Geophysical Research Abstracts
Vol. 19, EGU2017-16612, 2017
EGU General Assembly 2017

Oxidative Potential of ambient particulate matter in Athens, Greece.

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Exposure of populations to airborne particulate matter (PM) is a leading cause of premature death worldwide. Oxidative stress resulting from exposure of chemical species present in PM is a mechanism thought to cause adverse health effects. Apart from radicals present in aerosol, species that can catalytically deplete the antioxidant buffering capacity of cells, called Oxidative Potential (OP), are thought to be particularly toxic. The variability of OP over location, particle age, source and environmental conditions is virtually unknown for most populated regions of the world. Motivated by this, we have built and deployed one of the first operational measurements of OP in Europe at the National Observatory of Athens site in downtown Athens, Greece. OP for fine and coarse mode is measured using a semi-automated dithiothreitol (DTT) assay developed at the Georgia Institute of Technology; the assay measures the oxidation rate of DTT by water-soluble aerosol constituents, and simulates the rate at which the same compounds would deplete antioxidants in-vivo. The DTT oxidation rate per unit volume of air (water-soluble "DTT activity") and aerosol size class (fine, coarse) are used as a measure of aerosol toxicity.

We present continuous (24hr average) OP measurements in downtown Athens from July 2016 to January 2017, conducted through quartz fiber filter analysis. The dataset covers a broad range of aerosol sources (pollution from Europe, regional and local biomass burning, dust, marine aerosol, biogenic aerosol) and meteorological conditions. The daily water-soluble DTT activity ranges between 0.02-0.81 nmolmin^{-1} m^{-3} (averaging at 0.24 nmolmin^{-1} m^{-3}) for fine aerosol and between 0.01-0.52 nmolmin^{-1} m^{-3} (averaging at 0.08 nmolmin^{-1} m^{-3}) for coarse particulate matter, indicating that water-soluble fine mode aerosol components possess a significant fraction of the OP. The seasonal variability demonstrates a higher DTT activity during the coldest period of the year for both aerosol fractions; correlation analysis with aerosol tracers provides insights on the relative importance of each aerosol source. We find that OP study shows a reasonable correlation of DTT activity with brown carbon (BrC) (R^2=0.47) that ameliorates when BrC derived from wood burning (BrC_{wb}) is taken into consideration (R^2=0.56). Wood burning is widely used for domestic heating during wintertime in Greece in place of fuel oil and natural gas since the 2012 economic crisis, so the high OP levels associated with this particular source may exacerbate the health impacts of PM inhalation during periods of intense wood burning. Further attribution of OP with aerosol tracers is then used to quantify the drivers of OP on a seasonal basis.