Design and implementation tests of dynamical core for a general circulation model with a flexible and portable source code

Yasuhiro Morikawa[1]; Masaki Ishiwatari[2]; Yoshiyuki O. Takahashi[3]; Masatsugu Odaka[1]; Yoshi-Yuki Hayashi[1]

[1] Earth and Planetary Sci., Hokkaido Univ.; [2] Graduate School of Environmental Earth Science, Hokkaido University; [3] Graduate School of Science, Hokkaido University

Aiming for an atmospheric general circulation model (GCM) with a flexible and readable source code, a dynamical core is newly designed and its implementation tests are performed. It is expected that high source code readability reduces various costs of changing and improving programs, and that high model flexibility enables us to separate and/or add some parts of the program easily. With the help of such a flexible GCM, numerical calculations under the conditions of various planetary atmospheres will be easily performed to advance consideration on their structures from the viewpoint of comparative planetary science.

The dynamical core is designed with referring to AGCM5 (SWAMP Project, 1998), promoting the advantageous use of the function of Fortran90. For increasing flexibility, the model interior is hierarchically structured by the use of module, derived-type, and the generic procedure, and so on. For improving readability, the naming rule of functions and variables used in SPMODEL library (Takehiro et al., 2004) are extended. Rules of declaring variables and initialization/termination of modules are introduced following the Meteorological Agency standard coding rule (Muroi, et al., 2002) and the Fortran90 coding rule (Balaji, 2002) of the Flexible Modeling System (FMS) by GFDL. As I/O data format and library, gtool4 netCDF convention (Toyoda et al., 2000) and gt4f90io (Morikawa et al., 2004) are adopted. Gt4f90io simplifies the I/O part of the source code and improves readability and flexibility. As an attempt for easy generation of the program document, comment sentences in the form of RD (Ruby Documentation Project, 2005) are inserted in the Fortran90 source code to generate documentation files with HTML format and TeX format from source code automatically. This documentation method prevents the document from being inconsistent with the source code and reduces the cost of documentation management.

The benchmark test of the GCM dynamical core of Held and Suarez (1994) is performed. The dynamical core is descretized in the horizontal direction by the spectral method with triangular truncation. For the vertical discretization, the scheme of Arakawa and Suarez (1983) is adopted. Explicit leapfrog scheme is used for time integration, and time filter of Asselin (1972) is used to suppress computational mode. According to the results of 1200 day integration with the horizontal resolutions of T21 and T42. it is confirmed that the Hadley circulation and mid-latitudinal disturbances are well expressed in both cases. The profile of zonal mean zonal wind averaged temporally from 200 to 1200 day obtained by the T42 experiment is similar to that of the T63 experiment of Held and Suarez (1994).

The next plan for our dynamical core is to incorporate the semi-implicit time integration scheme, and to improve the source code so as to alternate the vertical difference scheme easily. The dynamical core developed here is named DCPAM, Dennou-Club Planetary Atmosphere Model, and is provided at http://www.gfd-dennou.org/arch/dcpam.

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