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Aerosol and cloud forcing on surface reaching solar radiation over different stations in India

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Surface reaching solar radiation (S) is a key component of the net radiation balance at the surface determining the regional climate. Reduction in S called solar dimming is probably due to the increased presence of aerosols in the atmosphere, caused by both natural and human activities, and clouds. But, the processes involved in aerosol-cloud-radiation interactions have not yet been fully understood.

Daily mean surface reaching solar radiation (S) and sunshine duration (SD) data over 12 different stations (Trivandrum, Chennai, Goa, Visakhapatnam, Pune, Mumbai, Nagpur, Kolkatta, Ahmedabad, Varanasi, Jodhpur, and New Delhi), which are widely distributed over the Indian region, have been evaluated for the period 1981-2006. Annual mean sunshine duration under all sky conditions showed drastic decrease over all stations with an average reduction of $\sim$ 0.34 h/decade. Daily mean S data has been segregated into clear and cloudy sky composites and annual means have been computed. All the stations showed decreasing trends under both clear sky (except two stations Chennai and Pune) and cloudy sky conditions. Aerosol forcing dominated over trends in cloud forcing at Kolkatta, equally contributed at stations New Delhi, Varanasi and Goa, and over all other stations cloud forcing dominated over trends in aerosol forcing resulting in a net decrease in surface solar radiation. The solar dimming (averaged over all 12 stations) under all sky conditions is $\sim$ 9 W/m2 per decade, under clear sky conditions it is $\sim$ 6 W/m2 per decade and under cloudy sky conditions it is almost double, $\sim$ 12 W/m2 per decade. The interaction between aerosol and cloud complicate to understand their separate effects on radiation. However, in the present study efforts are being made to understand the climatic effects of aerosols and clouds separately on the surface reaching solar radiation.