Polyols and glucose particulate species as tracers of primary biogenic organic aerosols at 28 French sites

Abdoulaye Samaké[1], Jean-Luc Jaffrezo[1], Olivier Favez[2], Samuël Weber[1], Jean M.F Martins[1], and Gaëlle Uzu[1]

[1]Univ. Grenoble Alpes, CNRS, IRD, INP-G, IGE (UMR 5001), F-38000 Grenoble, France.
[2]INERIS, Parc Technologique Alata, BP 2, 60550 Verneuil-en-Halatte, France

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Contact: abdoulaye.samake2@univ-grenoble-alpes.fr

Introduction

Chemical composition of particulate matter (PM) contains a large proportion of organic aerosols (OA), but its molecular speciation remains unresolved (Liang et al., 2017). OA associated with anthropogenic and secondary sources are extensively studied, while the contributions from primary biogenic aerosols (PBOA) remain poorly documented.

Primary sugar compounds (SC, i.e. polyols and monosaccharides) are ubiquitous water-soluble class of OA, and have been widely proposed as reliable tracers to characterize and apportion PBOA sources (Bauer et al., 2008). However, quantitative data on SC annual, spatial and seasonal distributions are still limited. Furthermore, the characterization of sources and the quantification of PBOA mass associated with these SC's remain elusive. Here, we provide a large overview of PBOA contribution to the total OM mass in France, as well their major components.

Methods

The present study primarily relies on the use of a large Database of PM_{10} SC concentrations in France over years 2014-2018. With 28 sites and more than 5,400 samples, it provides the most comprehensive dataset for these compounds. Positive Matrix Factorization (US EPA PMF 5.0 software) analysis was used to apportion the sources of PM for 16 of these sites with different typologies (i.e., rural, urban and traffic). A PBOA source profile was identified at each site thanks to the presence of more than 90% of the polyols total mass in the factor. PBOA factor was highly stable since the initial constrained and the bootstrap profiles mapped perfectly more than 99% of the time.

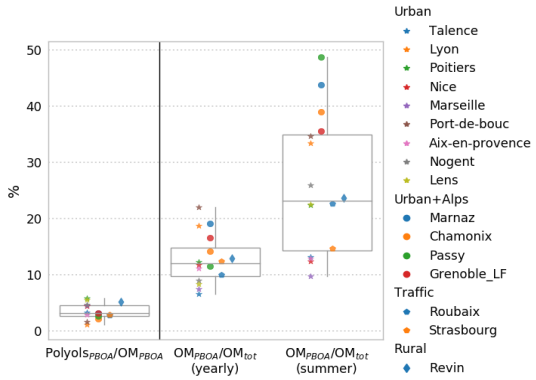
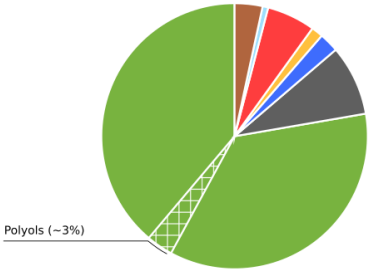


Figure 1. Mass contribution of polyols to OM in the PBOA factor, and contribution of OM$_{PBOA}$ factor to the total OM.



	OM	EC	NO_3^-	NH_4^+	nss-SO_4^{2-}	sea-salt	dust
mean	78	9	2	1	6	1	3
std	9	7	5	2	7	1	4
min	55	0	0	0	0	0	0
max	91	25	20	5	21	3	11

Figure 2. Average contribution (%) of species in the PBOA factor for the 16 sites. The hatched area represents the proportion of the OM apportioned by the polyols.

Conclusions

The main results show that PBOA represent a major component of PM_{10} organic matter (13±4 % by mass on a yearly average, 26±12 % during summer) across all sites in France. This contribution is even larger and can exceed 40 % of the total OM at sites in Alpine regions. Furthermore, the average PBOA chemical source profile obtained with PMF is made out of a very large fraction of OM (78±9 % on average), suggesting it is mainly related to direct biogenic emissions from biological particles (i.e., fungi, bacteria, plant debris) and not to soil dust resuspension containing microorganisms.

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