Intraannual fog variability and its relationship with spatio-temporal gradients in northern Chilean Atacama Desert

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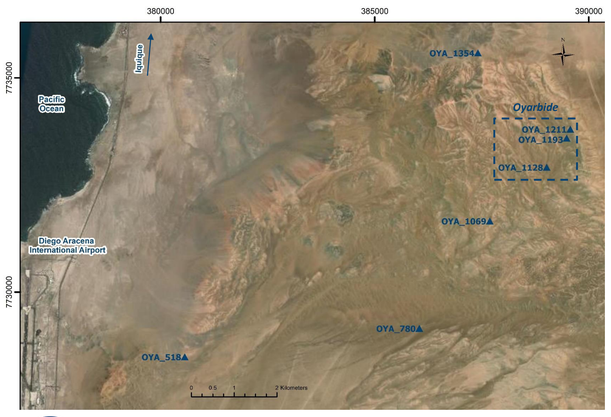
Introduction

In the coastal regions of the Atacama Desert, spatio-temporal dynamics in the ocean-atmosphere interactions create an advective coastal fog system, providing moisture which allows the development of high biodiversity along the coast at one of the driest places on Earth. Studies about fog have been conducted in this region since the middle of the 20th century, however there is a gap about the local-scale spatio-temporal fog dynamics and its interactions.

The study area is situated in the Chilean coastal desert of Atacama in the Tarapacá region (20°S). A transect of climatological stations is located between 518 m to 1,354 m altitude reaching 10.7 km inland. Here, we record high resolution temporal (hourly/10-minutes) atmospheric data. The new dataset allows to determine the detailed relationship between the spatio-temporal variability of the fog and its driving parameters.

Fog climate measurements at Atacama Desert

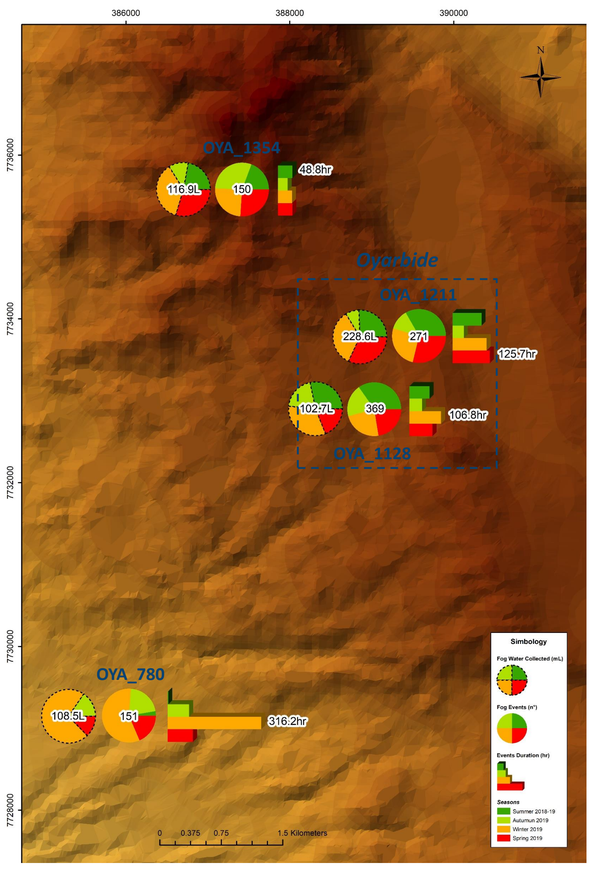
Since 2016 a regional fog climate network has been set up from coast to 1,354 m and 10.7 km inland ①. They generate a continuous 10-minutes record of air temperature & humidity (2 m), surface temperature (0.05 m), wind speed & direction (10 m/2 m), air pressure, global radiation, leaf weatness (0.05 m), dew and standard fog water (2 m) based on Standard Fog Collectors (SFCs).



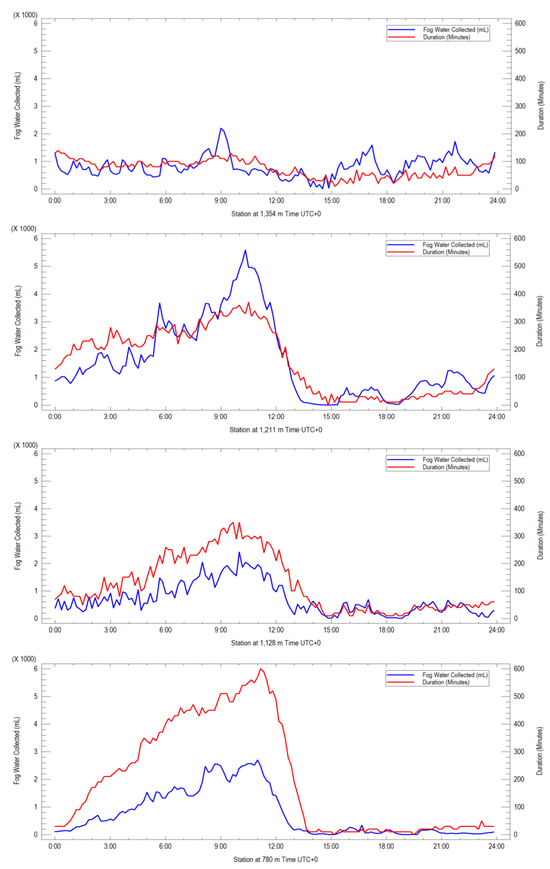
1 Fog climate network at Chilean Atacama Desert

Intraannual distribution of fog water collection

The seasonal distribution of fog water collected reveals a clustering in the Austral Winter ②A, especially closer to the coast (72%) with longest events (3.15hr). However, the most fog events occur in Oyarbide, mostly in Summer. The collection of fog water and its duration show less oscillation above the inversion layer (IL) (2.2hr and 2.2L) ②B. Below the IL, there is a greater daily oscillation of fog water collection with maximum of 5.6L (1,211 m) and 9.8hr (780 m), tends to converge with high amounts between 09:00 and 12:00.



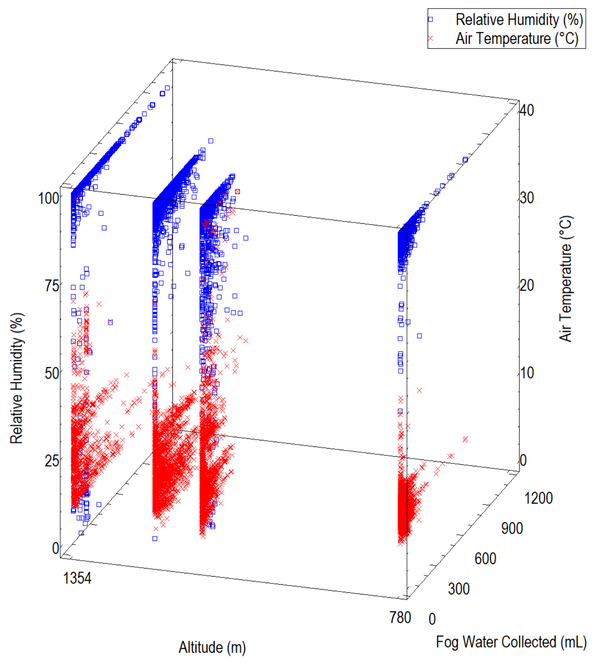
2A Fog water distribution between 780 m - 1,354 m (Austral Summer 2018-Spring 2019)



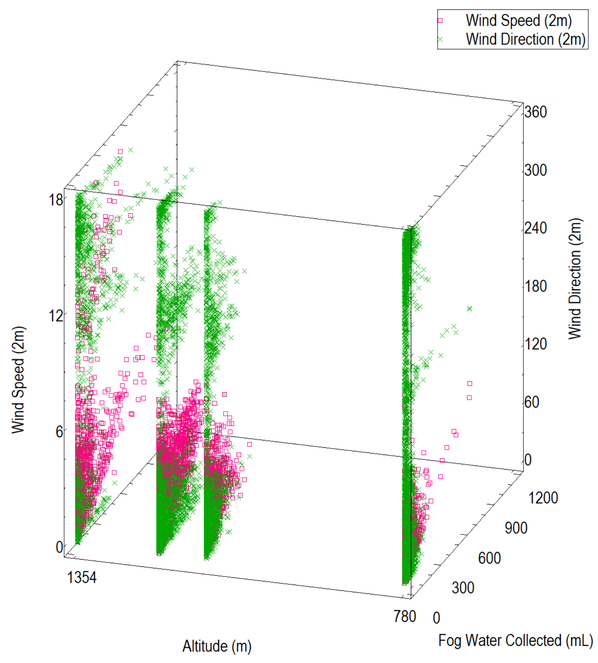
2B Hourly distribution of fog water (Austral Summer 2018-Spring 2019)

Climatological gradient

From coast to inland, the fog water collection occurs with a negative gradient of relative humidity (80-38%) and positive of air temperature (14.4-18.3°C) and wider oscillations in Oyarbide ③A. At the analyzed period, there is an increase of wind speeds with altitude, reaching up to 4.0 m/s above the IL. The largest amount of fog water is generated under N-NW wind regimes with less oscillation under the IL than above it (SW-W) ③B.



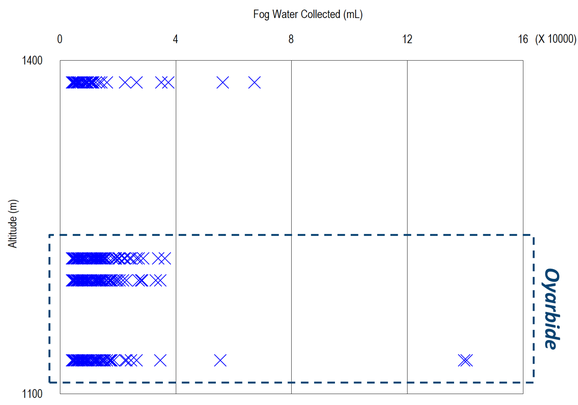
3A Altitudinal gradient of air temperature and humidty (Austral Summer 2018-Spring 2019)



3B Altitudinal gradient of wind speed and direction (Austral Summer 2018-Spring 2019)

Discussion

The greater oscillation in the frequency and size of fog events over the IL and in lower Oyarbide ④ coincides with moderate oscillation in the duration and collection of fog water. These conditions are related to a lower correlation of (+) humidity & (-) temperature with fog water collection and an increase wind regime oscillation with altitude.



4 Altitudinal gradient of fog events (Austral Summer 2019-Spring 2020)

Acknowledgment

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