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Retrieval of effective particle radius of clouds using MTSAT-2 and Fengyun-2E satellite data

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Aerosols, the tiny particles suspended in the atmosphere, can exert an important impact on radiative forcing and cloud-precipitation system of the earth. It is known that an increase in aerosols causes an increase in number density of cloud droplets but a decrease in cloud droplet size for given liquid water content. Furthermore, recent studies have shown that a marked increase of absorbing aerosols in South Asia has altered the characteristic of Asian monsoon. Therefore, it is important to obtain observational data of cloud particle properties such as an effective radius toward the deeper understanding of aerosol-cloud-climate interactions.

In this study, a method is proposed which retrieve effective particle radius of optically thick water clouds using hourly observation by geostationary meteorological satellites, Multi-functional Transport Satellite-2 (MTSAT-2) and Fengyun-2E (FY-2E). The use of ”the geostationary satellite” has a merit that it provides globally high temporal resolution, typically one or half hour, rather than the observation by polar orbital satellites such as the Advanced Very High Resolution Radiometer (AVHRR) boarded on the NOAA polar platforms or the MODerate resolution Imaging Spectrometer (MODIS) boarded on the Terra polar platforms whose observation interval is approximately once or twice a day.

Our retrieval method basically follows Kaufman and Nakajima (1993) in which the cloud effective particle radius is estimated from the cloud reflectance at 3.7 um band using NOAA/AVHRR instruments. At first, the retrieval developed for NOAA/AVHRR is directly adapted to MTSAT-2 and FY-2E data and the cloud effective radius is calculated. The results show confliction between effective radius values retrieved from MTSAT-2 and from FY-2E. In order to obtain harmonic results, several modifications and improvements are added to the original method and the more accurate algorithm is established. A good correlation is achieved between the retrieved values from two different satellites after careful consideration of response functions of each imager and scattering properties of water clouds. The validity of cloud effective radius obtained by this procedure is confirmed by comparing the results with those obtained by the MODIS cloud products.

The newly developed method is applied to obtain the distributions of the cloud effective particle radius over South Asian region for 2012. Well known characteristics, such that the cloud effective particle radius is smaller in continental clouds than in maritime clouds, are confirmed from FY-2E observations. It is also suggested that the cloud effective particle radius over the Indian subcontinent becomes larger and that over Arabian Sea becomes smaller during summer monsoon season.

The method also allows high temporal resolution and global scale observations of the effective radius compared to the conventional observations using polar orbital satellites.

Keywords: Satellite observations, Geostationary meteorological satellite, Effective particle radius of clouds, Aerosol indirect effects