Geophysical Research Abstracts
Vol. 18, EGU2016-6538, 2016
EGU General Assembly 2016

Self-organization of convective clouds and extreme precipitation

Christopher Moseley (1), Cathy Hohenegger (1), Peter Berg (2), Jan Haerter (3,4)

(1) Max Planck Institute for Meteorology, Hamburg, Germany, (2) Hydrology Research Unit, Swedish Meteorological and Hydrological Institute, Norrköping, Sweden, (3) Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark, (4) Departamento de Física Fundamental, Universitat de Barcelona, Barcelona, Spain

The response of convective-type cloud and associated precipitation rates to temperature changes is far from clear. Observational studies have identified a strong sensitivity of convective precipitation extreme intensities to surface temperature — even exceeding the thermodynamic constraint through the Clausius-Clapayron relationship (Berg et al., Nature Geoscience, 2013). It has been speculated that such strong changes may result from dynamical changes of the atmospheric flow, whereby thermodynamic constraints could be bypassed. Indeed, convective cloud has long been suspected to self-organize or even aggregate, but whether and how such structural transitions relate to modified precipitation rates is largely unexplored.

Large-eddy simulations (LES) are a versatile tool suited for high-resolution numerical experiments of the convective cloud field. At horizontal resolutions on the scale of 100 m, they now allow 3d simulations of the moist atmospheric dynamics within domains of hundreds of kilometers laterally. Such simulations grant access to virtually all relevant observables. Using LES along with precipitation cell tracking, we isolate the effect of self-organization, quantify structural changes within the cloud field as a function of time and extract mechanisms that lead to increased convective precipitation intensities. We make contact to classical measures of large-scale convective potential, e.g. CAPE, CIN and moisture convergence, and contrast cloud-scale feedbacks to those previously implicated in quasi-equilibrium, large-scale, aggregation processes. Together, our results suggest that the build-up of extreme precipitation must ultimately be understood within a non-equilibrium framework. We relate our findings to current developments in global and regional climate modeling.