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Determination of complex refractive indices of mineral aerosols from infrared to UV-visible

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Due to their ability to absorb and scatter radiations, aerosols play an important role in the energy budget of the earth-atmosphere system. However, quantitative estimations of their effects are quite uncertain due to their large spatial and temporal variabilities in terms of concentration and physical properties.

Measurements from space-borne instruments are the only way to observe aerosol distributions from regional to global scales. For instance, thermal infrared radiometers such as MODIS or SEVIRI are routinely used for aerosol detection. Nevertheless, these broadband sensors are not suitable to distinguish the aerosol chemical or mineralogical composition. Recent high spectral resolution infrared sounders such as IASI or TANSO-fts are able to overcome these limitations. However, to fully exploit the hyperspectral instrument capabilities, precise optical properties (i.e. refractive indices (RI) of various particles are needed.

This work aims to measure high resolution extinction spectra of model aerosols from the ultraviolet (UV) to the thermal infrared (IR) regions of the electromagnetic spectrum to derive accurate values of the corresponding RI. The latter are generally performed through absorbance or transmittance measurements from bulk material or diluted particles in solid pellets leading to possible experimental limitation, such as lack of knowledge of the particle size distribution. In this study, extinction spectra of model aerosol by UV-visible spectroscopy and FTIR spectroscopy have been collected.

Quartz particles (99 %, Sigma Aldrich) were dispersed by a mechanical way in a flow of nitrogen (5 L/min) within a glass container. The continuous flow of aerosol particles was introduced into a 10 m multi-pass cell within an FTIR spectrometer (Antaris IGS Analyser, Thermo Scientific) and a 1 m single-pass cell within a UV-visible-NIR spectrometer (MAYA 2000 PRO, Ocean Optics). Aerosol size distributions have been measured at the exit of the spectrometers with an aerodynamic particle sizer spectrometer (TSI APS 3321).

The RI are determined by combining Kramers-Krönig relations, the Mie theory and an iterative process. This allows minimizing errors in the retrieval procedure. The RI obtained are compared to those extracted from databases (HITRAN, GEISA, ARIA) and demonstrates the power of this new approach. The methodology will be also validated by performing experiments with calibrated quartz microspheres (99.9 %, AngströmSphere) of diameters D = 0.5 and 1 μm and results will be discussed.

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