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Radiative transfer simulation in the aerosol events

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This work intends to develop an efficient algorithm to retrieve aerosol characteristics in heavy aerosol events. It is known that the heavy soil dust is transported from the China continent to Japan on westerly winds, especially in spring, and provides us with severe damages on the social life and/or human health. It is natural to consider that incident solar light multiply interacts with the atmospheric aerosols due to dense radiation field in such a heavy aerosol event as dust storm. Accordingly the optical thickness of Earth atmosphere increases too much to do sun/sky photometry from surface level. However space-based observations are available for monitoring the atmospheric aerosols even in the heavy aerosol events. Then efficient retrieval algorithms for aerosols from space in such heavy aerosol events are needed. Precise interpretation of the multiple light scattering processes needs long computational time especially for optically thick atmosphere. Therefore efficient algorithms for calculation of multiple scattering in the aerosol events are desired. New algorithms for radiative transfer simulation for the dense radiation field are introduced. The successive order of scattering method, which treats with the radiation field reflected from an optically infinite atmosphere, is applied for our present problem. Finally, our algorithms are examined in practice by using satellite data obtained from Aqua/MODIS.

Before starting the retrieval for aerosol events from satellite data, the detection of heavy aerosol events should be considered. Namely our aerosol retrieval procedure is divided into two steps. The first step intends to detect the aerosol events from space as dust storm or biomass burning plume based on the spectral information provided with satellite. Then retrieval of aerosol properties is started in the second step. The diagnostic scheme of core part of the aerosol events is proposed, and then new radiation simulation code available for the core part of aerosol events is shown in detail.

For example, our new computational code of successive order of scattering method is applied for retrieval of dust aerosols from MODIS data. The size distribution of aerosol model is assumed to take a bi-modal log normal function with $(r\ and\ \sigma)$, which denote the mean of geometric radius of particles and the standard deviation, respectively. In this work the values of $(r_f, \sigma_f) = (0.14, 1.54)$ for fine particles, and $(r_c, \sigma_c) = (3.42, 2.06)$ for coarse particles. Thus parameter f, which represents the ratio of fine to total particles for bimodal size distribution, and the complex refractive indices of dust aerosols $m(\lambda) = n(\lambda) - k(\lambda)i$ are the required values. It is found from intercomparison between satellite data and reflectance calculated from semi-infinite model that the heavy dust event on 20 March 2010 over Ryanton peninsula can be interpreted by aerosol model with size distribution of $f = 0.1$ refractive indices of $m(0.46\mu m) = 1.58 - 0.003i$ and $m(0.55\mu m) = 1.57 - 0.002i$.

Finally the retrieved results of aerosol characteristics with another data are validated with ground-based measurements and/or model simulations.