Common retrieval of Atmospheric Aerosol Properties for geostationary and polar-orbital Satellite Imaging Sensors: Himawari8/AHI and GCOM-C/SGLI results

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Aerosols influence the energy budget of the earth’s climate system through scattering and absorbing solar radiation. The Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC, 2014) reported that the radiative forcing of the total aerosol effect in the atmosphere, which includes cloud adjustments due to aerosols, is -0.9 W m^{-2} and results from a negative forcing from most aerosols with a positive contribution from black carbon absorption of solar radiation. However, the range of the uncertainties remains large (-1.9 W m^{-2} to -0.1 W m^{-2}).

For a more precise estimation of the impact of aerosols on climate systems, investigation of the behavior of aerosols on a global scale is essential but challenging because aerosol amounts and characteristics vary over space and time.

Aerosol remote sensing studies have been carried out using polar-orbital Earth observation satellites. JAXA has launched Global Change Observation Mission-Climate (GCOM-C)/Second-generation GLobal Imager (SGLI) at the end of 2017, and Greenhouse gases Observing SATellite- 2 (GOSAT-2)/Cloud and Aerosol Imager 2 (CAI-2) in 2018. In several years, Earth Clouds Aerosols and Radiation Explorer (EarthCARE)/ Multi-Spectral Imager (MSI) will be launched.

In addition, the next-generation geostationary satellite of the Japan Meteorology Agency (JMA), Himawari-8, was launched on October 7, 2014. It carries the Advanced Himawari Imager (AHI), which has six bands from visible to near-infrared wavelengths. It is significantly different from the previous Himawari-6/7 having only one channel in the wavelengths, which made the estimation of aerosol difficult because the assumption of aerosol type is necessary. Himawari-8/AHI observes the top of atmosphere (TOA) visible and near-infrared radiance at a resolution of 0.5–2.0 km over Asia and Oceania at every 10 min, which enables frequent aerosol estimation over the same ground targets.

The synergistic uses of these various imaging sensors on both geostationary and polar-orbital satellites are helpful to understand a complete picture of aerosol distribution in the global scale. For this purpose, we developed the common retrieval algorithm of the atmospheric aerosol properties for various satellite sensors and over both land and ocean.

The algorithm is based on the method developed by Higurashi and Nakajima (1998) and Fukuda et al. (2013). The three main features in the concept of this algorithm are as follows: (1) automatic selection of the optimum channels for aerosol retrieval by introducing a weight for each channel to the object function, (2) setting common candidate aerosol models over land and ocean, and (3) preparation of lookup tables for every 1 nm in the range of 300 to 2500 nm of wavelength and weighting the radiance using the response function for each sensor.

The method was applied to Himawari-8/AHI and GCOM-C/SGLI. The validation study indicated that aerosol optical thickness estimated from our algorithm was generally consistent with the products from Moderate Resolution Imaging Spectro-radiometer (MODIS) and Aerosol Robotic Network, and SKYNET.

In addition, the utilization of the aerosol properties forecasted by a global aerosol transport model for the retrieval are discussed.

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