Retrieving aerosol complex refractive index from IR and UV-visible extinction spectra: application to SiO_2 particles and volcanic ashes

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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 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.

Particles were dispersed by a mechanical way in a flow of nitrogen (5 L/min) within a glass container where is introduced the sample. 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 simultaneously with an aerodynamic particle sizer spectrometer (TSI APS 3321).

The RI are determined by combining Kramers-Krönig relations, the Mie theory and an optimal estimation method. This allows obtaining an accurate errors budget of the retrieval procedure.

The methodology was validated by performing experiments with calibrated silica microspheres (99.9 %, AngströmSphere) of diameters D = 0.5 and 1 µm.

Retrieved complex RI are presented in Figure 1 and compared to Kitamura *et al* (2007) data.

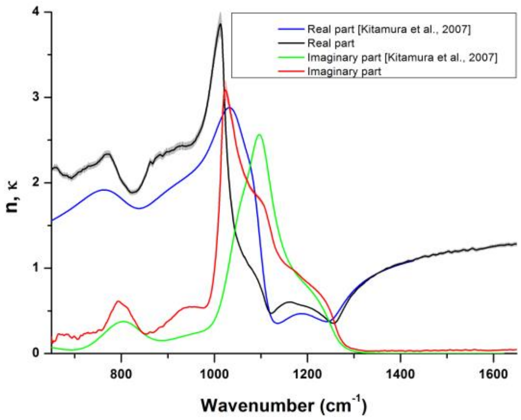

Figure 1. Retrieved imaginary and real parts of the complex refractive index of silica particles (within a selected IR range) and comparisons with Kitamura *et al* (2007) data.

High resolution (1 cm^{-1} in the IR) complex refractive indices are retrieved from 650 to 32.500 cm^{-1}. Compared to literature, these significant differences will greatly influence the inversion of atmospheric aerosol properties by remote sensing.

Extinction spectra from the UV to the thermal IR region have been also recorded for volcanic ashes sampled near Calbuco, Cordón Caulle and Eyjafjöll volcanoes. The retrieval of complex refractive indices is in progress. Furthermore, chemical analysis (XRD and XRF) are performed in order to determine mineralogical and oxide compositions of the ashes.

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