Chemical characterization by TAG-AMS of the Organic Aerosol of wood combustion emissions: comparison of pellet and logwood stoves

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In the context of climate change, it is in France a will of its Environmental Agency (ADEME) to strongly push toward biomass burning as an alternative source of energy for residential heating. In order to limit the consequences in terms of air quality, ADEME financially contributes to the expenses of home owner for the installation of new and cleaner wood stoves.

Yet biomass burning is known to be a predominant source of particulate matter (PM). Several studies reported primary biomass burning emissions as the highest contributor to the total organic aerosol mass during winter over Europe (Puxbaum et al. 2007, Favez et al. 2010). The emissions from combustion processes can contain a significant amount of carcinogenic compounds such as Polycyclic Aromatic Hydrocarbons (PAHs) and light absorbing carbonaceous aerosol. Thus to better understand the sanitary and potential atmospheric impact of these emissions and other residential burning sources, it appears crucial to characterize them in detail at a high level of chemical resolution.

For this purpose, we looked at the molecular composition of a variety of wood particulate emissions with the recently developed TAG-AMS (Thermal Desorption Aerosol Gas Chromatograph – Aerosol Mass Spectrometer).

The TAG-AMS is an online chromatographic system coupled to an HR – ToF – AMS (High Resolution – Time of Flight – Aerosol Mass Spectrometer) developed for molecular speciation of the organic aerosol at hourly time resolution (Williams et al. 2014). In this particular configuration, the TAG is modified from its initial set up to include an online derivatization step to permit the analysis of the most polar compounds.

In this study, the wood burning emissions were generated by three types of stoves:

- Stove A: logwood type, fabricated before 2002. Serves as a reference model
- Stove B: logwood type, fabricated after 2010.
- Stove C: pellet type, fabricated after 2010.

We also tested a variety of tree species for the experiments conducted with the logwood type of stoves. They included beech, maple, ash and spruce.

After dilution, emissions were led to the TAG-AMS sampling inlet and other co-located online instruments including two PTR-ToF-MS (Proton Transfer – Time of Flight – Mass Spectrometer) - one equipped with the new fastGC/module - for the characterization of the gaseous phase, a second HR-ToF-AMS for the bulk chemical composition and concentration of the non-refractory fraction of the aerosol, an Aethalometer AE33 for the concentration of the Black Carbon, and a SMPS (Size Mobility Particle Sizer) for the particle size distribution and concentration. The TAG sampled for approximately 5 to 10 minutes before thermal-desorption of the analytes and subsequent analysis.

A hundred of fine particle organic compounds were detected and quantified. Results show that the degradation product of cellulose (levoglucosan) largely dominates the chromatograms. We compare the emission factors of the main aerosol fraction in parallel with those of levoglucosan and other biomass burning markers for the different fuels and stoves types. Implications in terms of air quality improvement and source apportionment will also be discussed.

Favez, et al., Inter-comparison of source apportionment models for the estimation of wood burning aerosols during wintertime in an Alpine city (Grenoble, France), Atmos. Chem. Phys., 10, 5295-5314, 2007.

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Williams et al., The first combined Thermal Desorption Aerosol Gas Chromatograph- Aerosol Mass Spectrometer (TAG-AMS), Aerosol Sci. Technol. *48*, 358-370, 2014.