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Assessing spatial precipitation uncertainties in a convective-scale ensemble

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1. Introduction

Conventional point-to-point difference measures of error do not capture the benefits of convective scale modelling for e.g. precipitation forecasting. Various non-local error measures have been developed in recent years. Here we extend one such technique for use with a convective-scale ensemble system (the 12-member MOGRPEPS-UK, with a grid length of 2.2km). We assess model skill alongside the corresponding measure for ensemble spread.

2. Agreement scales

Consider two fields of surface precipitation rate (on the same horizontal grid), say from two ensemble members, or from a single member and from radar data. At each point an agreement scale is calculated at which we deem the fields to be suitably similar: i.e. at which one field would provide useful guidance for predicting the other.

$$\frac{(A_{i,j_L} - B_{i,j_L})^2}{{A_{i,j}}_L^2 + {B_{i,j}}_L^2} < 0.5\left(1 + \frac{L}{L_{max}}\right)$$

Equation 1: Criterion for forecasts to be suitably similar. A_{i,j_L}, B_{i,j_L} are the average rates centred at *i,j* for a neighbourhood of side L for fields A and B. L_{max} is the maximum neighbourhood considered.

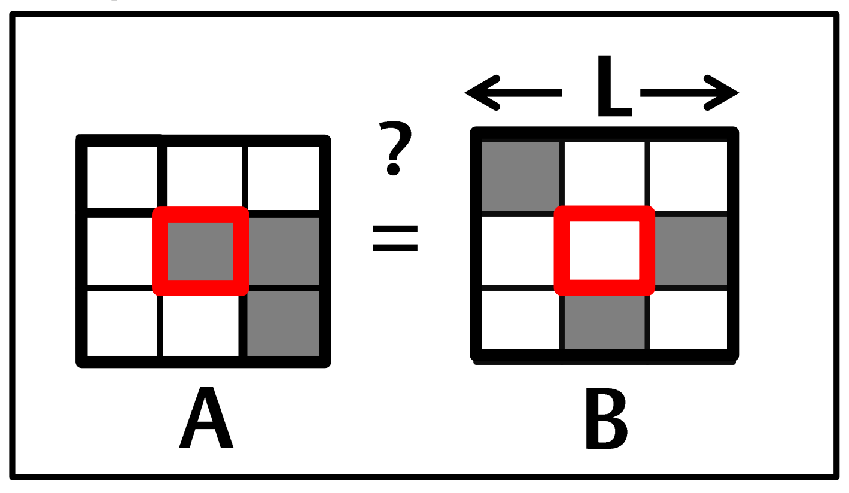

Figure 1: Schematic representing two forecasts with grid points of rain (grey) and no rain (white).

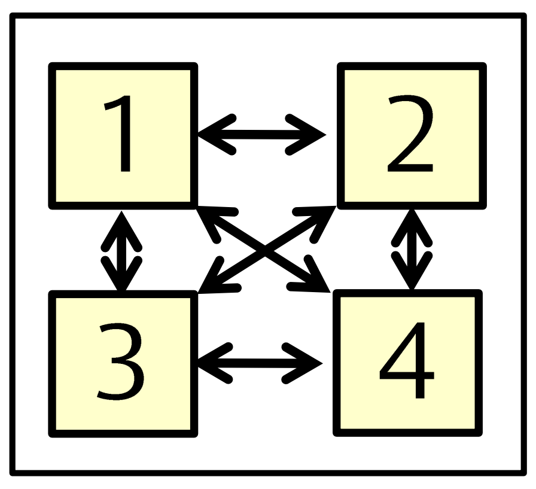

Figure 2: Schematic showing the possible comparisons of 4 forecasts.

Consider the schematic in Fig 1: compared at the central point the forecasts differ, but when the average is compared over the 3x3 area they are suitably similar. The minimum area for which the forecasts are deemed suitably similar defines an agreement scale as the half-width of the box.

The resulting agreement scale is averaged over all combinations of ensemble members (Fig 2) to produce an ensemble agreement scale. This produces a simple, intuitive quantification of spatial uncertainties in a way that is case and location dependent.

3. An example case

Fig 3 shows an example for 17 July 2013 at 17Z. 7 out of 12 members captured an observed line of thunderstorms, albeit with differences in location and orientation. Notice that the ensemble mean is physically unrepresentative here, suggesting scattered light showers. The agreement scale map provides a useful summary measure of the spatial uncertainty in the precipitation.

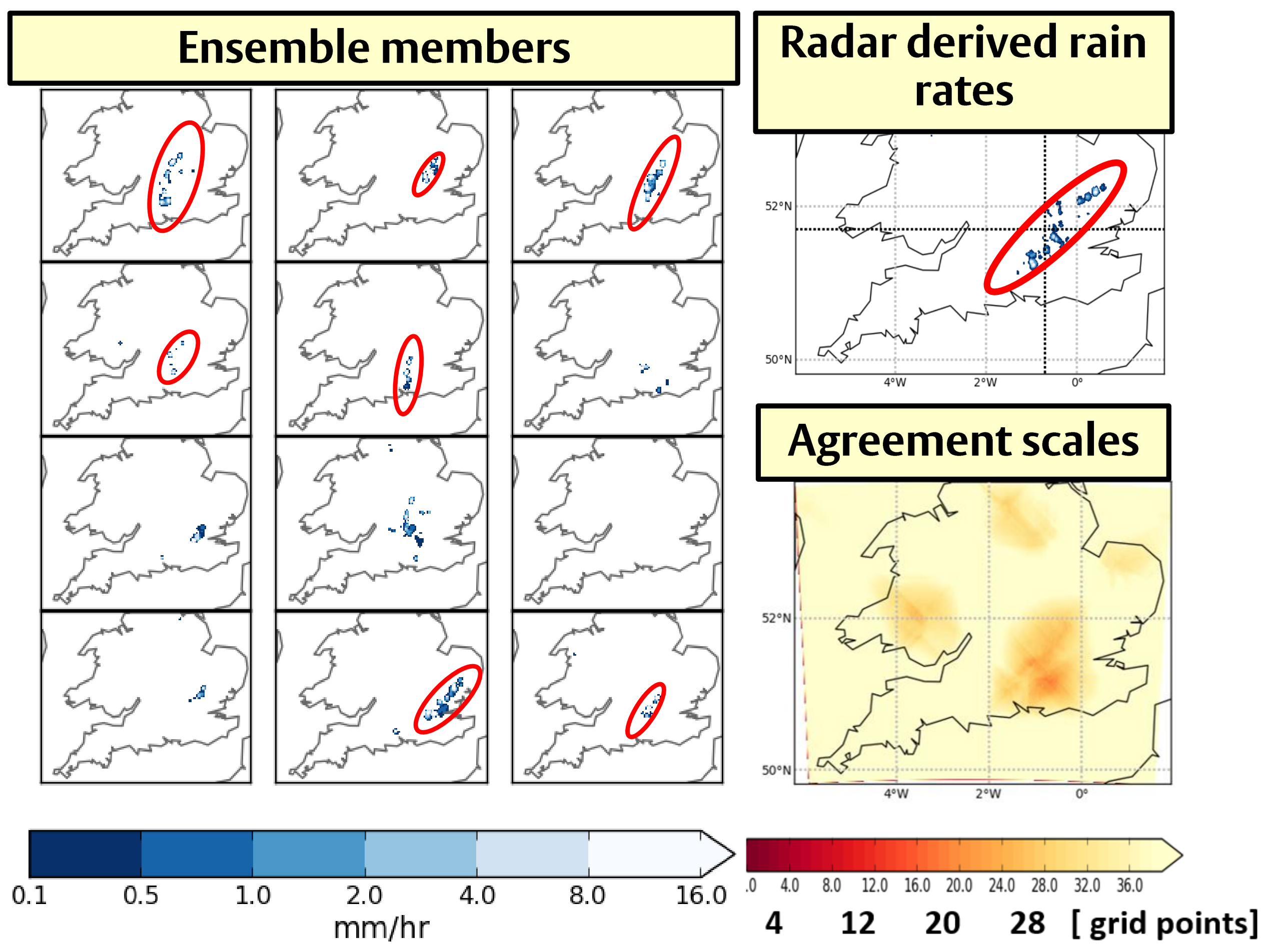

Figure 3: Ensemble member rain rates, radar derived rain rates, and the ensemble agreement scales for a case of a line of thunderstorms on 17th July 2013.

4. Analysis for summer 2013

A season of MOGREPS-UK convection-permitting ensemble forecasts, taken from the summer 2013 operational system, are analysed using this approach.

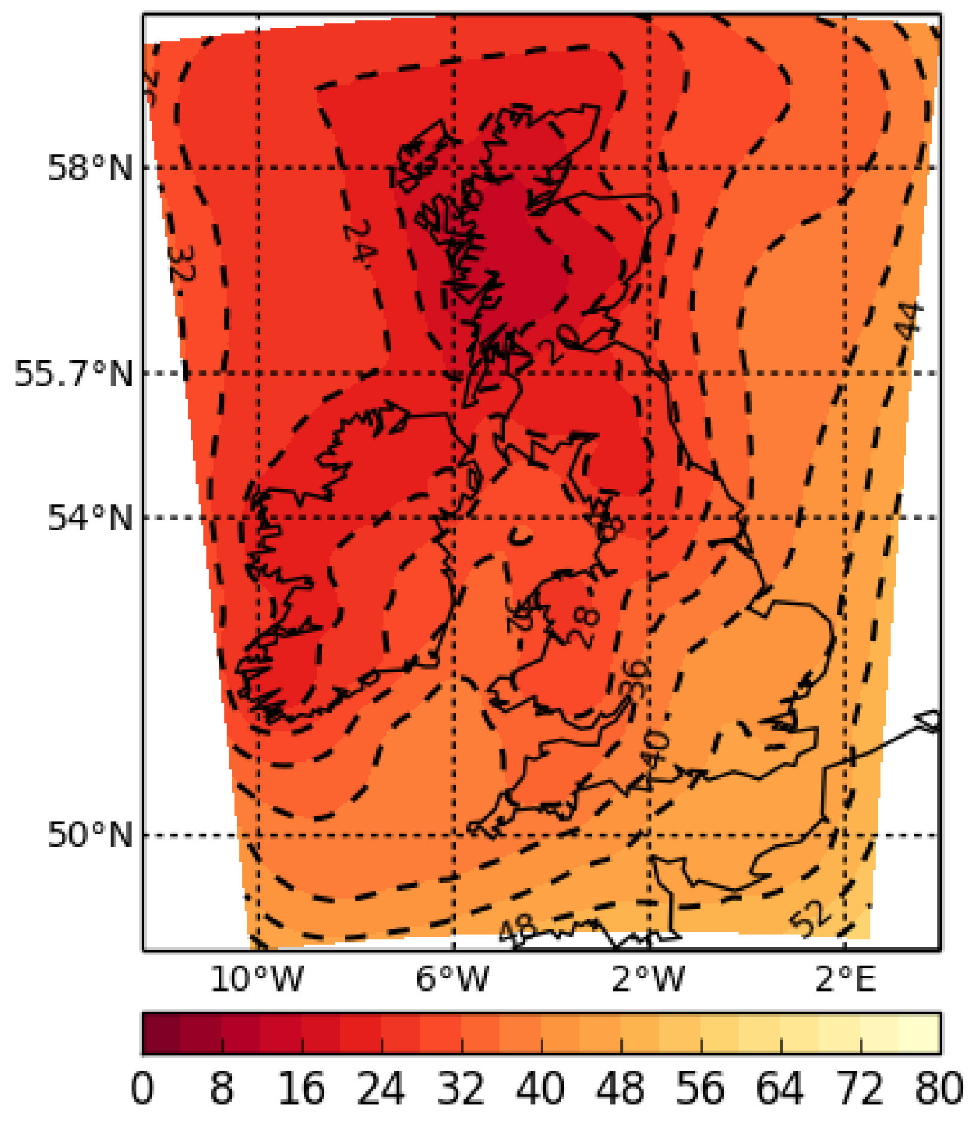

Figure 4: Mean of the agreement scales across all cases and times (T+6 to T+29) in summer 2013.

The season-average ensemble agreement scales are shown in Fig 4. They are location dependent, with more confidence in the location of precipitation found in the north and west of the UK. This can be partially (but only partially!) explained by the more frequent rainfall in these areas.

5. Spread-skill relationship

The model skill can be assessed by calculating agreement scales for member-radar pairs and comparing with the member-member results. For a well-spread ensemble (with radar data indistinguishable from the forecasts) these scales should concur. Using binned scatter plots we can assess the spatial spread-skill relationship whilst preserving a location-dependent comparison.

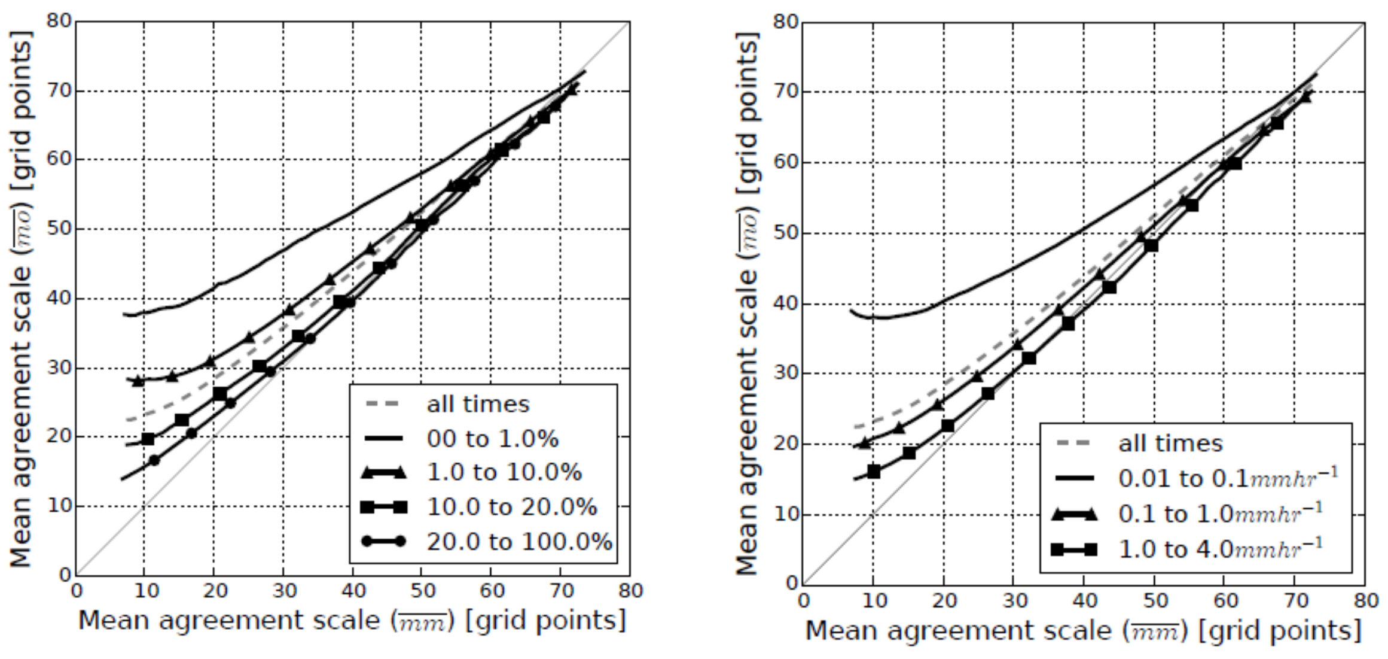

Figure 5: Bin-scatter plot for member-member and member-radar agreement scales, averaged over summer 2013. Times are split by fractional coverage of raining points (left) and by mean rain rate of raining points (right).

Overall, the ensemble was well spread for this summer, albeit with some indications that, when confident in the location of precipitation, it was over-confident. Poorer spread-skill relationships were associated with a low fractional coverage of rain, and low rain rates.

6. Diurnal cycle

There was little evidence of agreement scales increasing with lead time; instead a diurnal cycle was found, as shown in Fig 6.

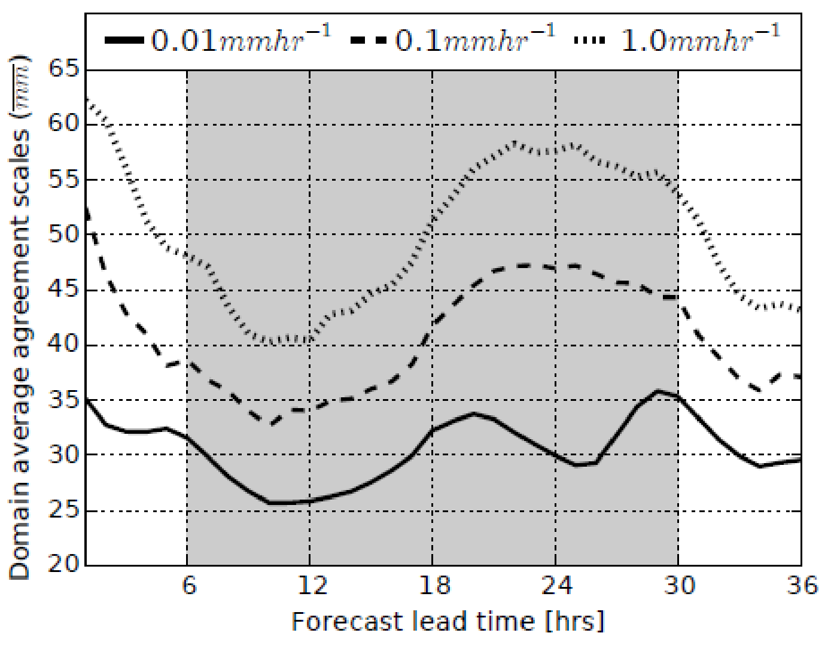

Figure 6: Domain mean member-member agreement scales, as a function of lead time. The different line styles are for different thresholds applied to the data.

7. Conclusions

Convection-permitting ensemble forecasts of precipitation require appropriate assessment tools that characterise spatial uncertainty. We have developed such a method and demonstrated its use to study factors influencing spatial uncertainties and the performance of ensemble systems.

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References

Dey SR *et al*, 2016: A new method for the characterisation and verification of local spatial predictability for convective-scale ensembles. *Quart. J. Roy. Meteor. Soc.*, available on early release using doi: 10.1002/qj.2792
Dey SR *et al* 2016: Assessing spatial precipitation uncertainties in a convective-scale ensemble. In preparation.