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Exploitation of IASI thermal infrared observations for dust research applications

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Thermal infrared observations of the 8-12μm window region can be used for dust remote sensing over land (including deserts) and ocean during day and night. A new innovative retrieval for the Infrared Atmospheric Sounding Interferometer (IASI) does not rely on assumptions on atmospheric state or surface properties, but only the spectral shape of dust extinction together with a singular vector decomposition of IASI observations are used to separate the dust signal from other influences (surface, clouds). Besides the retrieval of dust AOD (at 10μm and 0.5μm) the algorithm also provides estimates of dust particle effective radius and dust layer emission temperature. Furthermore the intrinsic retrieval uncertainty is evaluated for each observation independently.
The analysis of several dust events over the Sahara, the Arabian Peninsula and the Atlantic Ocean is presented showing the potential of the IASI observations for dust research. The twice daily sampling allows for good quantitative monitoring of the evolution of fast propagating dust storms as e.g. in February 2009 over Arabia or of large scale dust outbreaks over the Atlantic Ocean as e.g. in September 2010. Active dust source regions are characterised by high AOD and large particle sizes in the IASI observations. Thus this information can be used for a revision of dust source region activity maps - potentially also covering partly the diurnal cycle of dust source activity by exploitation of the two different sampling times per day provided by IASI.
First examples motivate that especially the half-daily sampling can be very useful for dust-cloud interaction research in convective cloud regimes with strong diurnal cycles, as two stages of cloud development (initial phase and maximum intensity phase) and dust interaction can be observed. Differences in cloud property sensitivity to dust can be used to obtain information about the sensitivity to different mechanisms of dust-cloud-interaction as proposed in the literature. The doubled sampling rate compared to solar retrievals is furthermore useful for the analysis of dust impacts on fast-developing cloud systems like mesoscale convective systems or early-phase tropical storms on the Atlantic Ocean. As also dust over cloud can be retrieved, IASI directly provides information about the likelihood of the dust really interacting with the clouds, which actually is missing in most solar retrievals. Providing an intrinsic retrieval uncertainty for each observation together with some particle size information and being sensitive to dust only makes the IASI observations especially well suited for dust data assimilation applications in numerical models.
The IASI instrument with its high spectral resolution throughout the infrared range, a suitable spatial resolution (pixel size about 12km) and its accompanying Integrated Imaging Subsystem (32x32 imager pixels per IASI observation) is furthermore well suited to obtain information about cloud properties like convective state, (mean) thermodynamical phase of the cloud droplets and identifying regions of very active convection.