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Towards the ability to retrieve dust mineral composition from space

L. Klüser, D. Martynenko, and T. Holzer-Popp
German Aerospace Center (DLR), German Remote Sensing Data Center (DFD), Wessling, Germany (lars.klueser@dlr.de)

In modern satellite aerosol retrieval algorithms mostly bulk optical properties of mineral dust samples with specific composition are used. Over- or underestimation of dust optical depth often reflects the unability to account for variations in optical properties of the airborne dust. Consequently also other dust properties like particle size or mass concentration cannot be retrieved with any good accuracy. The situation is even worse in the thermal infrared, where the use of different optical property databases has shown to give totally different results in terms of changes to the observed radiance. Although originally designed for sounding of atmospheric temperature and humidity profiles, thermal infrared instruments with high spectral resolution like the Atmospheric Infrared Sounder (AIRS), the Infrared Atmospheric Sounding Interferometer (IASI) or the newly launched Cross-track Infrared Sounder (CrIS) provide valuable information about dust extinction in the infrared window region. Extinction spectra of mineral dust components show highly variable extinction profiles in the infrared window between 830cm-1 and 1250cm-1. Differences in the shape of extinction functions can be used to estimate the optical fraction of the respective component to total dust extinction. For the current version of a IASI dust retrieval measured extinction spectra of six different dust components are used for estimating their relive contributions to the dust optical depth in the infrared. These components are quartz, anhydrite and feldspar as non-clay minerals and the clays illite, kaolinite, montmorillonite and chlorite. Unfortunately, iron oxides cannot be detected from infrared window observations as their spectral extinction variability is insufficient (this would be of large interest, as they are a major source of uncertainty for solar wavelength single-scattering albedo). In the current IASI algorithm singular vector decomposition is used to separate the contributions of atmosphere and surface emissivity from those of the dust. With this signal separation method sufficient information can be extracted from the dust extinction spectra for selecting the best matching contributions of each single component. In order to obtain mass fractions of the components the optical fractions are finally weighted by extinction efficiency and mineral density. Resulting mass fractions over the Atlantic Ocean off West Africa compare reasonably well with the mineral fractions observed during field campaigns.