

§56. Development of Non-Hydrostatic Ocean Circulation Simulation Code

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We have been developing non-hydrostatic coupled atmosphere-ocean model on the Earth Simulator. As oceanic component of the coupled model with high resolution, we adopted Yin-Yang grid system, which have developed Solid Earth Simulation Group of the Earth Simulator Center, as well as non-hydrostatic atmosphere component. Yin-Yang grid system is one of the overset grid which combines two identical latitude longitude grids.(Fig.1.) The unique feature of our ocean model to date is introduction of tide and momentum and thermodynamic equations for an compressible Boussinesq fluid.

In this report, as the first step of our developing, we show preliminary validation results of propagation of internal gravity wave and equatorial Kelvin/Rossby waves. We use hydrostatic Boussinesq equation systems as follows.

$$\frac{\partial f}{\partial t} = -\nabla \cdot (vf) - \nabla P + \rho g + 2f \times \Omega + \nu_H \Delta_H v$$

$$\frac{Dc}{Dt} = \nu_H \Delta_H c \quad \frac{DT}{Dt} = \nu_H \Delta_H T$$

$$P = \int_{-H}^z -\rho g dr \quad v_r = \int_a^0 \nabla \cdot_H v dr \quad f = \rho v$$

$$g = -\frac{90}{r^2} r \quad \rho = \rho(c, T, P)$$

We configure the salinity anomaly as an initial fluctuations. Radius of salinity anomaly about 3000km and depth is 500m. We perform simulation with horizontal resolution 260km and vertical resolution 100m. The simulation area is the rectangular area which width 45° of latitude direction, width 120° of longitude direction.

Fig.2. shows the propagation of the internal gravity wave. The propagation of initial fluctuation is understand. This propagation velocity is 4 (m/s).This is valid as a speed of the internal gravity. (Depth of the sea is 4km.)

Fig.3. presents the propagation of the equatorial Kelvin wave. The equatorial Kelvin wave which is spread to west is seen. In addition, propagation of the Rossby wave to east direction is seen. These propagation velocity is valid as a speed of the Kelvin/Rossby waves.

For verification of the simulation code, we have performed that the initial fluctuation keeps being spread as internal gravity wave and equatorial Kelvin/Rossby waves.

In the future, we will verify global non-hydro-static simulation result which considers realistic topography and Mellor-Yamada and Smagorinsky turbulent models which have already been introduced. In addition, we will study the impact of Constrained Interpolation Profile-Conservative Semi Lagrangian with Rational function (CIP-CSLR) scheme introduced our simulation code as a new.

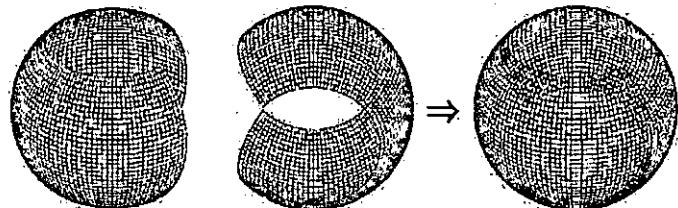


Fig. 1. Yin-Yang grid system. This grid system is one of the overset grid which combines two identical latitude longitude grids.

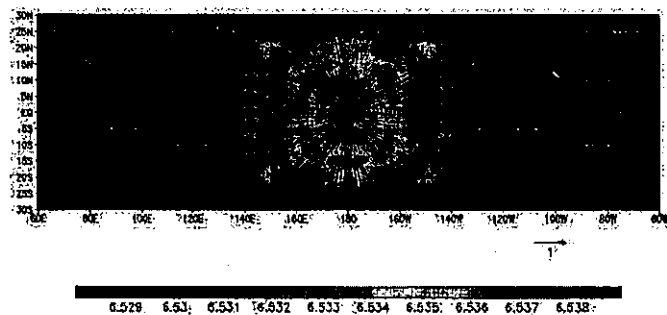


Fig. 2. Propagation of internal gravity wave.(t=10days)

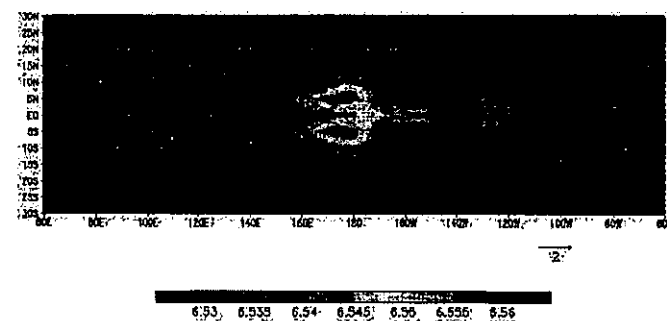


Fig. 3. Propagation of equatorial Kelvin/Rossby waves.(t=15days)

References

- 1) Kageyama, A., Sato, T., 2003, to be published *Geochem.Geophys.Geosyst.*, E-print: physics/0403123.
- 2) Matsuno, T., 1966, *J. meteor. Soc. Japan*, 44, 25-42