Source apportionment of organics and black carbon based on a four-year long dataset from a residential heating area in North-East Europe

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Keywords: source apportionment, residential heating, wood combustion
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The use of wood to generate heat in small scale stoves in private houses is increasing to due increasing prices of the other energy carriers. Tackling with climate change and reducing carbon dioxide emissions have extra influence on use of renewable energy sources as biomass. The price of wood is competitive enough as well. Downside of the use of biomass is deterioration of air quality due to increased emissions of certain pollutants. Particulate matter with PAH adsorbed onto it is by far most important of these pollutants if focusing on possible health effects. The wood burning in residential areas is contributing to pollutant levels in urban areas as sources having relatively low height and the concentrations around the sources can be very high. Majority of the stoves in the households are old type batch combustion masonry stoves. Particulates from batch combustion masonry stoves were more potent inducers of programmed cell death and genotoxicity than the particles emerging from the continuous combustion in a modern pellet boiler (Tapanainen *et al.*, 2011). In Tartu, Estonia, the levels of PM2.5 and BaP have been constantly high during cold season.

The current study was performed based on four selected cold periods (winter and spring) from 2015–2018 in Tartu, with the stationary air quality monitoring station near to roadway and residential wood combustion area. This station was used to assess the contribution of residential heating to the PM2.5, BC and BaP levels in Tartu. Heavy metals as well as benzene and BaP were analyzed daily. Fossil fuel and biomass burning related BC (BC_{ff} and BC_{bb}, respectively) were measured using 7-wavelength Aethalometer (Magee Scientific, model AE33). Gaseous substances (SO_2, CO, O_3, NO_x) were measured in parallel using Horiba ambient air analyzers. Aerosol chemical composition was studied using Aerodyne Aerosol Chemical Speciation Monitor (ACSM). Measurement data was analysed using positive matrix factorization (PMF) applied with SoFi software (Canonaco *et al.*, 2013). In addition to studying interdependence of pollutants, relationships between pollutant levels and meteorological conditions (e.g. temperature, inversion, wind speed and direction) were investigated.

It was found that the sum of ACSM-PM1 components and BC-PM2.5 contributed 73% to PM2.5 concentration while also having strong relationship with it (average r = 0.8). Organic aerosol (OA) plays the key role in PM2.5 concentrations (Figure 1). In the same way, biomass burning related OA (BBOA), being the most important primary OA component, contributes up to 13–26% to the OA concentration, depending on the year. The BaP levels have been exceeding EU target value 1 ng/m^3 during the last five years 1.5–2.7 times in average. A very strong correlation between BaP and BC_{bb} was discovered (r = 0.85). This clearly suggests that aethalometers can be used for quick and accurate estimation of BaP levels in residential wood combustion areas. Favourable accumulation conditions (wind speed <1 m/s and temperature inversion) were found to be frequent, being present during 55% of nights, but also affecting concentrations during the rush hours 35% of the cases. Moreover, the highest concentrations measured during the cold period as well as prolonged or shifted peaks in diurnal variability of the pollutants can mostly be attributed to accumulation.

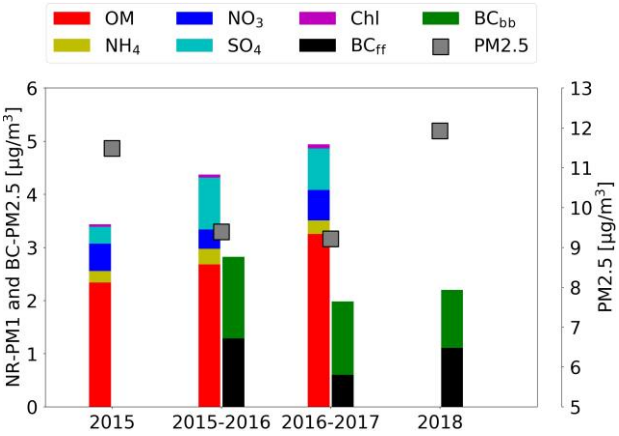

Figure 1. Average concentration of PM2.5 together with components derived from ACSM and aethalometer measurements performed during the cold periods from 2015–2018.

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