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**

Principal investigator: **Mark Reyers**

Report period: **2017-07-01 to 2018-06-30**

In the report period test simulations with WRF-CHEM/D for the region of the Atacam Desrt have been performed, since these simulations form the basis for the development of the statistical-dynamical modelling approach (see also project proposal). As the application of a regional climate model in this area is much more challenging than expected, dozens of rather short term simulations were required to find the optimal model setting. We therefore have consumed only a small part of the requested computing time during the first half of the report period. Aside from different parameterizations, we tested different analysis and reanalysis datasets as boundary conditions and different model domains in simulations for the years 2011 and 2015. Further, we have implemented different datasets for an online sea surface temperature update, as the Pacific plays a key role for the climate variability and the moisture supply within the Atacama Desert.

For evaluation purposes we performed a two-year simulation (2012-2013) with the final model setup with a horizontal resolution of 10x10km. This period covers a time frame for which station measurements at different sites of the Atacama Desert are available (Muñoz et al., 2018). As we intend to model aeolian processes, focus was given to near-surface wind. Additionally, we also analysed simulated temperature and some important dynamical and physical processes. Further, in a sensitivity study we simulated the prominent March 2015 Atacama flood. A comparison of our simulations with measurements and with results from the literature reveals, that the perfrormance of the WRF model is surprisingly good for the complex terrain of the Atacama Desert, despite some systematic biases. For example, the diurnal cycle of the near surface wind components is simulated qualitatively and for some sites also quantitatively realistic, as shown for the u-wind in Fig. 1a. The simulated temperature agrees well to measurements for most sites in the Atacama Desert (see Fig. 1b), and the simulated rainfall rates during the extreme March 2015 event (see Fig. 1c) are similar to observations analysed e.g. in Scott et al. (2017). Further, different relevant processes are captured by the model, comprising inter alia the so called Andean pumping and the near-coastal inversion layer and its variability (not shown). We therefore conclude that the WRF model is suitable for our purposes within the CRC1211.

After the successful evaluation of the WRF model, a long-term simulation for the period 1981-2017 with a horizontal resolution of 10x10 km on 80x120 gridpoints using ERA-Interim reanalysis data as boundary conditions has been performed. For 2017 the horizontal resolution has been refined to 3x3 km to assess the impact of a higher horizontal resolution on the model performance. For this period in situ measurements of a large number of variables for different west-east transects in the Atacama Desert are deliverd by the CRC1211 subproject A01, which will be compared to our simulations.

The model output is currently uploaded to the Database of the CRC1211 to make it available for all project members. Together with subprojects from Cluster C of the CRC1211 we plan to determine simulated moisture sources and trajectories and analyse their impact on 15N and D/H concentrations of near-coastal Tillandsia communities. Further, from personal communication we know that the model data will be used by subprojects of Cluster B to relate the water supply to the distribution of different near-coastal plant stocks in the Atacama Desert.

Due to the time consuming model tuning in the first half of the report period we will not be able to realize all the planned simulations within the report period. Hence, some of these simulations will be performed in the next allocation period (07/2018-06/2019) depending on the requests of the other CRC1211 subprojects. However, in the remaining report period (until the end of 06/2018) we will simulate a 30 year time slice with climate conditions of the Last Glacial Maximum, using MPI-ESM-P data as boundary conditions.

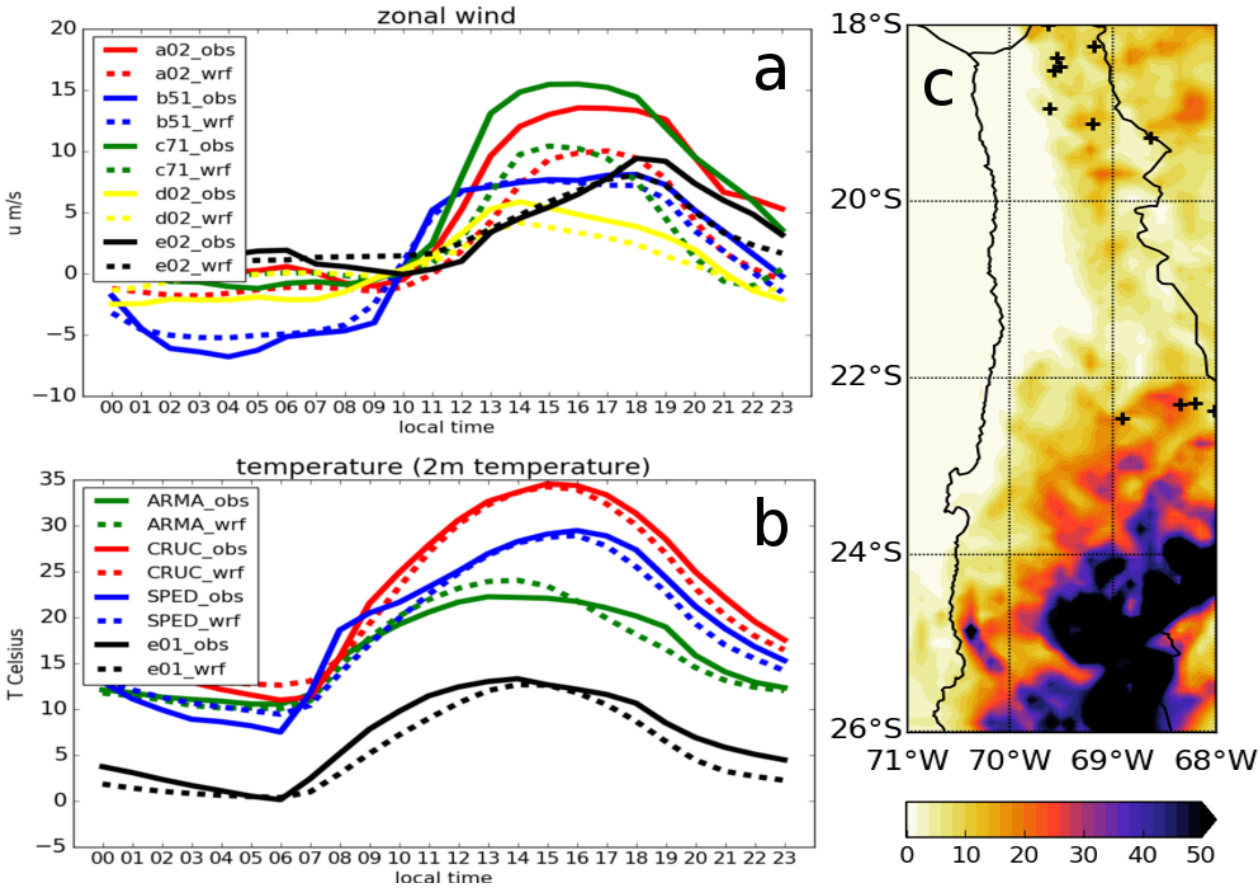

Fig. 1: Simulated and observed (a) 10m mean zonal wind and (b) 2m temperature for January 2013 at different sites in the Atacama Desert. (c) Simulated accumulated precipitation for 24-26 March 2015.

Literature:

Ricardo C. Muñoz; Mark Falvey; Mario Arancibia; Valentina Astudillo; Javier Elgueta; Marcelo Ibarra; Christian Santana; Camila Vásquez, 2018: Wind energy exploration over the Atacama Desert: a numerical model-guided observational program. Submitted to: Bulletin of the American Meteorological Society

C. P. Scott; R. B. Lohman; T. E. Jordan, 2017: InSAR constraints on soil moisture evolution after the March 2015 extreme precipitation event in Chile. Scientific Reports | 7: 4903 | DOI:10.1038/s41598-017-05123-4