The reactive oxidative potential from biomass emitted particulate matter (PM_{10}, $PM_{2.5}$ & PM_1) and its impact on human health

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The aim of this study is to evaluate the toxicity of airborne particulate matter (PM_{10}, $PM_{2.5}$ & PM_1) and its impact on human health, based on the production of ROS (Reactive Oxygen Species). Oxidative stress in an organism arises from excessive generation of reactive oxygen species (ROS) such as superoxide radical, hydrogen peroxide, and hydroxyl radical or from depletion of antioxidants. Particulate matter are able to produce ROS, because they contain redox active compounds (organic constituents, metals) depending on their production sources. An extensive campaign was carried out from January to April 2013 at two locations in the urban area of Thessaloniki to determine the chemical composition of urban aerosols and to correlate their toxicity (based on the PM ability to generate ROS) with biomass combustion as a way of residential heating.

PM were collected from a high traffic road and an urban background station. In addition, DTT assay was performed, which resulted in the calculation of the oxidative potential of each PM sample. In addition, MPPD Model was used in order to determine the deposition of particles across the three main regions (naso-pharyngeal, tracheo-bronchial and pulmonary) of human respiratory tract (HRT). Major mechanisms of PM deposition across HRT include diffusion, sedimentation and impaction. Secondary mechanisms involve interception and electrostatic deposition. Different HRT regions involve different deposition mechanisms, with regard to different PM size. Finally, region specific oxidative stress index[1] is calculated across three different regions of human respiratory tract (nasopharyngeal, tracheobronchial and pulmonary bronchioles region). This is actually the product of the mass of different size fractioned PM, multiplied to the oxidative potential of the specific size fraction, at the HRT region of interest. This calculation forms a new exposure metric, called region Specific Oxidative Stress index (SOS), which refers to the oxidative stress associated to a specific HRT region.

PM levels during the cold period where higher compared to the warmer period. In addition, PM levels in the urban background station were higher than the traffic one, indicating the strong presence of PM emission sources other than traffic. Based on additional chemical analysis of PM (levoglucosan, which is a specific biomass burning tracer), it was found that biomass burning for space heating was the reason why PM levels where higher during the cold period and especially in the urban background station. Moreover, particulate matter of urban background station not only had higher concentration values than particulate matter of traffic station, but also represented higher oxidative potential values. As a result, although exposure to PM for the people living close to the urban background station was almost 50% higher, the overall SOS index was up to 4 times higher. This was the result of

[1] This is a new index, originally developed in Environmental Engineering Laboratory

- the higher oxidative potential (per unit mass of PM) of PM of smaller fraction, which are mainly emitted by biomass burning.
- The higher deposition fraction of smaller PM retained at the lower HRT.

Although further research is needed in order to discover the mechanisms that PM induced ROS provoke respiratory, cardiovascular and other types of diseases, the use of region specific oxidative stress index allows us to better associate exposure to PM and the related health outcomes. The use of SOS index calculation across different regions of human respiratory tract may be very promising for contemporary epidemiology studies, taking into account PM size distribution that affects the deposition rate across HRT and PM toxicity. As an example, significantly better associations are expected for cardiovascular diseases and exposure to PM if the SOS index is used. In this case, smaller PM translocation through the systemic circulation is better taken into account rather than just using ambient air PM as an index. To conclude, SOS index allows the room for better associations of exposure to PM related health risks.