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Advancing the representation of convection across scales (ARCS)

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In the future Numerical Weather Prediction (NWP) systems ought to be scale adaptive, allow seamless prediction from nowcasting to decadal predictions and entail stochastic elements to represent the non-deterministic aspects of the atmosphere. Fulfilling these requirements poses daunting challenges. Convection is a particularly difficult case as convection neither acts on a bounded portion of the energy spectrum nor in isolation.

The overall goal of this project is to better understand the prominent multi-scale forecast challenges associated with the simulation of convection, to improve the representation of convection across model resolutions through this better understanding, and to help train a generation of students in the use, interpretation and development of NWP models. Our premise is that by adopting a holistic view, one that encapsulates the coupling of convection with other components of the land-atmosphere system across a range of scales, substantial progress can be made in the understanding and prediction of convection.

The project's specific approach involves focusing on prototype problems that will be simulated at three main resolutions: large-eddy simulation (LES) resolution with grid spacing of O(200 m) and fully explicit convection, convection-permitting resolution of O(2 km) and partly explicit convection, and coarse resolution of O(10-20 km) with fully parameterized convection. Analysis of the simulations will focus on the interactions between convection and its environment, interactions that give raise to convective organization. The use of a hierarchy of model resolutions will further allow for the systematic development of a scale-adaptive and stochastic convective parameterization