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Hybrid end-to-end aerosol classification model (HETEAC) for EarthCARE

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We present an aerosol classification model which is used in the framework of algorithm development for the Earth Clouds, Aerosols and Radiation Explorer (EarthCARE) mission of ESA and JAXA. The multi-sensor platform is planned to be launched in 2018 and comprises a cloud-profiling radar (CPR), a high-spectral-resolution cloud/aerosol lidar (ATLID), a cloud/aerosol multi-spectral imager (MSI), and a three-view broad-band radiometer (BBR). Three of these instruments (ATLID, MSI, and BBR) will be able to sense the global aerosol distribution and contribute to the overarching EarthCARE goals of sensor synergy and radiation closure with respect to aerosols.

In order to ensure the consistency of EarthCARE retrievals with respect to aerosol microphysical, optical and radiative properties, to support aerosol description in the EarthCARE simulator ECSIM, and to facilitate a uniform aerosol typing, the hybrid end-to-end aerosol classification model (HETEAC) is developed. The model is designed such that it covers the entire loop from aerosol microphysics via aerosol classification to optical and radiative properties of pre-defined aerosol types and allows consistency checks of modeled and measured parameters (end-to-end approach). The model's theoretical description of aerosol microphysics (bi-modal size distribution, spectral refractive index, and shape distribution of non-spherical particles) is adjusted to experimental data of intensive aerosol optical properties such as lidar ratio, depolarization ratio, and Ångström exponent measured with lidar and radiometer from ground (hybrid approach).

With HETEAC, a direct link between the aerosol properties observed with ATLID and MSI, i.e. lidar ratio and linear depolarization ratio at 355 nm and Angström exponent (355−670/865 nm wavelength range), and pre-defined aerosol types is possible. A suitable set of aerosol types is considered in the model which includes dust, clean marine, clean continental, pollution, smoke, and mixtures of them, as well as stratospheric aerosol. The aerosol type information is needed for the quantification of anthropogenic versus natural aerosol loadings of the atmosphere, the investigation of aerosol-cloud interaction, assimilation purposes, and the validation of atmospheric transport models which carry components like dust, sea salt, smoke and pollution. Furthermore, aerosol classification is a prerequisite for the estimation of direct aerosol radiative forcing. With an appropriate underlying microphysical particle description, the categorization of aerosol observations into predefined aerosol types allows us to infer information required for the calculation of broadband radiative effects and thus enables closure with the BBR measurements.