Features of aerosol optical depths over the Bay of Bengal and the Arabian Sea during premonsoon season: Variabilities and anthropogenic influence

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[1] Spectral aerosol optical depths (AOD) measured on board a cruise over the Bay of Bengal and the Arabian Sea during March–May 2006 are analyzed. Mean 0.5 μm AOD over the Bay of Bengal is higher (0.36) than the Arabian Sea (0.25). AODs obtained from MODIS Terra and Aqua are found to track well the Sun photometer AODs. A comparison between Sun photometer and MODIS AODs yielded a correlation coefficient of 0.96. MODIS fine mode fraction over the Bay of Bengal is higher (0.71) when compared to the Arabian Sea value of 0.60. Ångström exponent (\(a\)) over the Bay of Bengal is higher at 1.12, indicating the dominance of smaller size aerosols in the aerosol columnar distribution than the Arabian Sea (0.73), while Ångström coefficient (\(b\)) is comparable at 0.15 and 0.16 for the Bay of Bengal and the Arabian Sea. Background AODs are higher over the Bay of Bengal and the Arabian Sea indicating a strong continental influence. The scaling distance is lower over the Bay of Bengal due to nearly similar AODs, while the scaling distance over the Arabian Sea is about 2000 km. The anthropogenic influence in AODs over the Bay of Bengal and the Arabian Sea estimated using wind speed dependent AODs and maritime clean AODs are found to agree within ±1σ of the anthropogenic fraction obtained from MODIS AODs and FMFs. The mean anthropogenic contribution to the AODs estimated from the three methods is higher over the Bay of Bengal (68–75%) than the Arabian Sea (51–65%).


I. Introduction

[2] Atmospheric aerosols affect the earth-atmosphere radiation budget by scattering and absorbing the incoming solar radiation (direct effect), by acting as cloud condensation nuclei, and altering the cloud microphysical properties (indirect effect). The direct and indirect effects of aerosols produce large uncertainty in the prediction of climate change [Intergovernmental Panel on Climate Change (IPCC), 2001]. The perturbation in the atmosphere due to anthropogenic aerosols is globally comparable with that due to green house gases but it is opposite in sign. It is found that the overall cooling by the anthropogenic aerosols may be comparable with the warming of 2.43 Wm⁻² by green house gases [IPCC, 2001]. Aerosols are short-lived with a residence time of about a week in the lower atmosphere and are more concentrated in the source regions. Aerosols are produced by variety of natural processes as well as due to anthropogenic activities, and get distributed in the atmosphere through turbulent mixing and transport which result in their large seasonal and spatial variations. On a global scale, the natural sources of aerosols are dominant over the anthropogenic sources, but regionally anthropogenic sources can be three to five times larger than natural sources [Ramanathan et al., 2001].

[3] The current emphasis is on determining the regional variations in aerosol characteristics. The Indian subcontinent and the surrounding regions are rich sources for many kinds of aerosols of both natural and anthropogenic origin such as mineral dust, soot, nitrates, sulfate and organic aerosols. A number of observational campaigns have been conducted over the Indian subcontinent and surrounding oceanic regions in recent times to investigate the role of aerosols in altering the atmospheric radiation budget and the cloud properties. These include: Indian Ocean Experiment (INDOEX) [Ramanathan et al., 2001], and the Land Campaigns (LC) LC-I [Moorthy et al., 2005] and LC-II [Ramachandran et al., 2006], to name a few. INDOEX was conducted during the northeast winter monsoon seasons of 1996–1999 with an objective to study the spatial distribution of aerosols and trace gases over the Indian Ocean and the Arabian Sea [Tahmk and Cookley, 2002; Quinn et al., 2000]. During INDOEX, it was found that the top of the atmosphere aerosol radiative forcing varied from −30 to −33 Wm⁻², the surface forcing ranged from −64 to −71 Wm⁻² and the atmospheric forcing varied from 32