Program for Projection Modeling and Climate Change Study

Major Research Results

Since its relocation to Tsukuba in 1980, the Meteorological Research Institute (MRI) of JMA has promoted climate modeling, contributing to the past Intergovernmental Panel on Climate Change (IPCC) assessments. Since its establishment in 1991, the Center for Climate System Research (CCSR) at the University of Tokyo has also pursued climate modeling jointly with NIES, reflecting their outcomes in the Third Assessment Report (TAR) of IPCC (2001). Results from MRI and CCSR/NIES global climate models are shown in Fig. 7. The models have different climate sensitivities but similar spatial response patterns.

To obtain regional-scale information (i.e., downscaling), regional climate models have been developed at MRI, NIES and the Central Research Institute of Electric Power Industry (CRIEPI). Figure 8 displays winter precipitation over and around Japan calculated by three models. Despite differences among the models, regional characteristics, e.g. heavy precipitation in the Japan Sea side, are reproduced better by all regional models than by global models.

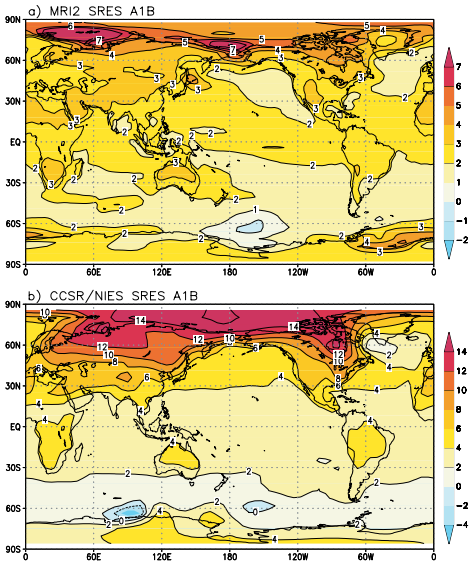

Fig. 7. Change in annual mean surface air temperature for the SRES (the IPCC Special Report on Emission Scenario) scenario A1B for the period 2071 to 2100, relative to the period 1961 to 1990 as simulated by the MRI model (top) and the CCSR/NIES model (bottom). The colors differ between them.

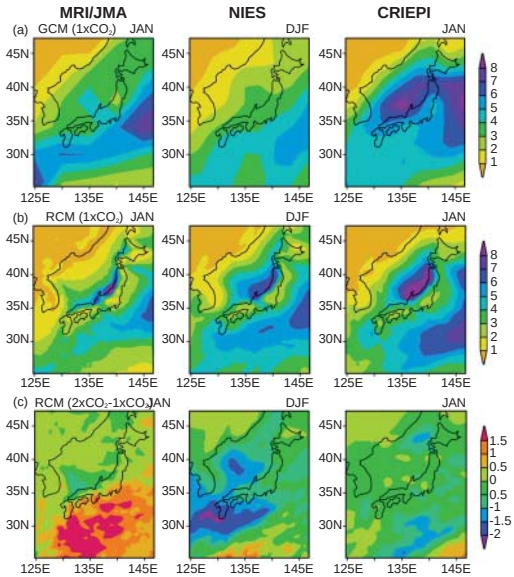

Fig. 8. Daily mean precipitation (mm/day) in winter simulated by global climate models (top) and regional climate models (middle), and the change due to CO_2 doubling simulated by the regional models (bottom). The results differ by research center (left, MRI/JMA; middle, NIES; right, CRIEPI).

Future Research Directions

The following are possible future modeling directions under the new situation with rapid progress in advanced computational ability.

- ✔ Increase horizontal and vertical resolutions within the framework of existing models.
- ✔ Develop new models by resolving the current parameterized small-scale phenomena or structure with much higher resolutions beyond the limits of existing models.
- ✔ Deal with model parameterization of physical processes in greater detail or more precisely.
- ✔ Other challenges, such as developing a new integrated model for the Earth environment for simulating the carbon cycle.

Along these directions, making use of the most advanced super-computer, the Earth Simulator made available in 2002, an ambitious “Project on Sustainable Co-existence of Human, Nature and the Earth” was launched in the same year by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). The five-year Project includes global projection studies expected to contribute to the Fourth Assessment Report of IPCC (AR4) as follows:

- ✔ High-resolution climate modeling and climate-change projection under the IPCC scenarios being conducted jointly by CCSR, NIES and the Frontier Research System for Global Change (FRSGC).
- ✔ Climate-change projection for long-term stabilization scenarios using the National Center for Atmospheric Research (NCAR) model by CRIEPI.
- ✔ Super-high resolution global climate change projection focusing on tropical cyclone, Baiu front, and also cloud resolvable regional modeling focusing on extreme events, e.g. severe rain storms by MRI and JMA (Fig. 9).
- ✔ Integrated Earth system modeling for projecting Earth environment change, introducing carbon cycle, atmospheric chemistry, and an ecosystem change into climate models by FRSGC.

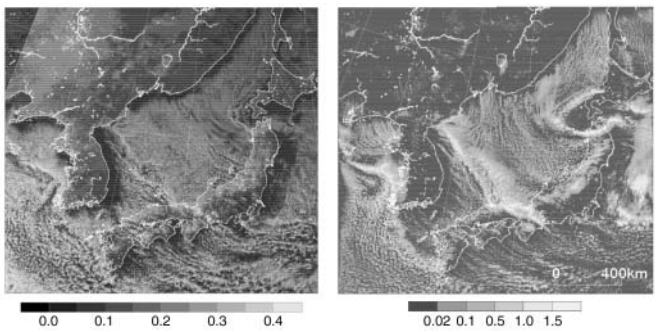

Fig. 9. The cold outbreak over the Japan Sea observed by Geostationary Meteorological Satellite - 5 (GMS-5) (visible image; left) and simulated by an MRI 1km-mesh non-hydrostatic model (total water path; right).