Characterization of surfactants in PM1 atmospheric aerosols: from bulk to single-particle analysis

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Cloud droplets are produced in the atmosphere by the condensation of water on atmospheric aerosol particles which, for liquid clouds, is described by Köhler theory. In addition to predicting cloud formation, this theory also predicts important cloud properties such as their droplet size distribution, that determine their optical properties and, over large scales, their contribution to the climate budget. For sub-micron aerosol particles, this theory predicts that droplet growth should be affected by two chemical terms: a bulk term linked to water activity, or “hygroscopicity”, and a surface term linked to the particle surface tension. While the first term has been extensively studied, very little experimental information has been available on the surface tension of atmospheric particles until recently, which largely contributed to ignore this parameter in models.

This lecture will summarize the various techniques developed until now, or currently under development, to characterize the surface tension of atmospheric particles and the compounds lowering it, or “surfactants”. A first group consists in bulk, liquid-phase analytical approaches (liquid extraction, colorimetric measurements, electrochemical measurements…), that have allowed to confirm the abundance of strong, amphiphilic surfactants in atmospheric PM1 aerosols. A second group of methods, initiated in recent years, focuses on characterizing individual atmospheric particles (optical tweezers, Atomic Force Microscopy…). The advantages and limits of each technique will be presented, as well as the remaining challenges in this field of research.