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Impact of anthropogenic emissions on biogenic secondary organic aerosol formation in Beijing

Jacqueline Hamilton (1), Daniel Bryant (1), William Dixon (1), Kelly Pereira (1), Freya Squires (1), Rachel Dunmore (1), James Hopkins (1), James Lee (1,2), Andrew Rickard (1,2), Yele Sun (3), and Weiqi Xu (3)

(1) University of York, Wolfson Atmospheric Chemistry Laboratories, Department of Chemistry, United Kingdom (jacqui.hamilton@york.ac.uk), (2) National Centre for Atmospheric Science (NCAS), University of York, York, UK, (3) Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, People's Republic of China

Cities within rapidly developing countries, such as China, often experience very poor air quality. Beijing regularly experiences periods of very high particle pollution, with annual and 24 hourly levels well above World Health Organisation guidelines. Generally, the highest levels of PM2.5 in Beijing are during the winter months. However during summer, residents are still exposed to dangerous levels of particle pollution. In summer, secondary organic aerosol can make up a large fraction of the PM1 mass but the sources of this material are still poorly understood. Previous measurements of the isotopic content indicate the non-fossil fuel emissions are generally the dominant contributor of secondary OC in Beijing, and modelling studies suggest a large contribution from biogenic SOA, with increased plant VOC emissions in summer.

We have investigated the temporal evolution of biogenic SOA tracer species in Beijing using a novel high throughput screening technique using liquid chromatography coupled to ultra high-resolution mass spectrometry. A database containing the retention time and accurate mass of 138 biogenic SOA compounds was constructed, including 19 isoprene, 83 monoterpene and 36 sesquiterpene tracer species. PM2.5 samples were collected every 3 hours during the day and one sample overnight, giving a total of 200 samples over a 5 week period. Hierarchical cluster analysis was used to group the BSOA tracers based on their temporal trends and 5 clusters were identified, which broadly described the chemistry that controlled their formation. The largest signal was associated with a cluster containing mainly organosulfates that had a strong correlation to both particulate sulfate and oxidised organic aerosol measured by High Resolution Aerosol Mass Spectrometry. Two clusters peaked during the day and were dominated by species formed by OH and ozone chemistry. Two clusters peaked at night and were driven by nitrate radical chemistry, but with different BVOC sources. The data highlight the importance of both local and regional biogenic SOA sources in Beijing and a strong impact of anthropogenic pollutants on the formation of BSOA in urban atmospheres.