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Long term measurements of the estimated hygroscopic enhancement of aerosol optical properties

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Water vapour has a major impact on aerosol optical properties, thus on the Radiative Forcing for aerosol-radiation interaction (RFari). However there is few studies measuring this impact over a large period. Optical properties of aerosols were measured at the GAW Puy de Dôme station (1465m) over a seven year period (2006–2012). The impact of hygroscopicity on aerosol optical properties was calculated over a two year period (2010–2011).

The analysis of the spatial and temporal variability of the dry optical properties showed that while no long term trend was found, a clear seasonal and diurnal variation was observed on the extensive parameters (scattering, absorption). Scattering and absorption coefficients were highest during the warm season and daytime, in concordance with the seasonality and diurnal variation of the planetary boundary layer height reaching the site. Intensive parameters (single scattering albedo, asymmetry factor, refractive index) did not show such a strong diurnal variability, but still indicated different values depending on the season. Both extensive and intensive optical parameters were sensitive to the air mass origin.

A strong impact of hygroscopicity on aerosol optical properties was calculated, mainly on aerosol scattering, with a dependence on the aerosol type and the season. At 90% humidity, the scattering factor enhancement (fsca) was more than 4.4 for oceanic aerosol that have mixed with a pollution plume. Consequently, the aerosol radiative forcing was estimated to be 2.8 times higher at RH= 90% and 1.75 times higher at ambient RH when hygroscopic growth of the aerosol was considered. The hygroscopicity enhancement factor of the scattering coefficient was parameterized as a function of humidity and air mass type.

To our knowledge, these results are one of the first presenting the impact of water vapour on the aerosol optical properties for a long period, and the first for a site at the border between the planetary boundary layer and the free troposphere.

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