Special Program in Applied Mathematics and Applied Mechanics

EHTW Earth System Model - A fully integrated OAGCM without traditional coupler

2013 - 10 - 02 (Wed.)
15:00 - 18:00
308, Mathematics Research Center Building (ori. New Math. Bldg.)

Taiwanese scientists have integrated an atmosphere-ocean coupled model (named as ECHAM/SIT/TIMCOM or EHTW Earth System Model), recently. This ESM model has been used for present climate simulation, future climate simulation, hindcast and 45-d forecast. Further development will be focused on extended forecast (> 7 d). Various ways for handling the bottom boundaries (ocean, ice and land) of the atmosphere will be explored.

The major significant model development in our current implementation is its inclusion of SIT solver (Tsuang et al., 2001). SIT denotes for Snow/Ice/Thermocline solver. The solver has improved ocean cool-skin and warm-layer simulations (Tu and Tsuang 2005) and has better formulation for SST effective thickness (Tsuang et al., 2009), and has been applied for Caspian Sea SST and ice simulation (Tsuang et al., 2001), TOGA Core SST simulation (Tu and Tsuang 2005) and South China Sea SST simulation (Lan et al., 2010). SIT solves the vertical heat diffusion equation for temperatures in snow, ice and water column in a tri-diagonal matrix. This solver is numerically unconditional stable. Hence, melting and refreeze of a thin sea ice, as well as the warm layer and the cool skin in the upper few meters of a water column can be resolved. This can give a unique surface diurnal cycle of ocean within the climate models. Only a few climate models have explored the importance of diurnal cycle. Second, our AGCM and OGCM coupling frequency is every AGCM time step. This is unique and to the best of our knowledge, no other climate model has used this approach because it is too expensive. The ECHAM/SIT/TIMCOM does not use any specific coupler while the OGCM is directly coupled with AGCM through SIT. So, the daily cycle of the ocean surface can easily be resolved. Finally, we don’t use any fancy interpolation scheme while our ocean grid collocates with the

atmospheric grid (or its subdivision equally). So this guarantees the surface fluxes are conserved without using any specific technique. These are the superior points of the current model architecture.

We should note that SIT is not only a pseudo atmosphere-ocean coupler but also a “simplified” 1-D ocean model which can have very high resolution in the ocean top 10 m. The average of 0-10m SIT result is then feeding into the ocean model as the OGCM boundary condition. Since it is a simplified 1-D ocean model, SIT can do more than a coupler. Our coupled simulation shall have some characteristics resolving high frequency atmospheric-oceanic dynamics. With this representation of OAGCM, it is found that many new features are well simulated such as diurnal variation of SST, Madden-Julian Oscillation (MJO), and ENSO, comparing to those of CMIP models.