Review Reports: GMD-2023-087

"DCMIP2016: the tropical cyclone test case" Manuscript submitted to GMD by Willson et al..

Evaluating the effects of the dynamical cores coupled with ideal physical parameterization suite by using a ideal test case is an effective way in the scope of atmospheric model development. Reed-Jablonowski (RJ) tropical cyclone (TC) test case which was documented in DCMIP2016 that has been making significant contributions to the design of ideal numerical experiments for model dynamical core, is an idealized tool to study the impact of variable resolutions, physical parameterizations, and numerical method on the simulation and representation of tropical cyclone–like vortices in GCM. In the previous work, the impact of the physical parameterization suite like a dilute plume Convective Available Potential Energy (CAPE) calculation of deep convection on the evolution of an idealized tropical cyclone within the National Center for Atmospheric Research' s (NCAR) Community Atmosphere Model (CAM) (Reed and Jablonowski, 2011b) and of the initial-data, parameter and structural model uncertainty (Reed and Jablonowski, 2011c) have been explored.

In contrast, this manuscript describes and analyzes a tropical cyclone test case namely RJ-TC by comparing 9 models like ACME-A, CAM-SE, SCU, DYNMICO, FV^3, FVM, GEM, ICON and NICAM in which the used numerics include spectral element (SE), finite difference (FD), and finite volume (FV) and the spherical grids cover cubed sphere, geodesic, Octahehral, Yin-Yang and Icosahedral triangular native grids. This is a comprehensive comparison of RJ-TC simulation results in which evolution of minimum surface pressure and maximum 1 km azimuthally averaged wind speed, the wind-pressure relationship, radial profiles of wind speed and surface pressure, and wind composites and so on are conducted.

However, it should be noted that the resulting TC behaviors in the 9 model dynamical core coupled with the simple physics package are very different, for example, as Fig. 1, the evolution of MSP can be classified as three categories: a group of ACME-A, CAM-SE and FV^3, a group of FVM, GEM, CSU-CP/LZ, DYNAMICO and ICON, a special ICON. Similar situations such as azimuthally averaged vertical wind composite of TC happened in quantitative analysis. Unfortunately, the specific reasons for these differences in outputs are not further elaborated in the manuscript. It would be better if the differences of transport scheme, numerical discretization, artificial diffusion etc. in the corresponding dynamical core and nonlinear interaction of TC could be addressed in details.

In a whole, this manuscript gives comprehensive TC behaviors which provide a valuable library of solutions that serve as a benchmark for modeling groups. I recommend publishing this submission in GMD with the following concerns.

1. For completeness, suggest a table list that describes the simple physics package used in the TC test case. Some physical parameterizations could be addressed in the appendix.
2. If possible, give the detailed transformation formulation between pressure-based level and height level.
3. Due to the 9 model of comparison, it is recommended that the color selected for figures be able to make a significant difference. For instance, the dot colors of CSU-LZ and NICAM is very close in Fig. 2 and it is not easy to recognize them.
4. Please check list of symbol in the table 1. For instance, q_{Cl} and

q_{Cl2} seem to be redundant. If some symbols are not used in this manuscript, remove them.

5. Please explain the meaning of abbreviation of "CSU-CP" and "CSU-LZ" in Fig. 1.
6. The superscript of the formula of (4) are prone to ambiguity. Please correct it as $(\quad)^{g/(R_d\Gamma)}$.
7. In Line 472, the paper name of citation is not correct. Please correct it.