Aerosol indirect radiative forcing over northern India

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Impact of aerosols on clouds and thereby on solar radiation is an important climate feedback, yet mostly uncertain, particularly for continental environments. In this study we attempt to estimate the climatological aerosol-induced indirect radiative forcing at Top of Atmosphere (TOA) during Indian monsoon period (June-September) from 2002 to 2013. The study was performed over core summer monsoon rainfall region (bounded between 75E-89E and 18N-28N) in India. Correlation analysis of MODIS observed aerosol optical depth (AOD) and CERES measured outgoing shortwave as well as longwave fluxes at TOA for All Sky (cloudy+ non-cloudy) and Clear Sky (Non-cloudy, only aerosol direct effect) cases were obtained. Quantitatively, the net atmospheric cooling due to aerosol direct effect was about -13 W/m^2 per unit increase in AOD, whereas aerosol-cloud feedbacks resulted in a net cooling effect of about -30 W/m^2 per unit rise in AOD. Further, correlation analysis of MODIS estimated cloud macrophysical properties (cloud top pressure and cloud fraction) and AOD suggested the dominance of cloud invigoration over this region during Indian monsoon. Hence, aerosol-induced taller and thicker clouds results in an aerosol indirect radiative forcing twice as high as aerosol direct forcing during Indian summer monsoon.