Packaging waste burning tracers in residential wood combustion area

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Estonia's health impact assessment study showed that due to fine PM in an ambient air, the life expectancy has shortened up to 13 months, with the highest decrease in city centers or areas with extensive domestic heating (Orru, 2011).

During domestic heating incomplete combustion often occurs, where organic material in the presence of chlorine from waste are causing the formation of chlorinated organic by-products. Burning waste can also be an important organic aerosol source.

Plastic materials cover the biggest fraction of the composition of municipal solid waste. Major compound in smoke from burning plastics include terephthalic acid, used predominantly in beverage bottles and similar containers (Polyethylene terephthalate-PETE), polystyrene (PS), polyporopylene (PP), etc. The specific key organic tracer for burning of plastics found in atmospheric particle samples also include 1,3,5-triphenylbenzene, which occurs in regions where plastic waste is burned (Simoneit, 2005).

This suggests that waste composition is largely composite of plastic material, and such waste burning can be traced using the characteristic species detected in the smoke of plastics and refuse burnings (Kumar, 2015). Currently, there are only few available studies related to tracers for plastic waste burning in aerosols.

As Estonia has a well organized municipal solid waste systems, it can be assumed, that people are not burning waste to dispose of it, but it could be considered more as an habitual behaviour. According to the members of Estonia's Chamber of Chimney Sweepers evaluation, in addition to the wood, paper and cardboard waste, people also tend to burn Tetra Pak®'s, sanitary napkins, diapers, various plastic packages, shoes, textile etc. According to the Estonian Environmental Inspectorate, it is difficult to assess the exact number of people who still practice burning household waste since such activities are done clandestinely. Burning waste can be an important contributor to particle pollution, because wood and wood chips account more than 90% of the fuel used for residential heating. Therefore, it is an important topic to address.

Methods and results

An investigation of aerosol chemical composition in Tartu (Estonia) using Aerodyne Aerosol Chemical Speciation Monitor (ACSM) was conducted. The measurements were carried out in winter 2015/16, with the measurement point near to roadway and residential wood combustion (RWC) area. The ACSM measured non-refractory PM1 chemical composition (Org, SO4, NO3, NH4 and Chl) with a time resolution of 30 min. 7-wavelength aethalometer (MAGEE Scientific, model AE33) were used for black carbon (BC) determination. PM10 and PM2.5 levels in ambient air were measured using BAM 1020 (MetOne) analyzers. Additionally, gas concentrations (NO, NO_2, CO, CO^2,), ambient air temperature (°C), relative humidity (%), wind speed (m/s) and direction were measured during the whole campaign.

For analyzing terephthalic acid from high-volume PM10 (Digitel DHA-80), 24 h filters were extracted by sonication-assisted solvent extraction and then analyzed with liquid chromatography mass spectrometry (LC-MS). Chromatography was performed on a reversed phase column with methanol and 0.1% formic acid as chromatographic eluents. Gas chromatography mass spectrometry (GC-MS) was used for analyzing 1,3,5-triphenylbenzene. Additionally, PM10 samples were analyzed regarding the heavy metals, and polycyclic aromatic hydrocarbons. Heavy metals (Al, As, Sb, Cd, Co, Cr, Mn, Mo, Ni, Pb, Se, V, Fe, Zn, Cu) were analyzed on ICP-MS (Agilent series 7500).

Contraty to widespread bias, hosehold waste combustion is not only a problem in developing countries, but it is also taking place in Europe.

In this research we have found that the packaging waste burning in household heaters and stoves might be quite important issue in some RWC areas.

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