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Modification of aerosol properties due to relative humidity

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Aerosols play vital roles in energy balance and human health. They have direct interaction with solar and telluric radiation by scattering and absorbing solar radiation, leading to, respectively, a cooling or warming effect of the atmosphere. The last assessment report by the Intergovernmental Panel on Climate Change (IPCC), states that the uncertainty in the total radiative forcing is mainly dominated by the high uncertainty in the aerosol radiative forcing. This is mainly caused by the poorly understood and quantified aerosol effects. Indeed, high relative humidity (RH), promotes water uptake by atmospheric aerosol particles (Pilinis et al., 1989), which modifies their size, morphology and chemical composition and therefore their optical properties (Zieger et al., 2013).

In-situ measurements of aerosols properties (scattering and absorption coefficients, size distribution) are usually performed at dry conditions (RH<40%) to avoid RH - effects when quantifying and characterizing the main aerosol properties. However, aerosols are present in a humid atmosphere. This is especially important for the aerosol properties that strongly depend on RH. Knowing the physical, chemical and optical properties of the aerosol particles at ambient RH is thus crucial in order to improve the estimation of the aerosol direct radiative forcing (Zhao et al., 2006: Kuang et al., 2016b).

The aim of this work is to study the evolution of optical (scattering and absorption), physical (size) properties of aerosols at different RH. Our study is based on laboratory measurements at controlled humidity. Pure aerosols were generated, such as sodium chloride (NaCl), ammonium sulfate ((NH4)2SO4), sodium nitrate ($NaNO_3$) and potassium chloride (KCl). Pure aerosols were then mixed together taking into account their molar fraction within the binary mixtures of above-mentioned compounds. The study was first conducted under dry conditions ($\sim$35% RH) to validate the instrumental set up. Measurements were performed at higher RH (from 40 up to 90%) using a nephelometer (AURORA 3000) and a particle counter (WELAS). The experimental results were then compared to reference tables used in the literature (OPAC etc...). The experimental results were compared to the theoretical calculations made by an aerosol thermodynamic model (ISORROPIA II). The discrepancies found will be presented and will be used to better understand the influence of water uptake on the radiative forcing estimated by climate models.