Laboratory measurements of the optical properties of mineral dust aerosols in the MIR and FIR spectral domains to support the exploitation of IASI-NG and FORUM forthcoming missions

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ABSTRACT

Mineral dust aerosols, entrained into the atmosphere by strong winds from arid and semi-arid regions, significantly affect the Earth's radiative budget through absorption and scattering processes. However, estimating the aerosol direct radiative effect (DRE) remains challenging due to the lack of detailed information about aerosol physical and chemical properties and their variability in space and time. The size of dust particles ranges from hundreds of nanometers to tenths of micrometers, depending on their origine and the aeolian processes they experienced. Their mineralogical composition is also very variable from regional to global scales.

The complex refractive index (CRI) plays a crucial role for remote sensing of mineral dust aerosols. In the mid-infrared (MIR), precise knowledge of the CRI has significantly improved the retrieval of aerosol parameters, such as optical depth, size distribution, concentration, altitude, and mineralogical composition, using satellite instruments e.g., IASI, AIRS, and MODIS. Despite these advances, the interactions between aerosols and radiation in the full IR spectrum remain largely unexplored. Initial measurements (up to 25 µm) using pellet spectroscopy have highlighted that the dust far-infrared (FIR) signature is comparable in intensity to that in the MIR and very sensitive to their source. In addition, the upcoming FORUM mission aims to measure Earth's spectrally resolved outgoing radiation in the FIR up to 100 µm, promising to provide crucial data for evaluating the DRE across the full IR range and enhancing dust detection and characterization from space. However, there remains a significant gap in CRI data uncovered in the FIR range.

To address the limited knowledge of mineral dust optical properties in the FIR, this work aims to create the first global map of the spectral optical properties (extinction spectra and CRI) of dust from low and high latitudes across the MIR and FIR ranges (5 to 100 µm, or 100 to 2000 cm^{-1}) to support IASI-NG and FORUM observations. Using three advanced laboratory setups (PC2A/LOA platform, CESAM chamber and SOLEIL synchrotron), with re-suspended natural aerosols, the study will produce high-resolution spectra for both dry and humid dust aerosols. This data will enhance the synergy with IASI, IASI-NG, and FORUM satellite data. The poster will highlight initial results for global dust sources, current activities, and future research plans.