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Characterizaiton and Source Apportionment of Organic Aerosols in Delhi, India, using Extractive Electrospray Ionization Mass Spectrometry (EESI-LTOF)

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In the highly populated regions of the world such as Indo-Gangetic plains, high levels of particulate matter have significant effects on radiative forcing, and also result in increased mortality and deleterious effects on human health. Here we present the results from a field campaign conducted in the Indian capital city of Delhi from January to March, 2018, using a recently developed extractive electrospray ionization long-time-of-flight mass spectrometer (EESI-LTOF), a high resolution long-time-of-flight aerosol mass spectrometer (L-ToF-AMS), and supporting instrumentation to elucidate the sources, formation mechanisms, and atmospheric transformations of organic aerosol.

New Delhi is home to nearly 19 million people and routinely experiences very poor air quality during the winter months. Contributing factors to the high particulate matter concentrations include a low boundary layer height, rapid increases in industrialization and vehicular traffic, and various combustion activities on both local and regional scales. Previous studies suggest significant contributions from sources such vehicular traffic, biomass burning, coal burning etc. as the dominating sources of air pollution in Delhi. Some studies have shown that about 10-20% mass of total particulate matter comes from secondary organic aerosols. Most of these results vary by among each other and lack complete characterization of sources in terms of number of sources they consider .Most of the studies report only three to four major sources which may not be true. Here we investigate the sources and transformations of OA at an urban background site located approximately 15 km south of the city center. Previous investigations of SOA have been hindered by the thermal decomposition and ionization-induced fragmentation experienced by conventional online instrumentation, which destroys the chemical information required to distinguish sources and reaction pathways. The EESI-LTOF overcomes this obstacle by continuous sampling of ambient aerosol into a charged spray of droplets (100ppm NaI in 1:1 v/v Water and Acetonitrile) generated by a conventional electrospray probe. Soluble components are extracted, the droplets are evaporated and the resulting ions detected as Na+ adducts of the parent. We assess the results in terms of molecular ions characteristic of sources such as biogenic SOA and primary and secondary wood and coal burning, and traffic, as well as a quantitative source apportionment using positive matrix factorization (PMF). Results are compared with the non-refractor PM2.5 composition measured by the L-ToF-AMS and organic gases measured by proton transfer reaction time-of-flight mass spectrometry (PTR-TOFMS). These results provide insight into the relative contributions the major sources and processes contributing to SOA formation.