Contribution from wood burning to the PM10 aerosol at four urban background sites in Flanders, Belgium

W. Maenhaut[1,2], R. Vermeylen[2], M. Claeys[2], J. Vercauteren[3], C. Matheeussen[3] and E. Roekens[3]

[1]Department of Analytical Chemistry, Ghent University, Gent, BE-9000, Belgium
[2]Department of Pharmaceutical Sciences, University of Antwerp, Antwerpen, BE-2610, Belgium
[3]Flemish Environment Agency (VMM), Antwerpen, BE-2000, Belgium
Keywords: PM10, OC, EC, levoglucosan, wood burning.
Presenting author email: willy.maenhaut@ugent.be

In an earlier one-year study (2010-2011) the contribution from wood burning to the PM10 aerosol was assessed for 7 sites in Flanders, Belgium (Maenhaut *et al.*, 2012). As a follow-up of that work, a new one-year study was performed, whereby PM10 samplings were made every fourth day from 30 June 2011 until 2 July 2012 at a background site in each of the following cities: Antwerpen, Gent, Brugge, and Oostende. The site in Gent was also used in the earlier study, but the other sites were new ones. The samplings were done for 24 h and 47-mm diameter Pallflex® Tissuquartz™ 2500 QAT-UP filters were used. After sampling the PM10 mass concentration was determined by weighing; organic and elemental carbon (OC and EC) were measured by thermal-optical transmission analysis using the NIOSH protocol (Birch and Cary, 1996) and the wood burning tracers levoglucosan, mannosan, and galactosan were determined with gas chromatography / mass spectrometry.

As in the earlier study, the three wood burning tracers were very highly correlated with each other at each of the sites (all r> 0.95). There was little difference in the levoglucosan to mannosan (L/M) ratios of the 4 sites. The annual mean L/M ratios ranged from 8.9 to 9.9. These ratios are larger than in the 2010-2011 study, where they ranged from 6.2 to 7.1 for the 7 sites. From our L/M ratios we derived the relative contributions of softwood and hardwood burning, thereby using the same approach as used by Schmidl *et al.* (2008). It was found that softwood burning accounted, on average, for about 50%, and there was little variation in this percentage with site or with season. In the 2010-2011 study, the annual mean percentages were higher, i.e., around 70%. It is estimated that the uncertainty in those percentages is of the order of 10% points and that it is largely of a systematic nature (i.e., resulting from the calibration curves for levoglucosan and mannosan in the current and earlier studies). The difference between the 50% and 70% of the two studies may therefore not be significant.

Similarly as in the 2010-2011 study, the concentrations of the three anhydrosugars showed a pronounced seasonal variation with highest levels in winter and lowest ones in summer. The anhydrosugar data of the 4 sites were highly correlated with each other. For example, the between site correlation coefficients for levoglucosan were in the range 0.92-0.97 for 3 of our 4 sites (Antwerpen, Gent, and Oostende), while the correlation coefficients between the levoglucosan data from Brugge and those of the other 3 sites were in the range 0.79-0.83. High site-by-site correlation coefficients were also observed in the 2010-2011 study, where they were in the range 0.80-0.96 for 6 of the 7 sites (Maenhaut *et al.*, 2012). Like in the earlier study it can again be concluded that wood burning in Flanders is a regional scale phenolmenon and that it is probably taking place in many individual houses on similar occasions (e.g., on cold days, weekends or holidays). The slopes of the regression lines (forced through the origin) of the levoglucosan data of Gent, Brugge, and Oostende on the data from Antwerpen were 1.11, 1.06, and 0.77, respectively, and thus close to 1, which is again consistent with a regional phenomenon with many wood burning sources throughout Flanders. The lower slope for Oostende is attributed to the proximity to the North Sea, so that the air there is often diluted by maritime air.

The levoglucosan data were used to assess the contribution from wood burning to the OC and the PM10 mass (Schmidl *et al.*, 2008). More specifically, levoglucosan was multiplied by factors of 5.59 of 10.9 to obtain respectively the OC and PM10 mass concentrations from wood smoke. These contributions varied substantially with season (with for the contribution to the OC the largest percentage in winter, followed by autumn, spring, and summer), but there was little difference between the contributions of the 4 sites. The seasonal means of the contribution from wood burning to the OC were 15-19%, 3.6-5.8%, 20-25%, and 34-41% for spring, summer, autumn, and winter, respectively, whereby the ranges are the ranges of the means for the 4 sites. As to the PM10 mass, the seasonal means of the contribution from wood smoke were 2.3-3.3%, 0.55-1.3%, 5.9-9.0%, and 6.5-9.8% for spring, summer, autumn, and winter, respectively, whereby the lowest mean percentage in each season was observed for Oostende. Both for OC and the PM10 mass, the results of the current study show good resemblance to the results from the 2010-2011 study.

Birch, M.E. and Cary, R.A. (1996) *Aerosol Sci. Technol.* **25**, 221-241.

Maenhaut, W., Vermeylen, R., Claeys, M., Vercauteren, J., Matheeussen C. and Roekens, E. (2012) *Sci. Total Environ.* **437**, 226-236.

Schmidl, C., Marr, I.L., Caseiro, A., Kotianová, P., Berner, A., Bauer, H., Kasper-Giebl, A. and Puxbaum, H. (2008) *Atmos. Environ.* **42**, 126-141.