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

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1) Introduction

The global modeling groups of NPD/JMA and the Climate Research Department of MRI/JMA have been developing a very high resolution global model GSM-TL959L60 on the Earth Simulator (ES) (Katayama et al., 2003). The GSM-TL959L60 is a 20 km mesh global spectral model and adopts a new semi-Lagrangian scheme (Yoshimura et al., 2003).

We have optimized the model on the ES, and the execution time of 1-month forecast is about 3.5 hours using 60 nodes of the ES. We have executed several experiments of short range (3-5 days) and long range (1-2 years) forecasts, and the various meteorological phenomena such as typhoons and the Baiu fronts were well reproduced.

We will improve the computational performance and the physical parameterizations of the model in 2004. The GSM-TL959L60 will become operational on the next JMA supercomputer system in 2007.

2) Computational performance

We have optimized the model on the ES. Especially, the Legendre transform is well optimized with the vectorized matrix library. The message passing among the parallel nodes is also well optimized with the one-sided communication of MPI-2. Figure 1 shows a scalability of the GSM-TL959L60 on the ES. The computational performance of parallel calculation is very well from 12 nodes to 60 nodes. The computing efficiency with 60 nodes of the ES is about 35% of the peak performance.
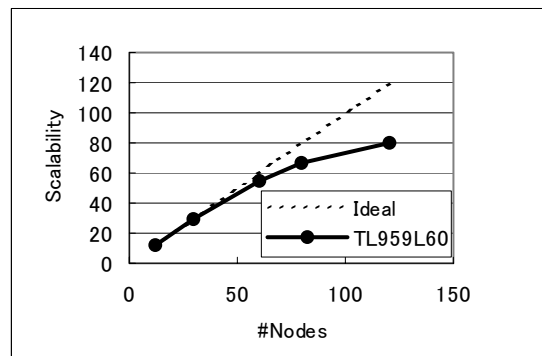

Fig.1 Scalability performance of the GSM-TL959L60 on the ES.

3) Forecast example of low temperature at Tokyo

It was a very cold summer in the eastern part of Japan in 2003. The surface temperature at Tokyo was very low in August 2003. It was not forecasted well with the operational NWP models.

We executed the forecast experiment with the initial field at that time. Figures 2 and 3 show the 5-days forecasts by the operational GSM-T213L40 and the GSM-TL959L60 on the ES. The low temperature at Tokyo was well reproduced in the 20 km mesh GSM-TL959L60. The GSM-TL959L60 also reproduced the blocking pattern in the east of Japan at 500 hPa height.

References

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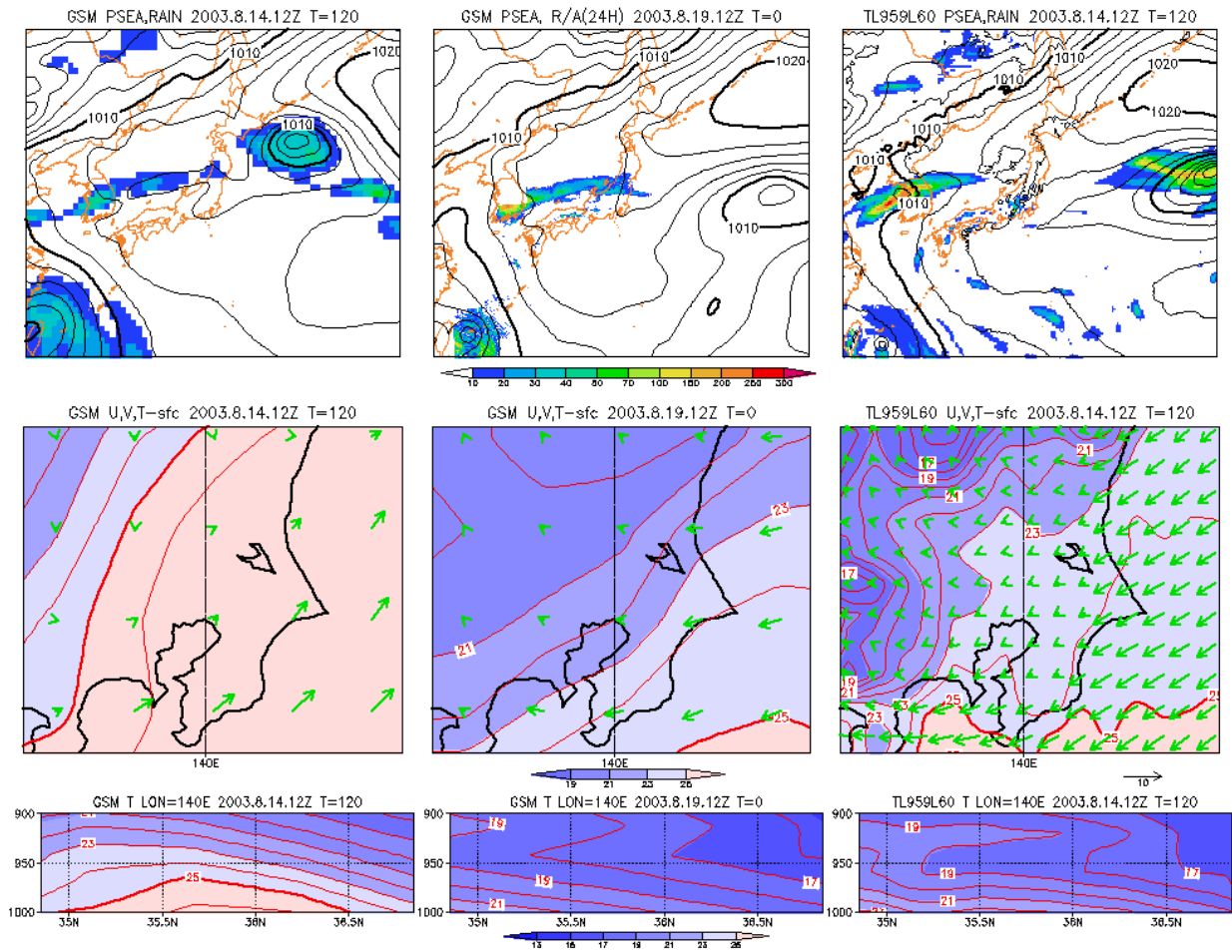
Fig.2 Forecast example of low temperature at Tokyo. GSM-T213L40 (left), global analysis and radar observation by JMA (center), GSM-TL959L60 (right). Psea and 24 hours precipitation (upper), surface temperature and wind (middle), vertical profile of temperature field in the lower atmosphere along 140E (lower).
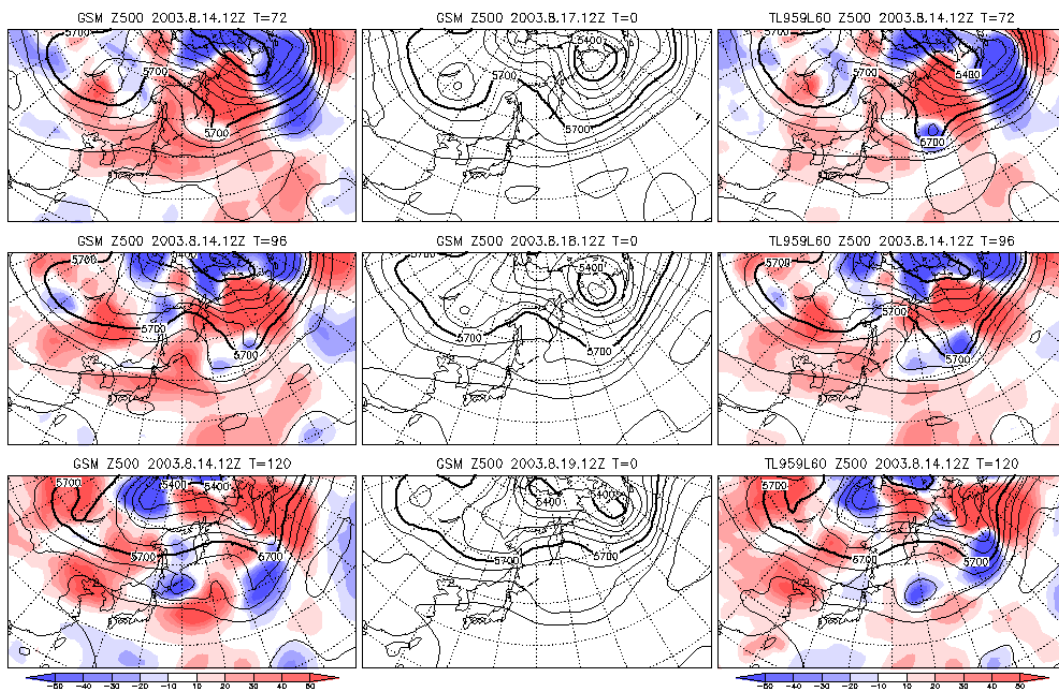

Fig.3 Forecasts of 500 hPa height field. GSM-T213L40 (left), global analysis (center), GSM-TL959L60 (right). Forecast times are 72 (upper), 96 (middle), and 120 hours (lower).