Development of nonhydrostatic model and next generation NWP at JMA

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Japan has long history of developing nonhydrostatic models. The first efforts to develop cloud model were started in 1970s by Takeda (1971), Takahashi (1975), Yamasaki (1975) and others. In 1980s, several nonhydrostatic models were developed in the Meteorological Research Institute (MRI) and the Japan Meteorological Agency (JMA). Among others, a nonhydrostatic model developed at the Forecast Research Department of MRI (MRI-NHM; Ikawa and Saito, 1991; Saito and Kato, 1996) was comprehensively documented and used as a research tool in 1990s. For its basic equations, fully compressible equations including a map factor (Saito, 1997) replaced the original anelastic equations, where the linearlization using the reference atmosphere was removed.

In NPD, another nonhydrostatic model was developed, and its numerics was reported by Muroi (1998). The two modeling centers agreed to unify the two models, and a joint work was started in 1999. The first version of the unified model, 'MRI/NPD-NHM' was completed in 2001.

Code parallelization of MRI/NPD-NHM to cope with the distributed memory parallel computers has also been performed since 1999. A parallel version of MRI/NPD-NHM was developed for this purpose. Since 2001, its extension, 'NHM', has been under development in JMA. This model is a community model for operation and research.

Development of NHM on the Earth Simulator (ES) has been performed in 2002. Main purpose is to study the change of local climate due to the global warming, while the result of the research is useful to develop a mesoscale model in the next generation NWP system.

The numerical assimilation and prediction system of JMA was fully replaced in March 2001. As for the short range NWP, operational run of a 10 km horizontal resolution mesoscale NWP model was started. The model, Meso Scale Model (MSM) covers full domain of Japan and its surrounding areas (3600 km x 2880 km) with 40 layers, and is run 4 times a day aiming at the prediction of heavy rain and disaster prevention. A newly developed mesoscale 4D-Var data assimilation has been implemented since March 2002.

JMA will replace MSM with NHM in 2004. The cloud microphysics and convective parameterization scheme of NHM have been refined for the 10 km horizontal resolution run. The split-explicit time integration scheme has been also refined to improve the computational robustness (Saito, 2002).

JMA is planning to upgrade the operational computer system in 2006. Horizontal resolution of NHM will be improved to 5 km and NHM will be run 3-hourly. A new nonhydrostatic variational data assimilation system (JNoVA) is also under development.