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A time-slice global warming experiment with super high resolution global and regional climate models on the Earth Simulator

A. Noda (1), M. Yoshizaki (1), S. Kusunoki (1) and Kyousei-4 Modeling Group (1,2)

(1) Meteorological Research Institute, Tsukuba, Japan (noda@mri-jma.go.jp)

(2) Advanced Earth Science & Technology Organization/MRI, Tsukuba, Japan

Project

The Meteorological Research Institute (MRI), the Japan Meteorological Agency (JMA) and Advanced Earth Science and Technology Organization (AESTO) are co-operatively conducting a five-year research project "Development of super high resolution global and regional climate models" funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

The purpose of the project is to develop a global atmospheric general circulation model (AGCM) with a horizontal resolution of 20 km, and a cloud-resolving non-hydrostatic regional model (NHM) with a horizontal resolution of a few km in order to investigate the effects of global warming on typhoons (tropical cyclones), Baiu front and meso-scale phenomena such as heavy rainfall and heavy snowfall.

We have developed proto-type models and performed a time-slice experiment on the Earth Simulator. Some interesting results will be presented by referring to the regional climate change in Europe.

Time-Slice Experiment

In the time-slice experiment, observed climatological sea surface temperatures (SSTs) (1982-1993, 12 year mean) were used for the present climate simulation. The SST

change from the present (1979-1998, 20 year mean) to the future (2080- 2099, 20 year mean) was obtained from a climate change simulation with a coupled atmosphere-ocean GCM, the MRI-CGCM2.3, for the IPCC SRES A1B emission scenario and its values were added to the observed SSTs for the warm climate simulation. The AGCM has been run for each ten-year period using the SSTs as lower boundary conditions. Then the NHM has been nested to the AGCM in June and July for each ten-year simulation.

Results

In the warm climate, precipitation over Western Japan, East China Sea, Yangtze River Basin of China increases in July. In contrast, decrease of precipitation is found over Northern Japan, Korean Peninsula and northern part of China. The Baiu front is likely to stay over Southern Japan and does not move northward even at the end of July in the warm climate.

The NHM confirms these features in finer scales. The rain amounts increase by 30% in Southern Japan (Kyushu) specifically and the frequency of heavy rainfall also increases in the warm climate.

On the other hand, the frequency of tropical cyclones (TCs) decreases by 30% globally at the end of the 21st century although the probability density of the stronger maximum wind speed increases.

Changes in extreme events related with surface air temperature and precipitation have been globally estimated in 20 km horizontal resolution.