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A new version of GAMIL dynamical core for climate simulation

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The dynamical core solving geophysical fluid dynamics is the foundation of development of weather and climate models. It needs to fulfill some key prerequisites, e.g. total mass conservation, total energy conservation, which are vital for conducting long time climate simulation and even weather forecast. The quadratic-conservation finite difference methods developed at IAP has long history, which have been used in the construction of AGCMs and OGCMs. One of the AGCMs is GAMIL (Grid-point Atmospheric Model IAP/LASG), which can conserve the total effective energy exactly and has good simulation performance under 2.8/2.0 degree resolution, but it has some difficulties to increase the resolution further. The major obstacle is the polar numerical stability causing rapid decrease of time step size. In this study, we have tested new ways to improve the stability, and reimplemented the barotropic dynamical core of GAMIL. The modification on the calculation of zonal tendencies is within a limited area around Poles, e.g. 5 latitudes at 1-degree resolution, and preserve the antisymmetric property of spatial difference operators, so as to the quadratic-conservation property of the whole dynamical core. Several standard test cases are used to verify the new scheme under the barotropic model using Arakawa-C staggering. It turns out the time step size can be increased by 5-6 times, and the results are comparable with the original one. For Rossby-Haurwitz waves test, GAMIL can simulate the four-wave pattern to 100 days, and for the newly proposed linear shallow-water equation test with analytical solutions, GAMIL can simulate the Rossby waves propagate westly up to 4 years.