Project: **682**

Project title: **Large-eddy simulations of cloud and convective processes**

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The project takes place at the Max Planck Institute for Meteorology at the Hans Ertel Zentrum (HErZ) for clouds and convection, which is funded by BMVI (Federal Ministry of Transport and Digital Infrastructure) for the period 2019-2022. The overall goal of the project is to improve our understanding and modelling ability of cloud and convective processes using large-eddy simulations (LES) and a multi-resolution approach. The work during the past year was split in two projects, one to investigate the cold pools over Germany using LES in support to the observations during the FESSTVaL campaign. FESSTVaL stands for the Field Experiment on Submesoscale Spatio-Temporal Variability in Lindenberg, a measurement campaign initiated by HErZ. The second project had a goal to investigate the impact of the subgrid shallow convection on the resolved convective and large-scale circulations over the tropical Atlantic.

The FESSTVaL campaign was postponed to 2021 because of the pandemic, however, a smaller measurement network was installed over Hamburg during summer. For selected 4 days during which cold pools developed (3rd, 18th, 25th, and 28th June), we simulated cold pools over Hamburg using the ICON model and compared the simulated cold pool characteristics to observed data. The size, strength, and location of the simulated cold pools are different from those in the observed results, which partly relates to the chaotic nature of convection. Simulation of more days is thus required and will be pursued.

The work on the effects of shallow convection on the large-scale circulations over the tropical Atlantic was a continuation of a collaborative study started in the previous HErZ phase. The study was finalized in 2020 and is now accepted in Monthly Weather Review under the title: “Local impact of stochastic shallow convection on clouds and precipitation in the tropical Atlantic” (Sakradzija et al.). During the past year, the full set of simulations needed for the analysis was repeated using the newest version of ICON at 2.5 km. The study case was the 20th of December 2013 over the tropical Atlantic and adjacent landmasses (a day of the NARVAL field study, Stevens et al., 2019). The ICON model was used in several different configurations to isolate the effects of the stochastic scheme and other relevant choices in the model configuration. A set of new experiments was also added, including two sets of simulations of a duration of 10 days. In the first set, one-day long segments were simulated to isolate the local effects of the stochastic scheme on the distribution of clouds and precipitation. The second set included 10-days long continuous simulation to include all possible interactions between the subgrid and resolved scales and large-scale dynamics. The model is evaluated by comparing synthetically generated irradiance data for both visible and infrared wavelengths against actual satellite observations. The results of this case study showed improvements in low-level cloud cover, deep convection and its organization, as well as the distribution of precipitation in the tropical Atlantic ITCZ. Furthermore, it was demonstrated that local effects of shallow convection are crucial to correctly simulate the clouds and precipitation in the tropical Atlantic, even without its remote effects on the ITCZ through its impact on the large-scale circulation.

Publications

Sakradzija M., F. Senf, L. Scheck, M. Ahlgrimm, and D. Klocke (accepted): Local impact of stochastic shallow convection on clouds and precipitation in the tropical Atlantic, Mon. Wea. Rev.

Stevens, B., F. Ament, S. Bony, S. Crewell, F. Ewald, S. Gross, A. Hansen, L. Hirsch, M. Jacob, T. Kölling, et al. (2019), A high-altitude long-range aircraft configured as a cloud observatory– the NARVAL expeditions, Bulletin of the American Meteorological Society, (2019).