natural and Agricultural Sciences, University of Pretoria, South Africa

Underground mining poses a difficult environment for both man and machines. At more than 1000 meters underneath the surface of the earth, ores and other mineral resources are still gained by conventional and motorised mining. Adding to the hazards caused by blasting and stone-chipping, the working conditions are best described by the high temperatures of 35-40°C and high humidity, at low air exchange rates. Separate ventilation shafts lead fresh air into a mine and others lead expended air back to the surface. This is essential for humans and machines working deep underground. Nevertheless mines are widely ramified, thus the air flow rate at the far end of a tunnel is sensed to be close to zero. In recent years, conventional mining was supplemented by mining with heavy diesel machines. These very flat machines called Load Haul Dump (LHD) vehicles accelerate and ease work in areas favourable for heavy machines. On the other hand, they emit non-filtered diesel exhaust, which constitutes an occupational hazard for the miners. Combined with a low air exchange, high humidity and inorganic dust from the mining it leads to "black smog" underneath the earth.
This work focuses on the air quality in mines employing LHDs. Therefore we performed personal sampling (samplers worn by miners during their work), stationary sampling and aethalometer (Microaeth MA200, Aethlabs) measurements in a platinum mine in around 1000 meters under the earth's surface. We compared areas of high diesel exhaust emission with areas of conventional mining where no diesel machines were operated.
For a better assessment of health risks caused by air pollution we applied a separated gas-/particle-sampling system, with first denuder section collecting intermediate VOCs. These multi-channel silicone rubber denuders are able to trap IVOCs while allowing particles ranged from 10 nm to 1 µm in diameter to be transmitted with an efficiency of nearly 100% [1]. The second section is represented by a quartz fibre filter collecting particles and adsorbed semi-volatile organic compounds (SVOC). The third part is a graphitized carbon black adsorber – collecting the SVOCs that evaporate from the filter.
The compounds collected on these three sections were analyzed in our labs with different thermal desorption techniques coupled with gas chromatography and mass spectrometry (GC-MS). VOCs and IVOCs were measured with a Shimadzu Thermal Desorption Unit (TD20, Shimadzu, Japan) coupled to a GCMS-System QP 2010 Ultra with a quadrupole mass spectrometer (Shimadzu). The GC was equipped with a 30m, BP-20 wax column (0.25mm ID, 0.25µm film) from SGE (Australia). Filters were analyzed with In-situ derivatization thermal desorption gas chromatography time-of-flight-mass spectrometry (IDTD-GC-TOF-MS). The in-situ derivatization thermal desorption unit is a modified GL sciences Optic 3 system (GL Sciences, Netherlands).
The results showed black carbon concentrations measured with the portable aethalometers showed peak maximums up to several mg per m³. The organic chemistry was dominated by very high concentrations of alkanes. Typical diesel engine exhaust markers like alkylated polycyclic aromatic hydrocarbons were detected as well as typical lubrication oil markers like hopanes.
A detailed overview of the organic and inorganic chemical composition in the mine and assessment of the health effects caused by the diesel engines of LHDs will be given in this presentation.

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THE IMPACT OF ELECTROSTATIC PRECIPITATORS AND SECONDARY HEAT EXCHANGERS ON PARTICULATE MATTER AND ACCOMPANIED INORGANIC AND ORGANIC SPECIES EMITTED BY WOOD COMBUSTION

Jürgen Orasche* (1), Jürgen Schnelle-Kreis (1), Hans Ruppert (2), Hans Hartmann (3), Ralf Zimmermann (1)

(1) Joint Mass Spectrometry Centre of the University Rostock and the Helmholtz Zentrum München, Germany, (2) Interdisciplinary Center for Sustainable Development, University Göttingen, Germany, (3) Technology and Support Center (TFZ) in Straubing, Germany

Simple constructed wood log stoves are responsible for a high fraction of emitted volatile and semi-volatile organic compounds (VOC and SVOC), inorganic salts and black carbon (BC). In the wood rich North American and European countries wood combustion is a major source of primary and secondary aerosols and also provides a large fraction of reactive gaseous and particle bound organic compounds responsible for the formation of an even larger fraction of secondary organic aerosols (SOA) contributing to total particulate matter (PM).
In this context we investigated in the utilization and efficiency of secondary measures, namely a secondary heat exchanger (SHE) and electrostatic precipitators (ESP) to reduce particulate emissions of small scale wood combustion appliances. The SHE is also able to improve the energetic efficiencies of those combustion devices. Generally the question arises if also the toxicity potential is lowered in the same order of magnitude as the reduction of PM mass. Therefore we also took into account that organic composition of particles might be affected by electrostatic charging and condensation of organics by cooling of the exhaust respectively. ESPs for instance are known to have a selective precipitation capacity due to different conductivity of particles.
The ESP was operated in combination with a wood log stove. The applied fuel was widely used spruce and beech wood. The reduced emissions of total PM were measured as well as the impact of secondary measures on chemical composition of particles.
The efficiency of the ESP was found to be improvable. A reduction of PM mass of about 50 to 61% in average was observed. This was mainly related to the reduction of elemental carbon (EC) and inorganic salts. Just 16 - 23% of EC were found to pass the ESP. Toxic elements like Zinc and Cadmium were reduced by 63 - 83%. The reductions of organic compounds were strongly related to the diversity of compounds. On the one hand concentrations of polycyclic aromatic hydrocarbons (PAH) were reduced within the same order of magnitude as total PM. The application of an ESP improved the PAH related toxicity equivalent (TEQ) by approximately 60%. On the other hand some compounds like oxygenated PAH (o-PAH) were found in even higher concentrations – partly formed within the ESP. The overall reduction of organic carbon (OC) was only by 4 - 33%.
The low emissions from pellet boilers were described in a previous study [1]. Here the emissions (PM, OM, TEQ and zinc) from the pellet boiler were improved significantly when operating the same boiler used in our study from 2012 with a SHE. In particular the TEQ was lowered by about 95 %.
The evaluation of the toxicity of biomass combustion particulate emissions by the content of toxic compounds, however, represents a rough estimate. Some compounds of wood smoke may have protective effects (e.g. phenolic compounds could have anti-oxidative character). The biological effects of the vast complexity of the chemical composition of biomass PM are currently under investigations of the Helmholtz Virtual Institute of Complex Molecular Systems in Environmental Health (HICE).

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CHEMICAL COMPOSITION AND SOURCE APPORTIONMENT OF PM2.5 USING CHEMICAL SPECIATION AND PMF MODELING IN BUSAN, KOREA

Geehyeong Park* (1)

(1) Busan Institute of Health and Environment

Air pollution by ambient fine particulate matter, such as PM2.5, and PM1.0, has become one of the most serious environmental and public health problems in many developing and developed countries. The IARC and WHO designate airborne fine particulates (PM2.5, and PM1.0) a Group 1 carcinogen because they deeply penetrate into the lung and blood stream unfiltered, causing permanent DNA mutations, heart attacks, and premature death. Many research reports the composition and the formation mechanism of PM2.5 around the world. It is very difficult to elucidate the source of PM2.5, because over 60% of PM2.5 came from the gaseous components such as SO2, NOx, and NH3. Many research shows that major components of PM2.5 are ammonium sulfate and ammonium nitrate. There has been a growing interest in the chemical speciation and source apportionment of PM2.5 and in understanding the formation mechanism of airborne PM2.5. This study analyzed PM2.5 composition and source apportionment, using chemical speciation and PMF modeling, of PM2.5 collected at four sites [green, residential (urban), commercial and industrial areas having different environmental situations] in Busan, Korea. Two year-PM2.5 samples were collected using a PM2.5 sampler; one year-daily (24 h) samples were obtained every three days from January to December in 2017 using PTFE filters for ionic matters and metallic elements and quartz filters for carbonaceous components. All samples were analyzed by an IC for ionic matters, an ICP-MS for metallic elements, and a Carbon analyzer for carbonaceous components. Identified annual mean(±SD) concentrations of PM2.5 at each site were 19.0(±9.6), 17.5(±10.4), 20.1(±10.0), and 24.4(±11.7) μg/m3 at green, residential (urban), commercial, and industrial areas, respectively. The highest fraction of PM2.5 in Busan was ionic materials (45.6 to 51.2%) followed by carbonaceous components (20.6~29.0%) and metallic elements (4.5~7.4%). Major ionic components existing as ammonium sulfate [NH4HSO4, (NH4)2SO4] and ammonium nitrate (NH4NO3) were NH4+, SO42-, and NO3- salts, which were transformed from gaseous SO2, NOx, and NH3, respectively. In the PMF receptor model (EPA PMF5.0) analysis for source apportionment, PM2.5 at the four sites showed major sources including secondary sulfate and nitrate, mobile sources, and heavy oil combustion and minor sources including sea salts, steel industry, soil (crustal included). In particular, the most important sources to PM2.5 were secondary sulfate + heavy oil combustion. The following important ones were secondary nitrate at the green area, mobile emission + road dust at the residential (urban) area, and mobile emission + road dust at the commercial area. However, the important sources of PM2.5 at the industrial area were secondary sulfate + secondary nitrate, fuel combustion + vehicle emission, and chlorine + heavy metal emission + soil. The contributions of sea salts in Busan is a little higher than other regions in Korea, such as Seoul, due to that it is adjacent to sea.

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SIMULATIONS OF THE ASIAN DUST AND THE HAZE EVENTS OBSERVED IN MARCH 2013 IN EAST ASIA

Soon-Ung Park* (1)

(1) CAEM

Aerosol Modeling System (AMS) that is composed of the Asian Dust Aerosol Model 2 (ADAM2) [1] [2] [3] for the Asian dust aerosol modeling and the Community Multi-scale Air Quality (CMAQ) modeling version 4.7.1 [4] for the anthropogenic aerosol modeling with the pollutants emission data from HTAP, MEGAN and GFFD3 has been employed to simulate the Asian dust and the haze events observed in March 2013 in the East Asia region especially over China and Korea. Three dust events are observed over Korea with the maximum PM10 concentration exceeding 200 μg m-3 whereas more than 9-day haze events in Beijing and 11-day haze events in Korea are observed in March 2013. It is found that the heavy haze events are associated with high aerosols and water droplets concentrations. These high aerosol concentrations are mainly composed of anthropogenic aerosols formed by gas to particle conversion of gaseous pollutants in the Eastern parts of China whereas these in the northeastern parts of China and the down wind regions of Korea and Japan are composed of the mixture of anthropogenic aerosols and the Asian dust aerosols. It is also found that the AMS model not only can identify different species of aerosols for the events of the Asian dust and the haze but simulates quite well those events.

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DATING DUST IN ARCHAEOLOGICAL SITES BY OSL

Naomi Porat* (1)

(1) Geological Survey of Israel

Landscape archaeological structures such as tumuli, hunting installations or farming terraces often lack datable finds. The only means to provide an estimated for the time they were constructed and used is by optically stimulated luminescence (OSL) dating of the sediment infill. This method dates the last exposure event of quartz grains to sunlight, a measure of deposition time. In the arid and semi-arid regions of Israel, in many cases this infill comprises dust that gradually accumulated after the installation was no longer in use, and its earliest time of deposition obtained by OSL would provide a minimum age for the site. If undisturbed, dust accumulation rates can also be calculated from the OSL ages.
Dust is advantageous as at the time of deposition it was fully exposed to sunlight and the OSL signal well bleached. Additionally, in Israel the coarser fraction of the dust is rich in very-fine-sand quartz highly suitable for OSL dating as it is derived from mature sand sources that often have favorable OSL signal properties.
This approach has been used successfully to date many sites by OSL. The methodology and dating results from two sites in Israel will be presented.

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DUST AND THE ORIGIN OF THE UNIVERSE

Thomas Prevenslik* (1)

(1) QED Radiations

Dust may be an annoyance in our everyday view of what we see on Earth, but cosmic dust that permeates interstellar space may be important in our understanding of the origin of the Universe. In 1926, Hubble's redshift measurements of light from distant galaxies changed the long-standing paradigm of a static and infinite Universe governed by Newtonian mechanics to a finite and expanding Universe following Einstein's general relativity, or GR. In the 1970's, Vera Rubin's redshift measurements of galaxy rotation curves showed a flat velocity profile in contrast to decreasing velocities predicted by Kepler's law, the high velocities suggesting dark matter had to be present to hold the galaxies together. Recently, GR was proposed [1] modified by scale invariance allowing high rotational velocities without the need for dark matter to hold the galaxies together. But scale invariant GR requires the large scale Universe to be empty space without mass which certainly is not self-evident, and in fact can only be erroneous because of cosmic dust.

In this regard, an alternative theory of the Universe is proposed : An expanding Universe and dark matter do not exist [2] if the respective recession and rotational velocities of galaxies are corrected for the redshift in galaxy light upon interaction with cosmic dust on its way to the Earth.

Historically, the redshift in cosmic dust went unnoticed for almost a century because galaxy light was assumed to follow classical physics by conserving the galaxy photon by an increase in temperature. But the heat capacity of the atom given by the Planck law of QM, although finite at the macroscale vanishes at the nanoscale, QM standing for quantum mechanics. Conservation of the galaxy photon in dust is therefore only possible by a non-thermal mechanism proposed here to be simple QED, but is far simpler than that proposed by Feynman and others.

Simple QED relies on the high S/V ratio at the nanoscale where the galaxy photon of wavelength wo is absorbed almost entirely in the dust surface placing internal atoms under the high EM confinement necessary for the heat capacity to vanish by the Planck law. S/V stands for surface to volume. A non-thermal standing photon having half-wavelength w/2 = d is then created as the galaxy photon energy adjusts to the EM confinement bounded by the dust surface. The speed of light c corrected for the refractive index n of the dust gives the energy E of the redshift photon, E = h(c/n)/w for a wavelength 2nd and redshift Z = (2nd - wo)/wo. Once the energy of the galaxy photon absorbed in the dust surface is expended to form the standing photon, the EM confinement vanishes and the galaxy photon now redshifted is free to travel to the Earth.

In cosmic dust, the redshift Z for Lyman - alpha galaxy photons is shown to approach the speed of light to significantly overstate recession and rotation velocities. However, by correcting galaxy redshifts for cosmic dust, not only does dark matter not exist, but both GR and scale invariant GR are irrelevant as galaxy dynamics follows Newtonian mechanics inherent in a static and infinite Universe.

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INDOOR DUST DIRECT EXAMINATION (E.D.P.A.®) AND BIOTIC POLLUTION IN CONFINED ENVIRONMENTS

Simona Principato* (1), Iolanda Moretta (2), Mario A. Principato (2), Luca Stingeni (3)

(1) Urania Research Center, Perugia (Italy), (2) Department of Veterinary Medicine, University of Perugia (Italy), (3) Clinical Allergological and Venereological Dermatology Section, Department of Medicine, University of Perugia (Italy)

Indoor biotic pollution is a condition in which living organisms cause infestations in confined environments and they are often represented by insects and mites of medical , agri-food , industrial, or forensic interest, depending on the environment and on the point of view taken into consideration. Indoor infestations can lead to several different problems, above all dermatological ones, due to the unavoidable interaction between humans and arthropods. Therefore it is necessary to know the causes to be able to act targetly and remove the problems (1,2). The Indoor Dust Direct Examination (E.D.P.A.®) is a patented diagnostic method, exclusively performed in the Urania Research Center in Perugia (Central Italy), that is able to detect the traces left by insects and mites in confined environments, through the examination of dust samples simply collected by sweeping the dust of the floor of every indoor area (3). The dust examination requires a global screening of the material, which is initially sifted and then analysed both at a dry and liquid states, until it leads to the detection of the traces and to the isolation and identification of the agent suspected to be the cause of the infestation (4,5). Among the fields of application of the E.D.P.A.®, the medical sector is the most relevant. Several cases of dermatitis of unknown environmental origin can be disclosed with the E.D.P.A.® , that allows to identify the etiologic agent, to discover where it is located, to discern if it is of outdoor origin, and then to intervene targetly to remove the cause and consequently to achieve spontaneous healing of dermopathy (6). In the year 2017 in housedust samples of n. 270 individuals suffering from dermatitis examined at URANIA Research Center the presence of mites was detected, above all of the genres Pyemotes (33,3%), Glycyphagus (16,2%) and Tydeus (14,8%) and in other n. 202 house dust samples the presence of insects, above all of the genres Scleroderma (13,8%), Solenopsis (17,3%) and Ctenocephalides (9,9%) . Those reports allowed to diagnose the environmental origin of the dermatological problem, confirmed by the patients' quick healing after the targeted house disinfestation. In the agri-food and industrial fields, the E.D.P.A.® enables to locate sites of larval infestation, to identify the species, to discover the origin of the pests and to calculate the time of the infestation, in order to have the control of the storages and of the production sites of the factory. It allows also to solve potential controversies between the enterprise and its customer. In the forensic field, the E.D.P.A.® can give also its contribution, detecting all the traces left in confined environments, discerning between their indoor or outdoor origin from the different concentration of the population of mites and insects or the different concentration of pollens and allows to find out if an area of interest was alterated.
In conclusion, the E.D.P.A.® allows to monitor every indoor environment to different aims through the examination of the dust samples. They can be sent to URANIA Research Center from all over the world, as the collected material does not undergo damages during shipping, nor it alterates for even long delivery times.

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INDOOR DUST CONTAMINATED BY BIOTIC AGENTS: STRATEGIES OF INTERVENTION

Simona Principato* (1), Iolanda Moretta (2), Mario A. Principato (2), Luca Stingeni (3)

(1) Urania Research Center, Perugia (Italy), (2) Department of Veterinary Medicine, University of Perugia (Italy), (3) Clinical Allergological and Venereological Dermatology Section, Department of Medicine, University of Perugia (Italy)

The Indoor Dust Direct Examination (EDPA®) reveals both the presence of pests of economic interest, especially in the agri-food chain (1,2) , and the presence of pests of medical interest in confined environments such as homes, offices, and so on (3,4). Following the detection of these pests, environmental measures are necessary that are not only related to the use of residual pyrethroids, knocking down or snatching, but also to the use of particular intervention strategies which may vary in relation to the parasite detected (5). In this note some special intervention modalities are reported that must be complied with to make an effective environmental disinfestation action The following pests were considered: Pyemotes ventricosus, Glycyphagus domesticus, Ctenocephalides felis, Cheyletiella blakei, Tydeus molestus. In 10 episodes come to our attention, we tried to recommend both the direct environmental treatment and the environmental treatment preceded by a targeted strategy in relation to the parasite, in order to verify which one was the most correct intervention modality to solve the infestation. In the case of Pyemotes ventricosus it was proved indispensable, before the environmental treatment, to carry out the physical removal of the woodworm-eaten furniture to which the biological cycle of the mite is related. In the case of Glycyphagus domesticus, a double intervention strategy was demonstrated indispensable before and after the environmental treatment with pyrethroids. In fact, it was essential to remove the parietal molds and to lower the rate of RH below 60% by a dehumidifier ; in addition, after the biocidal treatment, clothes and linen had to be washed in plenty of water and the vacuum cleaner had to be used on mattresses and padding in order to remove the irritant bristles of this mite. In the case of Ctenocephalides felis and Cheyletiella blakei, in order to solve the infestation, it was essential to treat the cat, which is the source of environmental infestation; at the same time it was important to disinfest the environment by using a residual pyrethroid such as lambda cyhalothrin. Finally, as regards Tydeus molestus, it was necessary to remove the plants inside the dwelling and to put a biocidal barrier on the internal perimeter of the windows and French windows in order to prevent the spontaneous entry of this mite from outdoor. Only with such strategic measures of targeted intervention could the pest control totally and immediately be resolved and the remission of dermatological symptoms be obtained. Our experience shows therefore how the study of the environmental dust can lead to unveil the parasitic origin of a dermatitis, but also that the complete resolution of the infestation and of the dermopathy can be achieved only through the application of a targeted environmental intervention strategy.

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AIRBORNE MICROBES CONTRIBUTE TO N2 FIXATION IN THE SURFACE WATER OF THE NORTHERN RED SEA; A MESOCOSM APPROACH

Eyal Rahav* (1), Adina Paytan (2), Esra Mescioglu (2), Yuri Galletti (3), Sahar Rosenfeld (1), Ofrat Raveh (1), Chiara Santinelli (3), Barak Herut (1)

(1) Israel Oceanographic and Limnological Research, (2) Institute of Marine Science, University of California, Santa Cruz, USA, (3) Institute of Methodologies for Environmental Analysis (IMAA), National Research Council (CNR)

Desert dust storms are common in the Northern Red Sea (NRS) region, providing nutrients and trace-metals that may stimulate N2 fixation [1]. Dust also carries a high diversity of airborne microbes (bacteria, archaea), including diazotrophs, that may remain viable during transport [1,2]. Here we evaluate the impact of atmospheric deposition and its associated airborne diazotrophs on N2 fixation in the surface water of the low-nutrients NRS, using mesocosm bioassay experiments. We compared the chemical (nutritional) and sole airborne microbial impact of aerosol additions on N2 fixation using 'live-dust' (release nutrients/trace-metals and viable airborne microorganisms) and 'UV-killed dust' (release only the chemical constitutes). Airborne diazotrophy accounted for about one-third of the measured N2 fixation (0.35±0.06 nmol N L-1 d-1 and 0.29±0.06 nmol N L-1 d-1, for 'February 2017' and 'May 2017', 'live-dust' additions, respectively). Two nifH sequences related to cluster III diazotrophs were amplified from the dust samples, consistent with the N2 fixation measurement results. We postulate that the deposition of viable airborne diazotrophs may enhance N2 fixation, especially in oligotrophic marine provinces subjected to high aerosol loads, and that the relative contribution of airborne N2 fixation may increase in the future with expansion of oligotrophic areas of the ocean and increased dust deposition.

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OPTICAL PROPERTIES OF IRREGULAR GRAINS: FROM LABORATORY MEASUREMENTS TO IN SITU COUNTING IN THE ATMOSPHERE

Jean-Baptiste Renard* (1), Edith Hadamcik (2), François Dulac (3), Gwenaël Berthet (1), Damien Vignelles (1)

(1) LPC2E-CNRS, (2) LATMOS-IPSL, (3) LSCE-IPSL-CEA-UVSQ

The solid aerosol particles in the atmosphere can have different shapes and porosities (they can be compact, fluffy, fractal, in the form of a single particle or of an aggregate of smaller particles), and varied sizes and refractive indices. Also, the bulk properties of an aggregate of a given type of particles can sometimes highly differ from the albedo and the refractive index of the constituent particles: As an example, the highly fluffy aggregate of transparent sub-micronic silica spherules can be darker than carbon particles at some scattering angles, because of the multiple scattering inside the aggregate. Thus, the retrieval of some physical properties of the particles, like size distribution and typology, from the measurements of the light they scatter is not easy and needs several a priori assumptions. In particular, optical in situ aerosol particle counting instruments provide accurate results if the nature (refractive index) of the particles is known in advance. Such instruments must be recalibrated or corrected when operated in different atmospheric environments, like carbonaceous pollution, desert dust plume or volcano plume. Nevertheless, inaccurate results could be obtained in case of highly porous particles.

We have established from laboratory measurements an original database of the optical properties (brightness and polarization) at 4 wavelengths from 450 to 1500 nm of the light scattered by aerosols of irregular particles, using a statistical approach. The scattering functions are available in the 15°-170° angular range and hundreds of scattering curves have been obtained for compact grains and aggregates having an extensive range of compositions and sizes (PROGRA2 experiment; www.icare.univ-lille1.fr/progra2/). The measurements are conducted at ground for compact particles smaller than ~10 micron in diameter and for fluffy particles, and in microgravity during parabolic flights allowing the levitation of larger particles. Such a data base has a large set of applications for remote studies of the dust in comets, in the interplanetary medium, and aerosols in planetary atmospheres including Earth.

From the main tendencies obtained with the PROGRA2 database, we have developed a light optical particle counter/sizer, LOAC, dedicated to the detection of irregular grains in the atmosphere, which can be used at ground and under all kind of balloons, including weather balloons. The measurements are conducted at two scattering angles with a field of view of several degrees only: the first one, around 15°, is used to detect the light diffracted by the particles, which is insensitive to the refractive index. The second one, at around 60°, is very sensitive to the refractive index. The statistical combination of the two-angles measurements allows us to retrieve the size-segregated concentrations in 19 size classes in the 0.2-50 micrometers diameter range and to estimate the main typology of the particles (droplets, semi-transparent particles like sand, absorbing particles like carbonaceous and/or fluffy particles).

We will summarize the main results obtained with PROGRA2 for irregular particles, and we will present the LOAC concept of measurements and the main results obtained in the field since 2013, in terms of particle size distribution, concentrations and typologies. The LOAC measurements were obtained in the atmosphere from balloons during different events like urban pollution, Saharan dust plumes, and volcanic ashes. Because LOAC is easy to launch under weather balloons or tethered balloons for low altitude measurements, it can be used on alert during specific events from almost all locations.

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BLACK CARBON (BC) AND FINE PARTICLES IN HIGH-RISE APARTMENTS IN SEOUL, KOREA

Donghyun Rim* (1)

(1) Penn State University

Human exposure to black carbon (BC) and fine particles has been associated with adverse health effects such as pulmonary, cardiovascular, and premature illness. Few studies have characterized daily-integrated BC and fine particle exposure in urban residential environments. The objective of this study is to investigate size-resolved particle concentration and residential exposure profiles in four high-rise apartments in a mega-city Seoul, Korea.

Time-varying BC and fine particle concentrations were continuously monitored over a period of 7 days in 4 high-rise apartment buildings. Black carbon concentrations were measured using an Aethalometer (Magee Scientific, AE51) while size-resolved particles were monitored using Portable Aerosol Spectrometer (Grimm, 1.109) and NanoScan SMPS. Indoor occupancy, occupant activities, and window opening events were recorded during the measurements. For the monitoring period, size-resolved particle infiltration factors and the efficiency of a stand-alone filter were estimated.

The results show that at four apartments, indoor BC concentrations ranged from 1.1 to 1.6 μg/m3, which are generally higher than urban background levels in other cities reported in the literature. Higher BC concentrations occurred mainly due to the penetration of outdoor particles via building cracks and open windows. BC infiltration factor varied from 0.8 to 0.96 depending on the particle size and ventilation conditions. Indoor PM2.5 concentrations ranged from 18 to 96 μg/m3. The highest indoor particle surface area was observed for the apartment with a gas stove, which was higher than those with an induction stove or no stove. This results suggest that gas stove contributes to a notable increase in particle surface area indoors. The results also show that a stand-alone HEPA filter reduces BC and fine particles by 30-70%.

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EVALUATION OF WRF-CHEM MODEL FOR SAHARAN DUST OUTBREAKS IN SOUTHERN ITALY

Umberto Rizza (1), Pierina Ielpo* (1, 2), Mario Marcello Miglietta (3), Cristina Mangia (3), Mauro Morichetti (4), Simone Virgili (4), Giorgio Passerini (4), Francesca Barnaba (5), Gian Paolo Gobbi (5), Luca Di Liberto (5)

(1) Institute of Amospheric Sciences and Climate - Italian National Research Council, Lecce division, (2) Water Research Institute - Italian National Research Council, Bari division, (3) Institute of Atmospheric Sciences and Climate - Italian National Research Council, Lecce division, (4) Department of Industrial Engineering and Mathematics Sciences, Università Politecnica delle Marche, (5) Institute of Atmospheric Sciences and Climate - Italian National Research Council, Rome division

In this study, the Weather Research and Forecasting (WRF) Model with online coupled chemistry (WRF-Chem) is applied to reproduce two Saharan dust outbreak events that took place over the Mediterranean in May 2014 and March 2016 and affected Southern Italy. The second event was particularly intense and determined PM10 peak measurements in the monitoring air-quality stations of the Apulia region over 900 g/m3. The first event was generated by a synoptic situation in the Mediterranean basin corresponding to a omega-like baric configuration with a cyclogenesis in the Atlantic coasts of Spain. Following the classification given by Knippertz and Stuut (2014) in
their review chapter, the meteorological condition of the second event corresponds to a mobile synoptic-scale cyclone that occurs typically in the Mediterranean in late-winter and spring. In both cases WRF reproduces well the observed synoptic meteorological conditions.
To evaluate the capability of WRF-Chem to simulate the two dust events characterized by different intensity, numerical experiments have been performed applying a physics-based dust emission model, with soil properties generated from three different Land Surface Models, namely Noah, RUC and Noah-MP. The model performance is analyzed using an observational dataset of aerosol and desert dust features that includes optical properties from satellite and ground-based sun-photometers, and in-situ particulate matter mass concentration (PM) data. The comparison with satellite data (MODIS-TERRA) shows that the model is able to reproduce well the horizontal field of the aerosol optical depth (AOD) and its time evolution. Inter-correlated analysis of the modeled AOD and the dust emission fluxes allow to identify the source regions of the observed plumes
On the one side, the combination of the dust emission model with the RUC Land Surface Model significantly over-predicts the emitted mineral dust; on the other side, the combination with Noah or Noah-MP Land Surface Model (LSM) gives better results, especially for the daily averaged PM10.

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FORENSIC ENTOMOLOGY: BIOTIC TRACES IN DOMESTIC ENVIRONMENT

Sabrina Roccaforte (1), Simona Principato* (2), Iolanda Moretta (3), Mario A. Principato (3)

(1) Criminologist Lawyer, Perugia, Italy, (2) Urania Research Center, Perugia (Italy), (3) Department of Veterinary Medicine, University of Perugia (Italy)

The Indoor Dust Direct Examination (E.D.P.A.®) is a method widely used to detect the presence in a confined environment of arthropods, both infesting and of health interest, through the study of their traces (1,2) . For its correct application, the dusts are generally collected after a period of two or three days, during which no cleaning is carried out, to get a certain parasitological uniformity in the various domestic environments.
The study of house dusts carried out over the years has led to refine the E.D.P.A. ® technique, so that its application can be taken into consideration in fields other than those strictly parasitological ones for which it was initially developed.
One of those of particular interest is the forensic field, where this technique can be used to help investigators in identifying important traces on the crime scene.
To this aim, in September-December 2017, the dusts collected in 20 houses located in the area of Perugia (Central Italy) were examined at the Urania Research Center. For each house the dust of 2 bedrooms were analysed , for a total of 40 samples.
In 22 samples the presence of the so-called "mite of the mattress" (Dermatophagoides farinae) was detected , with a charge ranging between 82 and 110 mites/g of dust. In 11/22 positive rooms, new samples were taken for three days (one sampling every 12 hours) after having washed the entire floor surface, while in the remaining 11 rooms only the central part of the floor was washed and the dust samples were collected separately from the washed surface and from the uncleaned perimeter.
The results obtained were particularly interesting: the E.D.P.A.® was negative in the 36 hours following the cleaning in the 11 fully washed rooms and in the samples collected at the central area of those washed only partially; afterwards the Dermatophagoides mites were found again in increasing numbers, up to a maximum of 43 mites/g at the end of the third day. On the other hand, the sampling performed on the unwashed internal perimeter showed a similar concentration of mites (75-98 mites / g) compared to the initial sampling.
During those tests it was noticed that something similar happened with other important traces present in indoor dusts, such as pollens, feces of woodworm, animal hair and skin scales.
An area of the cleaned floor can therefore be easily highlighted for an alteration of the traces or, at least, for their non-homogeneity. A comparison can be done between the density of the acarofauna and of the other traces present in different areas of the crime scene, in particular around the victim or, in any case, on the site where the crime is supposed to have been committed and along the perimeter of the room. This may provide diagnostic data able to clarify if the crime scene has been altered by environmental clean-up operations.
The various dust samples can also contain skin scales or other traces that may have different origin and that, once isolated by means of the E.D.P.A.®, can be made available to the investigators for further and more detailed investigations.

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INVESTIGATION OF OBSERVED DUST TRENDS OVER THE MIDDLE EAST REGION IN THE GEOS-5 MODEL SIMULATIONS

Adriana Rocha Lima* (1), Peter R. Colarco (2), Anton S. Darmenov (2), Edward P. Nowottnick (2), Arlindo Da Silva (2), Luke D. Oman (2)

(1) University of Maryland, Baltimore County, (2) NASA Goddard Space Flight Center

Recent studies have reported increases in frequency and intensity of dust storms in the Middle East, with implications for regional air quality and climate. Observations from the ground-based Aerosol Robotic Network (AERONET) of sun photometers and the space-based Moderate-Resolution Imaging Spectroradiometer (MODIS) have shown positive trends in aerosol optical depth (AOD) over the Middle East during the period from 2001 to 2010. AOD is a useful quantity to investigate as it is frequently simulated and increasingly assimilated in aerosol transport models. In this study, we evaluate the ability of the Goddard Earth Observing System - version 5 (GEOS-5) Earth system model to capture the observed Middle East dust trends. We investigate the changes in the simulated dust distributions over the Middle East region using two recent GEOS-5 simulations. The Modern-Era Retrospective analysis for Research and Applications, version 2 (MERRA-2) Reanalysis covers the period 1980 – present and includes prognostic aerosols and assimilation of AOD from ground-based and satellite observations. The MERRA-2 Replay covers the same period and is run with the same core GEOS-5 model version replaying the MERRA-2 meteorological fields but does not include AOD assimilation in the aerosol scheme. As the two simulations have the same meteorology a comparison highlights the impact of aerosol data assimilation on the ability to reproduce observed trends in dustiness. Our analysis finds that the observed positive AOD trend is reproduced in MERRA-2 Reanalysis (with aerosol data assimilated) but not in the MERRA-2 Replay (no aerosol data assimilated). This result highlights the importance of data assimilation in the model to simulate long term trends of atmospheric aerosols. It also indicates that the current representation of the dust processes in the model is not able to fully describe such long-term changes. In order to improve this capability, we analyzed the rate of change of important dust emission parameters, such as vegetation, soil moisture, and wind fields, and we examined the correlation of these parameters with the observed trends of deseasonalized AOT. Finally, we present the results of our investigation of the sensitivity of the dust emissions to changes in the normalized difference vegetation index (NDVI) over the Middle East region, and studies of how using the NDVI in the simulation impacts the ability of the model to describe the observed dust trends over this region.

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CHARACTERIZATION OF ATMOSPHERIC DUST COLLECTED BY CAR ENGINE AIR FILTERS (CAFS) FROM MEXICO CITY

Martín Rodriguez* (1), Birmania Heredia (1), Bruno Marichal (1)

(1) Departamento de Fisiología y Farmacología, Centro de Ciencias Basicas. Universidad Autonoma de Aguascalientes

Atmospheric dust consists of mixture of solid, liquid particles and adsorbed gases suspended in the atmosphere varying in composition, source and size. Atmospheric dust particles in urban areas is made up of dust deposited on the soil as well as by particles released by anthropogenic activities.The study of dust is often analyzed by the amount of matter suspended in the air and by the size of the particles. Macroparticles comprise particles derived from the combustion, erosion and disintegration of the soil, as well as biological material, plant debris, pollen and spores. While microparticles are related with vehicular traffic, industrial activities and power plants. The microparticles with a diameter less than 10 micrometers are classified as PM10, particles with diameters between PM10 and PM2.5 are defined as the coarse fraction. PM2.5 includes all particles less than 2.5 micrometers, also known as fine particles. The last group has been drwed the attention by the deleterious effects on the health, since, they are implicated in respiratory and cardiovascular diseases. Recently, we are reported the use of car air filters as active samplers to collect and analysis the atmospheric dust in streets of the Aguascalientes city1. Now we are presented the preliminary results of the CAFs from Mexico City.
Ten CAFs were collected on August 4-6, 2017. The particles collected by the filters were divided into two categories. The first consisted of those particles that could be removed by friction. The other one in those adhered particles which were not removed by friction. The oversize materials were removed by sieve through 200-mesh. The dust recovered was weighed using an analytical balance. The particles were observed using light microscopy. The elemental composition was evaluated by SEM EDX. The analysis of retained dust by the CAFs from Mexico City was 0.7 ± 0.5 g less than those CAFs collected from Aguascalientes City. The particles trapped in the 200 mash were most abundant that those previously reported. The composition was accompanied by animal biological material and plant debris. A detailed study of this material by SEM EDX, showed that the biological material incorporates air microparticles efficiently. The analysis of the dust particles separated from CAFs showed the presence of mineral and metallic particles. Particles adhered to the CAFs, were smaller less than 10 microns, with a main composition of silicates, as well as metal particles derived from vehicular deterioration, whose composition presented the presence of metals such as Fe, Cr, Ni Pt, Pd and Hg. The presence of agglomerates of heterogeneous composition and black particles were commonly observed in the CAFs, these particles were identified as Carbon by SEM-EDX. These preliminary results suggest that vehicular air filters collected from Mexico City really serve to monitor the dust in large cities.

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HETEROGENEOUS REACTION OF NO2 WITH VOLCANIC DUST IN THE ATMOSPHERE: UPTAKE COEFFICIENTS AND HONO FORMATION YIELDS

Manolis Romanias* (1), Jerome Lasne (1), Mohamad Zeinnedine (1), Frederic Thevenet (1)

(1) IMT Lille Douai, Université de Lille, SAGE, Département Sciences de l'Atmosphère et Génie de l'Environnement, 59000 Lille, France

Iceland has the largest area of volcanic desert on Earth. The intense volcanic activity and the large volcanic eruptions occurring every 3 to 5 years provide a recurrent and massive source of volcanic dust (v-dust) in the atmosphere. In Iceland, unstable sandy surfaces are widespread and subject to frequent high-velocity winds, making it one of the most active aeolian areas on the planet. Around 100 dust events each year can release up to 300000 tons of dust in a single storm. During a dust storm PM10 24-hour mass concentrations can exceed 7000 micron m-3 (1000 micron m-3 on average).
The continuous and massive release of v-dust in the troposphere by aeolian processes, followed by their long-distance transport may significantly impact the tropospheric composition. Surprisingly, there is a noticeable lack of studies aiming at identifying the impact of Icelandic dust on atmospheric physical chemistry.
In the framework of the current study we have investigated the heterogeneous interaction of NO2 with natural Icelandic volcanic dust. The experiments were conducted at room temperature with an atmospheric pressure coated-wall flow tube (CWFT) coupled with a NOx analyzer (Thermo 42C) for the detection of both reactants and products. The steady-state uptake coefficient (γss) of NO2, and the yields of the products formed were determined as a function of several environmental parameters such as volcanic dust mass, NO2 concentration (20-200 ppb) and relative humidity, RH (dry-75%) under dark and simulated solar irradiation conditions. γss was found to decrease with NO2 concentration, while no dependence on RH was observed. Under dark conditions, no products were formed in the gas phase above the detection limit. On the contrary, in presence of light, the formation of HONO was evidenced with yields ca. 15%, independent on NO2 concentration and RH.Our results suggest that more than 5 ppt h-1 of HONO can be formed during dust events.

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DUST STORMS IN THE MIDDLE EAST: AN OBSERVATIONAL AND MODELING STUDY OF TWO EVENTS USING IN-SITU AND REMOTELY SENSED MEASUREMENTS AND WRF-CHEM-RTFDDA

Dorita Rostkier-Edelstein* (1), Yongxin Zhang (2), Gregory Roux (2), Pavel Kunin (1), Rong-Shyang Sheu (2), Yubao Liu (2), Linlin Pan (2), Adam Pietrkowski (3), Sivan Twito (3)

(1) Israel Insititute for Biological Research, (2) National Center for Atmospheric Research, (3) Israeli Air Force

The combination of WRF-Chem and RTFDDA (Real-Time Four Dimensional Data Assimilation), WRF-Chem-RTFDDA, provides an ideal modeling system for simulating and forecasting dust storms in the Middle East due to (a) WRF-Chem's capability of simulating the emission, transport, mixing, and chemical transformation of trace gases and aerosols simultaneously with the meteorology, and (b) RTFDDA's capability of continuously assimilating both conventional and nonconventional observations and thus providing improved initial conditions for dust analyses and forecasts. In this talk, we will present a study of two dust storms in the Middle East using WRF-Chem-RTFDDA and in-situ (AERONET and surface stations) and remote sensing observations (MODIS and SMAP imaging, and profiles retrieved from the CALIPSO mission). WRF-Chem-RTFDDA was run including mineral dust only without the inclusion of anthropogenic aerosols and chemical reactions.

The synoptic conditions for the two dust storm cases are characterized by a cold front at the low level and an upper-level low-pressure system over the Western Mediterranean. Strong westerly and southwesterly winds associated with the cold fronts and the low-pressure systems are behind the development and evolution of the dust storms.

WRF-Chem-RTFDDA simulated synoptic weather conditions out to 48-h forecasts are largely consistent with the GFS analyses though some discrepancies in the system locations and intensities are noted. Simulated surface variables, wind speed, wind direction, temperature and relative humidity generally show small biases at all station locations. WRF-Chem-RTFDDA demonstrates its capacity in resolving the generation and evolution of the dust storms; however, model deficiencies are noted especially over the Saudi Arabia where the model fails to simulate the observed dust in the first period of one of the cases. We investigate various factors that may be responsible for the deficiencies, with too moist soil conditions in GFS and subsequently WRF-Chem-RTFDDA appearing to be the main one.

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EMISSIONS OF TOXIC ELEMENTS FROM SMALL SCALE WOOD COMBUSTION FURNACES - RESULTS FROM SYSTEMATIC EXPERIMENTS

Hans Ruppert* (1), Torben Seidel (1)

(1) Interdisciplinary Center for Sustainable Development, University Göttingen, Germany

Biomass combustion in Europe is widely applied e.g. for residential heating in stoves and boilers and combined heat and power production in industrial boilers. Alone in Germany, in every third household a small-scale wood-burning furnace is installed. Emissions during biomass burning and induced health problems may lower the acceptance of biomass burning. Especially fine (<1 µm) and ultrafine (<0.1 µm) particles loaded with toxic elements and organic compounds enter the alveoli of the lung and may trespass into the blood. Effective emission reduction measures are necessary.

To collect the hazardous fly ash, we applied in our studies an innovative PTFE filter holder with a 150 mm diameter. It guarantees sufficient material for the analysis and it assures a low contamination background (Seidel et al. 2013).

The emissions of particles and inorganic and organic compounds during combustion of wood depend strongly on the type and characteristics of wood fuel, on the burning system and its ash precipitation stages, on the completeness of burning, and on temperature related release and condensation processes of the contaminants. The concentrations of particles emitted through the chimney range between 15-35 (wood pellets combustion), 15-76 (chips), and 35-180 mg/Nm3 air (logs)(Seidel 2013). The percentage of the inorganic fraction in the fly ash varies from a 24 % (incomplete burning of wood) to 98 % (mostly pellet combustion) (Orasche et al. 2012). During the combustion of 1 kg of wood pellets around 0.2 g fly ash are emitted, wood logs produces 0.2-1.6 g/kg and wood chips combustion around 0.4 g/kg (Seidel 2013). The application of an electrostatic precipitator lowers the dust emission by about factor 3. The particle number distribution peaks between 0.08 and 0.3 µm diameter.

The amount of emitted risky elements increases with the amount of emitted fly ash. The emitted particles contain very high concentrations of some toxic element (µg/g fly ash; 40 samples): Cd 7-151, Zn 103-9800, Cu 3-281, Pb 0.1-230, Cr <3-2115, Ni 3-460, Mo <0.1-16, Sb <0.002-4.9, Tl 0.1-19, Bi 0.06-8.0, U <0.001-0.19 (Seidel 2013). Fly ashes from pellets show a tendency to smaller toxic element concentrations compared to those of wood chips and logs. Fly ash from beech logs tend to lower values than that of spruce logs.

Depending on the element, only a few to about 50 % of toxic elements contained in the wood fuel are released into the atmosphere. The amounts of emitted elements for all combustion experiments are (ranges expressed as µg per megajoule; 24 samples): Cd 0.11-9.1, Zn 14-290, Cu 0.4-24, Pb 0.07-10, Cr 0.2-134, Ni 0.1-63, Mo <0.05-0.3, Sb <0.0004-0.1, Tl 0.012-0.46, Bi 0.005-0.1, U <0.0001-0.0069 (Seidel 2013). Fortunately, a large portion of the elements is retained in different ash and condensation fractions as well as in the lining material within the furnace.

Combustion of wood pellets instead logs and chips, use of beech instead of spruce, and the implementation of an electrostatic precipitator lowers the emitted amounts of toxic elements. The role of the lining material of the furnace in the retention of elements needs closer investigations. As a consequence of enforcements in the Ordinance on Small and Medium Combustion Plants (1st BImSchV), the allowed emissions of particulate matter and other hazardous substance from new small scale furnaces are lowered from 150 to 20 mg/m3 air.

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AIRCRAFT OBSERVATIONS OF CHANGES IN DUST SIZE DISTRIBUTION DURING TRANSPORT AND IMPACT ON OPTICAL PROPERTIES

Claire Ryder* (1)

(1) University of Reading

Mineral dust is an important component of the climate system, impacting the radiation balance, cloud properties, biogeochemical cycles, regional circulation and precipitation, as well as having negative effects on aviation, solar energy generation and human health. These processes are all impacted by dust size distribution. Changes in size distribution during dust transport, particularly for coarser dust particles, are poorly understood and poorly represented in climate models.

Here, new observations of transported Saharan dust over the Eastern Tropical Atlantic made during the AER-D airborne fieldwork in August 2015 (Liu et al., 2017), will be compared to observations from Fennec of Saharan dust close to remote sources over the western Saharan desert during June 2011 (Ryder et al., 2013a, b). Both fieldwork campaigns utilized the same size distribution instrumentation, with full capability to measure coarse and giant dust particles, spanning 0.1 to 100 μm diameter.

Fennec observations over the desert show the presence of a very large coarse mode, with particles sized over 100 μm present 100% of the time beneath 3km, and particles sized over 20 μm were present in 99% of dust layers. Effective diameters varied between 2 to 20 μm. AER-D observations show a partially depleted coarse mode and lower total volume concentrations compared to Fennec, accounted for by the greater transport times in AER-D. AER-D mean effective diameter was 4 μm, with very little variability. Over desert, size is strongly impacted by altitude, with the largest particles present closest to the ground, while in the Saharan Air Layer (SAL), size is homogeneous with altitude. During both campaigns, larger particles were detected than can be explained by sedimentation theory along.

The Fennec and AER-D data is extended by compiling data from multiple campaigns, to show that dust size distributions change rapidly in the first day after dust uplift, with effective diameter decreasing rapidly. After around 1.5 days' transport, dust size distributions appear to stabilize, showing little change with subsequent transport.

We contrast size-resolved contribution to optical properties from AER-D to Fennec to explicitly quantify the contribution from the coarse mode, and find that only representing particles up to 10 μm, as is common in many climate models, omits 4% of extinction for AER-D and 38% for Fennec. For absorption, this size cut-off results in 13% and 72% of absorption being omitted for AER-D and Fennec respectively, and overestimates SSA by 0.005 and 0.05 respectively, which will lead to errors in radiative effects and atmospheric heating rates, and potentially atmospheric circulation.

These results show that during transport in the SAL coarse dust particles are present to a lesser extent than over the Sahara, but still have a significant contribution to optical properties and are transported further than predicted by settling velocity theory, thus presenting a challenge for models to represent the coarse mode and its impacts accurately.

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AIRCRAFT DUST OBSERVATIONS OVER THE TROPICAL EASTERN ATLANTIC DURING AER-D: COMPOSITION, SIZE DISTRIBUTION AND OPTICAL PROPERTIES

Claire Ryder* (1), Franco Marenco (2), Paola Formenti (3), Jennifer Brooke (2), Victor Estelles (4), Richard Cotton (2), Dantong Liu (5), Phil Rosenberg (6), Jonathan Taylor (5), Jim McQuaid (6), Hannah Price (7), Tom Choularton (5), Keith Bower (5), Hugh Coe (5), Martin Gallagher (5), Jonathan Crosier (5), Gary Lloyd (5), Eleanor Highwood (1)

(1) University of Reading, (2) UK Met Office, (3) LISA UMR CNRS 7583, (4) Universidad de La Laguna, Spain, (5) SAES, University of Manchester, UK, (6) University of Leeds, UK, (7) Facility for Atmospheric Airborne Measurements, Cranfield, UK

Mineral dust is an important component of the climate system, impacting the radiation balance, cloud properties, biogeochemical cycles, regional circulation and precipitation, as well as having negative effects on aviation, solar energy generation and human health. These processes are all impacted by dust size distribution and also by dust composition, which may be size dependent itself.

Here we present a combination of airborne instrumentational observations and analyses to characterize dust in the Saharan Air Layer (SAL) during the beginning of its trans-Atlantic transport pathway, from the AER-D fieldwork in August 2015, within the peak season of North African dust export.

Firstly we present dust size distributions from flights in the SAL using wing-mounted instrumentation applying light scattering techniques (PCASP, 0.1-3 μm; CDP, 3-50 μm) and light shadowing techniques (CIP15, 15-930 μm; 2DS, 10-1280 μm). These are contrasted to in-cabin size distributions retrieved from Scanning Electron Microscope (SEM) size distributions from filter samples using particle counting and sizing software. Each technique has its advantages and limitations, which will be highlighted and discussed.

Dust composition, as a function of size, will be presented, using single particle electron microscope data. The main components present are silicates, quartz and salts, with a small number of iron-rich particles. As particle size increases, the fraction of silicates and quartz increases, and salts and other components decreases. The fraction of iron-rich particles peaks between diameters of 0.5 to 5 μm. Size-resolved spectral refractive indices will be presented based on the composition data. At short wavelengths, the imaginary part of the refractive index, controlling absorption, is sensitive to particle size, due to a size dependence in fraction of iron-rich particles. At long wavelengths, little sensitivity to particle size was found.

Finally, optical properties calculated using various assumptions related to the composition and size distribution observations available will be presented. AER-D mean single scattering albedo was 0.95 (0.91-0.98), and initial results suggest that this variability was mainly controlled by variability in dust composition, rather than dust size, in contrast to observations over the Sahara.

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POLLUTION LEVELS, ECOLOGICAL AND HUMAN HEALTH RISK ASSESSMENT OF MERCURY IN SOILS, STREET AND LEAF DUST DEPOSITIONS OF AN URBAN ENVIRONMENT

Lilit Sahakyan (1), Gevorg Tepanosyan (1), Nairuhi Maghakyan* (1), Mkhitar Kafyan (1), Gayane Melkonyan (1), Armen Saghatelyan (1)

(1) Center for Ecological-Noosphere Studies of NAS RA

Dust and soils are the best indicators of an urban environment quality and can act as a sink of heavy metals. Mercury (Hg) - one of the most toxic and persistence element in the environment easily accumulated by airborne particles and soils. Investigation of both street dust and soils is of particular importance: 1) soil gives a picture of long-term pollution, and street dust is characterized by a shorter residence of time, 2) soil and dust can serve as secondary pollution sources for the other medias. Many researches also use tree leaves to study deposition, accumulation, and distribution of metal pollution. Combined studies of soils, street and leaf dusts are very few in the literature.

The objectives of this study are to 1) reveal Hg contents spatial distribution patterns and their relationship in different medias, 2) assess pollution levels, potential ecological and human health risk in the city of Vanadzor (Armenia). The latter is former industrial city and known by catastrophic accident of 1978 of the “Vanadzor Qimprom” chemical plant resulting to the released of significant amount of Hg into the city environment. The investigation conducted in 1987 have shown that even after 9 years, high content of Hg was detected in soils and plants. After 1987 investigations on pollution with Hg in the city was not carried out.

Street dust (42), leaf deposited dust (41) and soil (42) samples were collected from the same sampling locations from the whole territory of Vanadzor in July-August, 2016. The total concentration of Hg in the street dust and soil were determined by X-ray fluorescence spectrometry (Olympus Innov-X-5000 (USA)), while the content of Hg in the leaf deposited dust was determined by atomic absorption spectroscopy (AAnalyst 800 AAS PE, USA).

According to the results Hg concentration in street dust ranges from 0.04 to 0.27 with the mean of 0.27 mg/kg, in leaf deposited dust from 0.03 to 3.3, with the mean of 0.57 mg/kg, meanwhile, in soils: from 0.01 to 0.07, with the mean of 0.04. The highest Coefficient of Variation of Hg was observed for leaf deposited dust. Moreover, in comparison to soil, Hg contents were significantly higher in dust. Significant correlation between the concentrations of Hg in the street dust, leaf deposited dust and soils are not observed. Spatial distribution of concentrations of Hg suggested that high values detected near the chemical plant and car technical services, indicating their possible anthropogenic origin.

Content of Hg in 36 street dust and 11 leaf deposited dust samples exceed local background values from 1.15 to 10.9, with the mean of 5.32 and from 1.15 to 65.9 with the mean of 11.4, respectively, meanwhile in the case of soil in 5 samples: from 1.15 to 1.39 with the mean of 0.82. The excess vs. Maximum Accepted content stated in Armenia observed only in one leaf deposited dust sample, spatially located near the chemical plant.

In the city area mainly dominated the “moderately” and “moderately to strongly” pollution levels of Hg in the street dust, “unpolluted to moderately polluted”, “moderately polluted” and “strongly” polluted levels in leaf dust and "unpolluted" level in the soil. Ecological risk assessment showed that in the city area high, considerable, and low levels of potential ecological risk dominated in street dust, leaf deposited dust and soils, respectively. At the same time the results of human health risk assessment showed that detected contents of Hg are not risky for the population health.

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ADSORPTION OF ORGANIC MOLECULES ONTO OLIVINE SURFACES BY MEANS OF MOLECULAR MODELING SIMULATIONS

Ignacio Sainz-Diaz (1), Elizabeth Escamilla-Roa* (1,2), Javier Martin-Torres (1,2)

(1) Instituto Andaluz de Ciencias de la Tierra, CSIC-UGR, Granada, Spain; (2) Lulea University of Technology, Lulea, Sweden

Silicate particles can be present as dust components in atmospheric aerosols, extra-terrestrial space and planet atmospheres. Organic molecules, such as, water, methane, CO, CO2 and NH3, are emitted directly into the troposphere from biogenic and anthropogenic sources. Besides these molecules were detected also in several planets of our Solar System, most of the larger moons, and dwarf-planets like Pluto and Eric. The detection of methane on Mars was reported recently after measurements from the rover Curiosity. The kinetics and adsorption mechanisms of these molecules on the mineral dust components are not well understood. This investigation is difficult to be performed experimentally. The atomistic molecular modeling approach with computational methods can be a useful tool for this study for a better understanding of the experimental work of these systems.
The goal of this study is to investigate at atomic level the interactions of methane and other atmospheric species (CO2, H2O) onto Mg silicate surfaces with calculations based on the Density Functional Theory. Besides, the adsorption of mixtures of H2O, CO, CH4, and NH3 gases as models of dirty amorphous ice was calculated onto several surfaces of forsterite. Weak physisorptions and strong chemisorptions happen in these systems along with the chemical dissociation of water promoted by these adsorbates.

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ADSORPTION OF SULFONAMIDES ON SILICATE SURFACES AS MODELS OF MINERAL DUST NANOCOMPONENTS BY MOLECULAR MODELING APPROACHES.

Ignacio Sainz-Diaz* (1), Misaela Francisco-M´raquez (2), Catalina Soriano-Correa (3)

(1) Instituto Andaluz de Ciencias de la Tierra, CSIC-UGR, Granada, Spain, (2) Instituto Politécnico Nacional-UPIICSA, Mexico, (3) FES-Zaragoza, Universidad Nacional Autónoma de México, México.

Silicates particles are present as components of dust in atmospheric aerosols. Although dust particles are abundant in the Earth's atmosphere, however the kinetics and adsorption mechanisms for these dust components are not well understood. This study is difficult to be performed experimentally and atomistic molecular modeling methods can be a useful tool for this study. Phyllosilicates can be considered as natural nanomaterials that are common in soils. They can be lifted by the winds and be suspended on the aerosols during large period of time. On the other hand sulfonamides form a great group of antibiotics widely used since decades for human therapeutics and in veterinary for intensive livestock production. The efficiency of the administration of these drugs is very low and the presence of these antibiotics and their derivatives in soils is becoming important. Therefore, these compounds can be transported along with the mineral dust components. The adsorption of sulfonamides, Sulfamethoxypyridazine and Sulfamethoxypyrimidine, as models of sulfonamides, on pyrophyllite surface has been investigated by means of empirical interatomic potentials and quantum-mechanical methods, finding that this adsorption is highly favourable.

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OUTDOOR AIR QUALITY MEASUREMENTS USING LOW COST PARTICULATE MATTER SENSORS

Abdul Samad* (1), Ulrich Vogt (1), Bernd Laquai (1)

(1) University of Stuttgart

In the field of air pollution control, sensors have been increasingly used for emission measurements for a long time, in addition to the usual emission measuring devices. For studies in the ambient air, for a long time sensors were not sensitive enough to detect the usually very low concentrations of airborne contaminants in the outside air. In recent years, however, there has been a development spurt in various sensors, which also makes them suitable for use in outdoor air. Interesting are the low-cost sensors for different reasons: First, they are very inexpensive to purchase. The price is only a few percent (1 to 5%) of the cost of a commercially available professional measurement instrument, e.g. an aerosol spectrometer. In addition, the sensors are small, light, require little power and can often be powered by batteries or accumulators. Due to the low price, larger networks can be built by installing sensors at many points in a city or area. This gives a very good overview of the spatial and temporal distribution of air pollution in an investigation area. The other advantages mentioned, such as the low weight and the battery operation, make it interesting for mobile measurements as performed by the authors. As mobile measuring platforms bicycles, tethered balloons, possibly drones and public transport such as buses, trams and rack railways can be thought of.

Currently in many cities, sensor networks are emerging, some of them with several hundred sensors to determine the air quality, mainly the PM10 and PM2.5 components. The network operators generally do not put much effort into quality assurance, either because of a lack of awareness of the need for quality assurance or due to the lack of resources and technology. The authors have acquired different low-cost sensors from different manufacturers for particulate matter (PM10, PM2.5, PM1, particle count). Comparative measurements for PM with professional aerosol spectrometer devices were performed in the laboratory as well as in the ambient air. On the other hand, a concept was developed and comparison measurements were done, where low-cost sensors of the sensor networks were compared with professional aerosol spectrometers in order to reduce the uncertainty of the sensor results and increase the data quality. First simple correction approaches have shown that this can improve the deviation of the measurement results of the sensors with each other and in comparison to the aerosol spectrometers. An important influencing factor on the quality of the results of the particle sensors is the humidity. This influence must be considered in the evaluation. The results of comparison measurements of low cost sensors of different companies with professional aerosol spectrometers showed that all sensors need a calibration with a reliable standard. After calibration, one type of sensor delivered satisfying results for small particles in the range of 0.3 to 2.5µm (PM2.5 signal). For coarser particle in the range of 2.5 to 10 µm (PM10-PM2.5 signal) this sensor did not deliver satisfying results. The second type of sensor did not deliver satisfying results, neither for PM2.5 nor for PM10 signal. The third type of sensor delivered satisfying results for all PM channels, PM10, PM2.5 and PM1. Even more this sensor delivers reliable results for 16 channels between 0.38 and 17 µm for the particle number concentration.

In conclusion, low cost sensors can be used after the application of quality assurance measures prior to the measurements instead of expensive measurement instruments. But not all sensors deliver the same quality of data. Some are even inappropriate for usage in the ambient air.

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DESERT DUST CLOUD INTERACTIONS AND ITS IMPACT ON CLOUD CHEMISTRY

Cemal Saydam* (1)

(1) Academic Staff. Hacettepe University Department of Environmental Engineering. Ankara Turkey

Transport of desert dust is well-known and well documented natural phenomena especially with the help of satellite imageries. During the course of such transport desert dust and cloud interactions may take place along the course of acting synoptic scale meteorological event. So far scientific community has concentrated on the magnitude and impact of various deposition parameters and ignored the processes that is initiated by desert dust and cloud interactions. Upon contact with cloud water numerous prokaryotes embedded within the dust particles becomes active in minutes and releases oxalate as an osmosolute. This reducing acid that has been accepted to have industrial origin is in fact produced by the action of bacteria and fungus upon contact with cloud water hence plays an important role in the formation of IN's. Oxalate then attacks the surround clay mineral and forms iron oxalate and one mole of water within the cloud droplet and if the solar radiation is above a threshold level that is assumed to be greater than 200 Watt/sq.m then decarboxylation reaction takes place and one mole of reduced iron one mole of carbon dioxide and one mole of carbonyl radical forms. Carbonyl radicals may also stabilize by forming yet another oxalate molecule and acts as a feedback mechanism. The iron formed is in reduced form and has to be utilized rapidly something that is performed by bacteria and fungus. The carbon dioxide also shifts to bicarbonate since desert dust containing media has a pH at around 6-7. As solar radiation increases during the daytime dust cloud interactions also result in the formation of more sulfate molecules as to form more clouds. The action of oxalate on the outer shells of fungi further decomposes their outer shells that is made up from chitin. Decomposition of chitin forms methane under "oxic" conditions and enhances the formation of all essential amino acids. Covariance of CO2 and CH4 is routinely measured by all ICOS stations but to date, there are no explanations for this. This medium also favours wet precipitation provided that the cloud temperatures are adequate and the sporadic nature of rain events further enhances phytoplankton growth over the surface waters. The DMSP released by these algae during their termination phase also enhances DMSP-DMS(aq)-DMS(gas)-MSA-SO4 cycle hence cloud formation. This explains why we have more dust during the course of glacial events and the link between the atmospheric dust and surging of glaciers. As glaciers surge it will automatically shift the global rain belt towards equator on both hemispheres and at its peak level is also controlled by the wetting of dust generating zones. Once this era is reached atmospheric dust concentrations reduces dramatically hence dust cloud interactions and eventual sulphate and cloud formation decreases. This also triggers yet another deglaciation era as more solar radiation can reach to surface earth. The cycle goes on like this but with climatic timescales. But I do propose that we are about to enter a "controllable climate age" since we have the means of seeding the clouds with desert dust enhance wet precipitation (EP2277371 B1) by necessary natural ingredients and sustain algae blooms over the surface waters create a sink for the carbon dioxide generate as much DMSP as we require hence control cloud formation hence control the albedo and eventually climate.

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THE CONTRIBUTION OF TRAFFIC TO PM2,5 LEVELS AT A MALTESE TRAFFIC SITE

Mark Scerri* (1), Eduardo Yubero (2), Konrad Kandler (1), Stephan Weinbruch (1), Nuria Galindo (2), Dario Massabo (3), Paolo Parti (3), Lorenzo Caponi (4)

(1) Institute for Applied Geosciences, Technical University Darmstadt, DE-64287, Darmstadt, Germany, (2) Laboratorio de Contaminación Atmosférica, Universidad Miguel Hernández, Av. De la Universidada s/n, Edif. Alcudia, 03202 Elche, Spain, (3) Dipartimento di Fisica, Università degli studi di Genova, Via Dodecaneso 33, 16146 Genova, Italy, (4) PM_TEN srl, Via Dodecaneso 33, 16146 Genova Italy

The traffic station in Msida (35.90°N, 14.49°E, 2m AMSL), located in the Maltese archipelago (in the Central Mediterranean) forms part of the Maltese air quality network. PM2,5 levels have been monitored at this site since 2008 and have been reported to the European Commission ever since. The receptor is within 10 m of an important traffic node with flows of ~23000 AADT which links Malta's administrative capital (Valletta) to the main Commercial, Entertainment and Tourism hub (Sliema). Additionally the site is surrounded by heavily trafficked areas to both the north and south, including Malta's busiest traffic artery (~41000 AADT) at 2.5 km to the SSE. PM2,5 levels at the receptor are expected to be heavily influenced by traffic. Other contributors to PM2,5 levels are expected to be shipping (due to the presence of a busy shipping lane to the east of the receptor) but also natural sources such as Saharan dust and sea salt.
The objective of this study is to isolate and quantify the traffic aerosol source contributions to the PM2,5 levels in Msida. Traffic emissions are Malta's major air quality concern and it is expected that the conclusions of this study will help the policy maker to take the required action. The sampling campaign ran from 01 January 2016 to 31 December 2016, for a total of three hundred and sixty six samples collected on 46.2 mm Teflon filters and every two days on 47 mm quartz fibre filters at a flow rate of 2,3 m3/h. The filters were conditioned, prior to weighing, for 96 h at a relative humidity range >45% and < 50% and at a temperature of 20°C±1°C. A sample of 180 Teflon filters were chosen in such a way that the seasonal weekday and weekend averages were as close as possible to those of the full population of filters. The ratio of weekday : weekend filters was kept at 2.5. The filters were analysed non-destructively for black carbon (BC) using a multi-wavelength absorbance analyse. Subsequently the same filters were analysed for 17 different elements (Al, Si, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Br, Sr, Ba, Pb) by energy dispersive X-ray fluorimetry, and for 5 ions (SO42-, NO3-, NH4+, Na+ and Mg2+) by ion chromatography. Ammonium levels were determined by UV-visible spectroscopy following the conversion to indophenol blue. The maximum absorbance concentration (MAC) was determined from the gradient of the plot of absorption coefficient vs the elemental carbon concentration (determined using the thermal optical transmittance instrument) using 7 QF filters, which sampled during the same sampling period. This was then used to convert the BC readings in equivalent black carbon (eBC). The eBC values were also corrected for the systematic difference between the absorbance of the Teflon and quartz fibre filters at 635nm. This was done by comparing the absorbance of Teflon and quartz fibre filters which were exposed at the receptor on the same day, during a 9 day sampling campaign carried out in August 2017.The carbon measurements were carried out by the Physics Department of the University of Genoa (Italy), while the remaining analysis was carried out by the Atmospheric Contamination Laboratory of the Miguel Hernández University, Elche (Spain). The data with the concentration of the analytes and the respective uncertainties was used as an input into the US EPA positive matrix factorization - PMF model (version 5) in order to identify the sources contributing to PM2,5 levels in Msida. Measured PM2,5 concentrations (in ng/m3) were regressed against resulting PMF factor scores in order to calculate the different sources contributions. In all eight different sources explaining 93.3% of the measured PM2,5 mass, were isolated: Saharan dust (F1), Shipping (F2), Re-suspended dust/Mixed crustal source (F3), a contribution rich in ammonium sulphate (F4), Aged sea salt (F5), Traffic (F6), Fireworks (F7) and Fresh sea salt (F8). The contributions for each source to PM2,5 were as follows 12.8% (1.9 µg/m3) for F1, 8.6% (1.3 µg/m3) for F2, 10.5% (1.6 µg/m3) for F3, 22.0% (3.3 µg/m3) for F4, 11.0% (1.7 µg/m3) for F5, 23.0% (3.5 µg/m3) for F6, 1.8% (0.3 µg/m3) for F7 and 3.7% (0.6 µg/m3) for F8 . 6% of the mass of PM10 was not assigned to any factor. The direct contribution of traffic amounts to 23% of the PM2,5 levels however traffic emissions also affect the aged sea salt component, and the part of the mixed crustal component due to the re-suspension of dust due to traffic.

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EVALUATION OF THE IMPACT OF DUST TRANSPORT OVER THE SOUTHEASTERN TURKEY

İsmail Sezen* (1), Metin Baykara (2), Ali Deniz (1), Alper Ünal (2)

(1) Istanbul Technical University, Science Eng. & Tech, Atmospheric Sciences, Turkey, (2) Istanbul Technical University, Eurasia Institute of Earth Sciences, Turkey

Particle pollution is a major environmental problem with severe health implications especially in urban areas. Turkey, due to its geographical location is affected by surrounding major dust sources (Saharan desert, and other dust sources located in East-Southeast of Turkey). In addition, urbanization and industry play a role in particulate matter (PM) problem. In this study, nine-year period PM concentrations of Adana, one of the first industrialized cities, were investigated. A dust storm was observed in 7-15 September 2015. This might explain the high PM concentration of maximum monthly average PM concentration of 84 µg/m3. This dust storm was analyzed with AQUA/TERRA MODIS satellite images and high-resolution DEBRA DUST product. Weather Research and Forecasting (WRF v3.8.1) was used to analyze the synoptic weather conditions during the dust event while dust transport pathways were analyzed with Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT). Results indicate that possible reasons for high concentrations of PM in September, a period before winter and home heating emissions start, are agricultural burning surrounding the city and continuous dust storm events. This paper, while focusing on Adana, discusses the findings of the neighboring city Diyarbakır, too.

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REVISITING THE OBSERVED CORRELATION BETWEEN WEEKLY AVERAGED INDIAN MONSOON PRECIPITATION AND ARABIAN SEA AEROSOL OPTICAL DEPTH

Disha Sharma* (1, 2), Ron Miller (1)

(1) Goddard Institute for Space Studies (GISS), NASA, NY, (2) GISS

Dust influences the Indian summer monsoon on seasonal time scales by perturbing atmospheric radiation. On weekly time scales, aerosol optical depth retrieved by satellite over the Arabian Sea is correlated with Indian monsoon precipitation. This has been interpreted to show the effect of dust radiative heating on Indian rainfall on synoptic (few-day) time scales. However, this correlation is reproduced by Earth System Model simulations, where dust is present but its radiative effect is omitted. Analysis of daily variability suggests that the correlation results from the effect of precipitation on dust through the associated cyclonic circulation. Boundary layer winds that deliver moisture to India are responsible for dust outbreaks in source regions far upwind, including the Arabian Peninsula. This suggests that synoptic variations in monsoon precipitation over India enhance dust emission and transport to the Arabian Sea. The effect of dust radiative heating upon synoptic monsoon variations remains to be determined.

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CONTAMINATION LEVEL OF HEAVY METAL AND THEIR SOURCE APPORTIONMENT IN URBAN SURFACE DUST FROM XI'AN, CHINA

Dongqi Shi* (1), Xinwei Lu (1)

(1) Shaanxi Normal University

This study is to investigate the contamination level of heavy metal and apportion their possible source in the urban surface dusts from the different functional areas. The dust samples from the four functional areas in Xi'an, China were measured by X-ray fluorescence spectrometry for the concentration of Co, Cr, Cu, Pb, Zn, Mn, Ni, V, Ba, Ga, Hf, Rb, Sr and Y. The result indicated that the concentrations of Co, Cr, Cu, Pb, Zn and Sr in each area were significantly higher than the corresponding local soil background values. Except that Co and Sr were at the highest concentration level in the traffic area, the concentrations of Cr, Cu, Pb and Zn were at the highest level in the educational area, but Co, Cr, Cu, Pb, Zn and Sr all were at the lowest level in the residential area. The contamination levels of each heavy metal were elevated by using the geoaccumulation index, and enrichment factor, and the comprehensive contamination level of all investigated heavy metals was assessed by numero synthesis pollution index. The results indicated that Ba, Ga, Hf, Rb, Mn, Ni, V and Y were uncontaminated, and Co, Cr, Cu, Zn and Sr were moderately contaminated, while Pb was strongly contaminated. The assessment result showed about 25% samples collected from the four areas were slightly contaminated by heavy metal, about 45% samples appearing moderately contaminated and 30% samples being strongly contaminated. The educational area is contaminated most comparing to the other three areas. Base on the absolute principal component scores-multivariate linear regression method, Co, Cr, Cu, Pb, Zn, Ba, and Sr were identified as traffic and construction activities source, and the contribution of this source was Pb (86.1%)> Cu(75.4%)> Zn(67.9%)> Co(64.4%)> Ba(59.3%)>Cr(58.0%)> Sr(58%); Mn, Ni, V, Ga, Hf, Rb and Y were identified as natural source, and the contribution of this source was Ga(83.6%)>Mn(82.5%)=Y(82.5%)>V(80.5%)>Ni(77.3%)>Hf(62.6%)>Rb(62.2%).

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AEROSOL OPTICAL PROPERTIES IN GOBI AGRICULTURAL REGION OF NORTHWEST CHINA DURING DUNHUANG CAMPAIGN

Jinsen Shi* (1)

(1) 1) Key Laboratory for Semi-Arid Climate Change of the Ministry of Education, College of Atmospheric Sciences, Lanzhou University, Lanzhou 730000, China

Atmospheric aerosols are believed to have a significant influence on the earth's radiation budget and have the largest uncertainty in estimating the radiative forcing. From April to June 2012, an intensive field campaign was conducted on Dunhuang Xihu Farm (40.492°N, 94.955°E, 1061m above sea level), in Gobi agricultural region of northwest China. Aerosol optical properties, including the scattering coefficient, the hemispheric back scattering coefficient, the absorption coefficient, the single scattering albedo, as well as PM10 mass concentration, are presented in this paper. The mean scattering coefficients at 550nm for PM10 and PM1 are 54.24±75.79 and 27.65±30.89 Mm-1, respectively. The mean absorption coefficient and mass concentration for PM10 are 3.22±3.01 Mm-1 and 111.03±182.62μg/m3, respectively. The average single scattering albedo at 670nm for PM10 is 0.91±0.06, which is less than the mean value 0.94±0.046 for 675nm and close to the value 0.91±0.035 for 500nm that received through CE318 instrument during this campaign. For dust storm, blowing dust and clear sky weather, the ratios of scattering coefficient of PM10 to PM1 are 0.41±0.123, 0.49±0.106 and 0.61±0.063, and the mean values of single scattering albedo are 0.96±0.018, 0.94±0.027 and 0.86±0.039, respectively. A trajectory cluster analysis is applied to discern the source characteristics of aerosol optical properties for different air masses.

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CENTRAL EUROPEAN ARIDITY CHANGES IN RESPONSE TO NORTH ATLANTIC SST AND GLOBAL ATMOSPHERIC CO2 CHANGE DURING MIS3 (60.000 – 27.000 BP)

Frank Sirocko* (1)

(1) Johannes-Gutenberg-University, Mainz, Germany, Department of Geoscience

The organic carbon content in a lake sediment core from the dry maar of Auel (Eifel Germany) reveals the identical succession of cold MIS3 stadials as known from the North Atlantic and Greenland temperature time series. Each cold stadial of MIS3 was characterized by dust activity, which was inactive during the interstadial phases. This patterns indicates a primary influence from the North Atlantic SST on the central European weather and general aridity/humidity changes during the entire MIS3.
Pollen and botanical macroremains in the maar lake sediments are used to reconstruct the vegetation and aridity of the Eifel during MIS3. The summer insolation maximum of the early MIS3 is marked by a spruce forest with abundant thermophilous trees, but absence of any dust. The subsequent time from 49 000 – 27 000 BP is marked by stepwise changes of the landscape from the early MIS3 spruce forest to a boreal forest with few dust events, steppe with large dust storms every few years, tundra (with annual dust) and polar desert, which is characterized by absence of all vegetation but reveals annual dust storms after 23 000 BP. The four transitions between these landscape zones are coincident with the MIS3 maxima in global atmospheric CO2 gas content. Apparently, the central European landscape reaches a new equilibrium with every step in the decline of the global CO2 content. Dust frequency and vegetation change

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SINGLE-PARTICLE ANALYSIS OF TRAFFIC-RELATED ABRASION PARTICLES WITH SEM-EDX

Frank Sommer (1), Volker Dietze (2), Anja Baum (3), Stefan Gilge (2), Jan Sauer (3), Maschowski Christoph (1), Reto Gieré* (4)

(1) Institut for Earth and Environmental Sciences - Geology, Albert-Ludwigs-Unversität, (2) Air Quality Department, Research Center Human Biometeorology, German Meteorological Service, 79104 Freiburg, Germany, (3) Federal Highway Research Institute, 51427 Bergisch Gladbach, Germany, (4) Department of Earth and Environmental Science, University of Pennsylvania, PA 19104-6316, USA.

In Germany alone, each year over 110,000 tons of tire-wear particles and 12,000 tons of brake-wear materials were produced as an inevitable result of traffic. Tire-wear particles for example, contribute 30 vol% of the microplastics that pollute rivers, lakes, and oceans [1]. Our study examines the generation and properties of these particles; it does not examine material directly emitted and deposited on the road surface, but rather focuses on the airborne particles after mobilization (suspension) and re-suspension by wind and passing traffic.
The samples were collected along three highly frequented German roads with different traffic mode (fluid traffic, stop-and-go) and vehicle velocities [2]. The analysis was conducted by Scanning Electron Microscopy combined with Energy-Dispersive X-ray spectroscopy (SEM-EDX), supplemented by transmission light microscopy. For the chemical analysis and mineralogical single-particle characterization, 500 particles in the PM10-80 size fraction were selected at random and more than 1400 EDX spectra were taken. We classified traffic-related particles derived from tire wear, road wear and brake wear as well as particles from other sources (e.g. concrete, soil, technical devices).
Our results demonstrate that along busy roads, most PM10-80 consists of materials produced through the abrasion of tires, road surface and brakes. Once deposited on the road surface, tire-abrasion particles develop an encrustment of varying magnitude. These encrustments consist of particles derived from the wearing course, brakes and brake pads, and of other road dust. Therefore, the encrustment gives the tire-wear particles from each road an individual shape, structure and chemical composition, which depend on traffic mode and fleet. The heavy metal content (e.g., Cd, Pb) in tire-wear particles and in their encrustment is low compared with data from older studies. In contrast to studies from the past, no clutch wear was found.

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A NOVEL PARTICLE INJECTOR TO STUDY DUSTY PLASMAS AT THE NANOSCALE

Tim Staps* (1), Dirk Trienekens (2), Job Beckers (1)

(1) University of Technology Eindhoven, (2) Prodrive Technologies B.V.

Dusty plasmas have been existing in outer space for billions of years. During past decades, there has been increasing interest in these complex plasmas for industrial purposes. In advanced particle detection equipment, atmospheric plasmas are used for the detection of airborne particles to measure, e.g., the concentration or size distribution. Further development of such equipment is motivated by recent studies substantiating the concern that ultrafine particles induce various hazardous effects on human health and the environment [1, 2, 3].

Currently, we are developing a modular injection module that enables us to inject ultrafine (i.e.\ nanometer-sized) particles into a plasma, which complements our capability to inject fine (i.e.\ micrometer-sized) particles for dusty plasmas research. The present concept is based on electrohydrodynamic inkjet printing, where an electric field is applied between a micropipette (nozzle diameter $\sim 10 \mu m$) and a substrate to eject single droplets of a fluid-nanoparticle suspension. By varying the amplitude and duration of applied high voltage pulses, we can control the size and directionality of ejected droplets for influencing the nanoparticle concentration in a dusty plasma.

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METAL DUSTFALL AROUND NORWEGIAN INDUSTRIES STUDIED BY ANALYSIS OF NATURALLY GROWING MOSS SAMPLES

Eiliv Steinnes* (1)

(1) NTNU, Trondheim, Norway

On request from the Norwegian Environment Agency, a survey of atmospheric deposition of heavy metals around industrial enterprises in Norway was carried out. The participation was voluntary and 22 industries located at 17 different sites financed their own participation. The survey was based on analysis of samples of naturally growing moss collected around the enterprises during the summer of 2015 and includes 57 different elements. The number of sampling sites around each location varied from 5-20, depending on topography and general pollution level. For most of the sites this survey was a follow-up of corresponding surveys carried out in 2000, 2005, and 2010. In most cases the deposition of heavy metals near the industries depended closely on the industrial processes used as well as the local topographic and meteorological conditions. It is assumed that the metal fallout predominantly occurs as dry deposition.

The results are evaluated relative to corresponding background levels in moss in parts of Norway with low impact of air pollution. Like in previous surveys, the generally most polluted industrial location was Mo i Rana, where several ferroalloy industries are situated, followed by Odda, were the main air pollution sources are zinc and titanium industries. At most locations where results from repeated surveys are available only minor temporal variations in metal deposition levels are evident.

The observed levels are evaluated relative to background levels in moss at the location concerned. If that ratio exceeds 10 for an element at a given site, obvious pollution is indicated, and in cases where the ratio exceeds the background by a factor of 50, substantial pollution is evident. Some examples of substantial pollution at given sites will be demonstrated in the talk. Metals in focus are Ti, Cr, Mn, Ni, Cu, Zn, Cd, Hg, and Bi, which all show obvious pollution at one or more sites.

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DUST AS CARRIERS OF HARMFUL SUBSTANCES IN THE AIR

Eiliv Steinnes* (1)

(1) Department of Chemistry, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway

Microscopic particulate matter may carry a variety of substances harmful to humans in the atmosphere. Volatile and semi-volatile trace elements such as Zn, As, Cd, Sb, I, and Pb tend to be preferentially concentrated on the small-particle fraction emitted from high-temperature sources and may be transported over long distances before removed by dry or wet deposition. The same may apply to radionuclides released from nuclear accidents and some chemically persistent organic compounds, such as PAH from combustion processes. After deposition of these substances they may preferentially be concentrated in surface material such as soils and vegetation and subsequently be transferred to humans via food or drinking water.

Long-range atmospheric transport of pollutants from densely populated and strongly industrialized regions has long been a major source of contamination of more pristine areas of Europe. Norway is such an area where transboundary transport constitutes the major source of many air pollutants. This has led to widespread contamination of natural surface soils with elements such as Pb, Zn, Cd, As, and Sb. Another source of substantial contamination from abroad was the Chernobyl accident, where Norway was perhaps the most strongly affected country outside the former Soviet Union. The deposition of some fission products from Chernobyl by far exceeded the previous fallout from atmospheric nuclear weapons tests.

As a supplement to regular air monitoring of bulk deposition, samples of terrestrial moss and natural surface soils have been collected at 470 sites all over Norway every 5 years since 1977 and analyzed for a major number of substances. Results from these analyses have substantially improved the monitoring of airborne contaminants and the understanding of the fate of these substances in the terrestrial environment following atmospheric deposition. Some main results from this work will be presented and discussed.

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SKIN AND INDOOR BIOTIC POLLUTION: DERMATITIS CAUSED BY ARTHROPODS IN DOMESTIC ENVIRONMENT

Luca Stingeni* (1), Leonardo Bianchi (1), Katharina Hansel (1), Simona Principato (2), Mario A. Principato (3), Iolanda Moretta (3)

(1) Clinical Allergological and Venereological Dermatology Section, Department of Medicine, University of Perugia (Italy), (2) Urania Research Center, Perugia (Italy), (3) Department of Veterinary Medicine, University of Perugia (Italy)

Ectoparasitosis caused by arthropods in domestic environments is a topic frequently observed during Dermatologist's daily job (1). This is an increasing health problem in industrialized countries, but systematic studies on skin diseases caused by mites and insects in indoor environments have been rarely reported and only several case reports of skin injuries induced by a large variety of arthropods were described, mainly caused by Pyemotes ventricosus and Glycyphagus domesticus (2,3,4,5) among mites and Formicidae and Bethylidae families among insects (6,7). The presence of arthropods in indoor environments is conditioned by microclimatic factors, mainly high temperature and high relative humidity, arthropod reservoirs , such as plants, pets, molds on walls and woodworm eaten wooden structures (parquet, beams, furniture, firewood). Moreover, the reproductive cycle of arthropods is influenced by seasons, with increased risk of morbidity for humans.

The most frequent clinical picture is papular urticaria, characterized by erythematous-oedematous and papular lesions, that are frequently centered by tiny vesicles. We prefer to name this clinical picture strophulus instead of papular urticaria, which is frequently used to indicate skin diseases with different aetiologic and pathogenic mechanisms. Other clinical pictures are erythematous and escoriated papules, urticaria and scabies-like lesions, erythematous papules and pustules. Only rarely can the lesions appear such as varicella-like and erythema-multiform like eruption. Skin lesions mostly involve trunk and upper limbs, can be scattered or clustered in circumscribed areas or in linear arrangement, last from 2-10 days, are itchy and painless. Possible temporary hyperpigmentation and rare necrotic and ecchimotic sequelae are possible. Histopathology shows eosinophilic spongiosis, esocitosis and possible vesicles with dermal lymphocytic and eosinophilic perivascular infiltrate. The differential diagnosis is made with pseudolymphoma and some eosinophilic skin diseases.

Even if the clinical history and the clinical picture are often suggestive for ectoparasitoses, until our studies there were no validated methods to relate the presence of arthropods to specific ectoparasitoses and to relate the clinical features to the parasitological data. The Authors show the results of a prospective case-series study recently published (8) and conducted in one-year period in the three Dermatologic Clinics of Perugia, Bari and Ferrara.

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TRANSATLANTIC TRANSPORT AND DEPOSITION OF SAHARAN DUST: TWO YEARS OF MONITORING DUST FROM SOURCE TO SINK

Jan-Berend Stuut* (1)

(1) NIOZ - Royal Netherlands Institute for Sea Research, and Utrecht University

Using a source-to-sink approach, we are monitoring Saharan dust transport and deposition using an array of instruments collecting dust on land in Mauritania as well as from the atmosphere at sea (using dust-collecting tethered buoys) and settling through the ocean (using sediment-trap moorings), along a transect at 12oN between Northwest African and the Caribbean. We compare our results to Saharan-dust samples collected on Barbados, as well as to transatlantic Saharan transport and deposition modelled using a CESM. Next to the dust particles, we also study the marine-environmental effects of dust deposition, including plankton communities and biomarkers. In this presentation, we will introduce the projects in the framework of which this study is carried out, and present preliminary data on Saharan dust transport and deposition as well as marine-environmental observations.
For more info see: www.nioz.nl/dust

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INVESTIGATION OF POLYCYCLIC AROMATIC HYDROCARBONS IN SOILS AROUND ELBASAN INDUSTRIAL AREA, IN ALBANIA.

Jonida Tahiraj* (1), Elda Marku (1), Georg Raber (2)

(1) Chemistry Department, Faculty of Natural Sciences, University of Tirana, Albania, (2) Institute of Chemistry-Analytical Chemistry, University of Graz, Universitätsplatz 1, 8010 Graz, Austria

Polycyclic aromatic hydrocarbons (PAHs) have been recognized to cause serious health and environmental problems due to their cancerogenic, mutagenic and teratogenic properties. For the first time, a comprehensive study was conducted in Elbasan district in order to know the current situation concerning PAH levels in this area which is under the influence of the metallurgical activity since 1976, currently operated by a Turkish company. 36 surface soil samples were collected in total in urban, agricultural and industrial areas, in March 2017. The samples were ultra-sonicated with dichloromethane, and the extracts were analyzed using an Agilent 7890A gas chromatograph equipped with a quadrupole Mass Spectrometer 5975C. High levels of contamination were observed at station 7 (Coke Plant) and station 10 (Refractory Brick and Carbon Mass Plant), where the mean concentration of 14 PAHs was in range 17235 µg/kg and 1635 µg/kg (dry weight), respectively. PAH pattern was dominated by four and five ring PAHs (contributing to 37 %, 41 % and 42 % of the total PAHs content) at the industrial, urban and agricultural areas. The sum of the 14 PAHs in the industrial area was considerably higher than those in urban and agricultural areas. The diagnostic molecular ratios revealed that the sources of PAHs were of mixed origin. The highest sum of the 7 carcinogenic PAHs was found in the industrial area. In general, the PAH concentrations in this study were below the maximum PAH concentrations allowed by the Canadian legislation for soils.

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A COMPREHENSIVE STUDY OF HYGROSCOPIC GROWTH OF CA- AND MG-CONTAINING MINERALS

Mingjin Tang* (1)

(1) Guangzhou Institute of Geochemistry, Chinese Academy of Sciences

It has been well recognized that atmospheric heterogeneous reactions will change the composition of carbonates (e.g., calcite and dolomite), leading to the formation of products with much higher hygroscopicity, such as Ca(NO3)2, Mg(NO3)2, and CaCl2. However, the hygroscopicity of these products is not yet completely understood. In this work, using two complementary techniques, we systematically investigated hygroscopic growth of eight Ca- and Mg-containing compounds under subsaturated conditions, including Ca(NO3)2, Mg(NO3)2, CaCl2, MgCl2, Ca(HCOO)2, Mg(HCOO)2, Ca(CH3COO)2, and Mg(CH3COO)2. The first technique, developed recently in our group, is based on a commercially available vapor sorption analyzer, and it measures the change in sample mass at different relative humidities (RH) under isotherm conditions. Using this technique, the deliquescence relative humidities and the water-to-solute ratios as a function of RH (up to 90%) were measured at different temperatures (5-30 oC) for these compounds. In addition, a humidity-tandem differential mobility analyzer was used to investigate the change of aerosol particle diameter of these compounds was investigated as a function of RH (up to 90%) at room temperature. It has been found that different compounds, even with the same cation, show distinctive hygroscopic properties. Our results, which will be presented in the conference, would significantly improve our understanding in the change of hygroscopicity of carbonates during atmospheric transport.

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MULTI-PHYSICS ENSEMBLE USING DIFFERENT PLANETARY BOUNDARY LAYER SCHEMES IN WRF MODEL FOR PBL HEIGHT PREDICTION OVER APULIA REGION

Andrea Tateo* (1), Mario M. Miglietta (2), Francesca Fedele (3), Micaela Menegotto (3), Simona Ottonelli (3), Roberto Bellotti (4, 1)

(1) Dipartimento Interateneo di Fisica, Università deli Studi di Bari "A. Moro", Via G. Amendola 173, 70126, Bari, Italy, (2) CNR-ISAC, (3) Apulia Region Environmental Protection Agency (ARPA Puglia), C.so Trieste 27, 70126, Bari, Itali, (4) Istituto Nazionale di Fisica Nucleare (INFN), Sezione di Bari, Via Orabona 4, 70125 Bari, Italy

Since anthropogenic and natural aerosols accumulate in the PBL, the knowledge of Planetary Boundary Layer height (zPBL) evolution is very useful for prediction of pollutant concentration [1].
In our work, we considered two techniques to evaluate the zPBL: one based on the vertical gradient in the Lidar (Light Detection and Ranging) signal, the second based on the thermal inversion estimated by means of Radio Sounding measurements.
Since a homogeneous distribution of observational points (such as Lidar and Radiosoundings stations) is not possible, it is very useful to evaluate zPBL by Numerical Weather Prediction (NWP) models.
The goal of the proposed work is to compare the PBL height predicted by means of the WRF (Weather Research Forecast) model with the PBL height indirectly evaluated by means of the two aforementioned techniques.
Different WRF settings have been considered, associated with different PBL model Physics. In particular, we ran five different combinations of Planetary Boundary Layer schemes and Surface Layer Schemes. To evaluate the WRF output performances, we considered two-fixed location [2]. In particular, we compared the WRF output with the Lidar measures in the city of Taranto in the morning hours and with the radiosounding measures in the city of Brindisi at midday. Both cities are located in Apulia, the southeastern Italian region.
Results show that predicted values from all five different WRF parameterizations are comparable to each other and the simulated zPBL is on average less than the measured PBL height. We suppose that this behavior is due to the complexity of the Apulia morphology, a narrow peninsula between two seas, with particular reference to the effect of the land-sea discontinuity on the vertical structure of the PBL.
Since no WRF model implementation showed better performances, we used different methods of post processing, the first based on the Artificial Neural Network algorithm and the second on the Kalman Filter to improve our results. Both methods show a Mean Bias lower than each single forecast.

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DUSTSAFE: GLOBAL INSIGHTS INTO THE COMPOSITION AND RISKS OF HOUSEHOLD DUST THROUGH CITIZEN-SCIENCE

Mark Patrick Taylor (1), Jane Entwistle* (2), Gabriel Filippelli (3), Ming-Hung Wong (4), Paul Harvey (1)

(1) Macquarie University, Australia, (2) Northumbria University, UK, (3) Indiana-Purdue University, USA, (4) The Education University of Hong Kong, Hong Kong

Dusts can pose serious risks to human health, with an increasing number of associations now being reported between air particulates and a broad number of disease outcomes, representing a growing contemporary public health challenge. In addition, there is an urgent need for more effective and inclusive public engagement of environmental science, particularly around the meaning and value of contamination in residential settings. Increased awareness is required to improve societal understanding of science and enable genuine public engagement to produce workable solutions and collaborative (through co-creation) response strategies.

Indoor exposure represents possibly the greatest potential overall exposure by virtue of our 'indoor lives', with up to c. 90% of the day spent in homes, workplaces and different modes of travel. Household dusts may contain harmful agents that impact health via ingestion and inhalation pathways, yet our indoor environments are still poorly understood, modelled and characterised. An international team have collaborated to launch a new global citizen science program (‘DustSafe’) to examine environmental exposure from household dust. The program is addressing this knowledge gap by engaging with homeowners directly to collect and submit household vacuum dust samples for geochemical and biological analysis along with resident meta-data.

This paper reports on the on-going findings from phase 1 of the DustSafe project, launched in November 2017. Participant’s vacuum cleaner dusts have been analysed for metal(loid) concentrations using X-ray fluorescence spectrometry (XRF), with a particular focus on the transition metals (Cd, Cr, Cu, Fe, Mn, Ni, V, Zn) and other known potentially harmful trace elements (As, Pb). The program operates independently in each partner country and global data is uploaded to the web portal (http://www.360dustanalysis.com) providing summary spatial, geochemical and mineralogical interpretation and guidance for participants.

The program’s goal for phase 2 is a comprehensive ‘360’ high-resolution analysis of a selected subset of samples for a wider range of organic and inorganic contaminants: asbestos, flame retardants, allergens, anti-microbial resistance genes, pesticides and dioxins, perfluorinated chemicals and Pb isotopes for fingerprinting and sourcing.

Dust is considered to be a key contaminant exposure source particularly for young children. The DustSafe program will provide insights into the prevalence of significant legacy and emerging contaminants and provide a unique platform for engaging the public about potential health risks from dust exposure in their homes.

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DETERMINATION OF METALLIC COMPOSITION AND SOURCE CONTRIBUTION OF PARTICULATE MATTER IN THE URBAN ATMOSPHERE, CORLU TURKEY

Lokman Hakan Tecer* (1), Merve Ficici (2), Guray Dogan (3)

(1) Namik Kemal Uni. Dept. of Environmental Eng., Turkey, (2) United Environmantal end Energy Tech. ,Turkey, (3) Akdeniz Uni. Environmantal Eng., Turkey

In this study, the mass concentrations, the metallic composition and source contributions of atmospheric particulate matter were determined in the province of Çorlu in Tekirdağ- Turkey. Daily PM2.5 and PM2.5-10 samples were collected in an urban station between June 2015 and June 2016. The average PM2.5 concentration was found as 23.35 ± 13.42 μg/m3. This value was well above the annual limit of 10 μg/m3 set by World Health Organization. The average PM10 concentration was determined as 37.05 ± 26.57 μg/m3. The PM10 value in Çorlu was lower than the annual limit value of 40 μg/m3, which was set by the National Air Quality Assessment and Management Regulation. In both PM fractions, winter season concentrations were higher than summer season concentrations. The elemental compositions were determined by Inductively Coupled Plasma Mass Spectrometry. Elemental concentrations showed correlation with meteorological factors and emission changes. The pollutant sources in both particle fractions were using Positive Matrix Factorization. Four factors were identified in both of PM fractions. The sources of PM2.5 were determined as crustal dust (45%), biomass and coal combustion (20%), industrial and metallurgical emissions (18%), and road dust (17%). For PM2.5-10 fraction, crustal dust (30%), incineration (25%), traffic and road dust (24%) and mixed industrial emission (21%) factors were determined.

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THE EFFECT OF DUST ON LIMESTONE LICHEN COMMUNITIES IN THE NEGEV DESERT

Marina Temina (1), Giora Kidron* (2)

(1) Institute of Evolution, University of Haifa, Israel, (2) Institute of Earth Sciences, The Hebrew University, Jerusalem, Israel

Lichens play a pivotal role in the terrestrial food chain as providers of nutrients and organic matter to the ecosystem. They also play an important role in rock weathering and soil formation. Therefore, any information about lichens in different environments is very important in understanding the processes occurring in ecosystems. This is especially important for desert ecosystems where the scarcity of rain may severely limit the ecosystem's production. However, the role of many factors in the development of lichen biota in desert areas remains poorly investigated. For example, there is no information on the effect of dust on lichens, although the amount of dust storms in Israel is 50-60 days per year. The goal of the present research was to study the relationships between dust deposition and the development and distribution of lichen biota on limestone cobbles in the Negev desert under different conditions of humidity.

The research site was located at a second order drainage basin near Kibbutz Sede Boqer in the Negev Desert Highlands, Israel, approximately 500 m above sea level. At this basin, 13 stations were demarcated at the northern, southern, eastern, and western slopes. At these stations, dust was collected monthly in dust traps for two years. The amounts of collected dust were measured in the laboratory. In addition, the amounts of rain and dew as well as wetness duration following rain and dew events were measured at each station. For the study of lichen communities, ten cobbles overgrown with lichens were collected from each station and taken to the lab. The lichen species richness and covers, as well as the morphological and anatomical characteristics of species on collected cobbles were studied using a microscope.

Measurements of microclimatic parameters showed that the different slopes at the drainage basin represented specific ecological niches characterized by different amounts of deposited dust and different conditions of humidity. An analysis of lichen biota on the different slopes showed that dust influenced these organisms mainly in humid habitats. In arid habitats, the effect of dust on lichens was considerably rarer. Thus, our study demonstrated that the deposition of large amounts of dust is most dangerous for lichens in the rainy season. The negative impact of dust was expressed in the reduction of lichen species' diversity and their covers on limestone cobbles. Dust also contributed to the degradation of lichen thalli and their reproductive ability.

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DETECTION OF PARTICULATE MATTER EMISSIONS FROM STEEL MILLS ACCORDING TO CHROMIUM, NICKEL AND MOLYBDENUM LEVELS IN ROAD DUST IN SLOVENIA

Klemen Teran* (1), Mattia Fanetti (2), Gorazd Žibret (1)

(1) Geological Survey of Slovenia, Dimičeva 14, SI-1000 Ljubljana, Slovenia, (2) Materials Research Laboratory, University of Nova Gorica, Vipavska 11c, SI-5270 Ajdovščina, Slovenia

With increasing economic development, anthropogenic activities became the most important source of airborne particulate matter in urbanized areas. Main characteristics of airborne particulate matter generated during anthropogenic processes are small particle diameters, with a specific morphology and relative enrichment of trace elements in comparison to their crustal abundances. Settled atmospheric particulate matter represents one of the major components in road dust, together with soil particles, organic matter and different material deterioration products. Furthermore, short residence time of around 210 days [1] makes road dust a very suitable sampling medium for the detection of present emissions. Particles produced during high temperature processes in steel mills are especially interesting as they can be used as tracers for atmospheric dispersion and the transport of particulate matter [2]. This is due to their distinctive elemental composition and specific particle morphology in comparison with particles generated by other sources [3].

A comprehensive, nationwide sampling of road dust was carried out in Slovenia during 2016. A total of 270 sampling locations were spread across rural, urban and industrialized areas. Bulk road dust samples were collected from asphalt pores, using a hard plastic brush and a sheet of paper. In close vicinity to road dust sampling locations, topsoil (0-5cm) samples were also taken from automorphic soil for reference and comparison. All samples were sieved to fraction passing 63 μm mesh screen. Elemental composition of samples was determined in commercial laboratory using ICP-MS following the Aqua Regia digestion method. Samples with an anomalous elemental composition were further inspected using SEM/EDS, to determine metal-bearing particles.

Statistical and spatial data analyses indicated significant differences in Cr, Ni and Mo distribution between road dust and topsoil samples. Strong anomalies for Cr, Ni and Mo in road dust were detected on sampling locations in the proximity of operational steel mills. Maximum levels for Cr, Ni and Mo were 1839 mg/kg, 1334 mg/kg and 185 mg/kg respectively, which were up to 40 times higher in comparison to topsoil samples taken from the same location. Elemental levels in road dust were rapidly decreasing with distance from the plant, reaching their local background levels approximately 15 to 20 km from the steel mill. SEM/EDS inspection of road dust confirmed that spherical and smooth-edged particles with diameters between 2 and 60 μm, are the main carriers of Cr, Ni and Mo. These are characteristic for high temperature processes in steel processing plants.

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SPECTRAL DERIVATIVE ANALYSIS OF SPECTRORADIOMETRIC MEASUREMENTS IN PARTITIONING DUST-AEROSOL PROPERTIES FOR COMPLEMENTING LIDAR OBSERVATIONS

Si-Chee Tsay* (1), Tang-Huang Lin (2)

(1) NASA Goddard Space Flight Center, (2) National Central University, Taiwan

Processes in generating, transporting, and dissipating the airborne dust particles are global phenomena -African dust regularly reaching the Alps; Asian dust seasonally crossing the Pacific into North America, and ultimately the Atlantic into Europe. During its lifecycle, airborne dust frequently mixes with other types of anthropogenic/natural aerosols. To fully characterize the properties of airborne dust and its impact assessment is an important but challenging task. Since 1997 NASA has been successfully launching a series of satellites with active/passive sensors - the Earth Observing System - to intensively study, and gain a better understanding of, the Earth as an integrated system. Measurements and retrievals of passive imagers (e.g., spectroradiometer, interferometer) are highly complementary to the information provided by active sensors (e.g., lidar), offering wide swath coverage in con-trast to the high vertical resolution but limited “curtain” spatial coverage. In addition, the analysis of distinct spectral features of these spectroradiometric observations can provide not only the aerosol types but also their partitions. In this talk, we will present our recent development on the spectral derivative analysis of spectroradiometric measurements in complementing lidar retrievals of airborne dust properties.

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THE MINERAL AEROSOLS PROFILING FROM INFRARED RADIANCES (MAPIR) RETRIEVAL ALGORITHM: DUST 3D RETRIEVALS FROM IASI

Sophie Vandenbussche (1), Sieglinde Callewaert* (1), Martine De Mazière (1)

(1) Royal Belgian Institute for Space Aeronomy (BIRA-IASB)

Windblown desert dust, the most prominent type of aerosol in the low troposphere, affects the radiation directly through absorption, scattering and emission of light, and indirectly, through interactions with clouds. All radiative effects of dust depend on the horizontal and vertical distribution of that aerosol in the troposphere. The dust vertical distribution is not yet well characterized, at least not enough to allow studying the interactions between dust and clouds or the effect on atmospheric circulation.

The Royal Belgian Institute for Space Aeronomy (BIRA-IASB) has developed a retrieval strategy that produces dust aerosol vertical profiles from thermal infrared radiances measured by the IASI instrument onboard The Metop satellite series. This strategy is called Mineral Aerosol Profiling from Infrared Radiances (MAPIR) and has been used under ESA's Climate Change Initiative aerosols project to produce 9 years of dust 3D distributions (Popp et al, 2016). The validation has shown an AOD overestimation but a good mean aerosol altitude (Kylling et al., 2017). The full profiles have not been independently validated. MAPIR v3 also has convergence issues over some parts of low emissivity deserts.

The current research focuses on improving those weaknesses, and increase the retrieval speed to allow less costly reprocessing. This includes the replacement of the radiative transfer code from Lidort (Spurr et al. 2008) to RTTOV (ECMWF NWPSAF), testing different data bases for the ancillary parameters (aerosols refractive index, surface emissivity, ...), searching for retrieval windows less sensitive to uncertainties in those ancillary data.
MAPIR has also been successfully used in one test-case analysis of volcanic ash 3D retrievals (Maes et al., 2016). Additional research is needed to generalize those volcanic ash retrievals.

In this poster, we will describe the algorithm and its most recent improvements, discuss the matters still under investigation and show some results and comparisons with Aeronet and CALIOP.

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USE OF SATELLITE DATA FOR SOURCE DETECTION AND MONITORING OF DUST AEROSOL

Sophie Vandenbussche* (1), Sieglinde Callewaert (1), Nicolas Kumps (1), Martine De Mazière (1)

(1) Royal Belgian Institute for Space Aeronomy (BIRA-IASB)

Mineral dust aerosols are the most important tropospheric aerosol in annual mass burden, and a major actor in the climate system. The work presented here aims at a better characterization of dust sources, through an innovative approach using multiple satellite and weather data sets in a joint analysis.

BIRA-IASB has developed a strategy for the retrieval of mineral dust aerosols 3D distribution in the atmosphere from satellite thermal infrared measurements. This strategy, called MAPIR, is described in a separate contribution to this conference (Callewaert et al.). It has been used to obtain about 10 years of 3D dust distribution from IASI. IASI is a satellite instrument measuring radiances in the thermal infrared range in the nadir viewing geometry, offering almost global Earth coverage twice a day at local solar times of about 9h30 and 21h30. IASI flies onboard the Metop satellites for long time series of measurements: from 2006 to at least 2026.

This data set has been used in an ESA Living Planet Fellowship to study mineral dust sources with a new method [1]: we take advantage of the knowledge of the vertical distribution of the dust aerosols, information that is not available in the usual satellite data sets containing only total column information, and use additional data including land cover, land surface type, soil moisture, vegetation state, winds...to help discriminate between the locations of dust sources and deposition.

In this contribution, we explain the method developed for studying the mineral dust sources and we show its application to Tropical dust sources in Africa, Middle-East and Asia: their localization, partial diurnal cycle, and evolution over 10 years.

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MULTIANNUAL GRAVIMETRIC STUDY OF PM3.0 SIZE-SEGREGATED AEROSOL FROM KING GEORGE ISLAND, ANTARCTIC PENINSULA

Carmen Vega (1, 2), Verónica Víquez (1, 2), Margarita Préndez* (3)

(1) School of Physics, University of Costa Rica, (2) Centre for Geophysical Research Studies (CIGEFI), (3) Universidad de Chile, Facultad de Ciencias Químicas y Farmacéuticas, Santiago, Chile

Aerosol studies are of great importance to Earth Sciences. Chemical and physical properties of particulate matter (PM) determine its capability to act as cloud and ice condensation nuclei, its interaction with solar radiation, transport ranges, deposition rates, and its role in climate. Despite the relevance of fine aerosol on health, when entering the respiratory system, and its role as substrate for the absorption of toxic substances, direct gravimetric studies of Antarctic size-segregated aerosol are scarce [1–5]. This study presents a gravimetric analysis of PM3.0 size-segregated and total PM10 collected at Fildes Peninsula (62.2°S, 58.9°W), King George Island, Antarctica, during austral summer-autumn 1998 (January–April, with 13 PM3.0 samples; and December 1997–July 1998, with 27 PM10 samples), 2007 (January–May 7, with 16 PM3.0 samples), and 2008 (February–June 24, with 13 PM3.0 samples), within the framework of the XXXIV, XLIII, and XLIV Chilean Antarctic Expeditions. PM3.0 samples were collected in pre-weighted aluminium disks using an Andersen six-stage Cascade Impactor (ACI), with particle aerodynamic cut-off diameters (AD) of 2.84 μm, 2.04 μm, 1.40 μm, 0.8 μm, 0.41 μm; and a last stage collected in pre-weighted cellulose acetate filters (Millipore), with AD = 0.01 μm. PM10 samples were collected using a Partisol sampler. Aluminium disks and filters were weighted in a Precisa 40SM-200A scale (± 0.01 mg) placed inside a Plas Labs chamber with controlled atmosphere. Mean PM3.0 concentrations in standard air were 9 ± 6 μg m−3, 9 ± 3 μg m−3, and 10 ± 4 μg m−3, for samples collected in 1998, 2007, and 2008, respectively, whereas mean PM10 concentration was 6 ± 2 μg m−3, for samples collected in 1998. Concentrations of PM3.0 collected in 1998 were consistently higher than PM10 concentrations, especially during the period March 9–April 3, with PM3.0 concentrations being more than double of PM10 concentrations. PM3.0 collected in 1998 shows a significant positive linear trend (at the 95 % confidence level); whereas none of the other aerosol series show any significant linear trend during their respective sampling periods. Monthly normalized differential PM3.0 mass distributions show that during January–March 1998, PM3.0 size-distributions were mainly bi-modal, with the coarse mode (AD = 2.04 μm) dominating the aerosol load, followed by particles with AD between 0.41–0.8 μm in February–March, and particles with AD between 0.01–0.8 μm in January. In 2007, the period between January–April shows similar bi-modal aerosol mass distributions, with dominance of the coarse mode (AD = 2.04 μm), followed by particles with AD = 0.41 μm during February–April. Early May shows a dominance of the accumulation mode, with AD between 0.41–0.8 μm. In 2008, the coarse mode (AD = 2.04 μm) dominates throughout the sampling period (February–June), followed by particles with AD = 1.40 μm during March–April, and by particles with AD between 0.41–0.8 μm during February, and by particles with AD between 0.41–1.40 μm during June, and by particles with AD = 0.01 μm during early May. These preliminary findings on PM3.0 size-distribution will be further used in addition to an air-mass back-trajectory analysis to differentiate between sources and transport patterns of the different aerosol fractions arriving to the study site.

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FLAME RETARDANTS AND PERFLUORINATED ALKYL SUBSTANCES (PFASS) IN HOUSEHOLD DUST IN CENTRAL EUROPE AND NORTH AMERIC

Marta Venier* (1), Ondrej Audy (2), Pavlina Karaskova (2), Simon Vojta (2), Jitka Becanova (2), Kevin Romanak (1), Lisa Melymuk (2), Martina Kratka (2), Petr Kukučka (2), Joseph Okeme (3), Miriam Diamond (3), Jana Klanova (2)

(1) Indiana University, (2) Recetox, (3) University of Toronto

Concentrations of more than 20 brominated flame retardants (FRs), including polybrominated diphenyl ethers (PBDEs) and emerging FRs, 13 organophosphate ester flame retardants (OPEs), and 20 perfluorinated alkyl substances (PFASs) were measured in dust from 63 homes in Canada, the Czech Republic and the United States in the spring and summer of 2013.
Sampling and experimental details are reported elsewhere.1,2.3 Briefly, floor dust samples were collected using a pre-cleaned nylon sampling sock inserted into the tube of a conventional household vacuum cleaner, vacuuming the largest possible floor area and recording the area. Socks with dust were weighed, the dust was sieved to <500 μm, approximately 100 mg were weighed. The dust was sonicated, further cleaned and analyzed using GC/MS or HPLC-MS/MS.
Among the PBDEs, the highest concentrations were generally for BDE-209, followed by Penta-BDEs. Among alternative FRs, EHTBB, BEHTBP, and DBDPE were detected at the highest concentrations in dust. In general, FR levels were highest in the US and lowest in the Czech Republic -- a geographic trend that reflects the flame retardants market. Among OPEs, the highest concentrations were generally measured for halogenated compounds, particularly TCEP, TCIPP and TDCIPP, and also non-halogenated TPHP. The concentrations of OPEs in dust were significantly higher in the US than in Canada (CAN) and Czech Republic (CZ). OPEs were generally higher than BFRs in these houses. In particular, the sum of all OPEs was 1 to 2 orders of magnitude higher than the sum of all BFRs for all countries for dust.
Among PFASs, the most frequently detected compounds were perfluorohexanoic acid (PFHxA) and perfluorooctane sulfonate (PFOS). PFOS and perfluorooctanoic acid (PFOA) had the highest concentrations of PFASs in all countries. In general, concentrations in North America were higher than in the Czech Republic, which is consistent with usage patterns. Homologue profiles suggest that the shift from longer to shorter chain PFASs is more advanced in North America than in Europe.

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ATMOSPHERIC HETEROGENEOUS NUCLEATION REACTIONS OF HCL, HNO3, H2SO4 AND H2O: DFT STUDY OF MOLECULAR AGGREGATION

Marian Verdes* (1)

(1) Universidad Autónoma de Madrid

Heterogeneous reactions are crucial to know the evolution of polar stratospheric clouds (PSCs) as key clouds involved in ozone destruction [1,2]. PSCs particles may be composed by reactive species as HCl [3], HNO3, (specifically by HNO3·3H2O or NAT) [4,5], H2SO4 in liquid solution, as supercooled ternary solution (STS) [6] that is a cold mixture of H2O-H2SO4-HNO3; moreover, H2SO4 is also implicated in ice condensation on H2SO4·4H2O [7].
Previous theoretical studies of heterogeneous aggregation with H2O, HCl, HNO3 and H2SO4 had carried out whose electronic structures of these aggregates might be the embryos of heterogeneous nucleation reactions in particles of PSCs [8-10].
The relative stable electronic structures had optimized at low and high level of theory, from the 6-31G to aug-cc-pVQZ basis sets, using the hybrid method B3LYP within of Density Functional Theory. The ab initio electronic structures calculations to obtain the geometries of monohydrates of these trimers previously optimized follow the heterogeneous nucleation reactions:

$$[HCl{\cdot}HNO3{\cdot}H2SO4]\text{-}K + (H2O)n \rightarrow (HCl{\cdot}HNO3{\cdot}H2SO4)k{\cdot}(H2O)n$$
$$[HCl{\cdot}H2SO4{\cdot}HNO3]\text{-}K + (H2O)n \rightarrow (HCl{\cdot}H2SO4{\cdot}HNO3)k{\cdot}(H2O)n$$

where n signify the H2O position around the each K-global trimer aggregate for both group of electronic structures: HCl·HNO3·H2SO4 (CNS) and HCl·H2SO4·HNO3 (CSN).
After apply a systematic optimization methodology to achieve the electronic structures of monohydrates it had found thirty-two electronic structures of CNS monohydrates with different geometry from fifty-six candidate structures. The CSN monohydrates yielded ninety-three optimized electronic structures from ninety-nine candidate geometries. The different electronic structures of monohydrates achieved may contribute to explain the different geometries in the particles of PSCs. Their relative stabilities, IR spectra and electronic energies can help to predict the hydrogen bond interactions, their physico-chemical properties, even several shapes of the atmospheric particles or aerosols involved in ozone depletion.

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CHARACTERIZING DUST USING SCATTERED LIGHT

Gorden Videen* (1, 2), Evgenij Zubko (3)

(1) U.S. Army Research Laboratory, 2800 Powder Mill Road, Adelphi, MD 20783, USA, (2) Space Science Institute, 4750 Walnut Street, Boulder Suite 205, CO 80301, USA, (3) School of Natural Sciences, Far Eastern Federal University, 8 Sukhanova Str., 690950 Vladivostok, Russia

The way that light is scattered and absorbed is determined by the composition and morphology of the particles with which the light has interacted. The goal of remote sensing is to gain information about those particles from their scattered light, the so-called inverse problem. It has long been recognized that an exact solution to this problem cannot be achieved. However, recent advances have allowed us to place constraints on the dust properties, that when combined with a priori knowledge, can provide significant information. I plan to illustrate remote sensing of particles using examples of terrestrial and planetary science.

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LIDAR OBSERVATION ON THE CO-EXISTENCE OF ASIAN DUST AND ANTHROPOGENIC POLLUTION OVER NORTHERN TAIWAN

Sheng-Hsiang Wang* (1), Wei-Ting Hung (2), Jan-Bai Nee (3), Shuenn-Chin Chang (4), Sarah Lu (2), Wei-Nai Chen (5)

(1) Department of Atmospheric Sciences, National Central University, Taiwan, (2) Atmospheric Sciences Research Center, State University of New York, University at Albany, USA, (3) Department of Physics, National Central University, Taoyuan, Taiwan, (4) Taiwan EPA, Taiwan, (5) Research Center for Environmental Changes, Academia Sinica, Taiwan

In the late winter and spring time, East Asia is often affected by Asian dust (AD) transported through long distances from deserts in the Northwestern Asia. Taiwan, located downwind of dust storm outbreaks from China and at the outflow of urban-industrial pollutants from the Pearl and Yangtze River Delta, is exposed to a seasonal milieu of natural and anthropogenic aerosols in the atmosphere. In this presentation, we will demonstrate our +10 year's observational efforts (i.e., particulate matter monitoring, lidar profiling, aerosol optical measurements) in conjunction with NASA MERRA2 aerosol reanalysis and HYSPLIT backward trajectory on characterizing the co-existence transported Asian dust and anthropogenic pollutants over northern Taiwan. An integrated analysis with Lidar detection, surface PM2.5 observation, satellite product, and aerosol reanalysis data was conducted to investigate the characteristics and impact of co-existence. Our results show that those co-existence events were mostly transported from the Gobi deserts and mixed with lower level anthropogenic pollutants in the costal regional of China, following the passage of an eastward cold front, and reached to Taiwan. Some events show that the upper level Asian dust was down-dragged from 2 - 4 km rapidly to ~1 km within 24 hours following the passage of low-level trough at 700 hPa. Our results show that together with anthropogenic pollutants, the properties of airborne dust particles were changed and show different to those in the source region. Aerosol climatology and typical case studies will be presented in this presentation.

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GEOCATALYTIC UPTAKE OF OZONE ONTO NATURAL MINERAL DUST

Xianjie Wang* (1), Manolis Romanias (2), Frederic Thevenet (2), Antoine Rousseau (1)

(1) LPP, Ecole Polytechnique, UPMC, CNRS, Université Paris-Sud, Palaiseau Cedex, France, (2) IMT Lille Douai - Département Sciences de l'Atmosphère et Génie de l'Environnement

Beyond tailored and synthetic catalysts seeked for ozone decomposition, mineral dusts provide naturally mixed metal oxide materials. The steady state uptake of O3 evidenced on a wide concentration range, signs the catalytic decomposition of O3. Geocatalytic properties of such natural mineral dust open perspectives in atmospheric chemistry and catalytic processes.

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VALIDATION OF MICRO-PULSE LIDAR PBL HEIGHT RETRIEVALS USING AIRBORNE MEASUREMENTS

Yueh-Chen Wang* (1), Sheng-Hsiang Wang (1), Li-Jin Ke (1)

(1) Department of Atmospheric Sciences, National Central University, Taiwan

The height of PBL (planetary boundary layer) can use to describe the structure of lower atmosphere and has an important implication for air quality variability. Aerosols usually confined beneath the inversion layer where is considered as the top of PBL. Our micro-pulse lidar (MPL) is an active remote sensing technology, particularly sensitive to the backscattering signal of aerosols, providing the vertical distribution of aerosol backscatter and depolarization ratio up to 30 km height. However, the weakness of MPL observation is the insufficient in near-field return signal and rely on an overlap function to correct it. The accuracy of near-filed data is essential for PBL retrievals. In this study, we will try to (1) refine a set of overlap function; (2) validate the PBL height from MPL data retrievals using several independent PBL measurements (i.e., meteorological balloon sounding, unmanned aerial vehicle (UAV)). An experiment was carried out nearby Taipei sounding station during the period of June 21 – September 19 in 2017. The available sounding data is two to three times a day. In addition, state parameters (temperature, RH and pressure) information from UAV intensive flights are obtained on August 16, 17, 22, 25, and 29 to provide higher temporal resolution coverage in meteorological profile. Our preliminary results show intensive PBL met profile in conjunction with MPL data can clearly describe the PBL evolution during a day. The daytime PBL height in good agreement between airborne observation and MPL retrieval. In the presentation, we will also compare different PBL retrievals and discuss their pros and cons. Our research outcome can improve our understanding of high temporal resolution of PBL development and further apply to air quality monitoring.

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SINGLE-PARTICLE SEM CHARACTERIZATION FOR ASSESSING DEPOSITION VELOCITIES OF DIFFERENT PASSIVE DUST SAMPLERS

Andebo Waza (1), Kilian Schneiders (1), Jan May (2), Konrad Kandler* (1)

(1) Applied Geosciences, Technische Universität Darmstadt, (2) Energy Systems & Technology, Technische Universität Darmstadt

Mineral dust aerosol particles become the focus of increasing scientific attention mainly due to their effect on the radiative budget and impact on biogeochemical cycles. They are the single largest component of long-range transported global atmospheric aerosol budget, contributing about one third of the total natural aerosol mass annually.
Mineral dust is dominated by particles in the supermicron range and consists to a great extent of particles larger than 10 µm. Therefore, assessment of its properties can't rely on standard PM10 instrumentation. Frequently, deposition or other passive measurement techniques are used to sample mineral dust from the atmosphere. However, there exists a multitude of different collection instruments with different, usually not well-characterized sampling efficiencies, so the resulting data might be considerably biased with respect to their size representativity.
In this study, individual particle analysis by automated scanning electron microscopy (SEM) coupled with energy-dispersive X-ray (EDX) was used to characterize different, commonly used samplers (Big Spring Number Eight, Modified Wilson and Cooke, funnel, bucket and plate geometries) with respect to their size-resolved deposition velocities. Samples were therefore collected on pure carbon adhesive substrate inside the different passive samplers. In addition, computational fluid dynamics modeling was used in parallel to achieve deposition velocities from a theoretical point of view. The samplers were operated in a mineral dust transport regime (Izaña, Tenerife) in July – August 2017. During this time, a wide variation of aerosol concentrations and wind speeds was encountered, allowing for an accordingly wide value range of deposition velocity / sampling efficiency estimates.
First results show a difference of an order of magnitude in deposition velocities between different sampler types. This difference depends on particle size as well as wind speed. In particular, the particle size dependence of the samplers is different, so even if two samplers would measure an equal mass flux, the collected particles would still differ considerably.

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NASA MICRO PULSE LIDAR NETWORK (MPLNET) OBSERVATIONS ACROSS THE GLOBAL DUST BELT: TOWARDS AN INTEGRATED NEAR REAL TIME LIDAR PROFILING CAPABILITY

Ellsworth Welton* (1), Sebastian Stewart (2), Jasper Lewis (3), James Campbell (4), Simone Lolli (5)

(1) NASA Goddard Space Flight Center, (2) SSAI, NASA Goddard Space Flight Center, (3) University of Maryland, Baltimore County, (4) Naval Research Lab, Monterey, CA, USA, (5) Institute of Methodologies for Environmental Analysis (IMAA), National Research Council (CNR)

While there are dust sources located worldwide, the majority of atmospheric dust is generated within a "dust belt", roughly considered to extend across Northern Africa to the Middle East, over Southern Asia to China. These areas become heavily impacted by dust affecting their climate and regional air quality. Large amounts of dust are transported seasonally outside the belt, extending the influence of this region to places such as the Caribbean and Europe, as well as open ocean over the Atlantic and Pacific. Due to the large expanse of the dust belt, satellite observations using both passive imagery and active lidar profiling have provided invaluable data. Coupled with advances in modeling dust emission, transport, and deposition, satellite data and modeling have led to the ability to more accurately forecast dust plumes and their impact on the Earth system. Lidar observations remain the primary method to determine dust vertical distributions, especially relative to cloud heights and the atmospheric boundary layer. Such data is not readily available from passive imagery, and thus lidar provides essential data to study, verify, and improve our understanding of dust transport processes. The CALIOP lidar on CALIPSO, and recently CATS on the ISS, have provided valuable lidar profiles within the dust belt from space. EarthCare will launch soon, but the CATS mission has ended and CALIOP will eventually reach of end of life as well. Space missions have limited lifetimes and ideally bridge missions with overlap are needed to transition long term data sets over decadal scales. In addition, space lidar orbits provide snapshots of dust vertical distribution globally, but not continuous profiles at a given location. Thus, they cannot provide diurnal information or examination of finer scale processes, especially those in the boundary layer where their signals are weakest. A successful lidar observation strategy should rely on ground based lidar networks as well as space-based lidar assets. Lidar networks such as EARLINET, AD-NET, and MPLNET are now fully mature projects running for nearly 20 years. Each has developed high level of standards, data quality, and long-term observational databases. All three provide observations within the dust belt. In 2008, the WMO GAW Aerosol Lidar Observation Network (GALION) was created as a network of lidar networks with the goal to provide a coordinated framework of communication, best practices, calibration and processing standards, data definition, and eventually coordinated data distribution. Working together in the GALION framework, these networks can provide bridging capability between successive space missions, in addition they have the capability to provide continuous, near real time lidar data for diurnal studies. Finally, there are many network sites with advanced lidar systems capable of providing more accurate products and microphysical retrievals not possible from space. Here we present an MPLNET observation strategy to provide continuous, near real time, standardized lidar products that span the global dust belt. The MPLNET strategy has been designed to leverage GALION, complementing the more dense network coverage provided regionally by EARLINET and AD-NET.

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CHARACTERIZING METAL AND METALLOID ENRICHMENT PATTERNS IN ROAD DUST PARTICLE SIZE FRACTIONS OF HUMAN HEALTH CONCERN

Clare Wiseman* (1, 2), Jianjun Nui (3), Levesque Christine (3), Pat Rasmussen (3, 4)

(1) School of the Environment, University of Toronto, (2) Dalla Lana School of Public Health, University of Toronto, (3) Exposure and Biomonitoring Division, Environmental Health Science and Research Bureau, HECSB, Health Canada, (4) Earth and Environmental Sciences Department, University of Ottawa

Road dust is enriched with a range of metals and metalloids of human health concern such as Cu, Cd, Sb and Pb. The volume of road dust generated in urban areas, due to traffic-associated and other anthropogenic activities, can be significant. The City of Toronto, for instance, collected 17,512 tonnes of road dust in 2014 as part of their street sweeping program.[1] Combined with the presence of elevated concentrations of toxic constituents, this highlights concerns regarding the potential of road dust to serve as a major source of human respiratory exposures. To date, data is limited, however, regarding the particle size distribution and elemental enrichment patterns of particle size fractions that are likely to be resuspended and inhaled by exposed individuals (<10 microns).

The goal of this study is to characterize the metal and metalloid concentrations of inhalable urban road dust collected in Toronto, Canada and generate preliminary estimates of elemental flux. Road dust samples were collected from a variety of street types in 2015-2016, in collaboration with the City of Toronto, which uses regenerative-air street sweepers to isolate inhalable particles from the bulk material collected. Selected samples for analysis (32 inhalable and 32 bulk samples) were subjected to a 4-acid digestion (HF, $HClO_4$, HNO_3 and HCl), followed by multi-element determination using Inductively-Coupled Plasma Mass Spectrometry (ICP-MS).

Inhalable fractions of analyzed road dust were observed to be enriched with metals and metalloids relative to the bulk debris, including Cd (0.55 vs. 0.25 µg/g), Zn (649 vs. 252 µg /g), Sb (8.2 vs. 2.2 µg/g) and Pb (80 vs. 54 µg/g). Using available data on the total weight of road dust collected annually in Toronto, estimates for annual elemental fluxes indicate that road dust is a likely important source of human respiratory exposures. Pb loadings in the inhalable fraction of road dust, for instance, are estimated to range between 70 kg/yr and 141 kg/yr. Next steps will involve the collection of whole, unfractionated road dust samples from a variety of road types to conduct mass particle size distribution analyses. This will enable a more reliable estimation of elemental flux for the inhalable fraction.

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DUST ACCUMULATION VARIABILITY IN THE CHINESE LOESS PLATEAU IN RESPONSE TO LATE GLACIAL SHIFTS IN THE EAST ASIAN MONSOON

Zhiwei Xu* (1), Thomas Stevens (2), Shuangwen Yi (1), Joseph Mason (3), Huayu Lu (1)

(1) School of Geography and Ocean Science, Nanjing University, (2) Department of Earth Sciences, Uppsala University, (3) Department of Geography, University of Wisconsin Madison

Loess deposits in the Chinese Loess Plateau (CLP) are valuable terrestrial archives widely used to reconstruct past dust and East Asian monsoon dynamics. However, recent chronological studies reveal the loess as site-specific, episodic dust accumulation, and challenge the basic assumption regarding the loess as continuous record; while the regional comparability and spatial variability of loess sedimentation especially at subglacial-interglacial timescales has not been tested. This study focuses on the spatial and temporal variability of loess sedimentation in the CLP during the past twenty thousand years (ka), by investigating three new records from the transition zone between the CLP and the desert and revisiting several previous loess sites. Strong dust accumulation is found at the desert margin after about 15 ka, which is synchronous broadly with reduced dust accumulation at the northern and western plateau, and less preservation in loess tablelands from the central and southern plateau. It confirms that loess sedimentation is not spatially homogeneous at millennial timescales. Instead, it is controlled by various dust transportation, tapping and post-depositional processes in different geographic and geomorphologic settings. Finally, the clear seesaw pattern in loess sedimentation in the CLP after the termination of Heinrich Stadial I, are attributed to a combined effect of weakened winter monsoon and enhanced summer monsoon that are ultimately induced by the deglacial warming.

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ARSENIC AND HEAVY METALS DUST CONTAMINATION AND TOXICITY

A. Yadav* (1), P. K. Sahu (1), K. S. Patel (1), L. Lata (2), H. Milosh (2), P. Li (3), J. Allen (3), W. Corns (3)

(1) School of Studies in Chemistry/Environmental Science, Pt. Ravishankar Shukla University, Raipur, India, (2) Department of Soil Science /Geology, Maria Curie-Skłodowska University, Lublin, Poland, (3) PS Analytical Ltd, Arthur House, Unit 3 Crayfields Industrial Estate, Kent, BR5 3HP, UK

The dusts are fugitive due to contamination with toxicants i.e. carbons, heavy metals, polycyclic aromatic hydrocarbons (PAHs), etc. [1-2]. They are generated during fuel combustions, high thermal industrial processes and vehicular emissions with subsequent settling down of the dusts in the environments. They are in the respirable modes by poseing a real health–hazard to inhabitants and plants of heavily dusted regions [3-4]. Road dust is a diffused pollutant and affects the aquatic environments [5]. The trees were reported as bioindicator to assess the dust contaminations [6]. The some part of central India has been polluted tremendously with the As and other elements [7-9]. Therefore, in this work, contamination of the As and other heavy metals (HMs) i.e. Cr, Mn, Cu, Zn, Cd, Pb and Hg in the road and roof dusts of the arsenic contaminated area of the country i.e. Ambagarh Chowki, Rajnandgaon, CG, India is described. Their bioindicators and plant toxicities are described. The concentration of As, Cr, Mn, Cu, Cd, Zn and Pb in the road dust of 12 locations of Ambagarh Chowkiwas ranged from 165 – 329, 107 – 151, 704 – 998, 43 – 84, 61 – 117, 0.5 – 1.0 and 26 – 37 mg kg-1 with mean value of 328±29, 123±6, 825±50, 57±6, 83±9, 0.7±0.1 and 37±5 mg kg-1, respectively. A slightly lower concentration of the HMs (except As) in the roof dusts was observed. The toxic forms of As i.e. As(III) and As(V) are found to dominated in the dusts. The mean concentration (n=18) of As, Cr, Mn, Cu, Cd, Zn and Pb in tree barks of 18 common trees lie in the road sides was found to be 15±5, 27±7, 15±2, 106±38, 56±8, 0.7±0.4 and 3.4±1.0 mg kg-1, respectively. The mangiferaindica and phoenix sylvestris barks were found to be biondicator for elements i.e. As, Cr and Cu due to highest sorption. Whereas, millettiapinnata, acacia nilotica and ficus benghalensis barks were seemed as bioindicator for Zn, Cd and Pb for the highest sorption, respectively. Trees i.e. buteamonosperma,ficusreligiosa,millettiapinnata and tectonagrandisare found to be very sensitive to arsenic toxicity. Symptoms include necrosis and shotholing of basal leaves.

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ANALYSIS OF CHEMICAL COMPOSITION AND MASS CLOSURE OF PM2.5 IN BUSAN, KOREA

Eunchul Yoo* (1)

(1) Busan Institute of Health and Environment

Fine Particulate matter (PM) is a mixture with physical and chemical characteristics varying by location, time and season. Common chemical constituents of PM include inorganic ions, organic and elemental carbon, crustal material, particle-bound water, trace metallic elements and polycyclic aromatic hydrocarbons (PAH). In addition, biological components such as allergens and microbial compounds are found in PM. Many research recently reports the composition and the formation mechanism of PM2.5 around the world. There has been a growing interest in the chemical speciation and source apportionment of PM2.5 and in understanding the formation mechanism of airborne PM2.5. This study analyzed composition and reconstructed mass closure of PM2.5, using IMPROVE equation, of PM2.5 collected at four sites [green, residential (urban), commercial and industrial areas having different environmental situations] in Busan, Korea. PM2.5 samples were collected using a PM2.5 sampler; one year-daily (24 h) samples were obtained every three days from January to December in 2017 using PTFE filters for ionic matters and metallic elements and quartz filters for carbonaceous components. All samples were analyzed by an IC for inorganic ions, an ICP-MS for crustal and trace metallic elements, and a Carbon analyzer for carbonaceous components (organic carbon, elemental carbon). Major components of fine particulate matter (PM) are inorganic ions, organic matter (OM), elemental carbon (EC), geological minerals, salt, trace metallic elements, and water. Since oxygen (O) and hydrogen (H) are not directly measured in air pollution monitoring stations, more than ten weighting equations have been applied to account for their presence, thereby approximating gravimetric mass. Assumptions for these weights are not the same under all circumstances. OM is estimated from an organic carbon (OC) multiplier (f=1.4 in this study) that ranges from 1.4 to 1.8 in most studies. The mineral content of fugitive dust is estimated from elemental markers, while the water-soluble content is accounted for as inorganic ions or salt. The widely used IMPROVE equations were applied to characterize PM2.5 in this study; ASO4 (Ammonium sulfate), ANO3 (Ammonium nitrate), OM (organic matter), EC (Elemental carbon), CM (Crustal matter), TEO (Trace elemental oxides), NaCl (seasalt), PBW (Particle-bound water). Identified annual mean (reconstructed mass closure) concentrations of PM2.5 at each site were 18.7(18.1), 17.5(18.2), 20.1(20.5), and 24.4(23.8) μg/m3 at green, residential (urban), commercial, and industrial areas, respectively. Green; ASO4 6.19 (35.6%) > OM 4.20 (23.6%)> ANO3 3.46 (12.7%) > PBW 2.23 (12.3%) > CM 1.18 (7.0%) > EC 0.60 (4.8%) > TEO 0.08 (0.7%), residential (urban); ASO4 5.40 (32.5%) > OM 5.34 (21.3%)> ANO3 2.68 (18.3%) > PBW 1.92 (11.7%) > CM 1.54 (6.6%) > EC 0.97 (5.3%) > TEO 0.09 (0.7%), commercial; ASO4 6.99 (34.1%) > OM 5.36 (26.1%)> ANO3 3.20 (15.6%) > PBW 2.47 (12.0%) > CM 1.42 (6.9%) > EC 0.63 (3.0%) > TEO 0.14 (1.6%), and industrial; OM 6.22 (26.2%)>ASO4 5.84 (24.6%) > ANO3 4.65 (19.6%) > CM 2.68 (11.3%) > PBW 2.20 (9.3%) > EC 0.88 (3.7%) > TEO 0.65 (2.7%).

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STATUS OF RESEARCH AND MEASUREMENT METHOD FOR FINE PM(FPM, CPM) EMISSION FROM STATIONARY SOURCE

Jong-Sang Youn* (1), Ki-Joon Jeon (1), Hyunwook Cho (1), Sehyun Han (1)

(1) Inha University

Particulate matter (PM) emitted from large stationary sources consist of filterable PM (FPM) and condensable PM (CPM). FPM is directly emitted from the large stationary source as a solid or liquid phase and collected by filter sampler. CPM is gas phase at the stack (high temperature) condition, but condenses reacts upon cooling and dilution at the atmospheric condition. CPM is not measured and regulated in the most of countries. PM emission from large stationary source might be underestimated if CPM is not measured. The FPM is measured by filter methods such as cyclone, cascade impactor, and virtual impactor. The CPM is commonly measured by the dry impinger method (US EPA 202 method). It is also possible to measure the CPM using a dilution method such as ISO 25597, which simulates the atmospheric conditions after the outlet of stack. Traditionally, the measurement and management of fine PM from large stationary source has been focused on total PM(TPM). However, the importance of fine PM management in the large stationary emission sources such as power plants has been raised. In this research, we introduce various measurement methods for fine PM emitted from large stationary source.

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IDENTIFICATION AND CHARACTERIZATION OF DUST SOURCE REGIONS ACROSS NORTH AFRICA AND THE MIDDLE EAST USING MISR SATELLITE OBSERVATIONS

Yan Yu* (1), Olga Kalashnikova (1), Michael Garay (1), Huikyo Lee (1), Michael Notaro (2)

(1) Jet Propulsion Laboratory, (2) University of Wisconsin-Madison

Given the significant influence of dust storm activity on society and the environment, identifying dust source regions across the broader North Africa, Middle East, and Arabian Peninsula is critical but remains a challenge due to the limitations and uncertainties in the previous satellite-based dust source identification approaches. The Multi-angle Imaging SpectroRadiometer (MISR) instrument on the polar-orbiting Terra satellite provides a unique, independent source of information for studying dust emissions and concentrations. In the current study, a novel motion vector-based method is applied for dust source identification, benefiting from the development of MISR cloud motion vector product (CMVP). The motion vector retrievals are geometrically-based, which overcomes the weakness in Aerosol Index (AI)-based dust source identification that largely depends on retrieval assumptions of aerosol optical properties. Moreover, the MISR CMVP is capable of identifying optically thick dust plumes, which overcomes the limitations in the Aerosol Optical Depth (AOD)-based and AI-based dust source identification and complements infrared dust-tracking techniques.

According to MISR CMVP, dust source regions in North Africa and the Middle East are generally located in topographical depressions with bare and dry soils, including the Bodélé Depression as the most important dust source. The West African deserts generate substantial dust activities, which are underestimated by the AOD-based identifications. Seasonal distribution of dust activation is primarily driven by the climatology in wind and precipitation, highlighting the influence of Sharav cyclones, ITCZ, and Shamal wind on dust activation across the Mediterranean coast, West Africa and northern Sahel, and the Middle East, respectively.

Moreover, the MISR aerosol and stereo data since 2000 provides a unique opportunity for joint examination of the interannual variability in dust emission and concentration over the broader Middle East and North Africa. The joint analysis of MISR CMVP and MISR non-spherical (dust) AOD reveals a substantial increase during 2001-2012 in dust activation frequency and DAOD over the Middle East, mainly driven by the persistent drought and anomalously sparse vegetation cover in the Fertile Crescent. The central Sahel has experienced a moderate decrease in dust activation frequency and DAOD during 2001-2012, as a response to the recovery from multi-decadal drought and accompanying regreening. However, the trends in dust activation and DAOD over Middle East and central Sahel have diminished since 2013.

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FUTURE DECLINE OF AFRICAN DUST: INSIGHTS FROM THE RECENT PAST AND PALEO-RECORDS

Tianle Yuan* (1)

(1) NASA GSFC/UMBC JCET

African dust is a major aerosol source and interacts with diverse climate subsystems such as atmospheric composition and energy balance, tropical Atlantic sea surface temperature (SST), Amazon rainforest nutrient cycle, and cloud and precipitation. African dust exhibits strong variability on a range of time scales and its variability is found to correlate with various variables such as Sahel precipitation6, the North Atlantic Oscillation, and the El Nino/Southern Oscillation8. Here we show that the interhemispheric contrast in Atlantic SST (ICAS) drives African dust variability on interannual, multidecadal, and millennial timescales. The ICAS and its proxy are well correlated with satellite observed dust variability since the 1980s, with the Barbados dust measurements since the 1950s, and with dust proxies that extend as far as 1851. The ICAS affects dust emission by modulating surface wind speed in dust source regions. Positive ICAS anomalies lead to negative surface wind speed in dust source regions, which decreases dust emission and transport. The set of processes is robust because it appears to have operated for the last 20,000 years as suggested by paleo-records. The ICAS drive of African dust variability offers a unified framework to understand relationships found in the literature. The ICAS-dust connection implies that human activities have affected and will affect African dust variability by modulating the ICAS. A significant decline in African dust is projected due to anthropogenic increase of the ICAS based on coupled model simulations. The anthropogenic reduction in African dust will reduce African dust emission to a level never seen in the past 160 years within as little as three decades, which has broad consequences for dust and related climate subsystems in the North Atlantic region.

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POSITIVE DUST FEEDBACKS AMPLIFY TROPICAL NORTH ATLANTIC MULTIDECADAL OSCILLATION AND HOW MODELS ARE DOING

Tianle Yuan* (1)

(1) NASA GSFC/UMBC JCET

The Atlantic Multidecadal Oscillation (AMO) is characterized by a horseshoe pattern of sea surface temperature (SST) anomalies and has a wide range of climatic impacts. While the tropical arm of AMO is responsible for many of these impacts, it is either too weak or completely absent in many climate model simulations. Here we show, using both observational and model evidence, that the radiative effect of positive dust feedbacks contribute to generate the tropical arm of AMO. The feedbacks can be understood in a consistent dynamical framework: weakened tropical trade wind speed in response to a warm middle latitude SST anomaly reduces dust loading over the tropical Atlantic, which warms the tropical North Atlantic SST. It contributes to the appearance of the tropical arm of AMO. Most current climate models miss both the critical wind speed response and the positive feedback though realistic simulations of them may be essential for many climatic studies related to the AMO.

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HISTORY OF HEAVY METAL ACCUMULATION IN THE SVALBARD AREA: DISTRIBUTION, ORIGIN AND TRANSPORT PATHWAYS

Agata Zaborska* (1), Maria Włodarska-Kowalczuk (1)

(1) Institute of Oceanology Polish Academy of Sciences

In this study temporal changes of Pb, Zn, Cd and Cu concentrations were studied in 19 dated sediment cores collected from Svalbard fjords and the Barents Sea. The main aim was to study spatial and historical variations in heavy metal concentrations, deposition rates and sources in the context of different metal transport pathways. Metal concentrations ranged from 5.7 to 45.8 mg·kg-1 for Pb, from 13.4 to 54.5 mg·kg-1 for Cu, from 0.01 to 0.90 mg·kg-1 for Cd and from 55.6 to 130.4 mg·kg-1 for Zn. Some fjords were unpolluted by heavy metals while in others a clear signal of metal enrichment was found (outer Kongsfjorden, Hornsund, Adventfjorden). Large-scale processes such as atmospheric and oceanic transport were found to be important drivers of heavy metal contaminant distribution. The significance of global drivers varied among the fjords, due to coupling with local processes. Outer fjord parts, the most impacted by oceanic transport, were characterized by the excess 206Pb/207Pb values of ~1.17, while the inner basins were characterized by the excess 206Pb/207Pb of ~1.14 suggesting possible different importance of Pb sources (marine currents and atmospheric transport). High excess 206Pb/207Pb of ~1.20 in northern Svalbard fjord sediments can suggest a possible contribution from North American Pb sources.

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UPTAKE AND REACTIVITY OF ACETIC ACID ON NATURAL GOBI DUST SAMPLE

Mohamad Nour Zeineddine* (1), Manoulis Romanias (1), Veronique Riffault (1), Frederic Thevenet (1)

(1) IMT Lille Douai, Université de Lille, SAGE, Département Sciences de l'Atmosphère et Génie de l'Environnement, 59000 Lille, France

Acetic acid, AcA, is one the most abundant organic acids present in urban and remote area atmospheres 1. In the current study its interaction with natural Gobi dust sample is investigated at room temperature. The experiments are conducted in a flow reactor coupled with a SIFT-MS (selected ion flow-tube mass spectrometer) for the gas phase monitoring of the reactants and products.
The uptake kinetics of AcA on Gobi dust is studied as a function of concentration in the range 500 - 25000 ppb. From these studies it is determined that there is no influence of AcA concentration on the initial uptake. The effect of water vapor on AcA uptake on Gobi dust is an important parameter to characterize due to the level of water vapor in the atmosphere. In the range 0.01 % - 85 % RH, it is evidenced that the initial uptake of AcA on Gobi is inversely dependent on RH.
The adsorption isotherms of AcA are constructed under 85 % RH and the results are simulated with the Langmuir model to obtain the partition coefficient KLin. In terms of surface coverage it is found that AcA is strongly and irreversibly adsorbed on Gobi dust.
Furthermore, the reactivity of AcA on Gobi is investigated under dark conditions. It is observed that AcA reacts on Gobi dust in the first few minutes of uptake and transiently releases gas phase products namely carbonyls. The transient character of such reaction suggests that AcA modifies the surface chemistry of Gobi dust.
Although the reactions occurring on the surfaces of particles in the atmosphere are complex, the results displayed in this work provide information on the loss of VOCs on natural dust. It also highlights how natural dust particles and trace atmospheric gases react in the atmosphere and lead to the formation of oxygenated secondary trace gases.

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A REVISIT OF DUST RADIATIVE EFFECTS IN NORTH ATLANTIC WITH RECENT MEASUREMENTS OF DUST PHYSICAL AND OPTICAL PROPERTIES

Zhibo Zhang* (1), Qianqian Song (1), Hongbin Yu (2), Seiji Kato (3)

(1) University of Maryland, Baltimore County, (2) NASA Goddard Space Flight Center, (3) NASA

Using the recent in situ measurements of dust properties along with A-Train satellite retrievals, we study both the shortwave (SW) and longwave (LW) direct radiative effects (DRESW and DRELW) of dust aerosols in the North Atlantic during summer months. Through linear regression of CERES measured TOA flux with satellite aerosol optical depth (AOD) retrievals for cloud-free and dust-dominant cases, we estimate the instantaneous DRESW efficiency at the top of atmosphere (TOA) to be –49.7 W/m2/AOD based on CERES-MODIS AOD combination and –36.7 W/m2/AOD based on CERES-CALIPSO AOD combination. The corresponding DRESW is –14.2 W/m2 and –10.5 W/m2 respectively. We also estimate the instantaneous DRELW at TOA to be around 3.1 ~3.4 W/m2 based on the difference between computed dust-free outgoing longwave radiation (OLR) and CERES-measured OLR. After obtaining the observation-based DRE, we carry out a series of sensitivity studies, in which we compute the dust DRE based on observed 0.5 μm dust extinction profile from CALIPSO under different assumptions of dust particle size distribution (PSD), refractive index, and shape distribution. We find that two combinations provide a good fit to the observation-based DRESW efficiency and DRESW. One is based on a coarser PSD from the in-situ measurements made during the recent Fennec campaign coupled with a less absorptive SW refractive index reported in Colarco et al. [2014]. The other is based on a finer PSD from AERONET retrievals at Cape Verde reported in Dubovik et al. [2002] coupled with more absorptive SW refractive index reported in the OPAC. However, despite the equivalency in SW, only the Fennec PSD can also provide a reasonable fit to the observation-based DRELW. The DREs based on two spheroidal shape distributions are almost identical but significantly different from that based on spherical dust. Based on the optimal combination of dust physical and optical properties we estimate the diurnal mean DRESW efficiency of dust in the North Atlantic region during summer months to be around –28 W/m2/AOD at TOA and –82 W/m2/AOD at surface. The corresponding TOA and surface DRESW is about –10 W/m2 and –26 W/m2, respectively. Interesting, we find that the positive DRELW cancels about 30% of the DRESW, leading to significantly weaker net DRE of dust, about –6.9 W/m2 and –18.3 W/m2 at TOA and surface, respectively. Overall, our results suggest that the LW spectral region contain useful and important information of dust properties, especially dust size, that should be used together with SW observation to achieve more holistic understanding of dust DRE

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COMPOSITION AND MIXING STATES OF BROWN HAZE PARTICLE OVER THE HIMALAYAS ALONG TWO TRANSBOUNDARY SOUTH-NORTH TRANSECTS

Dong Zhiwen* (1)

(1) CAREERI,CAS

Pollutants that are usually transported from southern Asia to the Tibetan Plateau deposit on the Plateau surface, change snow albedo and thereby surface radiative flux. This results numerous climatic implications like as erratic monsoon, perturbation in hydrological cycle, etc. However, the accurate estimation of these climatic implications is not well understood, because the atmospheric pollution is a heterogeneous mixture of various particle types. Therefore, this part of climate research requires a detailed investigation of physical and chemical properties of atmospheric pollutants. This study aimed to examine the physical and chemical properties of atmospheric pollutants across the Himalayan regions along two transboundary south-north transects. The information of individual-particles was obtained using microscopy-based techniques that comprises transmission electron microscope (TEM) and Energy-dispersive X-ray spectrometer (EDX). Study capture the signatures of various types of atmospheric species such as black carbon (BC), mineral dust, fly ash, organic matter, sulfate, nitrite, ammonium, and NaCl. Microscopy-based techniques confirm that these particles were generally in mixing state, for example salt-coated particles accounting for 25 to 56% of the total particles in sampled locations. Our analysis shows that urban and rural locations are characterized with atmospheric particles which sourced from anthropogenic activities, whereas remote locations with those released from natural crustal. However, the relative contributions of anthropogenic particles were higher than that of particles released from natural crustal. The presence of such particles over remote locations of Himalayan region provides an evidence of prevailing atmospheric transport processes, which further need to be well understood. It is expected that this work would be helpful in understanding the regional atmospheric conditions and the transboundary transport process of haze particles. As these informations are of great importance in modeling studies, which further lead to improve understanding of haze particles climate effects.

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LIDAR MEASUREMENT AND COMPARISON OF DUST AEROSOL DURING THREE FIELD CAMPAIGNS IN 2010, 2011 AND 2012 OVER NORTHWESTERN CHINA

Tian Zhou* (1), Hailing Xie (1), Jianrong Bi (1), Zhongwei Huang (1), Jianping Huang (1), Jinsen Shi (1)

(1) Lanzhou University

For the first time, the ground-based measurements were carried out during field campaigns of April ~ June in 2010, 2011 and 2012 at Minqin, SACOL and Dunhuang over northwestern China, respectively. In this study, three dust cases were studied and the statistical results of dust occurrence and optical properties were also analyzed and compared. The results show that both lofted dust layers and near surface dust layers, they were characterized by the roughly extension of 0.25~3.6 km−1 in extinction coefficient and large particle depolarization ratio with values of 0.25~0.40 at 527nm wavelength. During the entire campaigns at each site, the corresponding frequencies of dust occurrence retrieved from lidar observation are all higher than 94%, and there is highest frequency in April. The vertical distributions revealed that maximum height of dust layers typically reached 6~9 km, even higher. The high intensity dust layers almost occur within atmospheric boundary layer. The monthly averaged particle depolarization ratio decreases from April to June, which imply dust loading reduce in ambient air. Comparing the relationship between aerosol optical depth at 500nm and Angstrom Exponent at 440nm-870 nm, it is confirmed that there is more complex mixture of dust aerosol with other aerosol types when the effects of human activities increase.

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USE OF NON-SPHERICAL AEROSOL MODELS IN THE MODIS DARK TARGET AEROSOL RETRIEVAL OVER OCEAN

Yaping Zhou* (1), Robert Levy (1), Shana Mattoo (1), Reed Espinosa (2), Lorraine Remer (3)

(1) NASA Goddard Space Flight Center, (2) NASA GSFC/JCET/UMBC/USRA, (3) NASA GSFC/UMBC JCET

The Dark-target (DT) aerosol retrieval is an operational algorithm of Moderate-resolution Imaging Spectrometer (MODIS) on Terra and Aqua satellites that retrieves spectral aerosol optical depth (AOD) over land and ocean since 2000 and 2002, respectively. Recently, DT has been implemented to Visible Infrared Imaging Radiometer Suite (VIIRS) aboard Suomi-NPP. Over the ocean, the DT algorithm is known to provide biased retrievals of AOD, Angstrom Exponent (AE) and fine mode fraction (FMF), especially in scenes known to be dust of African or Asian origin. These biases are scattering angle dependent and suggest errors in the phase function of spherical dust models used.

In this work, we experimented on dust AOD retrieval with a two-step strategy: first, dusty pixels are identified using a combined near-UV (Deep blue), visible, and thermal infrared (TIR) wavelength spectral tests; second, non-spherical dust models and lookup tables (LUT) are created for identified dusty pixels in the retrieval process. Many sensitivity tests are conducted to search for the proper dust models (size distribution, shape and refractive indices) that can represent space-based spectral and angular characteristics of dust aerosol. In particular, we compared ensemble dust optical properties from different models (GRASP and its earlier versions), databases (Texas A & M), shapes (sphere, spheroid and ellipsoid) and volume vs surface area equivalency assumptions. Initial results on sample granules and collocated AERONET pixels indicate that retrieval with non-spherical dust models can eliminate some scattering angle dependent bias in retrieved AOD and AE.

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IMPACT OF OUTDOOR PARTICULATE MATTER ON DOMESTIC INDOOR AIR QUALITY

Maria Chiesa, Rossella Urgnani, Riccardo Marzuoli, Angelo Finco*, Giacomo Gerosa

Università Cattolica del Sacro Cuore, Department of Mathematics and Physics, Via Musei, 41 - 25121 BRESCIA (IT)

In the framework of the project ANAPNOI (HEALTHY BREATHING FOR WELL AGEING) PM concentrations had been measured in domestic environments in relation to atmospheric parameters and house-specific factors for two different winter periods (December 2016-February 2017 and December 2017-February 2018) for 65 houses in the city of Brescia (Northern Italy) that is located in the Po Valley and is characterized by different PM emission sources (mainly traffic, residential heating but even industrial sources). In particular, a spectrophotometer (MINIWRAS 1371, GRIMM) has been used to monitor indoor and outdoor PM number concentrations (and, indirectly, PM mass concentrations) in a wide dimensional range (10 nm-35 μm). The I/O ratio of PM and PN concentrations had been used as an indicator of the impact of outdoor particulate matter on domestic indoor air quality when internal PM sources are not active [1]. The research had comprised both experimental activities (PM monitoring on field) and a following statistical analysis (ANOVA) to evaluate the correlations between the predictive factors (PM and PN concentrations) and the meteorological and house-specific data (e.g. house floor, fixtures quality and type, building energy class, location of the monitoring site with respect to influential PM sources…). The meteorological characterization of the two winter periods put in evidence great differences in terms of both meteorological and PM data distributions: a first ANOVA has thus been applied to all data resulted from the first monitoring campaign that covers about the 65% of all the monitored houses. From this analysis it emerged that the building energy class is the most closely related factor to indoor concentrations. Indoor PM and PN concentrations in high energy class houses (A-B classes) were more than 50% lower compared to the medium-low energy class concentrations (C-G classes). The abatement rate was up to 70% for indoor coarse particles. Even the windows opening time for 15 minutes affected the indoor air quality. Opening the windows in the afternoon ensured an indoor coarse particles concentration reduction by 35% compared to a windows opening in the morning. The research had even preliminary investigated the impact of common domestic practices linked to indoor aerosol emissions (e.g., ironing, cooking, house cleaning activities and PM resuspension) on indoor PN and PM concentrations [2]. The use of a steam iron impacted on both ultrafine (<100 nm) and alveolic (<200 nm) PM fractions. Even cooking activities impacted on the ultrafine and alveolic fractions but even generated inhalable particles due to nucleation and coagulation processes of finer particles. Instead, resuspension activities in indoor environments greatly affected the inhalable fraction of PM concentrations. In order to identify the best practices to be adopted at residential level to mitigate the impact of high PM concentrations on human health due to the activation of PM indoor sources the ongoing research of the effectiveness of natural ventilation, air purifiers and mechanical ventilation systems (technology that is often present in high energy class buildings) is giving interesting results.

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SIZE RESOLVED FLUXES OF PARTICULATE MATTER OVER A FOREST ECOSYSTEM

Giacomo Gerosa (1), Maria Chiesa (1), Laura Bignotti (1), Riccardo Marzuoli (1), Angelo Finco* (1)

(1) Università Cattolica del Sacro Cuore, Department of Mathematics and Physics, Via Musei, 41 - 25121 BRESCIA (IT)

Aim of the study has been the evaluation of PM emission and deposition on a forest ecosystem in a region characterized by high PM concentration values (Po Valley, Italy) in order to understand the PM uptake by vegetation with respect to a wide range of PM granulometries (14 nm-10 μm) using the eddy covariance (EC) technique. Thanks to an Electrical Low Pressure Impactor (ELPI+, DEKATI), concentrations of 14 granulometric classes with a temporal resolution of 0.1 s were measured. Measurement of PM fluxes is quite a novelty since only few studies have been already published on this topic; direct EC measurements of size resolved particles over forest ecosystems have been conducted: for particles larger than 100 nm [1] and smaller than 100 nm [2], for particles larger than 246 nm [3] and for particles with diameters between 0.01 and 8.10 μm [4].

The measuring campaign took place in the natural reserve of Bosco Fontana (45°11'52.2" N, 10°44'31.2" E, 25 m a.s.l.), a forest ecosystem located on the outskirts of Mantua city (Italy). The PM analyzer and an ultrasonic anemometer had been located at 42 m on a micrometeorological scaffolding tower. The vegetation is primary composed by oaks and hornbeams and a peculiarity of the dominant vegetation is to keep the leaves on branches till the buds appear and so, leaves could play an important role in the removal by impaction. The experimental campaign was run for nearly three months (14th September 2017-10th December 2017).

Preliminary results led to restrict the analysis to some granulometric classes (0.017-0.610 m - ELPI+ stages 2-9), because of the excessive noise recorded for the other classes. The diurnal profiles associated to stages 2 (0.017 m) and 8 (0.38 m) were representative of the behaviour of ultrafine and fine particles respectively. Both stages exhibit two peaks in number particle concentration: one in the early morning and the second in the late evening. These peaks, however, are more evident for stage 2 than for stage 8. This behaviour of number particle concentrations could be interpreted as the result of the reduction of the dispersion volume of pollutants due to the nocturnal stratification or to the condensation of water vapour.

The examination of the diurnal profile of particulate fluxes reveals a net emission from the late afternoon to the early morning and a deposition in the central part of the day. In particular, it emerged that, restricting the analysis to a specific time of the day (10.00-14.00) there are some granulometric classes that present a dominant diurnal emission pattern (0,02-2 μm) while other classes (> 2 μm) present a dominant deposition pattern. The trend of emission and deposition fluxes showed a dependence on the presence (or not) of dry leaves on the plants. Deposition velocities have also been calculated for all PM granulometries depending on the atmospheric stability class. The role of the vegetation stomatal activity and its influence on PM emission will be presented too.

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INDEX OF AUTHORS

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.