

Verification of solid precipitation using radar simulator for JMA nonhydrostatic model

Yasutaka Ikuta

Numerical Prediction Division, Japan Meteorological Agency,
1-3-4, Otemachi, Chiyoda-ku, Tokyo 100-8122, Japan

We are developing a volume verification method of three-dimensional distribution of liquid or solid water particles for the operational non-hydrostatic meso-scale model (MSM) at the Japan Meteorological Agency (JMA). The volume verification helps us understand the forecast characteristic of hydrometeors. It also contributes to providing information for an airplane safety operation and disaster prevention through the improvement in the representation of hydrometeors distribution.

The volume verification method makes use of a radar simulator. This radar simulator provides an equivalent reflectivity factor Z_e , Doppler velocity V_r and beam-path position. The Z_e was computed from the size-distribution of precipitation particles on beam-path through the geometry of the pointing angle of the virtual antenna in the MSM forecast. The V_r was calculated from the air motion and the mass-weighted terminal velocity of precipitation on that beam-path. The beam-path was calculated from a refractive index of reproduced atmosphere and the curvature of the earth. The estimates of position by simulated beam-path provide the plan position indicator (PPI) for each elevation from the MSM forecast. The PPI make it possible to compare the forecast with the radar observation, because the observed beam-path has uncertainty of three-dimensional position. The precipitation particles on beam-path were three types of precipitating hydrometeors which is rainwater, snow and graupel. Those size-distributions were diagnosed by the one-moment scheme of bulk microphysics parameterization, similar to the scheme of the MSM.

In order to compare these simulated elements, we have applied a Fractions Skill Score (FSS) approach (Roberts and Lean, 2008) to the volume verification. The FSS is

one of the several fuzzy verification methods of relaxing requirement of perfect time-space matching. These methods are more appropriate to estimate displacement error than traditional verification approaches.

A case study on 7 February 2008 was made using the radar simulator for the demonstration of volume verification. Figure 1 shows a comparison between the simulated Z_e and the observation, and the value of its FSS. For absolute threshold 20 dBZ FSS had been under the target skill, because the frequency bias is large. In contrast, for 99th percentile threshold (localized reflectivity) FSS became larger than the target skill in the large spatial scale. The forecast of such score can be regarded as a useful forecast, if the displacement error comparable to the spatial scale has been permitted. As a result of study, it turned out that the MSM forecasts weak reflectivity widely in a snowfall region. However, this wide spread representation of weak reflectivity was improved by inclusion of a prognostic equation for number concentration of snow particles into the two-moment experimentally. Additionally, it was indispensable to consider the displacement error in verification of the high reflectivity.

We conclude that it is expected that volume verification using the radar simulator and FSS approach will enable quantitative comparison of three-dimensional precipitation particle distribution.

References

Roberts, N.M. and H.W. Lean, 2008: Scale-selective verification of rainfall accumulations from high-resolution forecasts of convective events. *Mon. Wea. Rev.*, **136**, 78-97.

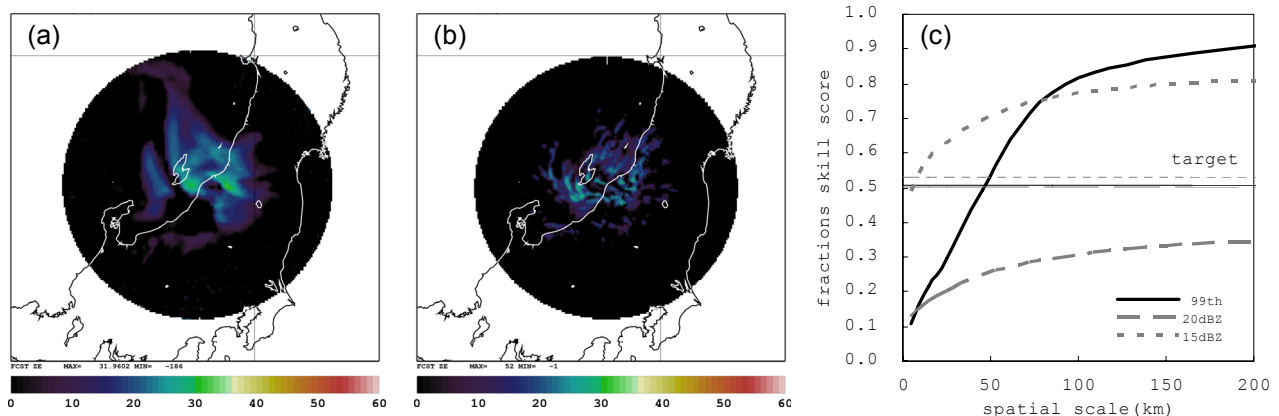


Fig. 1. Equivalent Reflectivity factor (dBZ) of the 0.0° elevation for (a) the radar simulator and (b) the observation at 0600 UTC 7 February 2008. The center of the map shown is the Niigata radar operating by JMA, and (c) FSS is computed from comparison between (a) and (b).