Using LES and observations to inform the representation of convective organization and memory in next-generation Earth System Models.

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The genesis and maintenance of spatial patterns in cumulus cloud populations have become intensely studied in recent years. This effort is motivated by the important role that organization plays in the coupling between convective clouds and the general circulation, in climate sensitivity, as well as in the grey zone problem in convective parameterization. Guided by this research, new conceptual modeling frameworks for capturing both organization and memory effects have been proposed, many of which take population dynamics into account. The nature of these new approaches creates unique data requirements for their calibration, training and evaluation. Where most previous model evaluation initiatives have focused on reproducing bulk statistical moments such as the mean and (co)variances, new schemes are required to also reproduce metrics reflecting spatial organization and convective memory. In this presentation we will briefly review the consequences of this development on how Large-Eddy Simulations (LES) and observations can be used for this purpose. As a practical example we will consider BiOMi (Binomials on Microgrids, https://doi.org/10.1029/2020MS002229), a newly formulated model to describe populations of interacting convective thermals as distributed over a two-dimensional Eulerian grid. Key elements include i) a fully discrete formulation based on a spatially-aware Bernoulli process, ii) object age-dependence for representing life-cycle effects, and iii) a prognostic number budget allowing for object interactions and movement. These features introduce convective memory and organization, but also optimize the computational efficiency of the framework. The BiOMi thermal population model is coupled to an EDMF parameterization and implemented in a primitive circulation model. First experiments for subtropical marine Trade wind conditions as observed during the RICO and EUREC4A field campaigns are discussed, including an evaluation against associated LES and observational datasets.Train a new convective population model against observations and LES to reproduce spatial patterns in convection.