Emission dynamic from residential wood combustion: PM, BC, OM, VOCs and levoglucosan

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During this last decade in Europe, the use of wood burning for residential heating has significantly increased because it is a renewable source of energy.

The determination of wood combustion pollutant emission factors (EFs) is usually performed by measurements directly carried out at the emission source. In these conditions, the results obtained are not representative of the PM chemical composition and concentrations observed in ambient air due to post-emission physicochemical processes: dilution, condensation and photo-oxidation of semi-volatile species.

The main objective of the Champrobois project was to study the physicochemical evolution of the aerosol emitted by two different residential log wood stoves (RWS, old and modern = 4* and 5*) from emission until its introduction in ambient air, in controlled "real" conditions. Measurements were performed directly at the emission source, at about 1 m from the exhaust stack (very close field, dilution factor about 10-20) and at about 50 m from the emission exhaust (close field, dilution factor about 500).

Using dedicated on-line instrumentation (TEOM, Aethalometer, ACSM, PTR-MS and PILS-LC/PAD) in the close field, one specific objective was to study the emission dynamic of PM, specific VOCs and biomass burning tracers [Black Carbon (BC) and levoglucosan] for different wood combustion conditions.

Results obtained showed that the pollutant emission dynamic and concentrations were closely linked to the combustion conditions (wood load, output) and phases (lighting, pre-load). As an example, BC accounted for the main part of the solid fraction of $PM_{2.5}$ during all the combustion process in nominal output conditions while, at the beginning and at the end of the combustion cycle, the emission of other species (i.e organic compounds) was major in reduced output conditions (Figure 1).

We also showed that the emission of the widely used biomass burning molecular tracer, namely levoglucosan, seemed only emitted under specific combustion conditions (cold start, pre-load, reduced output, large wood load inducing a decrease of the RWS temperature). This result is of primary interest in terms of PM source apportionment and evaluation of the contribution of the biomass burning source on ambient air PM concentration levels.

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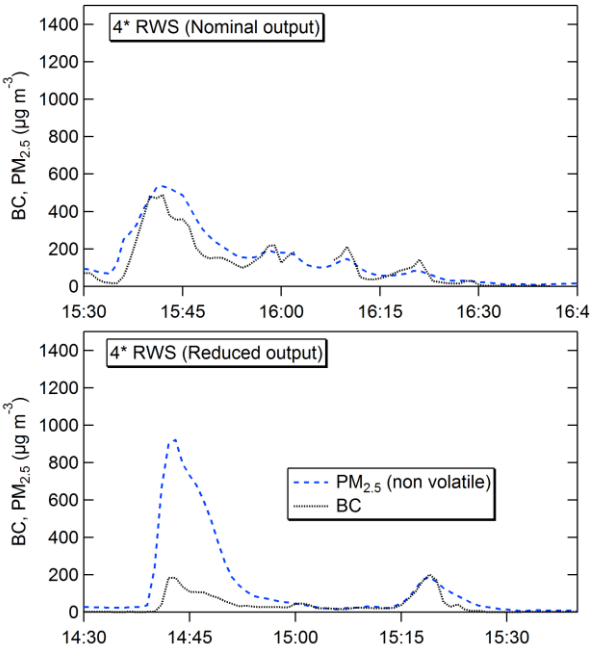

Figure 1. Time evolution of BC and $PM_{2.5}$ (non volatile) concentrations using the 4* RWS at nominal and reduced outputs.

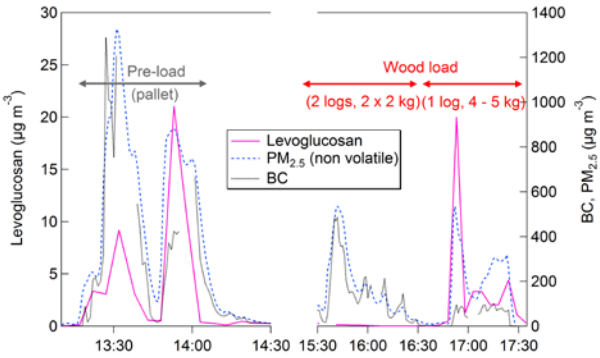

Figure 2. Time evolution of levoglucosan, BC and $PM_{2.5}$ (non volatile) concentrations using the 4* RWS for different combustion conditions and wood loads (nominal output, wood load: beech, 12% moisture).