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Exploring Physics-Dynamics Coupling in CAM Using Reduced Complexity Frameworks

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The use of idealized model configurations has had a long history in the understanding of the atmosphere. As global atmospheric models become more complex (i.e. higher resolution, shorter time steps, improved parameterizations, higher-order dynamics packages, more efficient grids), the use of idealized modeling for process studies remains as vital as ever. This work presents a hierarchy of reduced complexity testbeds that have been used to explore model sensitivities of precipitation processes at reduced computational expense. The role of physics dynamics coupling, in particular the choice of the coupling frequency, at high horizontal resolution and its impacts on circulations and precipitation processes are explored as they represent large uncertainties in current-generation global models. The National Center for Atmospheric Research's Community Atmosphere Model (CAM) is configured using the Spectral Element (SE) dynamical core in various configurations, including moist bubble, radiative-convective equilibrium and aquaplanet setups, to investigate the simulation of organized convection and precipitation at next-generation horizontal resolutions ($<$ 30 km grid spacing globally) for climate-scale modeling. Convection processes in CAM with the SE dynamical core are shown to be very sensitive to the choice of coupling frequency between the physics and the dynamical core, suggesting that smaller physics time steps are needed, particularly at high horizontal resolutions. Furthermore, the implementation of a quasi-equal area physics grid into CAM with the SE dynamical core is shown to improve some longstanding issues, such as grid imprinting, with the conventional coupling procedure, which is to evaluate the physics on the native cubed-sphere SE grid.