Chemical and optical properties of volcanic ashes: Laboratory measurements and remote sensing applications.

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During a volcanic eruption, a huge amount of aerosols are emitted into the atmosphere which can be transported over long distances. By absorbing and scattering radiation, volcanic ashes influence strongly the Earth radiative budget. These particles may also affect human health and for some intense events may perturb or interrupt air traffic.

Aerosols can be detected by remote sensing using in particular from infrared spectrometers. These instruments record the extinction signal of a mixing gas and aerosols contribution. From these observations, the main objective is to estimate the chemical composition, the size and the number concentration of the particles. However, the retrieval of these parameters needs to use the appropriate complex refractive indices m, which are mainly unknown and are, up to now, one of the main sources of uncertainty for studying aerosols from infrared remote sensing instruments.

For this purpose, a new methodology has been applied in order to retrieve complex refractive indices in a large spectral range from the measurement of the extinction spectra of various sampling aerosols. Volcanic ashes powder was dispersed by a mechanical agitation in a flow of nitrogen (5 L min-1) within a glass container. Then the aerosol flow is directed through two spectrometers recording the extinction spectra from UV-visible (MAYA 2000 PRO, Ocean Optics 200 to 1100nm) to Infrared (Antaris IGS Analyser, Thermo Scientific 2.5 to 25 μm) and finally to an aerodynamic particle sizer (TSI APS 3321) to record the size distribution in the range 0.5-20 μm. A combination of experimental data, Kramers-Kroning relationship and optimal estimation method is used to determine both the real n and imaginary k parts of the complex refractive index.

This methodology has been successfully applied for five volcanic ashes samples collected from Chile (Coron Caulle, Chaiten, Calbuco) and Iceland (Grimsvötn, Eyjafjallajökull). Moreover, a chemical analysis has been performed for each sample using X-ray diffraction (XRD) to establish the link between chemical and optical properties of materials. These results are then used to retrieve volcanic aerosol parameters from IASI/MetOp satellite instruments.

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