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Convective-Scale Practical Predictability Within Different Convective Regimes

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Introduction

- **What is the relative importance of initial/boundary condition uncertainty vs. model physics uncertainty for the spatial predictability of convection?**
- **Does the scale used for post-processing agree with the ensemble agreement scale?**
- **These practical predictability questions are considered via the use of the Met Office Global and Regional Ensemble Prediction System for the UK (MOGREPS-UK).**
- **Initial work considering the practical predictability of two distinct cases in MOGREPS-UK is considered here.**

Background

Error growth on convective-scales is typically an order of magnitude faster than that of synoptic scales (e.g Hohenegger and Schär, 2007).

However, the spatial predictability of convective events is highly variable (e.g. Dey et al., 2016).

The spatial predictability is somewhat linked to whether the convective events are in convective quasi-equilibrium or not (Flack, 2017).

Cases

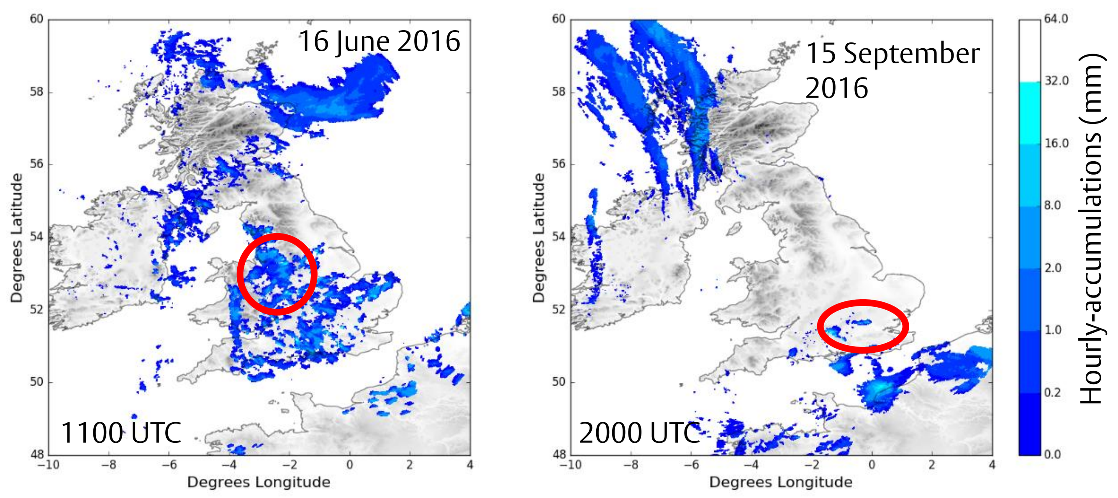

Fig. 1: UK Hourly-precipitation accumulations derived from radar. The circled regions show the general areas that had flooding (either surface water or flash).

Two flooding cases are examined (Fig. 1) 16 June 2016 (left) and 15 September 2016 (right).

16 June is a scattered showers case and indicative of convective quasi-equilibrium. 15 September had frontal convection and intense cells that developed near London, and is more suggestive of non-equilibrium convection.

MOGREPS-UK

MOGREPS-UK is a 2.2 km grid length, 12 member ensemble that produces 36 hour forecasts. The operational configuration is used with initial condition and boundary condition perturbations generated from the Met Office's global ensemble. Model physics perturbations are created from randomly perturbed parameters.

Operational Ensemble: Predictability of Magnitude

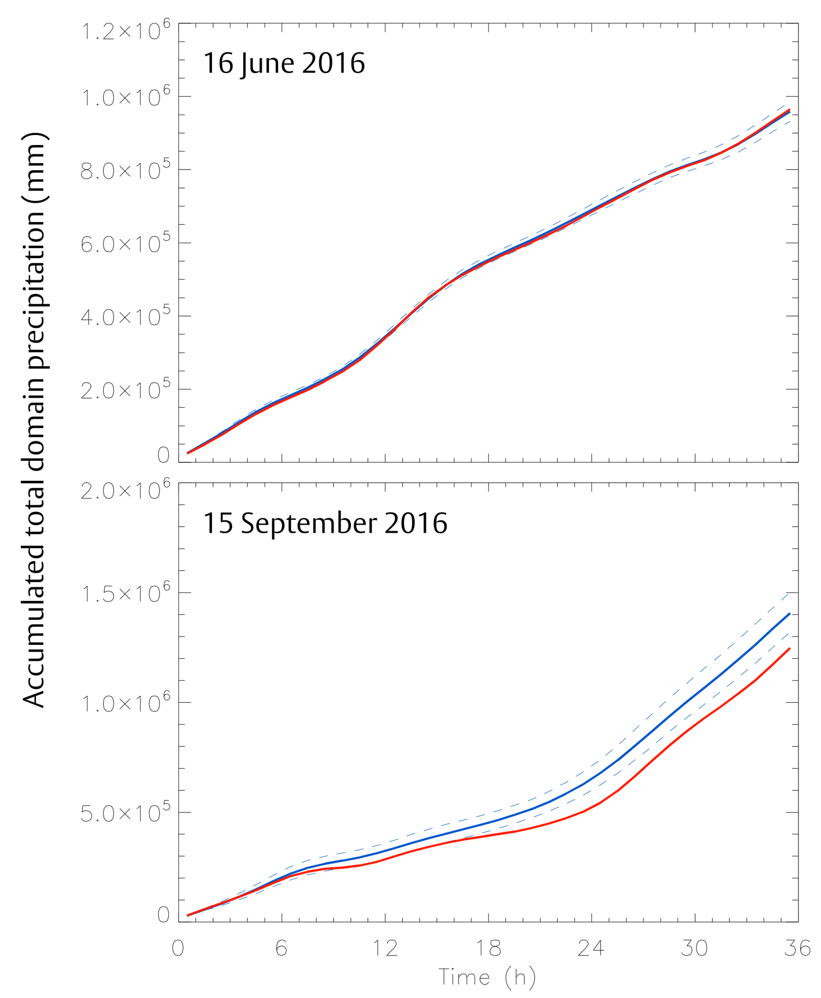

Fig. 2: Ensemble mean (solid blue) and control (red) with the 95% statistical significance level (determined from bootstrapping the ensemble; dashed) of total domain precipitation with forecasts initiated at 0300 UTC.

There is larger spread for 15 September compared to 16 June, and the control member for the September cases is also significantly different to the ensemble mean often lying beyond the 95th percentile (Fig. 2).

As expected the relative spread of the ensemble decreases with area (Fig. 3). The September case shows greater sensitivity to the magnitude of precipitation at larger areas than the June case, which complements the total ensemble spread, indicating that the magnitude of this event has low predictability.

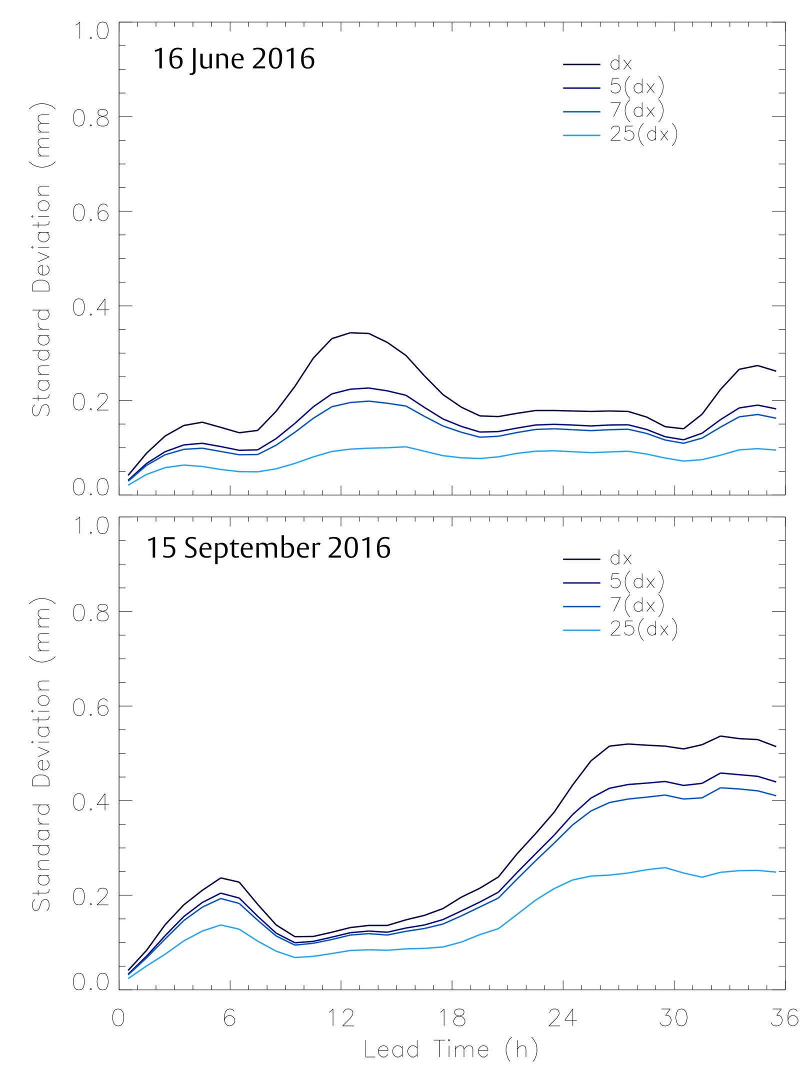

Fig. 3: The standard deviation of the means averaged over different neighborhoods from forecasts initiated at 0300 UTC.

Operational Ensemble: Spatial Predictability

The average Fractions Skill Score (FSS; Roberts and Lean 2008; Fig. 4) indicates higher spatial predictability at the grid scale for 15 September compared to 16 June, however the larger scales are more uncertain.

There is a large dip in the FSS at T+9 h for 15 September due to a decrease in the number of precipitating points above 1mm.

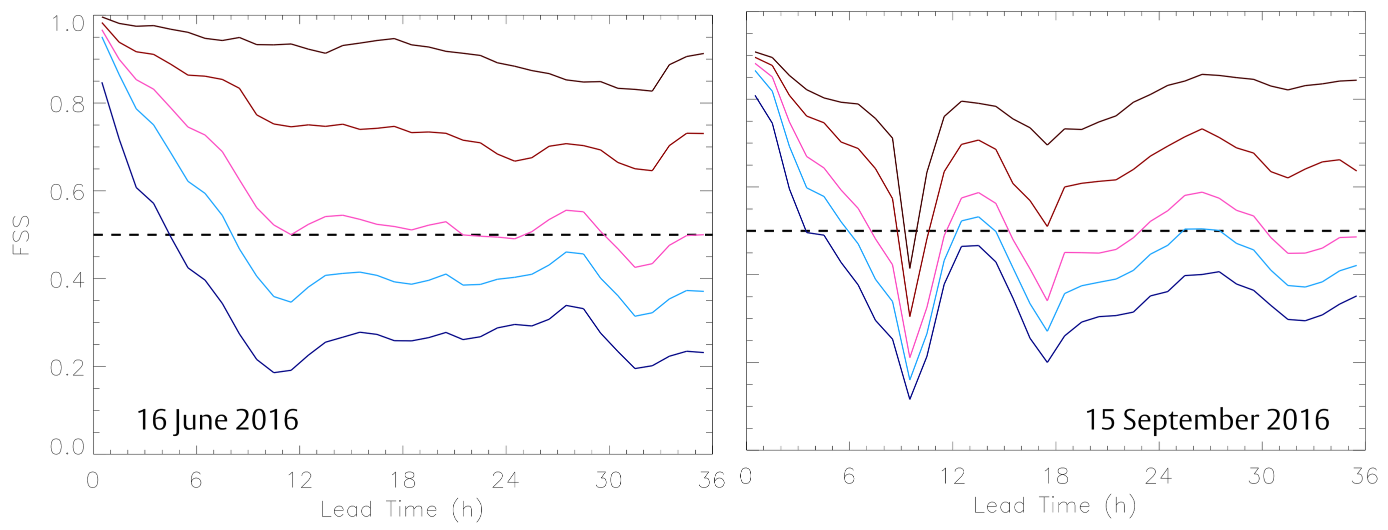

Fig. 4: The average FSS (with a 1mm precipitation threshold applied) between control and perturbed ensemble members, from forecasts initiated at 0300 UTC, the dashed line represents the skilful scale, and colors represent the different neighbourhood widths: grid scale (2.2 km); 7dx (15.4 km); 15dx (33 km); 43dx (94.6km); 163dx (358.6 km).

The Ensemble Agreement Scale (EAS; Dey et al, 2016; Fig. 5) indicates greater domain coverage of precipitation on 16 June, and thus more widespread perturbation growth compared to 15 September.

On average for 16 June the EAS is on the order of the cloud spacing (around 15 grid boxes or 33 km). 15 September has localised convection implying that the EAS is locally small. The EAS for the localised cell is larger than that of the scattered cells, thus indicating the importance of boundary condition perturbations, due to the different tracks forecasted for this event.

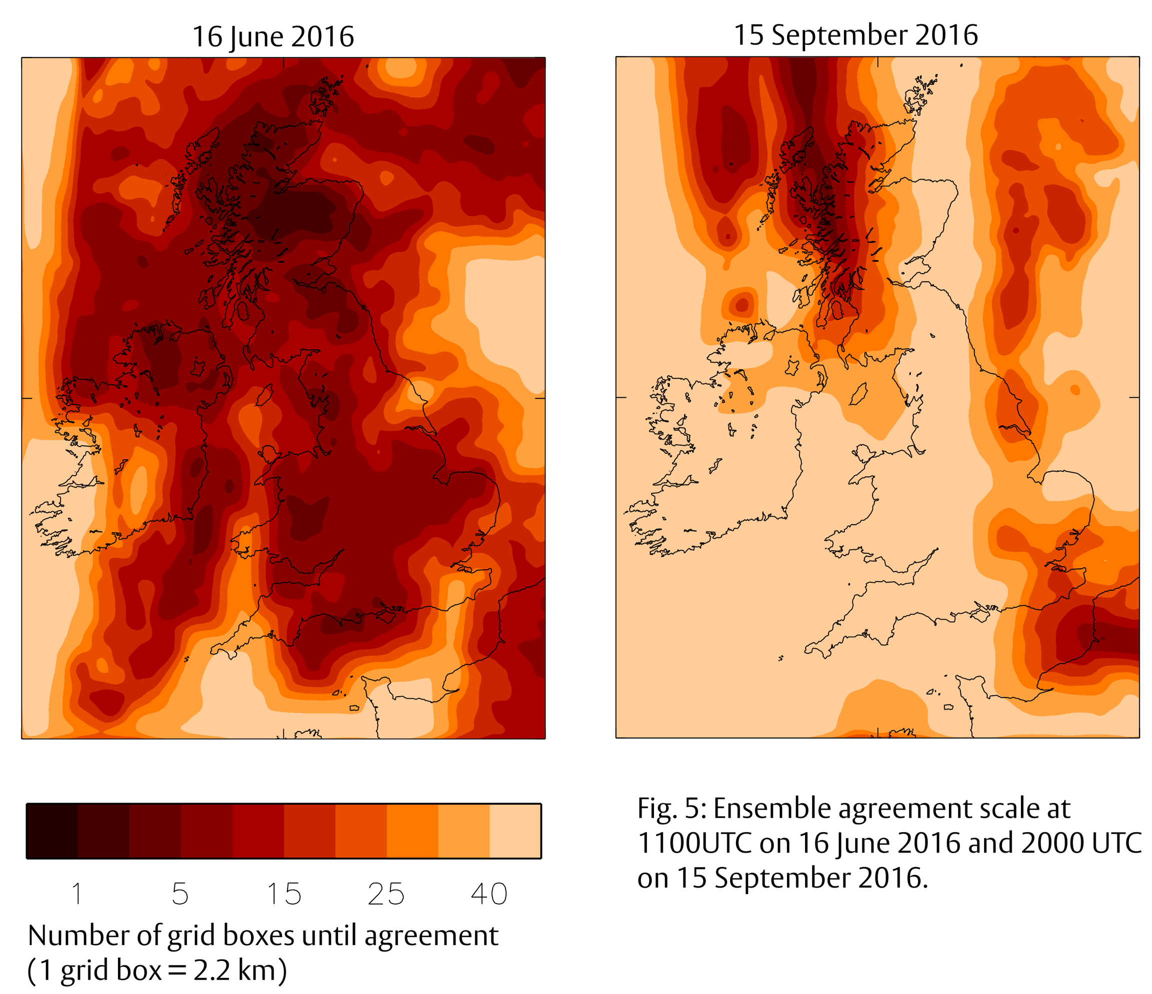

Fig. 5: Ensemble agreement scale at 1100UTC on 16 June 2016 and 2000 UTC on 15 September 2016.

Stochastic Boundary Layer Scheme

A stochastic boundary layer scheme is currently being developed at the Met Office, in which the variability is governed by the number of thermals over a specified area and time. A smaller number of thermals with a faster turnover-time results in smaller stochastic increments.

Initial runs have been performed with the UKV, and indicates modest spread forming when the convection occurs.

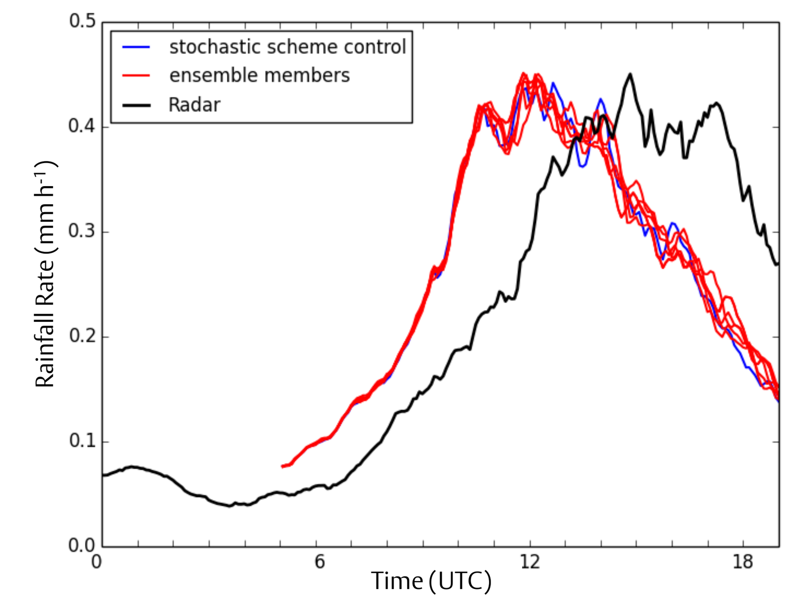

Fig. 6: The average rainfall rate for a 6 member stochastic physics ensemble and radar for comparison, where the averaging occurs over Southern UK.

Summary and Future Work

- **Perturbation growth is considered for two cases with operational MOGREPS-UK output.**
- **There is greater predictability of the intensity of the event for the June case compared to the September case.**
- **The September control is statistically different from the ensemble mean, whereas the June control is close to that of the ensemble mean.**
- **Given the limited organisation in June compared to September case the perturbation growth is more widespread, in agreement with Flack (2017).**
- **The stochastic boundary layer scheme shall soon be implemented into MOGREPS-UK to create a super-ensemble.**

References

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