Bonfire night 2014 in Manchester UK: organic aerosol source apportionment (ME-2) and night-time chemistry

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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. Bonfire night celebrations have place in November the 5th to celebrate Guy Fawkes Day, where bonfires and fireworks are displayed in different parks around the UK.

Online measurements were carried out at The University of Manchester, sampling atmospheric emissions on Bonfire night, 5th November, one week before and one week later, in 2013 and 2014. ME-2 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). Aethalometer measurents were taken, with further application of the aethalometer model (Weingartner et al. 2003) to determine solid fuel and traffic contributions. A Chemical Ionization Mass Spectrometer (CIMS) was used to measure gas phase concentrations.

ME-2 identified five sources: 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 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. Hence, aethalometer model was used to determine solid fuel and traffic contributions, being able to corroborate a high traffic contribution to aerosol concentrations around 18:00 hrs.

By analysing daily aerosol concentrations (Figure 1), it is possible to observe that in 2014, $PM_{2.5}$ concentrations were considered to be high (65 μgm^{-3}), according to DEFRA's Daily Air Quality Index while in 2013 $PM_{2.5}$ concentrations were considered low (12 μgm^{-3}); in the case of SFOA, concentrations ranged from 2.9 μgm^{-3} in 2014 to 0.65 μgm^{-3} in 2013. Looking at the formation of organic nitrate (ON), 30:46 ratios of 9–15 have been previously observed during the formation of ON (Hao et al. 2014). In this study, a 30:46 ratio of 9.5 was observed on bonfire night. Applying the equations suggested by Farmer et al. (2010), ON concentrations were estimated; the highest peak was observed during bonfire night with a concentration of 10 μgm^{-3}. CIMS measurements identified ON in the gas phase such as: peroxy acyl nitrates, and alkyl nitrates as well as HNO_3 and N_2O_5. Future work on this analysis will involve calibrating the CIMS in order to calculate their concentrations and possible correlations with ON in the particle phase.

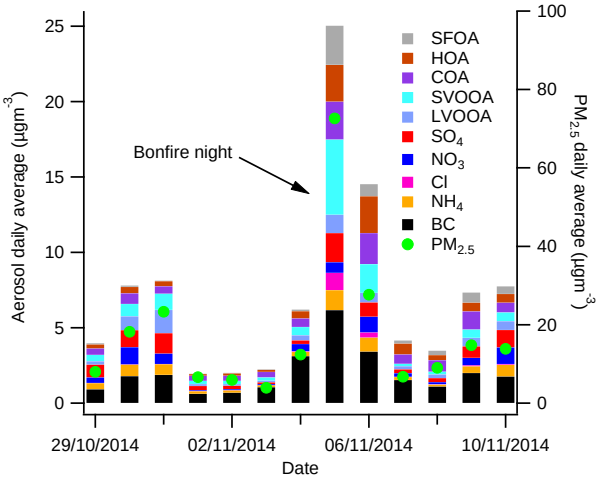

Figure 1 Daily average aerosol concentrations.

Aerosol source apportionment was successfully applied using ME-2 factorization tool and aethalometer model on bonfire night episodes where significant SFOA emissions were present. High aerosol concentrations were not only attributed to bonfires/fireworks emissions but also to meteorological conditions. ON was identified during bonfire night mainly from primary emissions likely with secondary reactions between gaseous and particulate species; further work will be done with CIMS data to better understand night-time chemical processes. 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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