Scaling and aggregation in three-dimensional moist convection

Chris Howland*[1], Daniel Lecoanet[2], and Geoffrey K. Vallis[3]

[1]University College Dublin – Ireland
[2]Northwestern University – United States
[3]University of Exeter – United Kingdom

Abstract

Unlike in classical Rayleigh-Bénard convection, boundary conditions in the Earth's atmosphere typically impose a *stable* mean density stratification. Convection is instead driven by local internal heating due to the condensation of water vapour. We consider this process in the simple moist convection model named Rainy-Bénard, in which any condensed water is removed from the system on a rapid time scale to mimic precipitation. The asymmetry of the buoyancy driving in the model leads to a state of narrow, moist updrafts surrounded by wide regions of unsaturated air, as observed in previous studies of other moist convection systems. Through three-dimensional direct numerical simulations of the Rainy-Bénard system, we identify how a Rayleigh number based on the moist static energy controls the strength and spacing of the updrafts. We further analyse the process of self-aggregation in the system, which leads to the spontaneous breaking of azimuthal symmetry in large updrafts.

*Speaker