Fuzzy Verification of Hydrometeors in a High-resolution Model Using a Radar Simulator

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The Japan Meteorological Agency (JMA) has been developing a local analysis-forecast system called the Local Forecast Model (LFM) with a horizontal resolution of 2 km to enhance information for disaster prevention and aviation forecasts. The LFM is composed of the NHM (Saito et al., 2006) as a forecast model and a rapid update cycle based on the 3D-Var version of JNoVA (Honda et al., 2005) as the local analysis system. One of its most important products is a very-short range quantitative precipitation forecast (VSRF). The LFM employs only a cloud microphysics scheme without convective parameterization in the moist process. Accordingly, accuracy improvement for forecast hydrometeors in cloud microphysics is expected to improve VSRF. However, no regularly observed hydrometeor data are available as reference values to verify the three-dimensional distribution of forecast hydrometeors. Therefore, simulated radar reflectivity using model-predicted hydrometeors are evaluated against observed radar reflectivity data. To simulate radar reflectivity, we developed a radar simulator following Caumont and Coauthors (2006). In addition, the fractions skill score (FSS) (Roberts and Lean, 2008) is adopted as a statistical metric to mitigate the well-known problems in high-resolution verification caused by displacement error.

As cloud microphysics for the NHM in the LFM, one-moment and two-moment schemes of bulk microphysical parameterization (BMP) are currently being tested. The experiments using one-moment and two-moment BMP are referred to as BMP-1 and BMP-2, respectively. Figure 1 shows the FSSs of the simulated reflectivity for BMP-1 and BMP-2. The FSSs of BMP-2 are larger than those of BMP-1 within a 30-dBZ threshold (Figure 1 (a)), and the middle-elevation (1.4° – 3.0°) scores are better than other elevation scores in a spatial scale larger than 40 km. However, the percentile FSSs at a high elevation are larger than those at a low elevation (Figure 1 (b)) because the detectable range permitting verification of the reflectivity peak represented by the percentile is limited at high elevations. Figure 2 shows that the FSS target skill could detect BMP-2 as a good forecast with a large threshold and a wide spatial scale, but the BMP-2 score at low elevation (0.0°) became slightly worse than that of BMP-1.

Verification using the FSS applied to simulated radar reflectivity reveals the characteristics of the elevation dependency of one-moment and two-moment BMP. This verification method is therefore considered to represent a skillful approach for hydrometeor verification.

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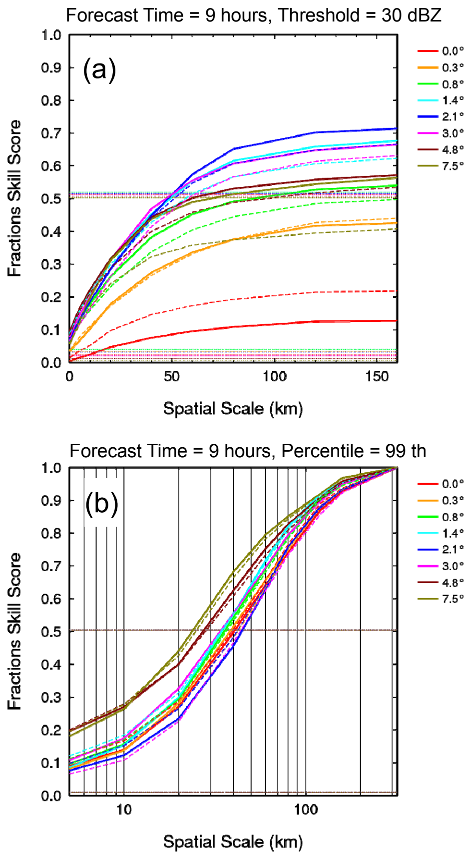

Figure 1: FSS for FT = 9 hours: (a) threshold 30 dBZ, and (b) 99th percentile. The elevation levels are 0.0°, 0.3°, 0.8°, 1.4°, 2.1°, 3.0°, 4.8° and 7.5°. The solid lines are BMP-2, and the dashed lines are BMP-1.

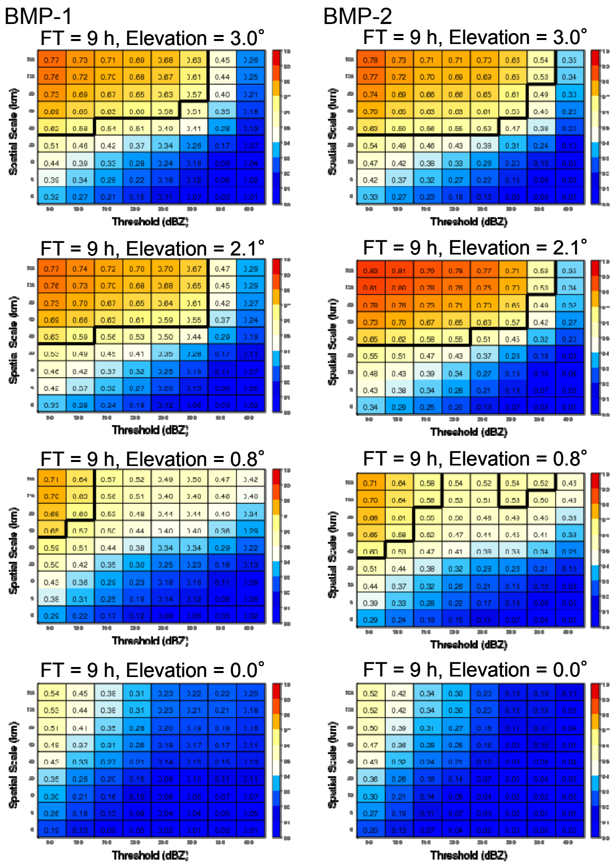

Figure 2: FSS diagrams: experiments for (left) BMP-1, and (right) BMP-2. The bold black lines show the target skill in each diagram. The thresholds are 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0 and 40.0 dBZ, and the spatial scales are 5, 15, 25, 45, 85, 125, 165, 245 and 325 km.

References

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