Surfactants in PM1 aerosols from boreal Northern Finland: importance for cloud droplet formation ?

V. Gérard[1], B. Nozière[1], E. Asmi[2], H. Lihavainen[2], N. Kivekäs[2], M. Aurela[2], D. Brus[2], L. Fine[1], A. A. Frossard[3] and R. C. Cohen[3]

[1]IRCELYON (Institut de Recherche sur la Catalyse et sur l'Environnement de Lyon), CNRS, University of Lyon, Villeurbanne, 69626, France
[2]FMI (Finnish Meteorological Institute), Helsinki, 00101, Finland
[3]Department of Chemistry & Department of Earth and Planetary Science, University of California, Berkeley, 94720, USA

Keywords: surfactants, atmospheric aerosol PM1, cloud
Presenting author email: violaine.gerard@ircelyon.univ-lyon1.fr

Clouds are essential components of the Earth's hydrological system and the main cooling factor of the climate budget. But some aspects of their formation are still not completely understood, in particular the role of surfactants (Boucher et al., 2013). Although Köhler theory predicts that surfactants should enhance cloud droplet activation, current models consider their role to be negligible (Farmer et al., 2015), and the surface tension of growing droplets is systematically assumed to be that of pure water.

Recent studies are starting to bring the evidence of the contrary, especially in laboratory experiments (Asa-Awuku et al., 2008; Ruehl et al., 2012; Giordano et al., 2013: Ruehl et al., 2014; 2016). In addition, the presence of strong surfactants, corresponding to surface tensions below 40 mN m^{-1}, has been evidenced in atmospheric aerosols from many different regions (Ekström et al., 2010; Baduel et al., 2012). In a recent study, the concentration of surfactants in PM2.5 aerosols from a coastal region was found to be large enough to decrease the surface tension of the droplets until they reach activation (Gérard et al., 2016).

It is thus now important to look for evidence of the role of surfactants on cloud droplet formation directly in the atmosphere (Nozière, 2016). For this, the surfactants present in PM1 aerosols at the GAW station Sammaltunturi, in Northern Finland (67°58'N 24°07'E, 565 m asl), a site directly impacted by the formation of orographic clouds (Lihavainen et al., 2008; Anttila et al., 2012), were extracted and analyzed from April to November 2015.

The PM1 aerosols were collected with a frequency of 24 hours on quartz-filters. The total surfactant fraction was extracted with a double extraction method (Gérard et al. 2016): a water extraction followed by a Solid Phase Extraction (SPE) removing interferents and concentrating the surfactants. The surface tension curves of the aerosol surfactants were determined with the pendant drop technique and their absolute concentrations by a colorimetric method (complexation with a dye, organic phase extraction, and UV-vis spectrophotometry detection).

In total, samples were collected over 223 days and included 70 cloud events, representing 25 % of the sampling time. The evolution of the surfactant concentration and properties, and of the surface tension of the PM1 aerosols during this campaign will be discussed and compared with meteorological parameters and other data measured simultaneously at the site.

This work was supported by the French Agence Nationale de la Recherche (ANR) and US National Science Foundation (NSF) on a joint ANR-NSF project (SONATA).

References

Anttila, T. et al. (2012) *Atmos. Chem. Phys.*, **12**, 11435
Asa-Awuku, A. et al. (2008) *Atmos. Chem. Phys.*, **8**, 799
Baduel, C. et al. (2012) *Atmos. Environ.*, **47**, 413
Boucher, O. et al. (2013) Clouds and Aerosols. In *Climate Change 2013: The Physical Science Basis.*, Cambridge University Press.
Ekström, S. et al. (2010) *Biogeosciences*, **7**, 387
Farmer, D. K. et al. (2015) *Chem. Rev.*, **115**, 4199
Gérard, V. et al. (2016) *Environ. Sci. Technol.*, ***in press***
Giordano, M. R. et al. (2013) *Environ. Sci. Technol.*, **47**, 10980
Lihavainen, H. et al. (2008) *Atmos. Chem. Phys.*, **8**, 6925
Nozière, B. (2016) *Science*, ***in press***
Ruehl, C. R. et al. (2012) *Geophys. Res. Lett.*, **39**, L23801
Ruehl, C. R. et al. (2014) *J. Phys. Chem. A*, **118**, 3952
Ruehl C. R. et al. (2016) *Science*, ***in press***