Large Contribution of Photochemically-Derived Molecules to Water-Soluble Organic Aerosols over The Western Himalaya

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Abstract

Aerosols play a crucial yet uncertain role in modulating the radiation balance of the sensitive Himalayan atmosphere. Organic aerosols (OAs) are one of the most prevalent but poorly understood fractions of aerosol mass over the Himalaya. Assessments of the contribution of OAs to climate change in this region are highly uncertain due to an inadequate understanding of their sources and formation mechanisms through chemical processes in the Himalayan atmosphere. Here we use the molecular-level composition of water-soluble OAs measured in total suspended aerosols collected during August 30 to October 11 in 2017 at Himansh (32.4°N and 77.6°E), which is a high-altitude site (4080 m a.s.l.), to track the precursor sources and formation mechanisms of secondary OAs over the western Himalaya. Air mass backward trajectories reveal that the possible source regions that could contribute to OAs through transport are located to the west and northwest of the campaign site. The molecular fingerprints of OAs with a predominance of low-molecular-weight compound oxalic acid (C_2), followed by malonic acid (C_3), provide robust evidence of extensive photochemical production of secondary OAs across the region. The positive relationships of oxalic acid with organic tracer molecules suggest that there is substantial production of secondary OAs via photooxidation of anthropogenic and biogenic volatile organic compounds. The ratios of specific organic tracer compounds further indicate that anthropogenic and biogenic-derived OAs are subjected to a high degree of photochemical processing during atmospheric transport. Notably, the contribution of organic molecules-bound carbon to water-soluble organic carbon reveals that the region has a greater proportion of water-soluble OAs that have undergone photochemical processing. Our results illustrate that the secondary OAs burden over the remote near-free-tropospheric site in the Himalaya is mostly controlled by the strong photochemical processing of anthropogenic and biogenic organic precursors during atmospheric transport.

Early Career Scientist

NO, I am not an early career scientist.

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