Pollution Levels in Fog at the Chilean Coast

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Fig. 1: A Large Fog Collector in Patache, Chile.

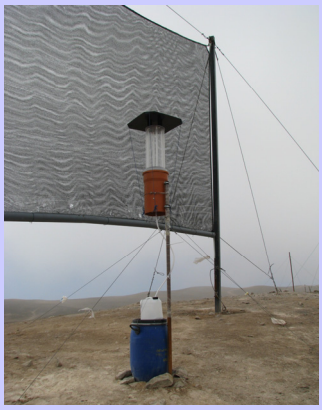

Fig.2: The cylindrical fog collector in front of the Large Fog Collector in Patache, Chile.

Introduction

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 (Fig. 1) for domestic use and for watering field crops.

Methods

Pure fogwater samples (38 samples from 8 fog events) were taken by using a passive Scientific Cylindrical Fog Collector (Fig. 2). Major ions and trace metals were quantified.

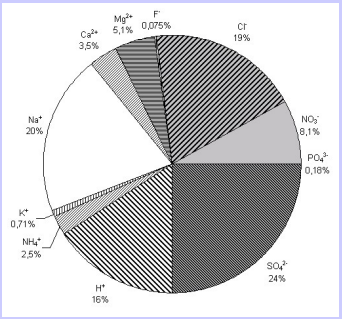

Fig. 3: Mean composition of the major ions of the advective fog events.

Results

- Very high mean ionic concentrations (3500 µeq/l, Table 1)
- A mean pH value of 3.3 (Table 1),
- Sulfate is the anion exhibiting the highest concentrations (880 µeq/l, 24 % Table 1 and Fig. 3)
- Sulfate and the trace elements are highly enriched (Table 2). Sodium, chloride and magnesium are typical seasalt ions
- A cluster analysis separates sulfate and the trace metals from the typical sea salt ions (not shown here)
- backward trajectories show, that the air masses generally reach the study site from southerly directions after travelling along the Chilean coast (Fig. 6)

Conclusion

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. The sulfate cannot primarily originate from oceanic dimethylsulfide (DMS).

		pure fog advective		Limit Values Chile
		mean	SD	
ec	µS/cm	400	215	
pH		**3.3**	0.21	6.5-8.5
H^+	µeq/l	560	330	
NH_4^+	µeq/l	88	56	
K^+	µeq/l	25	14	
Na^+	µeq/l	710	390	
Ca^{2+}	µeq/l	120	85	
Mg^{2+}	µeq/l	180	100	10280
F^-	µeq/l	< 5.3	–	79
Cl^-	µeq/l	670	420	11280
NO_3^-	µeq/l	280	170	806
PO_4^{3-}	µeq/l	6.3	5.5	
SO_4^{2-}	µeq/l	880	550	10410
total	µeq/l	3500	1900	
Fe	µq/l	< 200	39	300
Mn	µq/l	< 200	–	100
Zn	µq/l	< 50	13	3000
Cu	µq/l	49	41	2000
Se	µq/l	< 5.0	2.4	10
Cd	µq/l	< 0.5	0.25	10
Pb	µq/l	< 10	6.6	50
Cr	µq/l	< 2.5	–	50
Ni	µq/l	< 5.0	1.0	
As	µq/l	9.1	4.5	10

Table 1: Average concentrations of electric conductivity (ec), pH, major ions and heavy metals in pure advective fogwater samples as collected in Patache, Chile. Limit values of the Chilean drinking water regulation are shown.

	ER_{Ion} pure advective fog
K^+	1.7
Na^+	1.0
Ca^{2+}	4.2
Mg^{2+}	1.2
Cl^-	0.8
SO_4^{2-}	13
Fe	100000
Zn	50
Cu	96000
Cd	3900
Pb	250000
Ni	1800
As	2400

Table 2: Enrichment factors (ER, versus sea salt) of major ions and heavy metals in the pure fog water. Sodium was used as reference ion.

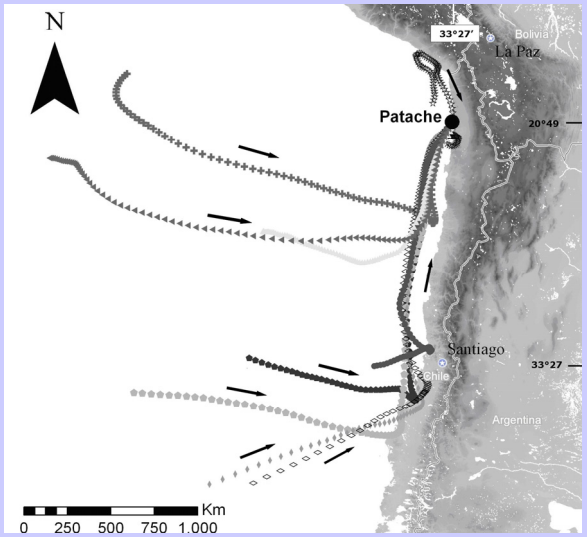

Fig. 6: Backward trajectories (96h) of the air masses of the nine fog events reaching Patache (NOAA Air Resources, *HYSPLIT-4)*

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