Met Office

MOGREPS-UK

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Recent parallell suites

OS39 – current operational suite

A mostly technical upgrade for MOGREPS-UK

- Global models increase in horizontal resolution – MOGREPS-G to 20 km (N640)
- UKV starts using hourly 4DVar (see presentation of Marco Milan) → adapting MOGREPS-UK to availability of new initial conditions
- Moisture conservation scheme

PS40 – Minor changes aiming to increase spread

The largest change in PS40 for MOGREPS-UK is to return to using the Incremental Analysis Update to add the perturbations to the initial analysis file used to start the forecast for each ensemble member. This change has been shown to increase the spread at the start of the forecast (see fig. 1).

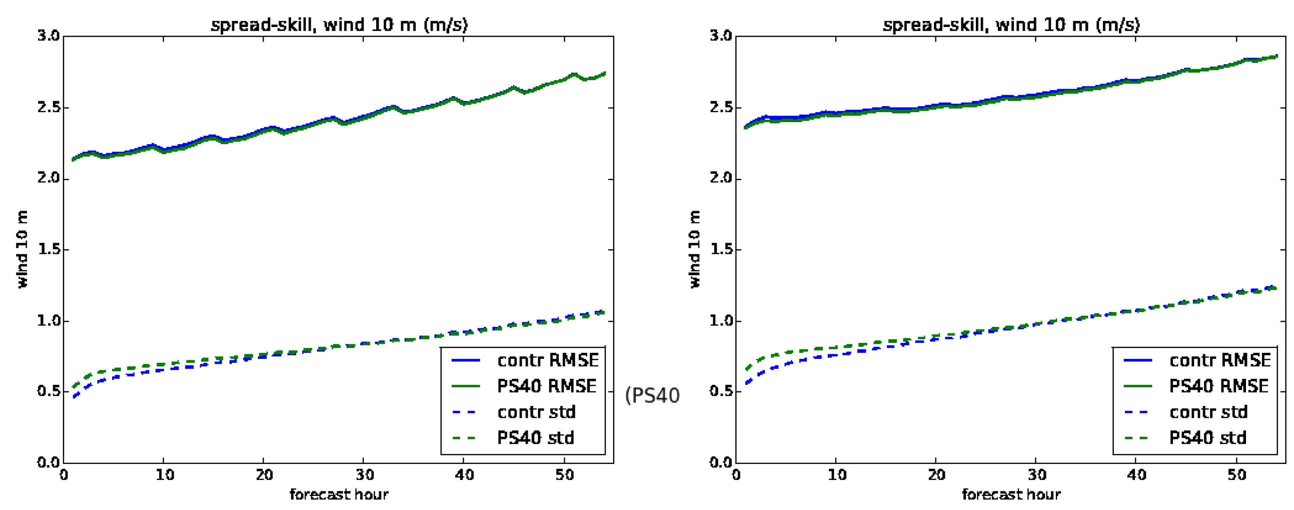

Fig 1: Spread-skill plot for summer (left) and winter (right) trial of PS40 for the 10 m wind speed

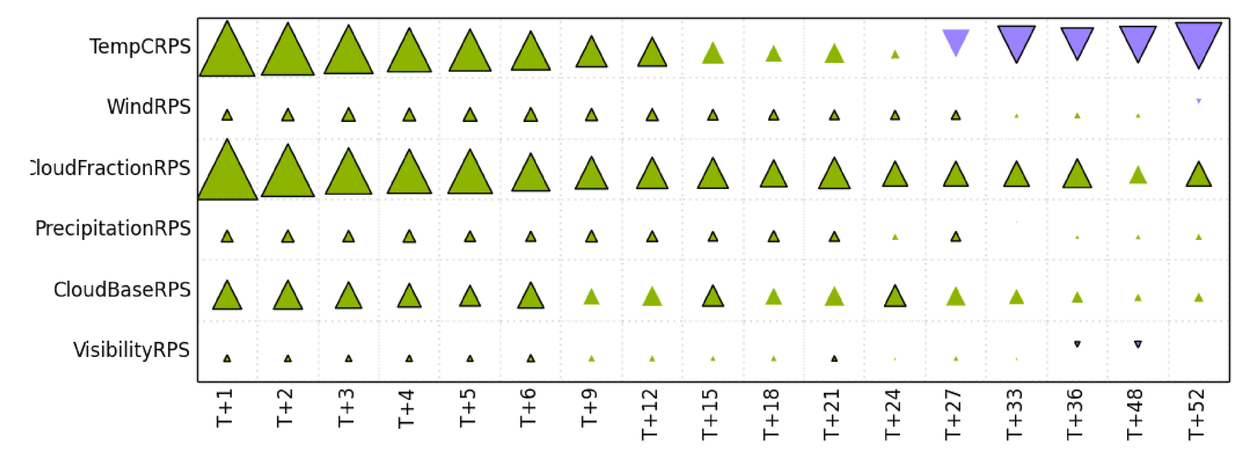

Fig 2: Summary of PS40 summer trial using a 3x3 neighbourhood. Green triangels indicate an improvement and purple triangles a detriment. The black outline indicates if the change is statistically significant.

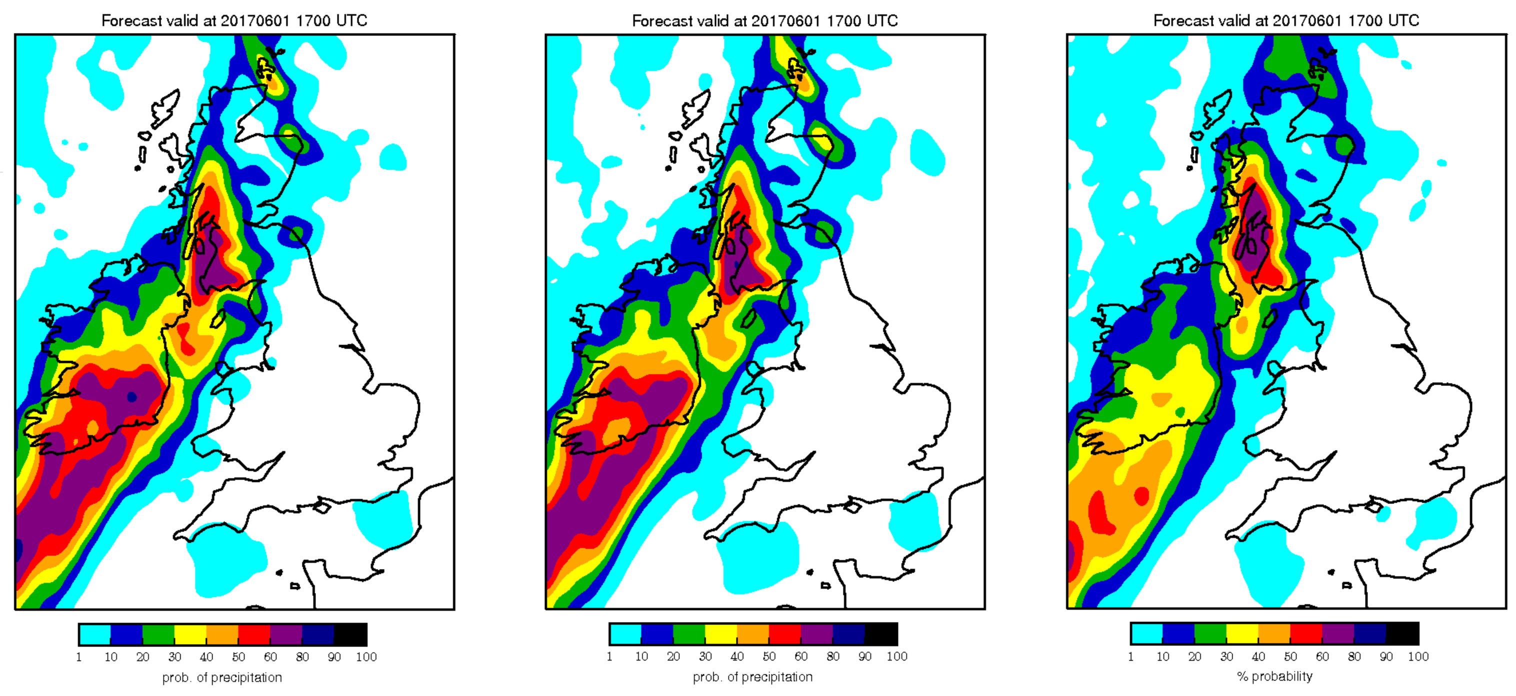

Fig 3: Probability of precipitation exceeding 1 mm/hr for 6h cycling ensemble with 12 members (left), 18 members (middle) and 18 member time-lagged ensemble (right).

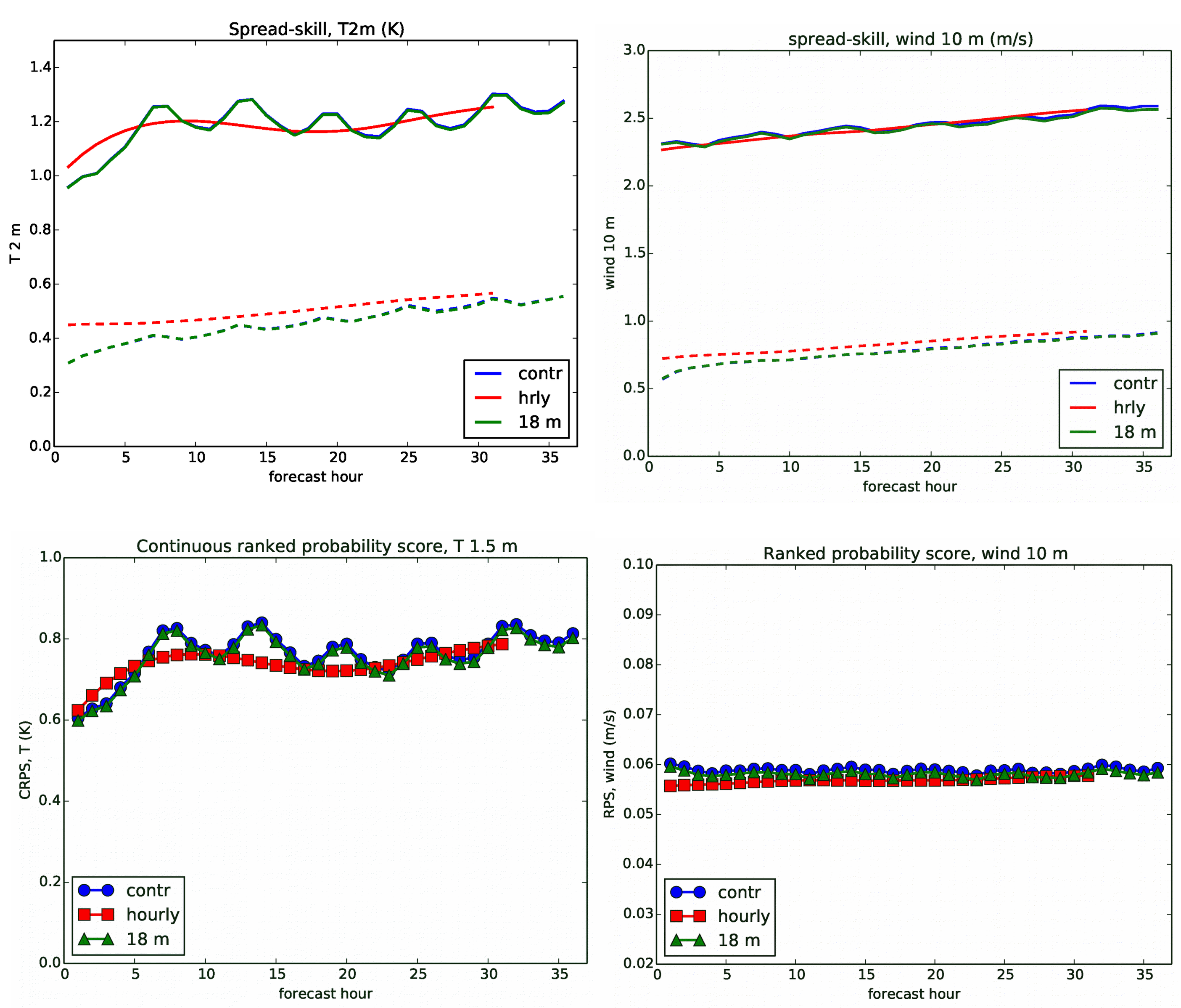

Fig 4: Verifcation scores for the period 1-21 June 2017

Towards an hourly ensemble

MOGREPS-UK is currently running with a configuration which centres the ensemble on the high-resolution deterministic UK model. For more details on this configuration see Tennant (2015). With OS39, which became the Met Office operational suite in July 2017, the UK deterministic model started running hourly 4DVar instead of three hourly 3DVar. In order to take advantage of this it has been decided to try and run MOGREPS-UK hourly too.

The current version of MOGREPS-UK has a tendency to be underspread and the operational meteorologists think it follows the control member too closely. Previous experiments on possible future configurations of MOGREPS-UK in Hagelin et al. (2017) have shown that increasing the number of ensemble members would have a beneficial impact of the performance of the model. However, doubling the ensemble size as suggested by Hagelin et al. (2017), would also create a large spike in the request for computer resources for the operational system and make it more difficult to fit into the schedule.

An alternative is to take advantage of the hourly UKV forecasts which are now available and create a small ensemble every hour centred on the latest UKV analysis. If these small ensembles are time-lagged over a period of six hours, this creates an 18 member ensemble. This setup will both increase the ensemble size and even the load on the supercomputer.

Verification of early trial

The hourly ensemble is compared against both a 12 member and an 18 member ensemble, which makes it possible to separately see the impact of the increased ensemble size and the impact of the hourly cycling. Overall, the hourly ensemble improves the forecast scores of MOGREPS-UK, both over the 12 member and the 18 member ensemble. The 18 member six hourly ensemble improves the forecast scores over the 12 member ensemble, as can be expected given the results shown in Hagelin et al. (2017). The differences between the 18 member hourly time-lagged ensemble and the 18 member ensemble using six hourly cycling show smoother scores for the time-lagged ensemble and overall the RPS and CRPS scores indicates an improvement in the scores with the hourly time-lagged ensemble. The largest effect is seen in the spread of the ensemble, which is increased throughout the forecast by using the hourly ensemble.

Surface Perturbations – Anne McCabe

Work is currently underway to represent uncertainty in the land-surface component of MOGREPS-UK. Two different options are considered:

1. to extend the current Random Parameter (RP) scheme to include three parameters from the land-surface parametrization;
2. to allow for variation in soil moisture content (SMC) between ensemble members by initialising the SMC with the T+12 values from a previous cycle (following the approach of Tennant & Beare, 2014).

These two approaches are compared with the current stochastic physics schemes used operationally in MOGREPS-UK: stochastic perturbations to temperature and moisture in the boundary layer (BL) and the RP scheme (McCabe et al, 2016). Two month-long trials were run for the summer and winter periods of 2016. Four experiments were performed in total with each experimental configuration building on the last (so the SMC cycling experiment, for example, has the BL Perturbations, RP scheme, and additional land-surface parameters switched on). Figure 5 shows the effect on the spread-skill ratio and Continuous Ranked Probability Score (CRPS) for surface temperature. Both the addition of land-surface parameters to the RP scheme and the cycling of the SMC have a positive impact on the verification scores, with the largest impact shown for the land-surface parameters. The limited effect of cycling the SMC parameters may be due to the type of weather we have in the UK or it may be that the land-surface scheme under estimates the sensitivity of the atmosphere to the SMC. The ratio of standard deviation of the ensemble members (spread) to the root mean square error (skill) indicates that the ensemble is still under-dispersed, but that each additional scheme contributes to drawing the spread and skill closer together. We should note that the spread-skill ratio does not take into account observational error so the spread and skill may be more closely matched than the figure suggests.

In conclusion, all the perturbation schemes considered demonstrate a positive impact on the spread-skill relationship and CRPS for surface temperature in MOGREPS-UK. Of the options considered for the land-surface, adding parameters from the land-surface scheme to the RP scheme had the greatest impact. Further work needs to be done to fully understand the sensitivity of the forecast to changes in SMC and how best to represent SMC variability in the ensemble.

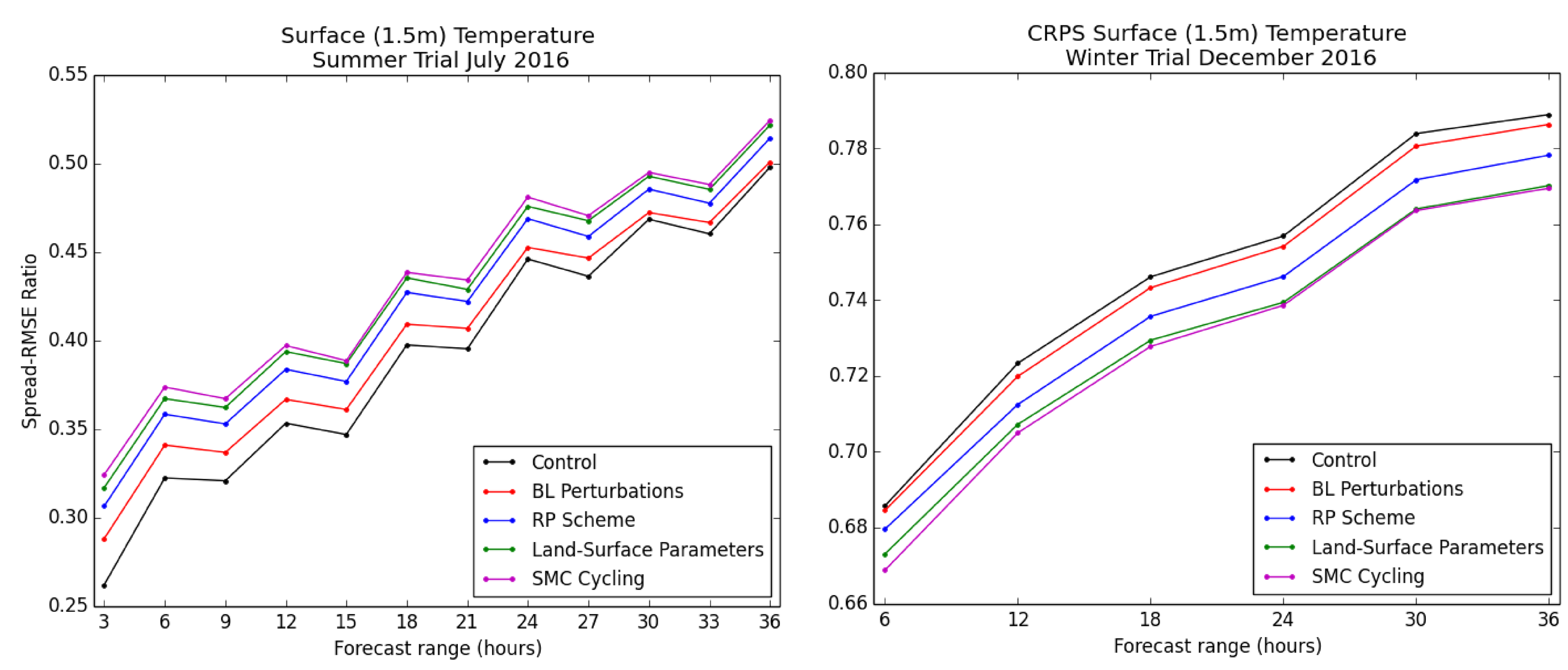

Fig. 5: Spread-RMSE ratio and CRPS for different options of stochastic perturbation. Each successive experiment contains all the changes of the previous one.

References

Hagelin, S., Son, J., Swinbank, R., McCabe, A., Roberts, N., and Tennant, W. (2017), The Met Office convective-scale ensemble, MOGREPS-UK, QJRMS, DOI:10.1002/qj.3135

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