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Study of Dust Characteristics over the Indo-Gangetic Basin by Measurement of Physical, Chemical, Morphological, and Optical Properties

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A campaign mode study is conducted at Kanpur (26.52N, 80.23E), India, to characterize the physical, optical, chemical, and morphological properties of dust over the Indo-Gangetic basin. The major objectives are to measure the aforementioned properties of mineral dust, change in its properties due to transport and mixing with pollution, and identify proxies based on chemical analysis. The measurement site is within the campus of Indian Institute of Technology, Kanpur, India. A variety of in-situ, remote sensing, and analytical instruments are employed to measure all aspects of dust properties. The campaign duration was April to July 2011, a period characterized by heavy dust storms and onset of Monsoon. AERONET observed AOD varied from 0.2 to 1.4, and Angstrom Exponent varied between 0.06 and 1.2. Based on PM2.5 and PM10 concentrations, BC mass and CO concentration, the aerosol types are classified among Dust, Polluted Dust, Burning, and Continental. The categories are selected considering the prevalent aerosol climatology in the region during this period. For most of the days, the inferred aerosol type is consistent with CALIPSO Feature Mask data. Measured aerosol size distributions show bimodal distribution for burning generated aerosols, and trimodal distribution for Dust and Polluted Dust. HYSPLIT calculated 10-day backtrajectories show air masses mainly coming across the desert regions of North West India for dust dominated days, and from Nepal on days associated with burning events. As seen in the aerosol extinction profiles measured by MPLNET, particles reached up to a height of $\sim$5 km during dusty days. SEM images of 17 samples collected for each PM category distinctly show a variety of particle shapes such as rhombic, platelets or sheet, and parallelepiped. The images clearly show presence of clay, minerals (dominant kaolinite and illite), carbonates, bioaerosols, and particles rich in C, O, Si, Ca and Cu. Elemental analysis of 11 blanks and 17 aerosol samples for each PM2.5 and PM10 is done using XRF technique. These samples include 2 samples for Burning event, 4 for Dust, and 6 for Polluted Dust cases. The analysis shows presence of Al, Ti, Fe, Ca, Mg, and K in the PM10 samples collected on dust dominated days, whereas high S content is found in PM2.5 for burning events (0.83 μg/m3 for burning events as compared to 0.67 μg/m3 for dust, and 0.25 μg/m3 for polluted dust). K/Al ratio is found high in burning event, a feature that is reflected more in PM2.5. Ca/Fe ratio is observed to carry signature of dust. SEM mineralogy is generally in agreement with elemental abundance variation estimated in XRF analysis. Ion analysis for 5 cations viz., Na+, NH4+, K+, Ca2+, Mg2+, and 3 anions viz., Cl-, NO_3-, SO42- are done. According to average concentration, SO42- dominates the PM2.5 (5.97$\pm$2.87 μg/m3) and PM10 (7.04$\pm$4.39 μg/m3) samples.