Investigation of Biomass Burning and Biogenic Aerosols through Molecular Markers: Measurements from the Canadian NAPS $PM_{2.5}$ Speciation Program

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The Canadian National Air Pollution Surveillance (NAPS) program, a joint program of the federal and provincial governments and territories focusing on urban air quality, has been in operation for over 40 years. In 2003, the NAPS $PM_{2.5}$ speciation program was initiated to better quantify the impact of sources on $PM_{2.5}$ concentrations (Dabek-Zlotorzynska *et al*. 2011)

In an attempt to obtain information on biomass burning contribution to $PM_{2.5}$, the measurement of monosacharide anhydrides (levoglucosan, mannosan and galactosan) was added in 2009 to the enhanced NAPS $PM_{2.5}$ Speciation Program. The analysis of polyols, arabital and mannitol, was used to estimate fungal contributions to $PM_{2.5}$.

The 3-year data from the measurement of levoglucosan (and other carbohydrates) in samples collected at the ten urban and two undeveloped sites (Figure 1) for 24 hours every 3rd day were used to (1) examine the spatial and seasonal variations of $PM_{2.5}$ levoglucosan, (2) investigate the relationship between levoglucosan and other chemical composition, and (3) estimate the biomass burning contribution to organic carbon and $PM_{2.5}$.

Figure 1. Map showing locations of the NAPS $PM_{2.5}$ speciation sites

Levoglucosan levels had a strong seasonality at all sites with high winter levels due to residential heating (Figure 2). The estimated wood smoke $PM_{2.5}$ contribution was greatest in Montréal, with a contribution greater than 30% during a cold season.

Using the relationship between levoglucosan and mannosan (L/M), hardwood combustion was found to be the dominant source of wood smoke to $PM_{2.5}$, particularly in the cold season.

Sugar alcohols (arabitol and mannitol) showed a seasonal trend of high levels in the summer. The month of maximum concentrations varied by site but in most cases maxima occurred in mid to late summer. This seasonal behaviour is linked to the favourable growth of fungi and production of spores at higher temperatures.

Elevated $PM_{2.5}$ concentration, OC/EC ratio, levoglucosan, mannosan and fungal spore tracer concentrations were observed during forest fire episodes at several sites, particularly in Alberta (AB) and British Columbia (BC) (Figure 3).

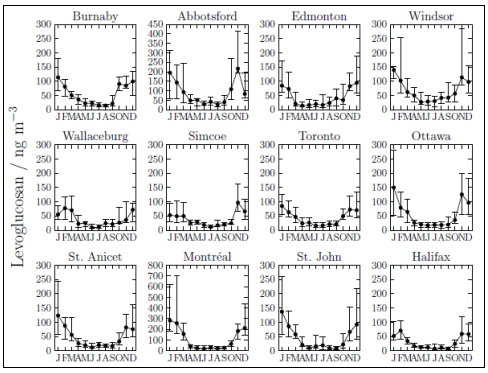

Figure 2. Levoglucosan concentrations by month & site 2010–2012 (median and 25th-75th percentile range).

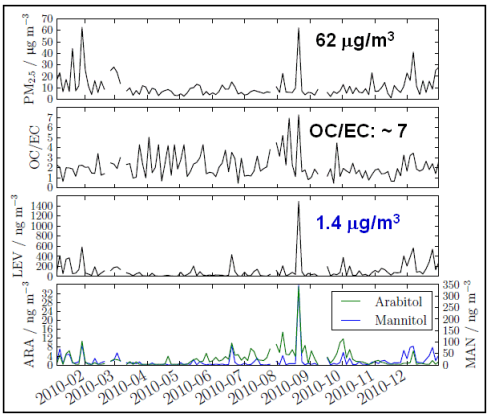

Figure 3. Long-Range Transport of British Columbia's Forest Fire Smoke observed in Edmonton, Alberta

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