

EGU21-9533

<https://doi.org/10.5194/egusphere-egu21-9533>

EGU General Assembly 2021

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Optimizing the localization scale for a convective-scale ensemble radar data assimilation

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For any ensemble-based data assimilation system sampling errors are introduced as a consequence of limited ensemble size, generating spurious background error covariances and leading to erroneous adjustments to the analysis. As a way to reduce the impact of these sampling errors, as well as improve rank deficiency, covariance localization is applied, which artificially reduces the weighting of error covariances beyond a defined physical distance between the background and observations deemed to be false.

In this study we perform sensitivity tests to find the appropriate horizontal localization scale for the SCALE-LETKF, a numerical weather prediction model that combines the SCALE regional model with the local ensemble transform Kalman filter. The system has been in development since 2013 to provide very high resolution modelling of convective weather systems and is unique in its ability to perform near real-time NWP operation at 500-m resolution refreshed every 30 seconds with observations from Phased Array Weather Radar (PAWR). Here, we perform sensitivity tests at 500-m resolution with 30-second update cycling of PAWR data for several testcases of heavy convective rainfall over Tokyo metropolitan area from August/September 2019. Test scores showed horizontal localization scale of 2-km generally provided optimal forecast skill for lead times up to 30 minutes, although there were variations on this dependent upon lead time and case study. We show that by reducing localization scale, systematic errors leading to over-intensification of convective activity in forecasts were reduced, resulting in improved consistency with observations. This was a consequence of generating more convectively stable, less dynamically active environment with smaller localization scale.