The impact of 1D+4DVAR assimilation of radar reflectivity in JNoVA

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1. Introduction

Japan Meteorological Agency has been operating a four-dimensional variational (4DVAR) data assimilation system (JNoVA; JMA non-hydrostatic model based variational data assimilation system) for operational meso-scale model (MSM). The main purpose of the MSM is support to provide the information of disaster prevention. We have been developing the assimilation system to give an initial condition of the MSM, especially targeting water vapor for improvement of the very-short-range precipitation forecast. New assimilation approach using radar data, 1D+4DVAR, leads to more improvement of the initial condition.

2. 1D+4DVAR

The cloud microphysics process of MSM is 3-ice 1-moment bulk microphysics parameterization (1-BMP) scheme. The hydrometeors diameter depends on a mixing ratio of each hydrometeor in 1-BMP scheme. The radar reflectivity factor is described as the sixth moment of the hydrometeors size-distribution. Then the assimilation of reflectivity data has to provide modification of the hydrometeor contents, but it also is difficult problem to treat balance between hydrometeor and momentum. To reduce the difficulty of problem, new approach dose not direct assimilate reflectivity. A 1-D retrieval is to estimate the relative humidity as pseudo observation from the radar reflectivity (Caumont et al., 2010). The combination of the 1-D retrieval and the JNoVA is called 1D+4DVAR. The observation operator of 1-D retrieval for reflectivity is a radar simulator developed in JMA. The radar simulator represents the beam bending by refraction index, the precipitation attenuation and the topographical blockage. The retrieval method of relative humidity follows the algorithm based on the Bayesian inversion (Olson 1996) using simulated reflectivity, and the retrieved relative humidity is assimilated in JNoVA.

3. Sensitivity test and summary

The sediment disaster event caused by heavy rain occurred on 24 Jul 2009 in YAMAGUCHI prefecture. The sensitivity experiment has been done in this case. The experiment configuration is that radar reflectivity is not used in the control experiment (CNTL), and used in the test experiment (TEST). The precipitation forecast of CNTL gives good representation, but it is not enough to represent the distribution and peak of precipitation (Fig.1a). The new indirect assimilation of radar reflectivity makes up for this insufficiency to provide the better forecast in TEST (Fig.1b). This is because the environment in the initial condition for the hydrometeor is improved by the application of new approach.

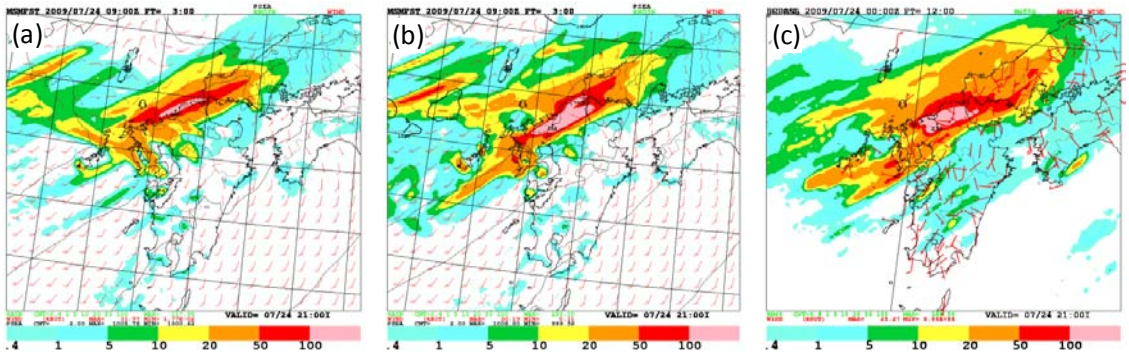

Fig. 1. Three-hour accumulated precipitation on 24 Jul 2009 1200UTC: three-hour forecast from initial condition by (a) CNTL and (b) TEST: (c) observation.

References

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