IRS2012-274
International Radiation Symposium 2012
Dahlem Cube, Berlin, Germany, 06 – 10 August 2012

Sensitivity of aerosol radiative forcing to mixing state and shape of the particles

Y. Derimian, O. Dubovik, D. Tanre, and T. Lapyonok
Université Lille1/CNRS, Villeneuve d'Ascq, France

Aerosol direct radiative forcing simulations often rely on assumption of external mixtures of homogeneous particles and spherical aerosol model. In our work we examine the uncertainty that can be introduced by these assumptions for internally mixed aerosol or non-spherical mineral dust. The broadband fluxes in our study are simulated using an extract of the AERONET operational code that implements spectral integration of calculated radiances in the range from 0.2 to 4.0 μm. The aerosol single scattering properties in the AERONET code are modeled using kernel look-up tables produced for homogeneous particles with a set of size parameters, complex refractive indices and a preselected axis ratio distribution. For conducting this study the code was adopted for modeling scenario of two externally mixed aerosol components (components with different size distributions and complex refractive indices), and internal aerosol mixture (the core-shell structure of particles). For instance, our simulations show that core-shell mixture of mineral dust with carbonaceous material can produce spectrally different and stronger absorption relative to case of external mixture. Therefore, it enhances the aerosol radiative forcing efficiency at the bottom of the atmosphere and in the atmospheric layer. We also evaluate the variability of simulated broadband solar flux and radiative effect calculations due to particle shape. The computations employed for evaluation of this effect are not limited to usage of an integrated value of the asymmetry parameter. Instead, twelve moments of phase function expansion are used to account for the details of the aerosol phase function. In addition, the spectral variations of the phase function are taken into account by recalculating phase function for each step of spectral integration. Our test shows that neglecting non-sphericity of aerosol particle shape for dust results in a pronounced bias of up to 10% overestimation of the daily averaged aerosol cooling effect. The importance of the mixing state and non-sphericity effects in daily forcing estimates are also analyzed for different latitudes and seasons (solar geometry and daylight duration) and for varying surface reflectance.