Session: C12 Poster: M34A

State of mixing of aerosols and its effect on optical and radiative properties

Rohit Srivastava[†]; S. Ramachandran
[†] Physical Research Laboratory, India
Leading author: rohits@prl.res.in

Aerosols are a major atmospheric variable which perturb the Earth - atmosphere radiation balance by absorbing and scattering the solar and terrestrial radiation, and also affect the life time and albedo of cloud. In the atmosphere, aerosols exist in different mixing states. For example, in external mixing there exist no physical and chemical interaction among the different aerosol species. In core-shell mixing, one type of aerosol (e.g., black carbon) gets coated over other type of aerosol (e.g., sulfate). In homogeneous internal mixing all types of aerosols can be mixed together resulting in an aerosol entity with the same chemical composition. The diversity of aerosols present over a location due to local sources and long range transport can give rise to a complex aerosol mixture. Assumptions on the state of aerosol mixing and effect on optical properties give rise to uncertainties in modeling of direct as well as indirect climate forcing of aerosols. A methodology is proposed to estimate the optical properties of aerosols in different mixing states. This methodology is utilized to determine the probable mixing state of aerosols and its seasonal variation over an urban location (Ahmedabad) by comparing the measured aerosol optical properties and fluxes with the model derived values. Ahmedabad is an urban densely populated (~ 5.8 million) city in western India and has large and small scale industries, and a variety of vehicles. The Arabian Sea and Thar desert are located in the southwest and northwest of Ahmedabad respectively and serve as the major sources of sea salt and mineral dust during monsoon (June, July, August and September) and pre-monsoon (March, April and May) respectively. The meteorological conditions over Ahmedabad exhibit large seasonal variations. Aerosol optical properties and radiative forcing are estimated for different mixing scenarios including external and core-shell mixing. Black carbon (BC) core and sulfate shell give rise to enhancement in the absorption as compared to external mixing. SSA is invariant when BC mass is more than 50% of total mass. Single scattering albedo (SSA) spectra of core-shell mixed aerosols are mainly governed by shell species and all spectra merge with each other when BC mass is greater 50% of total mass in BC/sulfate mixing. Aerosol optical depth and radiative forcing are highest for external mixing in an urban environment. The probable mixing states are found to vary when SSA varies. Aerosol radiative forcing at surface estimated for probable mixing states from Ozone Monitoring Instrument (OMI) derived SSA follows the forcing calculated from the observed flux during all the seasons except monsoon. Surface forcing in case of external mixing is higher when compared to forcing estimated for mixing states derived for OMI SSA. Atmospheric forcing in case of external mixing is about 3 to 7 times higher than the probable state of mixing. Top of the atmosphere (TOA) forcing becomes positive during pre-monsoon and monsoon for external mixing while it is always positive and negative for mixing states obtained for in situ (lower SSA) and OMI (higher SSA) respectively. The study reveals that the state of aerosol mixing is important in assessing the impact of aerosols on regional and global climate.