Large-scale structures in moist atmospheric convection

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Convection is an evergreen of nonlinear fluid dynamics, and it continues producing fascinating and unexpected behaviors. Under appropriate conditions, convective flows tend to form large-scale circulations, often associated with the formation of plume clusters. This problem has been studied in detail for Rayleigh-Benard convection [1-3], where plume clustering (but not merging) was observed at moderately high values of the Rayleigh number [4, 5]. When compressibility of the static state and constant radiative cooling are introduced, mimicking a sub-saturated atmosphere and generating a case of penetrative convection, plume clustering disappears [6]. When water phase transitions and precipitation are introduced, the situation changes again: one observes either an open cellular cloud field formation [7] associated with oscillating shallow convection, or the self-aggregation into a single, permanent cloud cell at the largest possible scale [8-11]. We explore the problem of plume clustering in moist convection by using the atmospheric model WRF, run at high resolution with different types of cloud microphysics, turbulence parameterizations and radiative-convective settings, and adopting a simplified horizontally doubly-periodic configuration with homogeneous vertical boundary conditions. Time allowing, we shall end with some general considerations on the ability of convective models such as WRF to reproduce observed precipitation when nested into large-scale reanalyses.

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