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Breaking the boundaries between the "physics" and "dynamics" development - what can we learn from the nu-FV3 running at the global 3-km resolution

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Traditionally, many atmospheric processes, which are too small-scale or complex to be explicitly resolved in a GCM, are represented by the physics parameterization. With increasing computing power, a well scalable dynamical core with non-hydrostatic capabilities can drive the GCMs into the "gray-zone" resolutions, and explicitly resolving specific physical processes is now possible. The FV3 group at the NOAA/Geophysical Fluid Dynamics laboratory is developing a new type of Global Cloud-Resolving Model (GCRM) based on an integrated dynamics-physics concept, in which several fast-acting physics (e.g., cloud microphysics) are incorporated into a new FV3 (Finite-Volume Dynamical Core on the Cubed-sphere) framework. This new modeling framework improves the dynamics-physics interaction and increases the overall computational efficiency due to the separation of the fast-acting physics from the slow-physics, allowing a near tenfold increase in overall time step. We have also built some of the SubGrid Orographically (SGO) forced processes into the new FV3 to allow SGO introduced effects to be propagated naturally by the dynamics. By breaking the traditional boundary between "dynamics" and "physics", the integrated dynamics-physics concept employs more straightforward physical laws and shows much better "scale-aware" properties.

A preliminary version of this new type of GCRM is used for the DYAMOND (DYnamics of the Atmospheric general circulation Modeled On Non-hydrostatic Domains) project. We have carried out several 40-day "convective-parameterization-free" experiments across the gray-zone at three different horizontal resolutions: 13, 6.5, and 3.25 km. As a potential tool for sub-seasonal predictions, we shall analyze the forecast skill (first 10 days) as well as the systematic "climate basis" for the last 30 days.