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Retrieving optical thickness and height of Asian dust from AIRS measurements

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The aerosol optical thickness (AOT) and height of Asian dust were retrieved from the Advanced Infrared Radiation Sounder (AIRS) hyperspectral IR brightness temperature measurements. First a statistical Artificial Neural Network (ANN) approach was used in order to examine whether hyperspectral measurements are suitable for the retrieval. For the ANN method, AIRS brightness temperatures at 209 channels and sensor's geometrical information are used inputs. In training the model, inputs were related to the Moderate Resolution Imaging Spectroradiometer (MODIS) and the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) aerosol data, over the East Asian domain (15ºN – 55ºN, 70ºE – 15ºE). The model was trained for the AOT retrieval using four months (Feb – Apr 2007) of MODIS visible AOT and AIRS data, while for the dust height two-years (2007 – 2008) of collocated CALIPSO and AIRS data were used for the training. Results demonstrated that the retrieved AOT from AIRS are comparable to MODIS-driven AOT with a correlation coefficient of 0.79. And retrieved dust heights agree reasonably well with CALIPSO dust heights, but with a lower correlation coefficient of 0.56.

Since a better description of dust optical properties and accurate radiative transfer modeling are prerequisite for dust retrieval from the perspective of a forward model approach, the fast Radiative Transfer for TOVS (RTTOV) (Version 9.3) model was implemented with new optical properties of Asian dust. The size distribution of Asian dust was retrieved from nine years of sky radiometer measurements at Dunhuang (near Taklimakan desert of China). And, for the given size distribution, effects of three refractive indices of the Optical Properties of Aerosols and Clouds (OPAC) mineral aerosol, dust-like aerosol observed by Volz, and High Resolution Transmission (HITRAN) quartz were examined and compared against AIRS measurements. Results indicate that use of Asian dust size distributions contribute to a general reduction of radiance biases over dust-sensitive window bands. The Volz refractive index, showing the best simulation performance against AIRS measurements, was chosen.

A physically-based 1DVAR approach was further taken to retrieve AOT and height of Asian dust. Land surface conditions were specified by the geographically varying spectral surface emissivities from University of Wisconsin (UW)/Cooperative Institute for Meteorological Satellite Studies (CIMSS) monthly mean global infrared surface emissivity data. The retrieved AOT and dust height from the ANN method were used as an initial guess in a 1DVAR approach. Results indicate that hypersepctral infrared measurements are sufficient for the dust retrievals for both day and night, from which continuous monitoring of dust evolution can be possible.