

## Report for DKRZ project bb1166 (Haerter)

Project: **1166**

Project title: **Cloud-cloud interaction in convective precipitation (INTERACTION) and DakE continuation**

Principal investigator: **Jan Haerter**

Report period: **2025-05-01 to 2026-04-30 (INTERACTION) [2024-07-01 to 2025-12-31 (DakE continuation)]**

All projects have evolved substantially but it is clear that additional resources are needed to conclude them. Substantial effort went into simulation trials focused on pairing observations taken during our METEOR cruise (tropical Atlantic) and the DakE field campaign (West Africa) with simulations. Publications are forthcoming but follow ups will be tackled using the resources requested.

We summarize the previous allocation period here.

*MCS in Europe.* As proposed, a suite of idealized midlatitude WRF simulations has already been carried out over Europe and the analysis is complete. Whereas useful as case studies, they also show that additional numerical experiments are needed to further draw a relation between cold pool induced clustering and temperature changes in mid-latitude MCS. Background: Da Silva and Haerter (May 2025), Nature Geoscience, revisits the question of a possible super-Clausius-Clapeyron (C-C) rate in extreme precipitation increases with temperature. It was shown that the statistical shift in rain type alone accounts for the observed super-C-C scaling rate, and when considered in isolation, both stratiform and convective precipitation extremes increase at the C-C rate—thus refuting hypothesis (1). MCS, which play a dominant role in generating precipitation extremes, do feature a super-C-C scaling rate because of a substantial increase in their convective fraction with dew point temperature above 14 °C. Analyses of intensity–duration–frequency curves show that extreme sub-hourly storms are the most strongly intensified with higher dew point temperatures.

During the past allocation period, we have already conducted two high-resolution case study simulations over the Great Hungarian Plain using the WRF model. Our results indicate that, to further investigate the role of cold pools, an additional set of sensitivity experiments in which rain re-evaporation is systematically modified (full, reduced, and suppressed) is needed.

*Sea surface temperature variation.* A suite of diuSST simulations (point 2 in previous allocation period) using SAM have been carried out over the past allocation period. These simulations give us insight into the coupling of the diuSST module with the SAM atmosphere. These simulations are currently being analyzed. Further simulations are needed to address the findings from the FreshAtlantic observational campaign (Atlantic Ocean, METEOR) as the corresponding observational results are just now being written up by the team. These will be supplemented by the additional simulations proposed in (2) in the current proposal, where we are addressing the coupling between small scale convection and the large-scale environment. The ERC Synergy grant, described in the previous proposal, is now envisioned to be submitted in Nov, 2026, with the team reorganized to place a stronger focus on coupled modeling.

*Machine-learning based nowcasting.* A machine-learning based nowcasting for Dakar, Senegal, has been developed using the WRF simulations (point 3 in previous allocation period) for West Africa from the previous allocation period, a publication is currently in preparation. These WRF simulations were paired with observational data from the DakE observational network east of Dakar - an activity my working group has been running since September 2023. We currently have a network of 20 automatic weather stations and >100 small measurement devices in the region and the nowcasting developed using the WRF simulations will likely improve forecasting abilities for the region. Furthermore, it will help better understand the monsoonal climate in West Africa. Some technical difficulties arose in the field, such as technical shortcomings with devices delivered by the vendor, such that the nowcasting is not published yet. In addition, to further develop the nowcasting robustness, additional simulation data is required from WRF, especially for time periods overlapping with our current observational measurements (2023-2026) but also for the years approaching 2023. Therefore, we are currently requesting additional resources to carry out these simulations.

Additional idealized monsoon simulations have been carried out (point 4 of previous allocation period) to address the diurnal cycle effect on the monsoon as well as the distinction between memory (hysteresis) and bi-stability effects in the global monsoon. To this end, in particular increasing the frequency of the annual cycle has been insightful. These simulations have already been analyzed and are currently being written up in a forthcoming paper.

## References (all within bb1166)

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