

Development of a 20 km mesh global NWP model on the Earth Simulator

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1) Introduction

The Japan Meteorological Agency (JMA) has been operating a MPI parallel version of a T213L40 global spectral model (GSM) which corresponds to a 60 km mesh model. GSM supports the official one-week forecast and provides the lateral boundary condition for the JMA Regional models. In order to provide finer scale forecast, we are developing a very high resolution GSM which corresponds to a 20 km mesh global model.

In the summer of 2002, the researcher groups of the Numerical Prediction Division (NPD/JMA) and the Meteorological Research Institute (MRI) got computer accounts from the Earth Simulator Center to study the global warming with super high resolution atmospheric models on the world fastest supercomputer "Earth Simulator" (ES).

The global modeling groups of NPD/JMA and the Climate Research Department of MRI have developed a new global model which is called "JMA-MRI unified global model". The features of this model are Fortran90 coding style, a new semi-Lagrangian scheme and some new physical schemes. We are testing this new model as the next JMA operational global model (TL319L40). We are also trying to execute a very high resolution global model such as TL1023L40 20 km mesh model on the ES.

2) Development on the ES

The ES is the world's fastest supercomputer. Its peak performance is 40Tflops. The ES is a distributed memory parallel computer system which consists of 640 processor nodes. Each processor node is a shared memory system which contains 8 vector processors. Its operating system software and compilers are almost same as NEC-SX series supercomputers. The MPI library is used for inter-node parallelization, and microtasking, which is shared memory parallel programming, is used for intra-node parallelization in our global model. In order to get a high performance, it is necessary to make some program tuning both for vector processing and for microtasking. Automatic vectorization and parallelization are applied by the Fortran90 compiler, but we need to rewrite some codes and/or insert some directive lines manually for full optimization. Current performance of our global model is 18% of the peak performance.

3) 20km mesh global model

Several experimental runs of T682L40 20km mesh global model was executed on the JMA supercomputer system (Hitachi SR8000E1). We have been trying to run TL1023L40 semi-Lagrangian 20km mesh global model on the ES. The horizontal grid space of TL1023L40 is 2048x1024. The elapse time of 1 day forecast is about 2 hours on 8 nodes of the ES. We are trying to execute the TL1023L40 model on 100-200 nodes. Figure 1 shows a forecast example of TL1023L40. The spiral cloud patterns around typhoons and the small scale clouds on the Tibetan plateau are well simulated in the TL1023L40 20 km mesh model.

4) Future plans

We will continue to optimize the JMA-MRI unified global model to get the best performance on the ES. The JMA operational global model will change to TL319L40 semi-Lagrangian model in 2003. It is expected that the semi-Lagrangian GSM which corresponds to 20 km mesh resolution will be executed on the next JMA supercomputer system in 2006.

TL1023L40 Typhoon forecast (09 Jul 2002 00UTC, FT=24, GMS-IR forecast images)

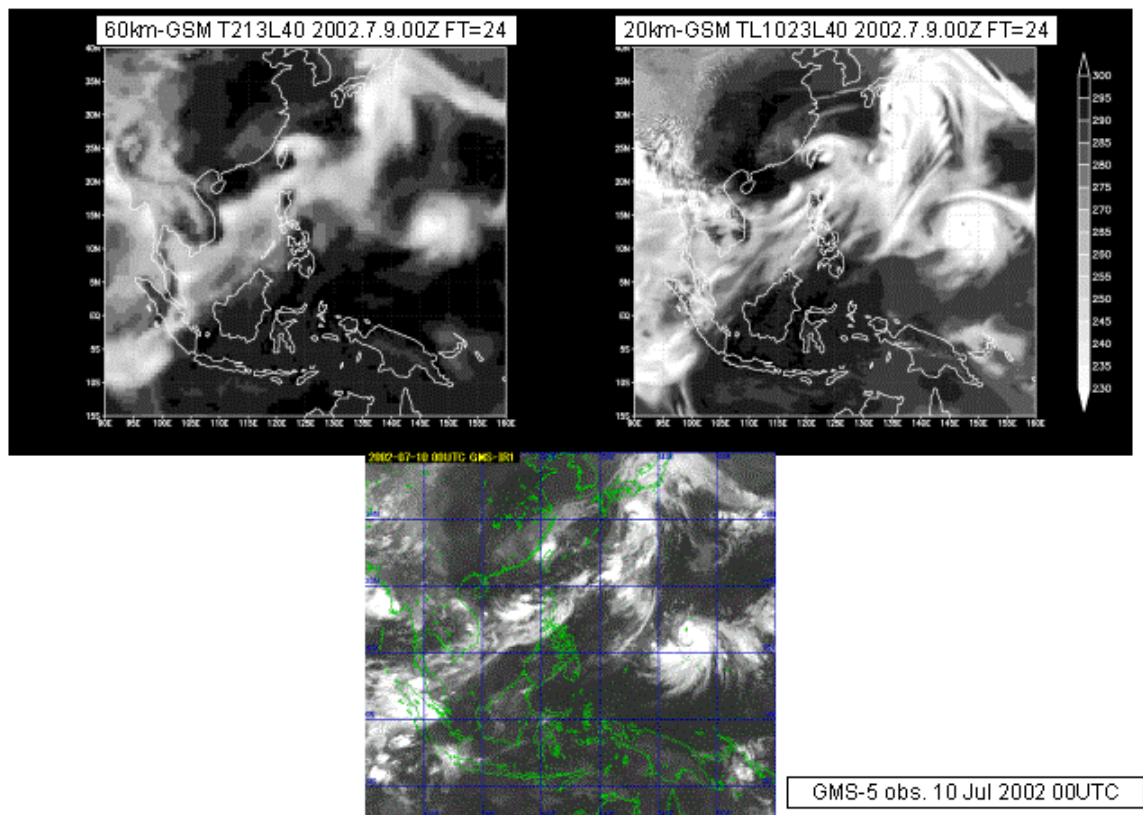


Fig.1 Forecast cloud images of T213L40 (upper left), TL1023L40 (upper right) and observation by GMS-5 (lower).