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Separation of biogenic and biomass burning submicron aerosol from a boreal forest in Hyytiälä, Finland during HUMPPA-COPEC 2010

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Forests play an important role in the emission of primary and secondary organic aerosol (POA, SOA). Biomass burning is believed to be the largest source of global primary organic carbon (POC), estimated to be 31-45 TgC yr-1 [1]. In addition, biogenic volatile organic compounds (BVOCs) produce a large portion of global SOA, as BVOC emissions are believed to be 10 times greater than anthropogenic VOC emissions [2]. The oxidation of BVOCs produces considerable amounts of SOA, 12-70 TgC yr-1 [3]. In addition, the influence of anthropogenic emissions (i.e. NO_x) can substantially enhance biogenic SOA formation [4]. Due to large uncertainties in the role aerosols play in the climate sysyen, there is a need to better understand the chemical composition of organic aerosols derived from forest ecosystems. One approach to better understand the composition and contribution of biogenic derived organic aerosols is to apply Positive Matrix Facotrization (PMF) on a time series dataset [5]. Due to chemical similarity and multi-collinerarity, separation of biogenic and biomass burning aerosol in boreal forests has been problematic in previous work [6].

To investigate the composition and sources of atmospheric aerosol in a biogenically influenced site, submicron particles were collected from July 12 to August 12, 2010 at the boreal forest in Hyytiälä, Finland and analyzed using Fourier transform infrared (FTIR) spectroscopy and aerosol mass spectrometry (AMS). Campaign average organic functional groups from FTIR analysis of submicron aerosol includes alkane (37%), carboxylic acid (28%), organic hydroxyl (15%), non-carboxylic acid carbonyl (15%), and primary amine (5%), with traces of organonitrate and organosulphates. AMS analysis indicates that the aerosol composition was heavily dominated by organics (69%), followed by sulphate (21%), nitrate (6%), and ammonia (4%). Measurements of particle-phase organic functional groups and inorganic ions collected during the HUMPPA-COPEC10 campaign are compared with gas-phase biogenic and inorganic aerosol precursors to elucidate controlling factors on SOA formation in the Scots pine forest of Hyytiälä, Finland. Back trajectory analyses indicate that the submicron aerosol was greatly influenced by emissions from Russian wildfires which impacted Hyytiälä in late July and early August.

Factor analysis of organic functional groups (FTIR) and organic mass fragments (AMS) provides new insight into organic particle composition as characterized by the two independent methods. PMF analysis of FTIR spectra resulted in clear separation of biogenic and biomass burning organic aerosol, while separation of the AMS data was more complicated and resulted in incomplete separation. PMF analysis on the AMS data generated a biogenic organic aerosol (BOA) factor with a clear diurnal cycle; however, the highly oxidized biomass burning organic aerosol (BBOA) factor may not be entirely separated from other highly oxidized factors. Factor analysis on both FTIR and AMS datasets indicates over 60% of the organic aerosol in Hyytiälä comes from biogenic sources. Other separation techniques, including clustering and regression are investigated, and chemical comparisons of BOA and BBOA factors are explored.

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