Estimation of cloud optical properties and surface shortwave radiation from Himawari-8 satellite data: Influence of heavy aerosol on calculation of shortwave radiation in China

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Abstract: Optical properties of clouds and heavy aerosol retrieved from satellite measurements are most important in the calculation of the surface solar radiation (SSR) of the ground surface. To obtain high spatial (5km) and temporal resolution (10 minutes) of SSR data from the new generation geostationary satellite Himwari-8, we established the cloud properties retrieval algorithm (Letu et al., 2018) to produce an input data of the SSR calculation algorithm. Then we developed a LUT-based algorithm to estimate SSR from the retrieval of cloud property parameters (cloud phase, cloud optical thickness and cloud effective particle radius) and aerosol optical thickness. Furthermore, the SSR is estimated by inputting the cloud and aerosol parameters, and other auxiliary data (e.g., solar zenith angle, surface albedo). To generate and optimize the LUT for SSR, sensitivity analysis of SSR to solar geometry (solar zenith angle), atmospheric conditions and surface condition (surface albedo) is conducted.

Furthermore, shortwave radiative flux simulated from Himawari-8 satellite products is compared to ground-based observations in Xianghe and Xuzhou sites of China. In clear and cloudy sky with clean atmospheric conditions, the shortwave radiative fluxes using satellite products agree well with ground-based measurements. However, in cloudy sky with polluted atmospheric conditions, the fluxes using satellite products are overestimated by about 18 % as compared to the ground-based measurements. Aerosols below the cloud layer can bias the retrieval of the cloud optical and microphysical properties (e.g., optical thickness and effective particle radius) and lead to the overestimation of the shortwave radiation at ground level.