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Pollution Levels in Fog at the Chilean Coast

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Abstract

During July and August 2008 fog water was collected for chemical analysis in Patache, at the coast of northern Chile, 60 km south of Iquique (20°49'S, 70°09'W). Advective fog events occur regularly at the cliff in the coastal range at about 800 m above MSL. People collect these types of fog water at some places along the coast with Large Fog Collectors (LFC) for domestic use and for watering field crops. So far, no chemical analysis of fog water was performed in Patache. Pure fogwater samples (38 samples from 8 fog events) were taken by using a passive Scientific Cylindrical Fog Collector. Major ions and trace metals were quantified.

The analyses indicate very high ionic concentrations (mean 3500 µeq/l) and very low pH values (mean 3.3). The mean H^+-concentration represents 16 % of the total ionic equivalent concentration. Sulfate is the anion exhibiting the highest concentrations. A mean value of 880 µeq/l was found, which accounts for 24 % of the total mean concentration. In contrast to sulfate, nitrate shows only a low percentage of 8.1 %. Further major ions are sodium (20 %) and chloride (19 %), which are typical seasalt ions in coastal fog.

High correlations between the measured ions suggest a causal link between concentration in the fog samples and the liquid water content (LWC) of the cloud. The higher the liquid water content the lower are the ionic concentrations.
Enrichment factors with sodium as reference ion were calculated to identify potential emission sources contributing to the observed pollutant levels. We found that K^+, Na^+, Mg^{2+} and Cl^- mainly result from seaspray. Sulfate, however, is enriched by a factor of 13. The measured trace elements are highly enriched by factors up to hundreds of thousands (Zn: 50, Ni: 1800, As: 2400, Cd: 3900, Fe: 100000, Cu: 96000, Pb: 250000). A cluster analysis supports the conclusion that sulfate and the trace elements originate from anthropogenic activities. The sulfate cannot primarily originate from oceanic dimethylsulfide (DMS).
With regard to the back trajectories, the air masses generally reach the study site from southerly directions after travelling along the Chilean coast. Presumably the air masses pick up pollutants in the densely populated cities, industrial plants and power plants along the Chilean coast and transport them over hundreds of kilometers to Patache. Here, they were detected as ingredients in fog water and lead to high pollution levels therein.

References

Sträter, E., Westbeld, A. and Klemm, O. (2010): Pollution in coastal fog at Alto Patache, Northern Chile. Accepted for publication in Environmental Science and Pollution Research.