Aerosol Typing and Space-borne Lidars – Potentials and Limitations

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Together with CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations) and Aeolus, EarthCARE (Cloud, Aerosol and Radiation Explorer) will be the next (ongoing) satellite mission to be equipped with lidar. Lidar is a powerful tool that advances our understanding of the global aerosol distribution since it provides vertical profiles of aerosols and their microphysical and optical properties. All this information can help us assess the uncertainties induced to the climate system by the different aerosol effects. However, an accurate assessment requires detailed knowledge on the aerosol type.

CALIOP (Cloud-Aerosol Lidar with Orthogonal Polarization onboard CALIPSO), ALADIN (Atmospheric Laser Doppler Instrument onboard Aeolus) and ATLID (Atmospheric Lidar onboard EarthCARE) have different capabilities and, therefore, target different goals. CALIOP, as an elastic backscatter-polarization lidar, has its own aerosol classification scheme that aims to assign lidar ratio values to the detected features (Omar et al., 2009; Kim et al., 2018). Apart from being the first wind lidar in space, ALADIN is also the first lidar in space able to measure extinction coefficients directly via the high-spectral-resolution lidar (HSRL) technique in the UV. Even though aerosol monitoring is not the main scope of Aeolus (coarse resolution), aerosol optical properties are retrieved with ALADIN as spin-off products (Flament et al., 2021) as already successfully shown (Baars et al., 2021). For ATLID, a UV-HSRL as well, the aerosol-classification model HETEAC (Hybrid End-To-End Aerosol Classification model, Wandinger et al., 2016) is based on a combined experimental and theoretical (hybrid) approach and allows the simulation of aerosol properties, from microphysical to optical and radiative parameters of predefined aerosol types (end-to-end).

In this presentation, we will discuss the potential and the limitations of the current space-borne lidar missions with respect to aerosol typing and with a strong focus on the upcoming EarthCARE mission. An aerosol-typing algorithm aiming to support the efforts for ground-based validation of the EarthCARE products will be also presented. The issue of harmonization of the multiple satellite instruments (CALIOP, ALADIN and ATLID) and a potential synergy between Aeolus, EarthCARE, and ground-based lidar systems for aerosol typing will be also addressed.

References:

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