Apportioning the wood burning source in an urban area by Positive Matrix Factorization using 4-hour resolved PM10 data

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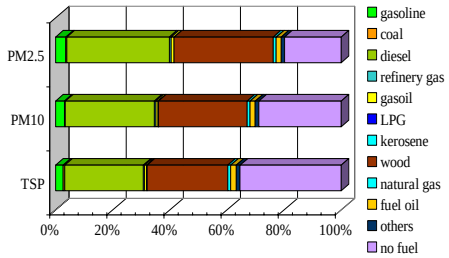
INEMAR emission inventory (updated 2005) for the Lombardy region (Po valley, Italy): wood is the second fuel in importance after diesel contributing to combustion emissions. According to these estimates, **wood combustion accounts for 31% to PM10 in Lombardy**.

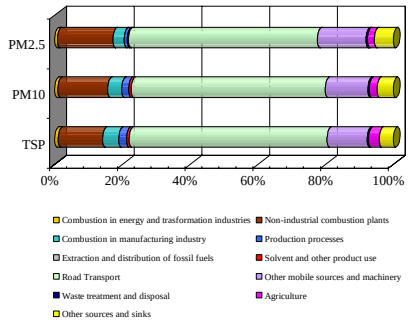
Emissions in Lombardy in 2005 by fuel



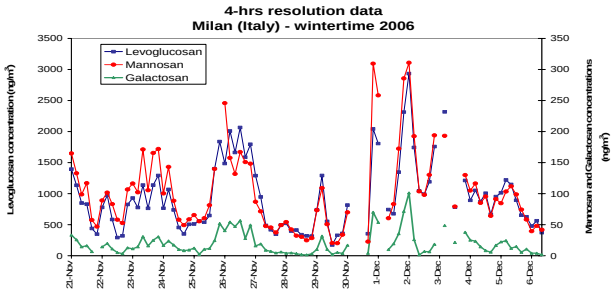
APAT-ARPA Lombardia Report (2007):
22.9% of the families in Lombardy use wood combustion (25.6% is the estimate at the national level) for an average yearly consumption of **3.4 tons/family**.
About **738 000 wood burners are installed in Lombardy** mainly for domestic heating. However, wood combustion for domestic heating is often coupled with other combustion materials (i.e. methane in 70.2% of the cases).

The sampling site

Emissions in the Milan province
Data from INEMAR emission inventory, 2005



Results: concentrations



Levoglucosan, mannosan, and galactosan concentrations showed very similar temporal patterns with median concentrations of 821 ng/m^3 for levoglucosan, 88 ng/m^3 for mannosan, and 14 ng/m^3 for galactosan.

Experimental

Sampling: **4-hours resolution PM10** (6 samples/day, 90 samples in total) from 21 November to 6 December in Milan (Italy) in parallel on PTFE and quartz fiber filters (pre-fired at 700°C for 1 hour) using CEN-equivalent samplers operating at a flow rate of 2.3 m^3 h^{-1}.

PM10 mass concentration: gravimetrically determined in an air controlled weighing room (T=20±1 °C, R.H.=50±5%) using an analytical microbalance

Chemical speciation:

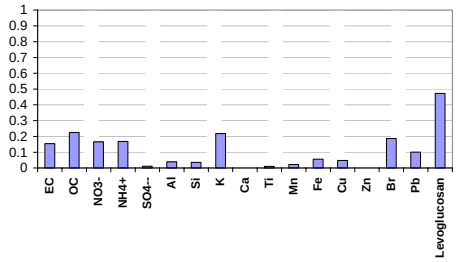
- **elements** (Al, Si, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Br, Sr, Ba, Pb) by Energy Dispersive X-Ray Fluorescence
- **water-soluble major anions and cations** (i.e. SO_4^{2-}, NO_3^-, and NH_4^+) by Ion Chromatography
- **TC/EC/OC** by Thermal-Optical Transmittance
- **Levoglucosan, Mannosan and Galactosan** by HPAEC-PAD

Receptor Model:
Positive Matrix Factorization (PMF2) was applied to the 4-hour resolution chemically speciated data to infer wood/biomass burning contributions to PM10. Multi-linear regression was carried out for source apportionment.

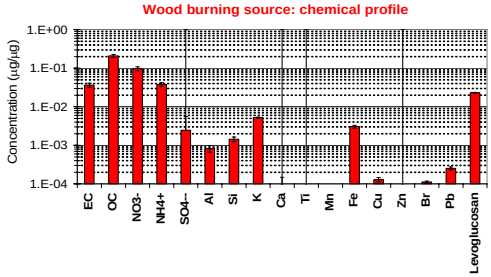
PMF results

Positive Matrix Factorization resolved the wood burning source together with other 6 sources (traffic, re-suspended soil dust, construction works, industry, sulphates, and nitrates). In the following only results related to the wood burning source will be reported.

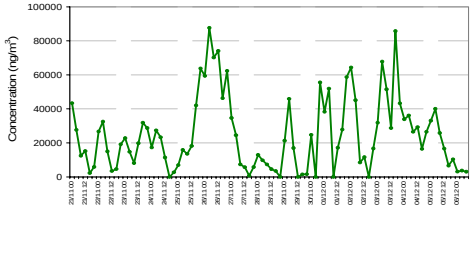
Wood burning source: Explained Variation



Wood burning source: chemical profile



Wood burning source: temporal pattern



The **wood burning source** during the investigated winter period on average accounted for **23%** to PM10 in Milan.

From PMF results **"real world" emission ratios** were obtained and compared with those measured at the source (literature data)

Levoglucosan/OC = 0.11 to be compared with **0.15±0.09** *(Szidat et al. (2006) J. Geophys. Res., 111, D07206 and therein cited literature)*
EC/OC = 0.17 to be compared with **0.16±0.05** *(Szidat et al. (2006) J. Geophys. Res., 111, D07206 and therein cited literature)*
K/Levoglucosan = 0.23 to be compared with **0.6-1.1** obtained by *Caseiro et al. (Atmos. Environ. 2008)* with soluble potassium instead of total K (as in our case)