Ensemble versus deterministic performance at km-scale

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Abstract

What is the benefit of a near-convection-resolving ensemble over a near convection-resolving deterministic forecast? In this paper, we demonstrate a way in which ensemble and deterministic Numerical Weather Prediction (NWP) systems can be compared using a probabilistic verification framework.

Three years of raw forecasts from the Met Office Unified Model (UM) 12-member 2.2 km MOGREPS-UK ensemble and 1.5 km UKV deterministic configuration were compared, utilising a range of forecast neighbourhood sizes centered on surface synoptic observing site locations. Six surface variables were evaluated: temperature, 10 m wind speed, visibility, cloud base height, total cloud amount and hourly precipitation.

Deterministic forecasts benefit more from the application of neighbourhoods, though ensemble forecast skill can also be improved. This confirms that whilst neighbourhoods can enhance skill by sampling more of the forecast, a single deterministic model state in time can not provide the variability, especially at the kilometer-scale, where rapid error growth acts to limit local predictability.

Ensembles are able to account for the uncertainty at larger, synoptic scales. The results also show that the rate of decrease in skill with lead time is greater for the deterministic UKV. MOGREPS-UK retains higher skill for longer. The concept of a skill differential is introduced to find the smallest neighbourhood size at which the deterministic and ensemble scores are comparable. This was found to be 3 x 3 (6.6 km) for MOGREPS-UK, and 11 x 11 (16.5 km) for UKV. Comparable scores are between 2-40% higher for MOGREPS-UK, depending on the variable. Naively, this would also suggest that an extra 10 km in spatial accuracy is gained by using a km-scale ensemble.