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Application of singular vector decomposition for mineral dust retrieval from IASI over land and ocean

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Singular vector decomposition (SVD) is applied to Infrared Atmospheric Sounding Interferometer (IASI) observations in the thermal infrared window region (8-12μm). SVD is a well suited mathematical tool to separate the most dominant components of spectral variability within the IASI observations, which then can be used to separate the dust signal from other influences. As the obtained independent singular vectors form an uncorrelated basis of the spectral domain, this method leads to a reduction of dimensionality of the problem while exploiting the whole spectral range rather then single channels.
IASI observations are transformed to an "equivalent optical depth" (including atmospheric optical depth as well as surface emissivity) rather than applying the SVD directly to brightness temperatures in order to reduce the influence of the emitting body's temperature onto the signal. The singular vectors with strongest dust contribution are used for a projection of different dust extinction models onto the observations, providing dust Aerosol Optical Depth (AOD) at 10μm as well as the transfer to 0.5μm assuming log-normal particle size distributions from OPAC. The use of different dust models also enables to obtain some information about dust particle size. Remaining contributions of surface and atmosphere are accounted for through a correlation-weighted projection of singular vectors for which dust is not the dominant contribution. Together with a correction for thermal emission by the dust this leads to a retrieval which is capable of providing dust information over ocean, vegetated land and deserts and also above clouds. The intrinsic retrieval uncertainty, based on the assumptions and corrections in the algorithm, is evaluated for each observation independently.
Moreover the exploitation of only the thermal infrared window guarantees independence of solar illumination, thus quantitative dust observation with IASI is possible twice daily, providing higher sampling rates and, near source regions, potentially also some information about the diurnal cycle of dust activity.
Evaluation against AERONET for the Sahara, Arabia and Atlantic Ocean domain shows reasonable results for dust AOD quantification with a correlation of 0.66 between IASI observations and AERONET coarse mode AOD. Moreover a very good capture of transient dust events and sensitivity to dust aerosol only is evident from the evaluation; furthermore it shows that at least some qualitative information about dust particle size is contained in the retrieval results. The application of the algorithm to the monitoring of several large scale dust events proves the potential of the half-daily sampling for dust monitoring