Selective ensemble nowcast for short-term precipitation prediction system combining both radar echo extrapolation and NWP

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High-resolution precipitation Nowcasts (HN) provided by JMA (Japan Meteorological Agency) is a state-of-the-art operational short-term precipitation prediction basing on the extrapolation of radar echo motions. The results of HN is used for hydrological disaster prevention and disaster prevention information such as inundation and flood risks are created. As generally known that evolutions of heavy precipitation events show significant chaotic features. However, schemes covering uncertainties of precipitation prediction are not sufficiently considered in the single prediction system of HN. In addition, modifications for prediction error are not sufficiently considered in HN. In this study, a nowcast precipitation prediction system named as the selective ensemble nowcast (SEN) is introduced. In SEN, the most accurate few prediction members are selected by the evaluation using scores of previously predicted precipitation among multiple predictions basing on precipitation motion extrapolation with various schemes. We also introduced a scheme to correct predictions based on the error information in past. The system showed the comparable accuracy of scores to those of HN. For the rainband cases, the shapes of distribution and the amounts of accumulated precipitation were more accurately predicted in the proposed system for the forecast time of 60 minutes. It showed higher responsiveness to the occurrence of rainfall for cases of rapid changing in precipitation of isolated system. For stationary rainband (isolated rapid changing rain) cases, bias correction of precipitation estimated for longer (shorter) terms is selected among the ensemble member.
In addition to the precipitation motion extrapolation nowcast, cloud-resolving non-hydrostatic atmospheric model simulations as a numerical weather prediction (NWP) are also expected to be used for short-term precipitation predictions. For the initiation of the simulations, thermodynamic structures within cumulonimbus clouds must be expressed using radar observation information. Moreover, The data assimilation calculations should be calculated with lighter computational costs because the simulations are performed with rapid update. A simplified data assimilation technique named as the upstream low-level humidification (ULH) scheme was introduced by Wakazuki (2015). In the ULH scheme, information of intense precipitation is converted to the low-level moisture on the upstream side in about 20 minutes before, and the pseudo observations of low-level humidification are assimilation by the nudging scheme. Intense precipitations were sufficiently induced by the low-level disturbances. In addition, several schemes to remove unexpected intense precipitations are introduced. In this study, the dynamical simulation predictions are also used as candidates of the SEN combining with precipitation motion extrapolation nowcasts. The dynamical simulations were effective and beneficial to the precipitation predictions after forecast time of 60 minutes.

Keywords: quantitative precipitation forecast, nowcast, cloud-resolving model