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Generating probabilistic forecasts from convection-permitting ensembles

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The Met Office is embarking on a new neighbourhood-based probabilistic strategy for post processing all its Numerical Weather Prediction (NWP) Models with particular emphasis for the UK on the use of the "convection-permitting" 1.5km UKV model and the 2.2km MOGREPS-UK ensemble. An overview is provided by Mylne (2017). NWP models such as these are capable of simulating actual weather phenomena, such as showers or fog patches, rather than predominantly the meteorological environment as was the case with previous coarser-resolution models. As a result, the nature of the forecast errors and expectations of users has radically changed. Errors in forecasts of local weather can still be serious even with these models, but are now much more to do with day-to-day misplacement or over/under forecasting of weather features and less to do with the representativeness of the NWP model grid squares, or more arguably, NWP model biases. Expectations of accuracy increase as NWP model grids get finer and the technology for delivery gets faster. This combination of increased expectation and spatial errors in forecasts is particularly a problem when generating automated forecasts for point locations because there is no time for a human expert to gather the bigger picture and intervene. The forecast has to be taken from the NWP model grid square at the location of interest even though the shower or cloud hole is very likely to be in the wrong place. It means there is an even more pressing need to run an ensemble of forecasts at convection-permitting resolutions (than there was at coarser resolutions) and move to a probabilistic interpretation of the output to account for the spatial uncertainty. Since convection-permitting models are expensive it is only possible to run a small ensemble and that will still significantly under-sample the full range of outcomes at any given grid square. Hence additional "neighbourhood processing" is required to include nearby grid squares as surrogate alternative outcomes and hence increase the ensemble size. This generates smoothly-varying probabilistic forecasts which can be blended between models to create a seamless probabilistic evolution.
The scientific rationale behind the probabilistic neighbourhood processing and blending approach will be explained along with a discussion of some of the potential shortcomings and ways that they can be overcome. One of the main issues is how to obtain an optimal neighbourhood size for any given situation; another is how to deal with topographical variations. To deal with the first issue, an adaptive approach has been developed that uses the ensemble members to generate appropriate neighbourhood sizes. This produces smaller neighbourhoods in areas where ensemble members are in close spatial agreement and larger neighbourhoods where there is greater spatial uncertainty. It has the advantage that tuning is not required provided that the underlying ensemble is reasonable. Both the visual effect on the probabilities and the effect on forecast skill will be shown. Our objective is to build this into the new post processing system. Methods to deal with topography are also a focus of attention and will be discussed.
Ref: Mylne (2017): A new strategy for integrated Post-Processing and Verification for the Convective Scale age, EMS Conference, Dublin 2017.