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PhD-Thesis Offer
Formation and properties of atmospheric secondary organic aerosol (SOA): chemical composition and volatility

Context. Aerosol particles are key components of the earth system and have a significant impact on both human health and Earth's climate due to their ability to scatter and absorb solar radiation and their effects on cloud properties and lifetimes. The organic fraction of particles consist of a wide variety of chemical compounds and may account for 20 to 90 % of their submicron mass. Organic Aerosol (OA) can be emitted directly as primary particles or can be formed in the atmosphere. Secondary Organic Aerosol (SOA) forms via three major mechanisms: (1) effectively irreversible condensation of very low volatility organic vapors produced by gas-phase oxidation (Donahue et al., 2011; Pierce et al., 2011); (2) volume-controlled reversible absorption of semivolatile organic vapors into preexisting particle organic phase ; and (3) absorption of semivolatile and volatile organic vapors into preexisting aerosol followed by particle-phase reactions to form effectively nonvolatile products such as organic salts, oligomers and other high molecular weight oxidation products.

It is well known that NOx levels critically influence formation SOA formation.[1] In the recent years a clear decrease of NOx levels has been reported in Europe while average temperature tend to increase as a consequence of climate change. These changes can play an important role altering Volatile Organic Compounds (VOCs) oxidation pathways and SOA formation and evolution in the changing atmosphere. Volatility is undoubtedly one of the key properties of OA because it determines the distribution of organic compounds between the gas phase and the particulate phase, thus controlling the atmospheric fate of OA.[2] Despite significant improvements in the last 20 years, the chemical identity and physico-chemical evolution of OA are still partially unknown. Such uncertainties lead to erroneous predictions of the concentrations and impacts of AO in air quality and climate models.[3]

Topic: The PhD thesis will focus on the formation and the evolution of SOA under variable environmental conditions as temperature, humidity, seed particle concentration, precursor's concentration (VOCs) of anthropogenic and biogenic origin and NOx levels. The photochemical generation of SOA will be carried out in an aerosol flow tube (type PAM chamber) where temperature can be varied from 3 to 35 ° C. Photon flux can also be varied using different sets of UV lamps. The partition between the gaseous and particulate phase, SOA formation yields of as well as the speciation of the majority organic species (potentially toxic) will be studied with advanced analytical tools existing in the laboratory, as the MASSALYA * platform. Gas phase analysis of Volatile Organic Compounds (VOCs) will be carried out with a Proton-Transfer-Reaction Mass Spectrometer (PTR-ToF-MS Ionicon at high resolution), allowing on-line. For non-polar organic compounds, adsorbent cartridges will be used followed by GC-MS analysis. The organic fraction of the particles will be analyzed by Thermo-Desorption-GC-MS using a new tool "CHemical Analysis of aeRosol ON-line (CHARON)" of which the laboratory has one of the first prototypes.[4]

The identification and quantification of the main oxidation products in the gas and particulate phase will allow the estimation of the partition coefficients and the determination of the volatility distribution of OA under different experimental conditions. This PhD thesis is carried ou in the context of the national project ACROSS-Go project (Atmospheric ChemistRy Of the Suburban forest) funded by the INSU-CNRS. ACROSS-Go main objective is to improve the understanding of the effects of mixing of urban and biogenic air masses on tropospheric VOCs oxidation and SOA formation. The project will investigate the evolution of the Parisian plume during summer pollution episodes during an extensive field campaign. Three main sites will be equipped with state-of-the art instrumentation: an urban site inside Paris, a peri-urban site at SIRTA and a wooded site in the heart of the Rambouillet forest. The transect would also include mobile and fixed installations of Airparif and Lig'Air air quality monitoring networks. The fundamental knowledge acquired through this PhD work is essential for the interpretation of field data (ACROSS measurement campaign), and is lacking in current studies. The results will further support new parameterizations air quality models.

Applications: Candidates will hold a Master degree with a strong component in Chemistry, Physical-Chemistry, Physics and/or Environmental Sciences. Application includes CV, motivation letter, contacts of one (or two at most) senior scientists who can recommend the candidate, marks from previous 3 years. All documents must be sent to barbara.danna@univ-amu.fr before the end of **May 2021.** LCE webpage: https://lce.univ-amu.fr

References

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3. Louvaris, E. E.; Karnezi, E.; Kostenidou, E.; Kaltsonoudis, C.; Pandis, S. N., Estimation of the volatility distribution of organic aerosol combining thermodenuder and isothermal dilution measurements. *Atmospheric Measurement Techniques* **2017,** *10* (10), 3909-3918.
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* https://lce.univ-amu.fr/fr/massalya)