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Modeling the life cycle of fog in the Namib desert with COSMO-PAFOG

Maike Hacker (1), Bianca Adler (2), Hendrik Andersen (2), Jan Cermak (2), Norbert Kalthoff (2), Robert Spirig (3), Roland Vogt (3), and Andreas Bott (1)

(1) University of Bonn, Institute of Geoscience and Meteorology, Bonn, Germany (mhacker@uni-bonn.de), (2) Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, (3) University of Basel, Basel, Switzerland

Fog and low stratus clouds are a typical feature in coastal deserts. In the hyper-arid Namib Desert at the southwestern African coast, fog is an important source of water for ecosystems. The knowledge of the spatial and temporal patterns of fog in the Namib-region contributes to a deeper understanding of fog processes and fog-related ecosystems and thus is of great ecological and socio-economic interest.

The central aim of our study is to understand processes controlling the spatial and temporal development of coastal desert fog in the Namib by means of numerical simulations. Low stratus clouds form at the top of the marine boundary layer over the cold Benguela Current. These low clouds are advected overland by meso-scale circulations. The interaction of turbulent mixing with microphysical and advection processes in the formation, maintenance and dissipation of fog and low clouds in the Namib Desert imposes high requirements on the corresponding parametrizations.

Numerical simulations are performed with an extension of the regional weather prediction model COSMO (Consortium for Small-scale Modeling) which is adapted for the application in the Namib region. To account for microphysical processes involved in fog formation, the microphysical parametrization of the one-dimensional fog forecast model PAFOG (PArameterized FOG) has been implemented into COSMO. The resulting fog forecast model COSMO-PAFOG is run with kilometer-scale horizontal resolution.

In our study, five case studies are analyzed and the model results are compared to satellite and ground observations obtained during the field campaign within the framework of the NaFoLiCA (Namib Fog Life Cycle Analysis) project. Tuning of turbulence-related model parameters improves the agreement of model simulations with observations. Especially the cloud cover compared to satellite observations and the diurnal cycle of temperature and humidity are better reproduced in the model simulations with adjusted turbulence parameters. The analysis of the thermodynamical processes yielding fog formation reveals that cooling in the atmospheric boundary layer is the main process leading to saturation while moisture changes play a minor part.