Geophysical Research Abstracts
Vol. 18, EGU2016-16766, 2016
EGU General Assembly 2016

Investigation of aerosol characteristics from the central Himalayas and its adjacent foothills

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Studies on atmospheric aerosols are important in the South Asia, especially over the Himalayas owing to their crucial role in regional climate change, radiation budget etc. The present study provides some of the crucial insights into the understanding of aerosol characteristics and associated processes over the central Himalayan region. The long term ground based aerosol data from high altitude site, Nainital (29.4°N, 79.5°E, 1958 m), India, are utilized extensively and estimated trends of the aerosol optical depth (AOD) and black carbon (BC) shows the increasing trend over this region. The significant amount of aerosol abundance is also observed in spring season each year. Further, in order to understand the transport and influence of aerosols from the Indo-Gangetic Plain (IGP) region to the nearby Himalayas, aerosols observation initiated from the low altitude site Pantnagar (29.0°N, 79.5°E, 231 m), India, are also utilized.

Observations at these both sites which are merely at a distance of ∼30 km show marked differences in the levels and seasonal and diurnal variations. The Himalayan site, is marked with low AOD and BC, except in spring, while IGP site is marked with high level of aerosols throughout the year. BC is maximum in winter (7.9±5.2 μg m-3) and minimum in summer-monsoon in IGP which exhibits nearly an inverse relation with mixing layer depth which is strongest in winter. On the other hand, BC reaches maximum in spring at Nainital.

AOD is high throughout the year in IGP which shows annual peak (AOD500nm>0.6) in May-June, dominated by coarse mode, while fine mode aerosols dominates in late autumn and early winter. The Nainital site is marked with very low AOD in winter typical to clean site. Seasonal mean BC is found to be significantly higher at Pantnagar in winter (∼652%), followed by in autumn (∼577%), summer-monsoon (∼318%) and spring (∼248%) as compared to those at Nainital. Co-located observation of AOD along with aerosols extinction retrieved from CALIPSO data reveal highest levels of columnar AOD and aerosol absorption in spring, unlike those BC, possibly due to higher abundances of aerosols above the ABL. Surface, columnar and vertical observations of aerosols and back-air trajectory assisted analysis revealed less possibility of direct transport of the aerosols from IGP to the central Himalayas in winter while possibility of direct transport is suggested to be more in spring season. WRF-Chem simulated BC variations are in reasonable agreement with observation, while their levels are underestimated by model.