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Probability forecasts from an adaptive spatial method to deal with under-sampling in a convection-permitting NWP ensemble

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The Met Office has a 2.2-km ensemble (MOGREPS-UK) with 12 members run every 6 hours out to 36 hours. MOGREPS-UK is a downscale ensemble that uses initial conditions and boundaries from the ∼33km global ensemble (MOGREPS-G). It does not currently introduce any convective-scale perturbations either at the analysis time or during the forecasts. This is a scientifically valid approach to begin with, which will be a benchmark for future developments. For a UK-sized domain and ∼1-day forecast the precipitation uncertainty is strongly influenced by the uncertainty in the mesoscale flow coming through the boundaries and then modulated by topographical effects and small-scale dynamics.
The positional uncertainty of a localised high-impact precipitation event in a ∼24-hour forecast is typically much larger than the size of the precipitation entity itself. As a result, the raw 12-member ensemble is insufficient to provide smoothly varying probabilities for convective rainfall. A neighbourhood form of post processing is necessary to effectively increase the ensemble size and 'fill in the gaps' caused by under-sampling. A fixed-sized neighbourhood has been used, but this is not ideal because the spatial predictability varies from day to day and place to place.
This presentation will discuss the validity of a downscaling ensemble and the need for more members. A new method for determining the spatially-varying rain-location differences between ensemble members will then be described. The differences are used to obtain a flow-dependent spatially-varying neighbourhood size for generating probability forecasts. The probabilities are smooth because there are no unphysical gradients from under-sampling, but still convey as much sharpness as the ensemble spread allows whilst retaining reliability. Examples and verification results from the use of this approach will be shown. It also has applicability to other ensemble systems, to variables other than precipitation, for spatial ensemble verification and understanding spatial predictability.