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Driving factors of aerosol concentration changes in the foothills of Central Himalayas

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Because of their short residence time in the atmosphere and uneven sources, the concentration, composition and properties of aerosol particles at a given location vary strongly depending on the air mass history and atmospheric mixing properties. Therefore detailed analysis is needed before a representative picture of the amount or composition of aerosol particles can be obtained.

In this study we have analyzed 10 years (2005 - 2014) of aerosol data from Mukteshwar, a high-altitude site at 2180 m elevation in the foothills of Central Himalayas. The site is located on a mountain ridge with valleys on both sides. On larger scale the area consists of is low (peaks 1500 - 2500 m) mountains between the Gangetic Plains (100-200 m) and the actual Himalayas (peaks 6000 – 8000 m). The site is located in monsoon climate with most of the annual precipitation falling during the monsoon months (July and August).

The data includes a variety of physical and optical properties of aerosols. We have analyzed the data for diurnal, weekly, and annual cycles, and for inter-annual variability and trends. We have also tried to identify the driving factors behind these changes.

There were clear diurnal cycles in aerosol particle concentrations during all seasons apart for monsoon. All external aerosol parameters showed 1.5 - 2 times higher values during afternoon than during night time. This was linked to the diurnal pattern of turbulent mixing layer height, bringing polluted air from the valleys to the site. The timing of the pattern was consistent with increased turbulence, increased water vapor concentration in the air and change of wind direction at the site. The aerosol internal properties did not show a clear diurnal cycle.

There were some weak indications of a weekday-weekend cycle during some months for some aerosol parameters, but no consistent patterns were found.

The seasonal cycles of all external aerosol parameters were very clear. Every year the monsoon rains removed most of the aerosol particles from the air. Then the aerosol concentration started to accumulate, showing a lower peak in the fall and a higher one in the pre-monsoon season. These peaks coincide with the crop residue burning seasons and also with the sand storm season. The winter moths typically showed somewhat lower values, which could be explained by the lower mixing layer bringing less polluted air to the site.

Apart for a negative trend in PM, no statistically significant trends were found for any of the aerosol parameters, and the observed inter-annual aerosol patterns were in general different from that of the emission inventories. There were deviations from the typical seasonal pattern of aerosols, but we were able to link each of those deviations to anomalous weather patterns such as weak or late monsoon.

In conclusion we can state that the diurnal and seasonal meteorological patterns govern the aerosol concentrations at Mukteshwar so strongly that they hide other possible factors affecting the aerosol properties.

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