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Variations of aerosol radiative forcing at different types of sites in China based on SONET long-term observations

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Atmospheric aerosols directly change the radiation budget and energy balance of earth-atmosphere system through the absorption and scattering of solar radiation. Accurate estimation of aerosol direct radiative forcing is of great significance for the study of global climate change. Due to the spatial-temporal heterogeneity and complex aerosol chemical composition, it is not easy to accurately estimate the long-term effects of aerosol radiative forcing. The Sun-sky radiometer Observation NETwork (SONET) provides highly accurate datasets of columnar atmospheric aerosol properties from 20 distributed sites around China since 2009, which enables the ground-based study of long-term aerosol direct radiative forcing. Based on the simulations, we analyzed the long-term variations in aerosol direct radiative forcing (RF) and efficiency (RFE) over China through the input of key aerosol parameters (including aerosol optical thickness, single scattering albedo, asymmetry factor and Ångström exponent) obtained from different types of sites within the SONET observation network. Results of multi-year average aerosol radiative forcing effects illustrated that: all SONET sites showed negative values of multi-year average aerosol RF and RFE, indicating the cooling effects both at the top and bottom of atmosphere (TOA and BOA) over a long-term scale. The aerosol cooling effects at BOA were stronger than those at TOA (i.e., difference between RFs at TOA and BOA was positive), suggesting overall atmospheric warming effects of aerosols at different types of sites. However, the heating efficiencies of aerosols at different types of sites to the atmosphere were significantly different. The fine-mode light-absorbing components dominant at urban, suburban, and coastal sites were more efficient to warming the atmosphere (with large difference between RFEs at TOA and BOA), in comparison to the coarse-mode dominant aerosols (with stronger scattering effects) at the arid, semi-arid, and continental background sites. As for long-term variations of monthly average values, aerosol RFs at TOA and BOA changed with fluctuation of aerosol optical depth. In particular, there was a downward trend in aerosol RFE at BOA at the Beijing site, indicating the aerosol cooling efficiency at the surface and the warming efficiency within the atmosphere all declined at Beijing over the past decade.

Keywords: aerosol, SONET, radiative forcing; radiative forcing efficiency

References

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