Observation on the toxicology of PM 2.5 particles in some rural aerosols

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Introduction

Organic aerosol is major aerosol type in biogenic aerosols
In recent research, emphasize has been given to the chemical characterization and quantitative determination of polar water-soluble organic compounds in the fine size fraction (< 2.5 μm) of natural aerosols because of their cloud and climate effects
In this project, we examined some continental rural aerosols which were collected, during a field campaign in the summer
The polar organic compounds measured included oxidation products of isoprene that only have been recently discovered (Claeys et al., Science, 2004a;b):
- -2-methylthreitol
- -2-methylerythritol
- -2,3-dihydroxymethacrylic acid

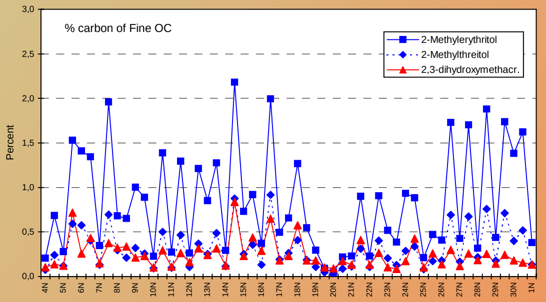


Fig.3 shows the time trends for the PM2 particulate mass (PM derived from a separate filter sampler) and for the PM2.5 OC, malic acid, the tetrols and the sugar alcohol mannitol

Fig. 2. Analytical procedure

Part of quarts filter(in glass flask)

Addition of recovery standards (methyl-β-D-xylanopyranoside)

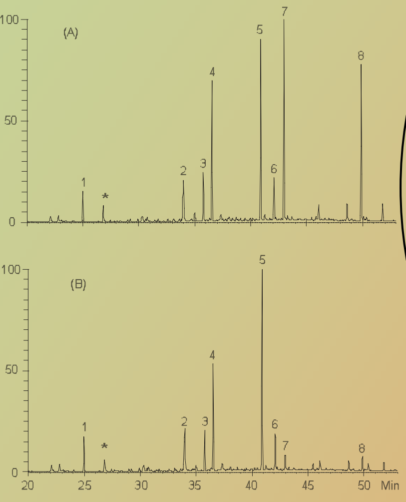
Extraction 3x20 mL CH3OH under ultrasonic agitation

Concentration to 1 mL rotary evaporation at 213 Pa and 35 oC

Filtration on Teflon filter (0.45 μm)

Silylation MSTFA + 1% TMCS : pyridine (2 :1) at 70 oC for 60 min

GC?ion trap MS, EI, full scan, mass chromatography



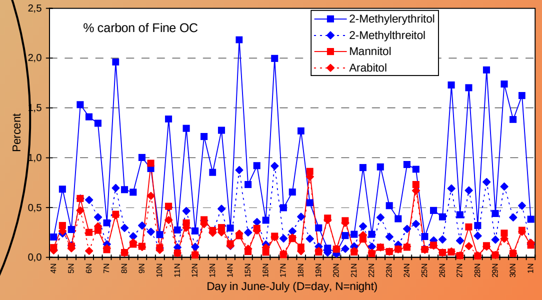


Fig. 4 shows the trends in the day/night differences for the two tetrols and the two sugar alcohols of the percent carbon in the fine OC.

Fig. 1. GC/MS TIC obtained for (a) a day-and (b) nighttime fine aerosol sample. 1, 2,3-dihydroximethacrylic acid; 2, malic acid; 3, 2-methylthreitol; 4, 2-methylthritol; 5, methylsilanopyranoside; 6, levoglucosan; 7, arabitol, mannitol

Table 1. Median concentrations and concentration ranges as derived from PM2.5 samples (n=20). Data for PM, OC, WSOC and EC are in μgm-3, for the others in ngm-3

Species	Median conc.	Conc. range
OC (μg.m-3)	4.2	1.94 – 6.8
WSOC	2.6	0.98 – 4.7
EC	0.20	0.077 – 0.59
Malic acid (ng.m-3)	38	11.5 – 79
Levoglucosan	12.3	3.5 – 95
Arabitol	4.8	0.69 – 25
Mannitol	5.3	0.62 – 29
2-methylthreitol	7.5	0.79 – 34
2-methylerythritol	21	1.03 – 85
2,3-dihydroxymethacrylic acid	7.6	2.2 – 18.3

Chemical analysis

The coarse and fine filters (both front and back) of all Hi-Vol samples (20) were analyzed for organic carbon (OC) and elemental carbon (EC) by a thermal-optical transmission (TOT) technique
The fine filters (both front and back) of all samples were analyzed for water-soluble organic carbon (WSOC)
The fine front filters were subjected to the analyses for polar organic compounds
A part (1/16) of filter was extracted with methanol. Analysis for levoglucosan, related saccharidic compounds and malic acid with a GC/Ion trap MS method (Pashynska et al. 2002)The analytical procedure is shown in Figure 2. Total ion cromatograms (TIC) obtained for day-and nightime sample) are presented in fIgure 3. Major organic compounds detected in the TIC were:2,3-dihydroxymethacrylic acid (1); malic acid (2); 2-metthylthreitol (3); 2-methylerytritol (4); levoglucosan (6); arabitol (7) and mannitol (8)

Table 2. Mean percentages of the OC attributable to rhe WSOC and to the carbon in the organic compounds as derived from the PM 2.5 samples

Species	Mean % + std.dev.
WSOC	61 + 9
Malic acid	0.97 + 0.49
Levoglucosan	0.54 + 0.66
Arabitol	0.19 + 0.17
Mannitol	0.21 + 0.22
2-methylthreitol	0.28 + 0.22
2-methylerythritol	0.76 + 0.57
2,3-dihydroxymethacrylic acid	0.23 + 0.15
Sum (compounds)	3.2 + 1.6

References

Claeys M, Graham B, Vas G, Wang W, Vermeylen R, Pashynska V, Cafmeyer J, Guyon P, Andreae MO, Artaxo P, Maenhaut W. Science 303, 1173-1176 (2004a)
Claeys M, Wang W, Ion AC, Kourtchev I, Gelencser A, Maenhaut W. Atmos.Environ. 38, 4093-4098 (2004b)
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Conclusions

Figure 4 shows the time trends for PM2 particule mass (PM, derived from a separate filter sampler) and for PM2.5 OC, malic acid, the tetrols (sum of 2-methreitol and 2-methylerythritol), and the sugar alcohol mannitol
PM and OC show relatively little variation (their concentration range remains limited to a factor of about 3)
The time trends of OC and PM are fairly similar to each other. Also the trend for malic acid is similar
There is clearly more variation in the time trends of the tetrols and in particular manitol (the sugar alcohol arabitol exhibited a similar trend as mannitol). For these compounds, there is clearly a tendency for higher concentrations during the day than during the night
The day/night difference for the two tetrols and the sugar alcohols were also very apparent in the trends of the percent carbon in the fine OC (Fig.4)