Project: **1053**

Project title: **CRC 1211 - A03: Statistical-dynamical modelling of Aeolian processes in the Atacama Desert over geological time scales and their implications to life at the dry limit**

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Report period: **2019-07-01 to 2020-06-30**

In preparation for the second phase of the Collaborative Research Centre 1211 (CRC1211 “Earth – Evolution at the dry limit”; funding period 2020-07-01 to 2024-06-30; proposal is currently reviewed by the DFG; see also the request) we have focused on the simulation of fog in the Atacama Desert during the report period. Again, we have used the WRF model for our simulations. Due to the complex topography of the Atacama Desert and the necessity of a suitable representation of the boundary layer for fog simulations, the horizontal and vertical resolution has been clearly increased when compared to our former WRF runs. A horizontal resolution of 3.3km together with 65 vertical model levels were used for the WRF simulations. Altogether three runs were performed:

1.) An evaluation run for the period February 2018 to March 2019. For this period observations from stations installed in the Atacama Desert by other CRC1211 projects are available. Hence this run will be used to evaluate the performance of the model in simulating fog and the associated processes.

2.) A WRF run for the period November 2011 to December 2012. This period is characterised by neutral ENSO conditions.

3.) A WRF run for an El Nino phase (November 2014 to December 2015) to study the fog occurrence under strong El Nino conditions.

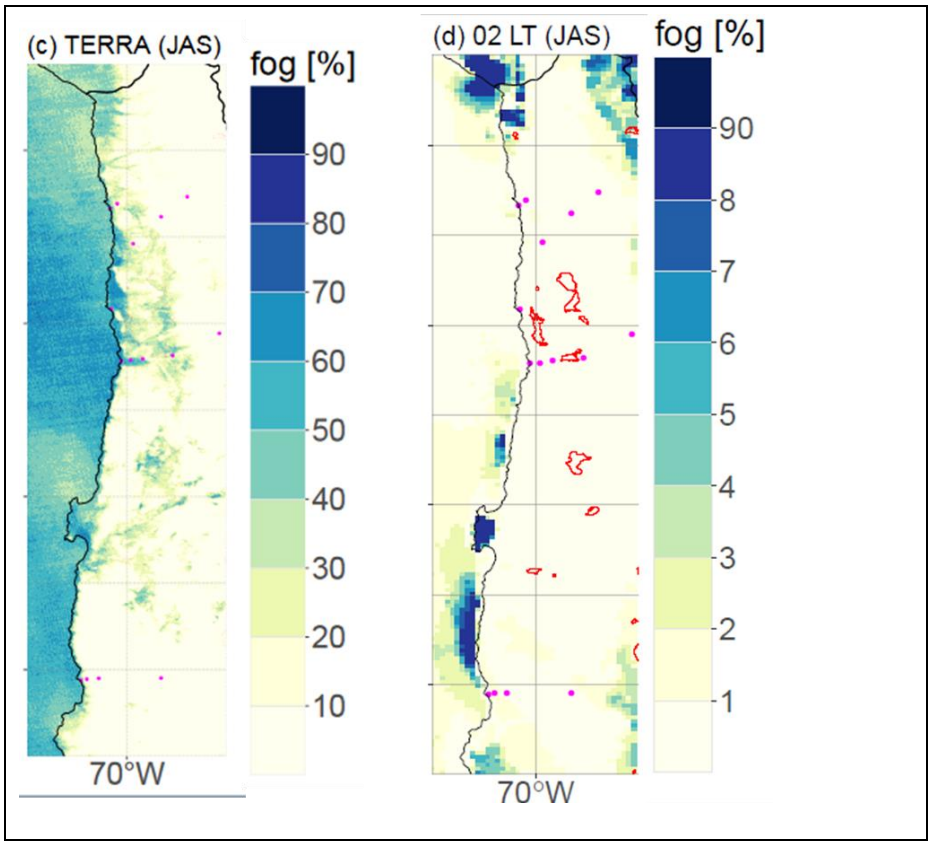

Fig. 1: Frequency of fog occurrence during winter (July, August, September) as derived from the MODIS Terra satellite retrievals (left) and as simulated by the WRF model (right).

A detailed analysis of these three runs is currently ongoing. However, first comparisons of the evaluation run with a fog climatology as derived from a satellite product indicate that the fog occurrence is clearly underestimated by the WRF model (Fig. 1). This underestimation is due to the fact that the simulated inversion height is too low, and that near coastal canyons like the Rio Loa, which enable the coastal fog to penetrate inland, are not displayed adequately even in highly resolved WRF simulations. To deal with these issues in the second CRC1211 phase, we decided to additionally predict fog with a neuronal network using different WRF simulated variables as predictants. The prerequisite for a successful setup of such a network is a good knowledge of the fog characteristics in the Atacama Desert and the associated processes. In the report period we therefore analysed the fog variability at different CRC1211 stations to improve our knowledge of the involved local processes. For this analysis we used a self-organising map (SOM) to identify the atmospheric variables which are most crucial for the fog variability. A SOM with 8x8 nodes was constructed with Python, using daily courses of fog at a near coastal station as input (Fig. 2 left).

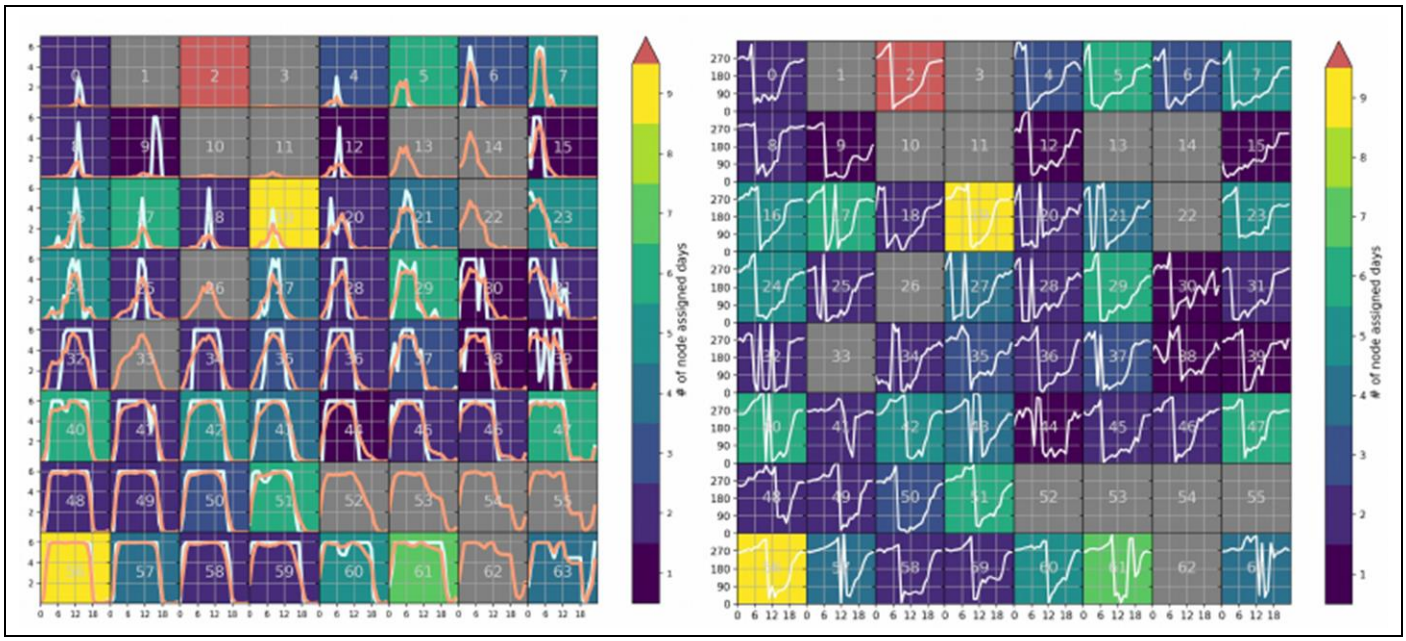

Fig. 2: Left: Daily fog courses at the 64 nodes of the 8x8 SOM, given as hourly sum of 10-minute intervals with fog at CRC1211 station 12 (red curves). The background colouring represents the number of days which are assigned to the different SOM nodes, and the white curves show the mean daily fog courses of all these assigned days. Right: Mean daily courses of the wind direction of all days assigned to the different SOM nodes.

The daily courses of fog may strongly vary, with fog persisting over many hours of the day (lower left region of the SOM), with short nocturnal fog peaks (upper right region of the SOM), and without fog throughout the day (node #2 of the SOM). It turned out that aside from temperature and relative humidity the wind direction plays an important role for the near-coastal fog variability in the Atacama Desert (Fig. 2 right). We conclude that persistent westerly winds are associated with continuing fog occurrence (lower left region of the SOM), while short fog periods are accompanied by premature shifts from westerly to easterly wind directions (upper right region of the SOM). Different other atmospheric parameters are currently analysed in the remainder of the report period, including the strength and the height of the inversion over the subtropical Southeast Pacific. Based on the results of these analyses we will construct the neuronal network using the relevant variables from the WRF simulations 1.) to 3.) (see above).