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Development of aerosol and cloud retrieval algorithms using ATLID and MSI data of EarthCARE

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EarthCARE (Earth Clouds, Aerosols and Radiation Explorer) is a joint Japanese (JAXA)-European (ESA) satellite observation mission for understanding the interaction between cloud, aerosol, and radiation processes in the earth climate. Four sensors of cloud profiling radar (CPR), multi-spectral imager (MSI), broadband radiometer (BBR), and high spectral resolution lidar (ATLID) are installed on the EarthCARE satellite. We are then developing an algorithm to derive aerosol and cloud optical properties and their vertical distributions using all the ATLID level 1 data of Mie copol (βmie,co), Mie crosspol (βmie,cr), and Rayleigh (βray) attenuated backscatter coefficients at 355nm (ATLID algorithm). The developed algorithm estimates extinction coefficients (α), backscatter coefficients (β) and depolarization ratio (δ) of particles (aerosols and clouds) without prescribing a particle lidar ratio (S=α/β), using a popular direct method. This algorithm identifies molecule-rich, aerosol-rich, or cloud-rich slab layers using the ratio of βmie and βray; it also classifies aerosol type (e.g., dust, maritime) and cloud type (e.g., water-droplet, ice-crystal) using the derived α, β, and δ by the threshold methods developed in this study. Planetary boundary layer height is retrieved from the gradient of the ratio of βmie and βray. Furthermore, the algorithm retrieves extinction coefficients for dust, sea-salt, black carbon, and water-soluble particles using the difference in depolarization and light absorption properties of the aerosol components from the retrieved α, β, and δ. With this method, we assume an external mixture of aerosol components and prescribe the size distributions, refractive indexes, and particle shapes for the aerosol components. Water-soluble particles are defined as small particles with weak light absorption, consisting of sulfates, nitrates, and organic water-soluble substances. We are also developing an aerosol retrieval algorithm using both the ATLID and MSI data (ATLID+MSI algorithm). The developed algorithm retrieves vertically mean mode-radii for water-soluble particles and dust as well as the extinction coefficients for the four aerosol components from the radiances at 670 and 865nm of MSI level 1 data and the derived α, β, and δ data. With this method, we use the spectral property of aerosols sensitive to particle size, as well as the depolarization and light absorption properties. The optical properties of aerosols and clouds and their global distribution provided by the developed algorithms help clarify the radiative effects of aerosols. Recently, it was pointed out that light absorbing aerosols (e.g., black carbon) affect cloud formation, large-scale circulation, and the hydrologic cycle; therefore it is important to analyze global distributions of aerosol components as well as total aerosols in order to assess the semi-direct and indirect radiative effects of aerosols. In the conference, we report the latest status of these algorithm developments and demonstrate the performance of the algorithms by applying ground-based high spectral resolution lidar and Mie-scattering lidar data and CALIOP data.