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Clouds, precipitation and aerosol retrieval from EarthCARE multi-instrument observations.

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The combined ESA-JAXA Earth Clouds, Aerosol and Radiation Explorer (EarthCARE) satellite aims to advance our understanding of cloud-precipitation-aerosol interactions and contribute to the improvement of their representation in numerical models. One of the key EarthCARE mission requirements is to retrieve cloud, precipitation and aerosol properties along a vertical cross-section such that the top of atmosphere (TOA) radiative fluxes for each 10x10 km square surrounding the cross-section can be estimated to within 10 Wm-2. To achieve the EarthCARE objectives the satellite payload will include a cloud profiling radar with Doppler capability, a high-spectral-resolution lidar and a multispectral imager. A broadband radiometer also onboard will provide independent closure for global radiation fields computed using retrieved atmospheric profiles.

We have developed the algorithm "CAPTIVATE" that will operationally produce realistic estimates of atmospheric vertical cross-sections for a wide range of cloud, aerosols and precipitation conditions using observations from all three sensors on-board EarthCARE within a unified synergistic variational framework. CAPTIVATE incorporates many novel features, such as explicit representation of radar and lidar multiple scattering, an new fast forward model for solar radiances, a Kalman smoother to provide robust aerosol retrievals even in the presence of noisy lidar measurements and routine reporting of advanced diagnostics of retrieval confidence such as properties of the averaging kernel.

After describing the key features of the algorithm, we will present a detailed evaluation using a 6000-km swath of synthetic EarthCARE data simulated from 250-m cloud-resolving model simulations. We will also show, using the ECMWF forecast fields, the potential of such synergistic retrieval to evaluate global atmospheric models performance and to improve the representation of the interaction of cloud, aerosol, precipitation and radiation.