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Creating a probabilistic, multi-model post-processing system at the Met Office

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The Met Office is developing a new probabilistic, multi-model post-processing system. Initial activity is focussing on the Met Office's convection-permitting models: the UKV, a deterministic model with a resolution of 1.5 km, and MOGREPS-UK, an ensemble model with a resolution of 2.2 km. The system, called IMPROVER, will be used to generate skilful and consistent forecasts of meteorological outputs by representing the forecast uncertainty in probability space. The Met Office is moving to an NWP system for the UK that runs both hourly UKV forecasts out to 12 hours and hourly 3-member MOGREPS-UK forecasts out to 5 days. IMPROVER needs to be able to deal with this information and transition to using the global ensemble MOGREPS-G and the ECMWF ensemble beyond 5 days. The output from IMPROVER will be comprised of probability-based outputs that focus on both "ordinary" weather (gridded and at point locations) for automated products, and on high-impact weather for operational meteorologists and public weather services.

Substantial progress has been made so far on the processing of single-level quantities, such as temperature, wind speed, rain, snow, cloud and visibility. For example for wind speed, we have incorporated an existing deterministic post-processing method, which accounts for surface roughness and height differences into a processing chain that converts either deterministic or ensemble model input into probabilities by selecting a series of thresholds. The probabilities are also constructed using "neighbourhood processing", in order to apply sufficient spatial smoothing to account for under-sampling of the positional uncertainty in small-scale features caused by having too few ensemble members. These smoothly-varying (but not bland) probability fields are subsequently blended by time-lagging forecasts from the same model, and then by combining forecasts from different models e.g. UKV and MOGREPS-UK.

The use of a basic neighbourhood processing approach runs the risk of smearing probabilities uniformly over locations with differing topography which may be unphysical (e.g. probability of valley fog or warm daytime temperatures spreading onto hills). Therefore, we have focussed on developing a topographically-aware approach, so that only grid points with a similar topography are neighbourhood processed together. In a similar vein, the calculation of a snow-falling level probability using the vertical integral of wet bulb temperature has allowed the use of neighbourhood processing in the diagnosis of the chance of precipitation being rain or snow.

Results from initial trialling of IMPROVER will be presented to demonstrate the capability of the system and the performance will be compared with the current deterministic, operational post-processing system. Some of the challenges of moving this new system towards operations will be discussed, as well as some of the changes that downstream systems and users are likely to adopt to fully exploit the probabilistic output.