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Global change impact on oxidative potential and toxicity of atmospheric particles from the East Mediterranean basin: the ARCHIMEDES initiative

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Climate change (CC) has important social, economical and health implications, notably in accordance with variation in air pollution or microbiome modification and its related toxicity mechanisms. CC will have a strong influence on meteorology, inducing dryer and warmer conditions in some regions. The Mediterranean basin is foreseen as a hotspot for regional climate warming, favoring larger dust episodes, wild fire events, vegetation emissions and changes in air pollution physic-chemical characteristics due to enhanced photochemical reactivity. Increasing concentrations of biogenic volatile organic compounds (VOCs), ozone, and radicals will be associated with rising concentrations of secondary organic aerosols (SOA) and other oxidized aerosols. These expected changes in aerosol composition are currently studied within the international ChArMEx (Chemistry-aerosol Mediterranean Experiment) program, part of the interdisciplinary MISTRALS metaprogramme (Mediterranean Integrated STudies at Regional And Local Scales). According to the LIFE/MED-PARTICLES (LIFE) project, this might result in more adverse effects on health.
However, toxicologists are far from having a detailed mechanistic knowledge of the quantitative causal relations between particles (PM) and health effects suggested by epidemiological evidences. Detailed toxicological studies looking at contrasted PM origins and chemical compositions are highly needed, particularly on strongly aged SOA suspected to increase the oxidative potential (OP) and to enhance the toxicity of airborne particles. Intensive researches onto the underlying mechanisms of inflammation started to describe the outlines of the intricate relationship between oxidative stress and inflammation. It is therefore, of great importance to better determine the OP of PM from contrasted surroundings, its relationship with CC through PM's physical, chemical and microbial characteristics, and its toxicological consequences within the lungs.
Recently, several projects under the ARCHIMEDES (Envi-MED funded) initiative including various research groups from Eastern Mediterranean countries have been submitted to French research calls. Their objectives are to develop an integrated testing strategy (ITS) through a combination of high throughput screening (HTS) methods based on acellular and lung cellular systems evaluating the respective OP (DTT, ascorbic acid and GSH depletion, DCFH oxidation) of various PM samples according to their origins in terms of sources and CC forecast. In order to ensure significant variability in ageing of the size segregated PM (fine, coarse) tested, samples from both northern (France) and southern countries (Cyprus, Israel, Turkey) should be collected at different seasons and site typologies, searching for various compositions and mixing states in SOA (biogenic, anthropogenic), metals and PAHs. These projects will combine relevant chemical, microbiological (DNA extract) and toxicological experiments (transcriptome, epigenome and secretome). A joint toxicological analysis related to their harmful effects on relevant oxidative (ATP, TAS, GSH/GSSG, gammaH2AX), inflammatory, genetic, and epigenetic endpoints within novel tissue-engineering tools will help in recapturing the native lung environment ex vivo.
In the CC context, such projects will help to (1) better understand the cellular and molecular mechanisms of PM toxicity, (2) detect and predict their respiratory effects, (3) better comprehend the relationship between the physicochemical characteristics and the toxicological effects of PM, (4) provide innovative biomarkers that could be subsequently validated in humans and thereby contribute to the predictive toxicology.