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EarthCARE lidar aerosol-cloud profile retrieval algorithms

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The Earth Clouds Aerosol and Radiation Explorer (EarthCARE) mission is a combined ESA/JAXA mission to launch in early 2020. The mission consists of a cloud-profiling radar (CPR), a high-spectral resolution cloud/aerosol lidar (ATLID), a cloud/aerosol imager (MSI), and a three-view broadband radiometer (BBR) covering both LW and SW bands. The mission will deliver a suite of cloud, aerosol and radiation products.

The atmospheric Lidar (ATLID) carried by EarthCARE is a linearly polarized 355nm high-spectral resolution (HSRL) lidar. By passing the received signal through an etalon the return from cloud/aerosols can be distinguished from the thermally broadened return from atmospheric molecules. In principle, this allows for the direct determination of the extinction profile as well as the extinction-to-backscatter ratio (also known as the lidar-ratio or S). This is in contrast to elastic backscatter lidars (e.g. CALIPSO) which must specify the S in order to derive the extinction profile. The direct HSRL extinction retrieval using the detected molecular signal requires high SNR data in order to be successfully implemented. The smoothing necessary to reach the required SNR levels leads to horizontal averaging on the order of 100km for aerosol fields.

Averaging on the order of 100km is defensible for aerosol fields, but not for cloud observations. Further, in contrast to the molecular attenuated backscatter fields the SNR of the cloud/aerosol returns on the 1km horizontal scale are such that elastic backscatter lidar inversion methods (i.e. Klett-like) can be applied. This has led to the development of a hybrid strategy which involves combining information provided by low-horizontal resolution S retrievals with high horizontal resolution Klett-like retrievals. The algorithm is cast in an optimal estimation framework and accounts for lidar multiple-scattering. Once estimates of S and the aerosol/cloud depolarization are available they can be used to determine cloud phase (i.e. liquid or ice) and assign classes to the detected aerosols.

In this presentation the EarthCARE will be briefly introduced with a focus on ATLID and the ATLID products. The ATLID L2a algorithms that will determine extinction backscatter and target classification will be presented and discussed. The operation of the algorithms will be illustrated using simulated signals generated using the EarthCARE simulator corresponding to a number detailed frame-sized (6000km) scenes. The work described in this presentation was conducted as part of ESA/ESTEC contract No. 4000112018/14/NL/CT.