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Studying organic aerosols during bonfire night in Manchester: ME-2 source apportionment

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Over the past decade, there has been an increasing interest in short-term events that negatively affect air quality (Zhao et al. 2014) such as bonfires and fireworks. In general, during these episodes, high particulate matter concentrations drop within 24 hrs; however, it is the fine fraction that dominates the emissions, known to have a potentially negative impact on air quality, thus the impact of bonfires/fireworks on air quality must be considered. Aerosols and gases were measured using a variety of instruments at The University of Manchester, sampling atmospheric emissions on Bonfire night, 5 November, one week before and one week later, in 2013 and 2014. The Multilinear Engine (ME-2) factorization tool was used through the recently developed source finder interface (SoFi, Canonaco et al. 2013) to identify sources of organic aerosols (OA) sampled with an Aerosol Mass Spectrometer (AMS).

ME-2 identified five sources: solid fuel OA (SFOA), hydrocarbon like OA (HOA), cooking OA (COA), semi-volatile (SVOOA) and low volatility (LVOOA) during both years. In 2014, air pollutant concentrations were particularly high, with the highest SFOA concentrations being 20 μgm-3 at 20:30 hrs. when fireworks from different parks in Manchester were launched. Black carbon (BC) concentrations started increasing before the fireworks, around 18:00 hrs; these concentrations are representative of bonfire emissions. However, traffic emissions may be contributing to BC here; further work will be done to differentiate traffic emissions from solid fuel emissions. By analysing daily aerosol concentrations according to DEFRA's Daily Air Quality Index, it is possible to observe that in 2014, PM2.5 concentrations were considered to be high (65 μgm-3) while in 2013, PM2.5 concentrations were considered low (12 μgm-3); in the case of BBOA, concentrations ranged from 2.9 μgm-3 in 2014 to 0.65 μgm-3 in 2013. The discrepancy between these studies is mainly a result of different meteorological conditions: 5ºC in 2014; 12ºC in 2013.

For NH4NO_3, a range of 1.5–2.9 for the ratio of concentrations NO+/NO+2 (m/z ratio of 30:46) has previously been reported (Fry et al. 2009) while the ratio for organic nitrate is much higher, with values of 10–15 (Hao et al. 2014). In this study, a ratio of 9.5 was observed on bonfire night and a ratio of 3.5 was observed during episodes without bonfire/fireworks emissions.

This study shows OA source apportionment on bonfire night where significant SFOA emissions are present, suggesting that high concentrations are not only attributed to bonfires/fireworks emissions but also to meteorological conditions. Organic nitrate was identified during bonfire night suggesting a nighttime chemistry with anthropogenic oxidants. This analysis may provide vital information to strengthen legislation as well as to support health studies in order to improve air quality in the UK.

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