

# Organic aerosol: distribution between fog water and interstitial air - a report for two mountainous sites in Germany

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Keywords: fog water, interstitial aerosol, dicarboxylic acids, SOA  
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Aerosols are in the focus of current research because of their potential impact on humans and ecosystemic health. They may cause cardiovascular and neurodegenerative diseases and are in charge of oxidative stress. The toxicological effect of organic aerosols depends on their reactivity, influenced by their composition. In this context, fog and cloud water are important media. Due to its special microstructure, fog enables chemical reactions that do not exist in the gas phase. Long residence times near ground level support such chemical reactions. Furthermore, fog and cloud water are media for particle reformation. Hence, fog and cloud water considerably influence aerosols, their composition and properties in the atmosphere.

To date there is a demand in understanding transformation processes of organic compounds by fog and cloud water. We report measurements of the chemical composition of fog and interstitial aerosol samples from a) Zinnwald-Georgenfeld, 877 m a.s.l., eastern Erzgebirge, and b) Fichtelberg, 1,214 m a.s.l., highest elevation of the German Erzgebirge. The Erzgebirge was chosen because of a periodic occurrence of long-distance air mass transport, charged with high pollution concentrations. The most important source for these pollutants is the highly industrialized Northern Bohemian Basin (200–300 m a.s.l.) with a major concentration of Czech Republic's lignite power plants, petrochemical and heavy industry. Furthermore, the sampling site is characterized by a high frequency of fog events.

Passive string collectors were used to sample fog water, as described in Lange *et al.* (2003). Interstitial aerosol was collected using an aerosol sampler, based on impaction principles, and operating with quartz fiber filters. We determined the concentration of major ions, trace metals and carbonaceous material next to pH-values and electrical conductivity. TOC (OC/EC), carboxylic acids, sugar and sugar derivatives, and nitrophenols were in focus of the organic analysis.

Fog waters, characterized by a pH of 4 and an electrical conductivity of  $130 \mu\text{S cm}^{-1}$  (mean values), showed an inorganic composition dominated by sulfate, nitrate and ammonium. Thereby, Zinnwald is the more polluted site; Fichtelberg is much less influenced by air pollution. Main trace elements are Fe, Al, Zn and Pb.

Within the organic fraction of fog water 22 "substituted" carboxylic acids (C5-C10) were determined, belonging to six different groups (aliphatic monocarboxylic acids (MCA), functionalized aliphatic MCA; aromatic and nitro-aromatic MCA, aliphatic dicarboxylic

acids (DCA), functionalized aliphatic DCA, and aromatic DCA). Zinnwald was dominated by levulinic, benzoic, adipic and 7-oxooctanoic acid ( $0.98 \mu\text{mol L}^{-1}$ ,  $0.25 \mu\text{mol L}^{-1}$ ,  $0.15 \mu\text{mol L}^{-1}$ ,  $0.09 \mu\text{mol L}^{-1}$ ). Fichtelberg showed the highest concentrations for 2-isopropylmalic, azelaic and suberic acid ( $0.08 \mu\text{mol L}^{-1}$ ,  $0.06 \mu\text{mol L}^{-1}$ ,  $0.05 \mu\text{mol L}^{-1}$ ). Furthermore, 8 short-chain carboxylic acids (C1-C4, oxalate, malonate, formiate, malate, succinate, glutarate, acetate and glycolate) were determined at both sites. For the interstitial aerosol, three different short-chain acids were found: oxalate ( $12.9 \text{ ng/m}^3$ ), malonate ( $5.8 \text{ ng/m}^3$ ) and succinate ( $2.9 \text{ ng/m}^3$ ). The differences between the liquid and the interstitial phase were significant. There is enrichment in the fog water with a factor of 2 (oxalate), 6 (malonate) and 10 (succinate) (Figure 1).

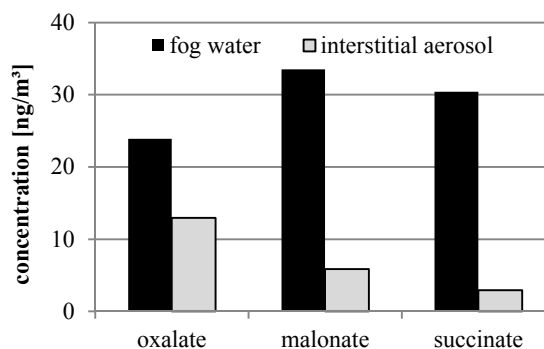


Figure 1. Concentration of carboxylic acids/salts in fog water and in interstitial aerosol.

Possible explanations for the observations could be photochemical processes, different phase distributions of the carboxylic species (in relation to the fog/interstitial phase) and the long residence time of fog concerning to increased process intensities

However, there must be further research to improve our understanding of transformation processes of organic compounds by fog and cloud water. This needs further investigation.

## References

- Lange, C.A., Matschullat, J., Zimmermann, F., Sterzik, G., Wienhaus, O. (2003) Fog frequency and chemical composition of fog water – a relevant contribution to atmospheric deposition in the eastern Erzgebirge, Germany. *Atmos Environ*, **39**, 3731-3739