Lessons learned from the use of the Earth Simulator ---development of a climate model---

Seita Emori[1]

[1] Frontier Research System for Global Change

I have been using the Earth Simulator (ES) since last July to perform the subject 'Research on the Climate Change Projection using a High-Resolution Atmosphere-Ocean Model' (directed by Prof. Sumi of CCSR, Univ. of Tokyo), a part of 'Research Project for Sustainable Coexistence of Human, Nature and the Earth' promoted by MEXT.

For the climate change projection, which we are aiming at, ensembles of various validation and scenario experiments, totaled thousands of years, should be performed in a limited period (2 to 3 years). We have thus targeted that a 100-year integration should be finished in one month. Since our spectral atmospheric model (CCSR/NIES AGCM) is parallelized with MPI in single dimension both in spectral and grid spaces, the maximum number of parallelized portion is limited, where the limit is proportional to the horizontal resolution. On the other hand, the calculation amount is proportional to the cubic of the horizontal resolution, resulting in that the model speed is reduced proportional to the square of the horizontal resolution. The resolution of the atmospheric model is determined according to this limit. The use of task-parallelization may relax the limit. Since our ocean model (COCO) is a grid model with longitude-latitude coordinate, we have rotated the model grid system so that the model North Pole is placed in Greenland to avoid the concentration of longitudinal grids around the North Pole. A coupler to properly transfer fluxes between the rotated ocean and the non-rotated atmosphere has also been developed. The thus determined specification of the coupled ocean atmosphere model is as follows:

Atmosphere: T106 (~1.1 deg), 56 levels, 80 processors(10 nodes)
Ocean: 0.28 deg x 0.19 deg, 48 levels, 608 processors(76 nodes)
The total of 86 nodes is only 13% of the whole resources of the ES.

At present, the development of the coupled model is completed and the test calculation is being performed. The atmospheric model can reproduce tropical disturbances and Baiu front, while the ocean model can reproduce meso-scale eddies. They are substantial progress from the previous models. However, the ES is clearly not the best system for a long-term calculations like ours. Short-term calculations with the whole resources of the ES could bring out more advantages of the ES.