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Horizontal Diffusion in a Global Atmospheric Model with a Double Fourier Series (DFS) Dynamic Core

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This study describes the affect of horizontal diffusion in a global atmospheric model with a double Fourier series (DFS) dynamics. The DFS dynamical core that has been developed by Cheong is implemented into a version of the Natioinal Centers of Environmental Prediction (NCEP)'s global atmospheric spectral model, as an alternative dynamic option. The new dyanmical core with full physics has been evaluated against the NCEP's original dynamic core using the spherical harmonics (SPH), in therms of short-range forecast for a heavy rainfall event, and seasonal simulation frameworks. As a result, it reveals that the new dynamical core (DFS) does not exhibit discernible deficiencies in accuracy of the simulated climatology as well as in the forecast of a heavy rainfall event. Most importantly, the DFS algorithm guarantees the computational efficiency in the cluster computer by a factor of about 2 at T254 resolution, that is about 50 km, complying for a theoretical value computed from a dry primitive equation model framework.

It is, however, identified that horizontal diffusion for small scale phenomena is stronger in DFS than in SPH, which results in the suppression of kinetic energy at high-wave numbers and the reduction of local maximum in precipitation. This aspect can be regarded to be its characteristics of each dynamical core. Recognizing the fact that the SPH with smaller diffusion can be computationally stable since the zonal wave damping is introduced, additional use of numerical diffusion for DFS, as is implemented in SPH, may be necessary to reproduce the kinetic energy spectra similar to that in SPH. Therefore, horizontal diffusion is examined with vertically-different wavenumber truncation in vorticity, divergence, temperature, and specific humidity. It reveals that kinetic energy is strongly affected by the horizontal diffusion of vorticity and divergence. Further details will be discussed in the conference.