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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Project overview:

The DFG funded Collaborative Research Centre (CRC 1211) “Earth – Evolution at the dry limit” (www.sfb1211.uni-koeln.de) aims at the interface between landscape evolution and biological evolution in arid to hyper-arid regions on geological time scales. In the first phase (until June 2020) focus will be given to the Atacama Desert in Northern Chile, which is considered to be the driest desert on Earth.

Within the CRC 1211, the sub-project A03 of the Institute for Geophysics and Meteorology (IGMK) at the University of Cologne will focus on the simulation of aeolian processes. These processes virtually govern the geomorphological evolution in such a hyper-arid region, as fluvial processes are in principal non-existent. Aeolian processes are not only related to climate change and variability but also to the bio-ecological evolution, as bacteria and fungi form crusts which may supress aeolian transport. At the same time, wind erosion prohibits the growth of crusts and vegetation. To analyse this complex interplay between climate, aeolian processes and bio-ecological evolution on geological time scales, highly resolved paleoclimate simulations including dust modelling are necessary.

Simulations will be performed with the regional climate model WRF-CHEM/D. Within A03 a new module for Aeolian-Biogenic interactions will be constructed and implemented in the model chain. The overall goal is to obtain simulations of the Aeolian-Biogenic interactions for the last several 100ka with a horizontal resolution of up to 1km. To reach this goal, we will combine the dynamical downscaling approach with a statistical downscaling (statistical-dynamical downscaling SDD). The idea is to dynamical downscale only a few paleoclimate time slices using a multiple self-nesting of WRF-CHEM/D, such that all relevant climate modes of the past are captured. The frequencies of the relevant climate modes are then identified in the global paleoclimate ensemble of PMIP3 / PMIP4. Highly resolved climatologies for the target area over geological timescales are finally derived by recombining the high resolution simulations of the climate modes with their respective paleoclimate frequencies. We plan to dynamical downscale time slices of about 50 years for the following climate conditions: (i) present day, (ii) historical, (iii) Last Glacial Maximum, (iv) Interglacial, (v) mid-Holocene. Simulations for present day conditions are required for validation purposes and boundary conditions for this simulation will be obtained from reanalysis data. Boundary conditions for historical and paleoclimate simulations are taken from the MPI-ESM-P output.