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Representing model error in the Met Office convection permitting ensemble prediction system

Anne McCabe, Richard Swinbank,
Warren Tennant and Adrian Lock

ECMWF/WWRP Workshop
Model Uncertainty
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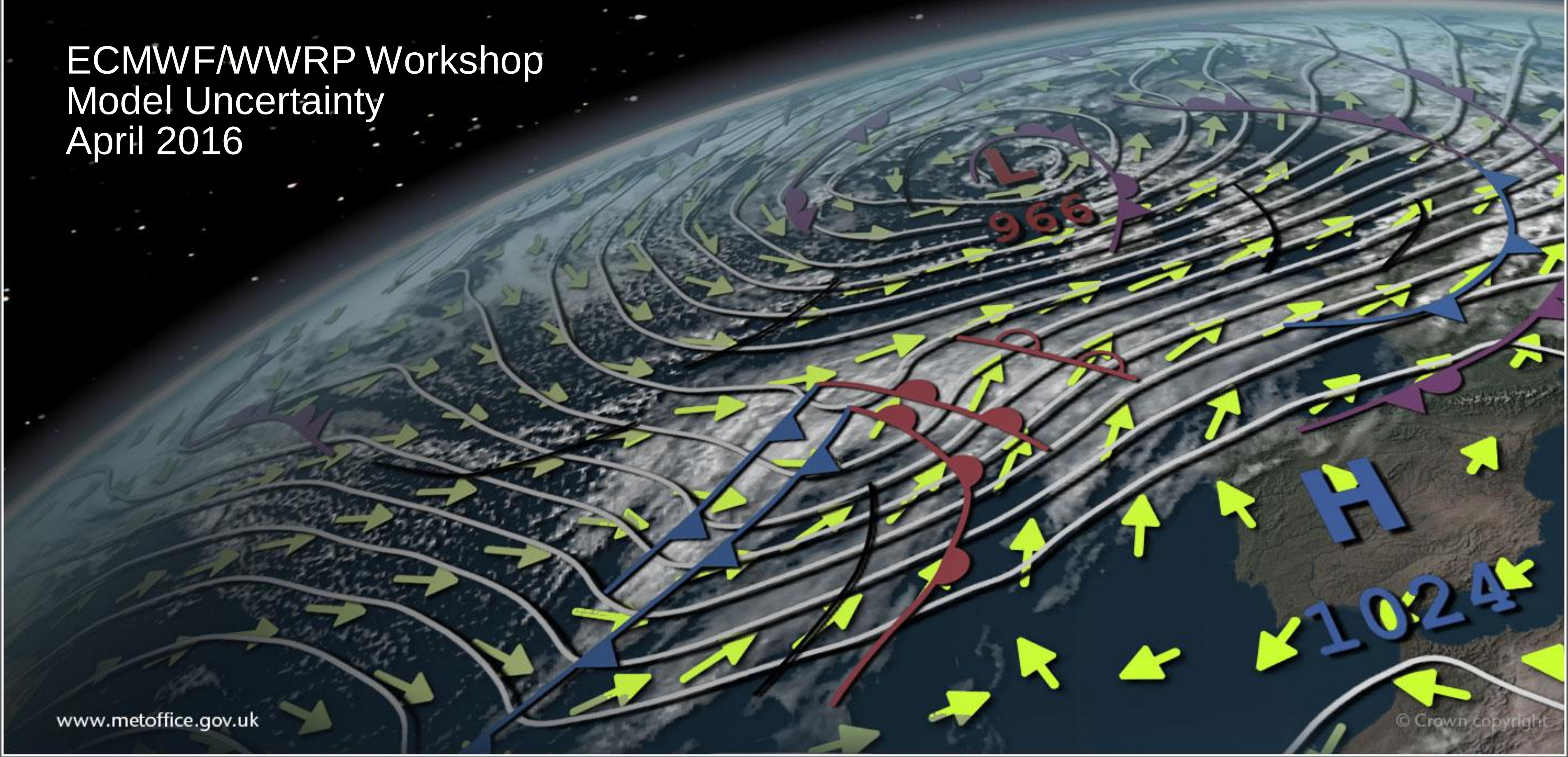

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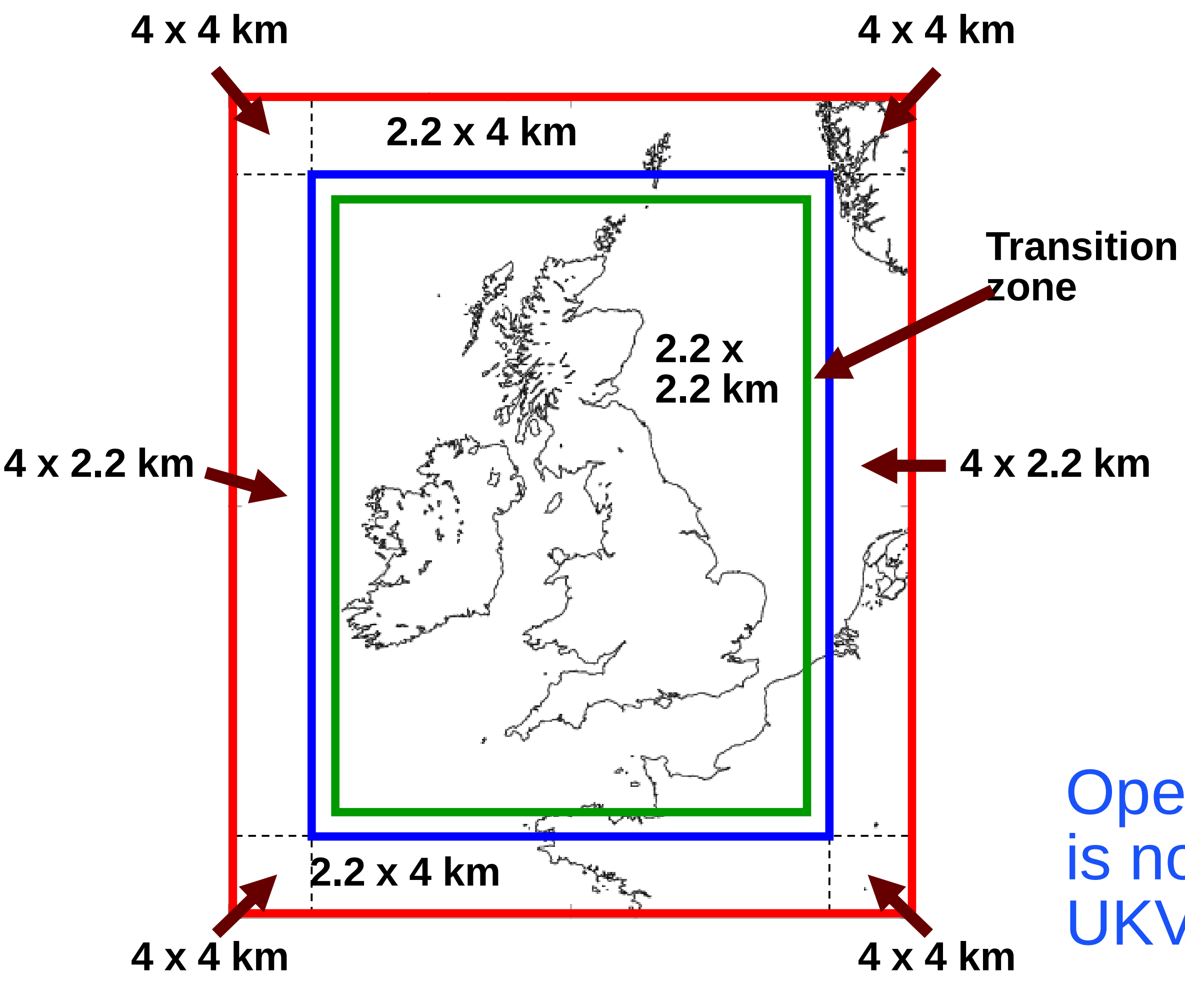
Outline

- MOGREPS-UK
- Representing model uncertainty at the convective scale
- Improved Random Parameter Scheme
- Fog case studies
- Verification statistics from month long trials
- Future work

MOGREPS-UK set-up from 2013 to early 2016



- Straight downscaler of the MOGREPS-G forecast
- Initial & boundary conditions from global forecast.
- Model physics as 1.5km UKV
- 4 cycles per day, 12 members to T+36.

Operational MOGREPS-UK is now centred around the UKV analysis (March 2016)

Model uncertainty in a convective scale ensemble prediction system

Need to represent model uncertainty to accurately represent forecast probabilities

- ➢ Use experience of modelling uncertainty at the synoptic scales

Different physical processes dominate at the convective-scale

- ➢ Adapt stochastic physics schemes to specifically target areas of model uncertainty relevant for convective scale

What are the relevant areas of model uncertainty?

- ➢ Use experience of forecasters and parametrization modellers to identify key areas in the model that are either inherently uncertain or known to be inadequately represented

Which stochastic physics scheme?

Schemes to target missing physical processes:

SKEB – based on synoptic scale arguments; would need reviewing to apply at the convective scale

BL perturbations – backscatter the effect of unresolved processes

Pragmatic approaches to target missing aspects of model uncertainty:

RP scheme – represents knowledge uncertainty in parametrizations

SPPT – perturbation to total tendencies; independent of physics parametrizations

Start with RP scheme and BL perturbations

Random Parameters Scheme

Basic Idea: *choose a subset of parameters from relevant parametrization schemes and vary them stochastically throughout the forecast*

Advantages:

- Addresses knowledge uncertainty in physics parametrizations
- Physically realistic tendencies
- Conceptually simple and computationally cheap to implement

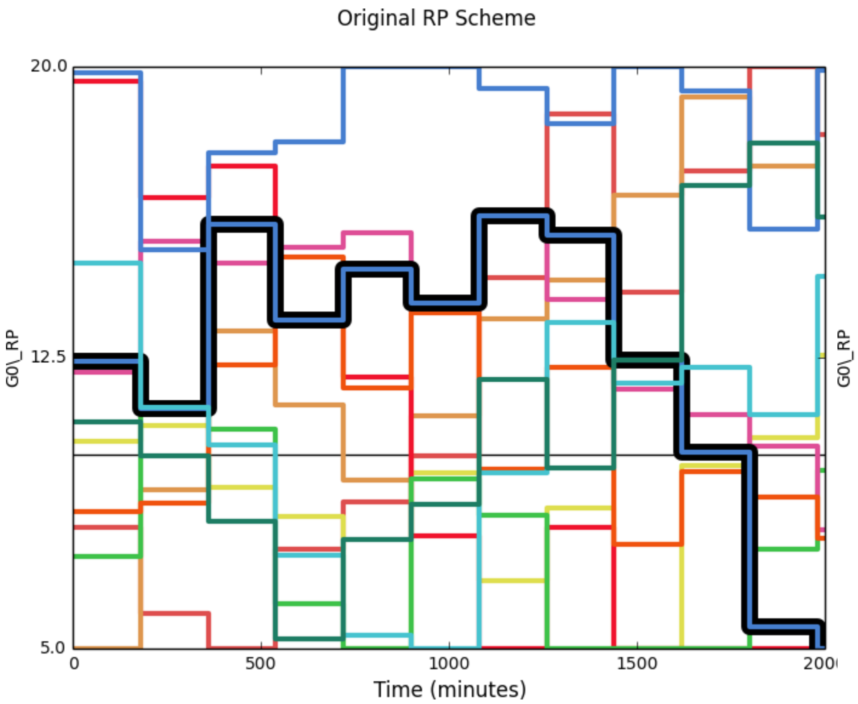
Difficulties:

- Needs to be regularly reviewed / revised as parametrizations change
- Choice of parameters and ranges can be subjective
- Modest impact on spread and skill
- Question of best time evolution of parameter values

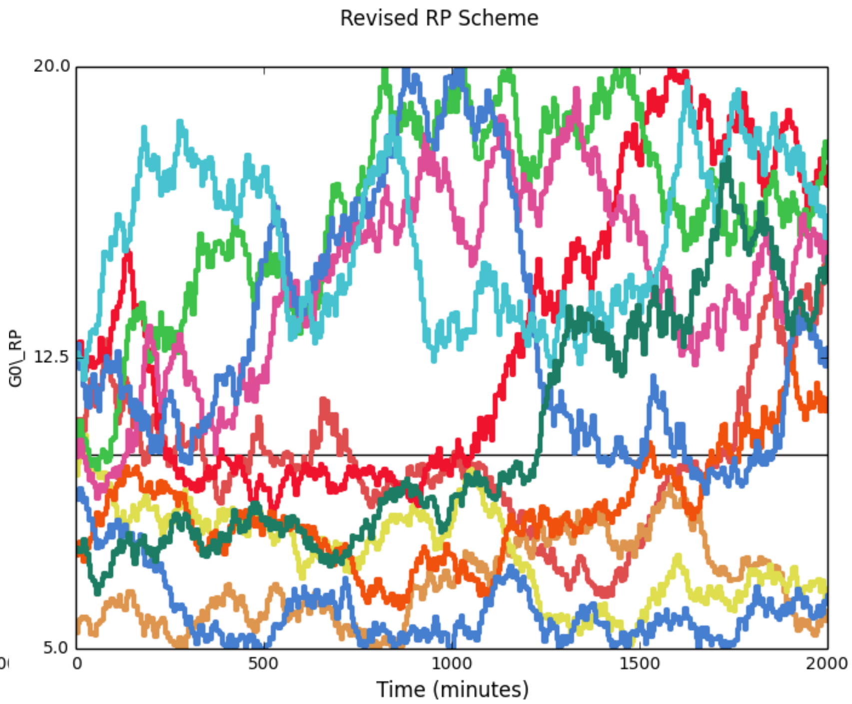
Improved RP algorithm

Slower, more smoothly varying parameter path

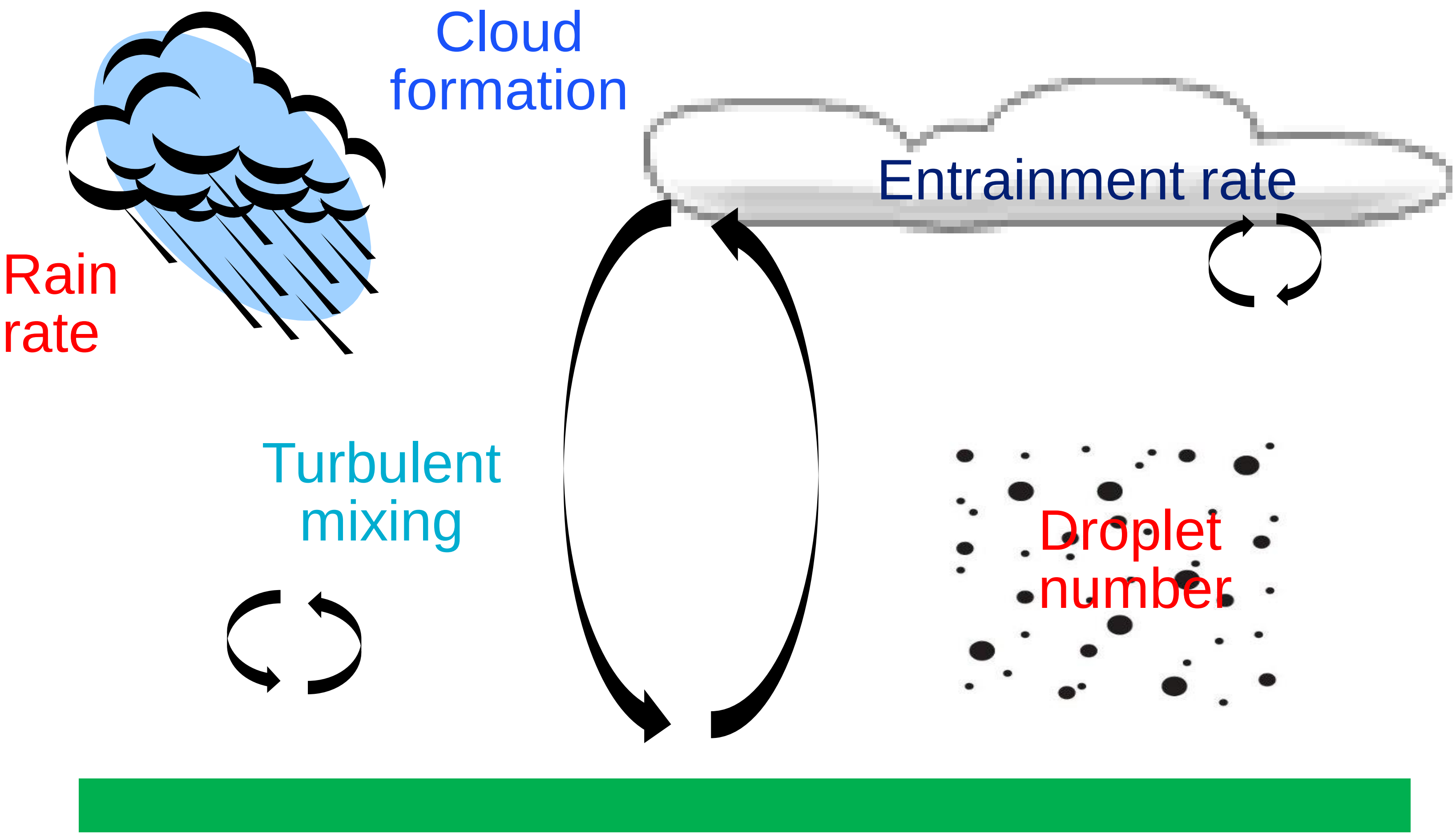
Original



Improved

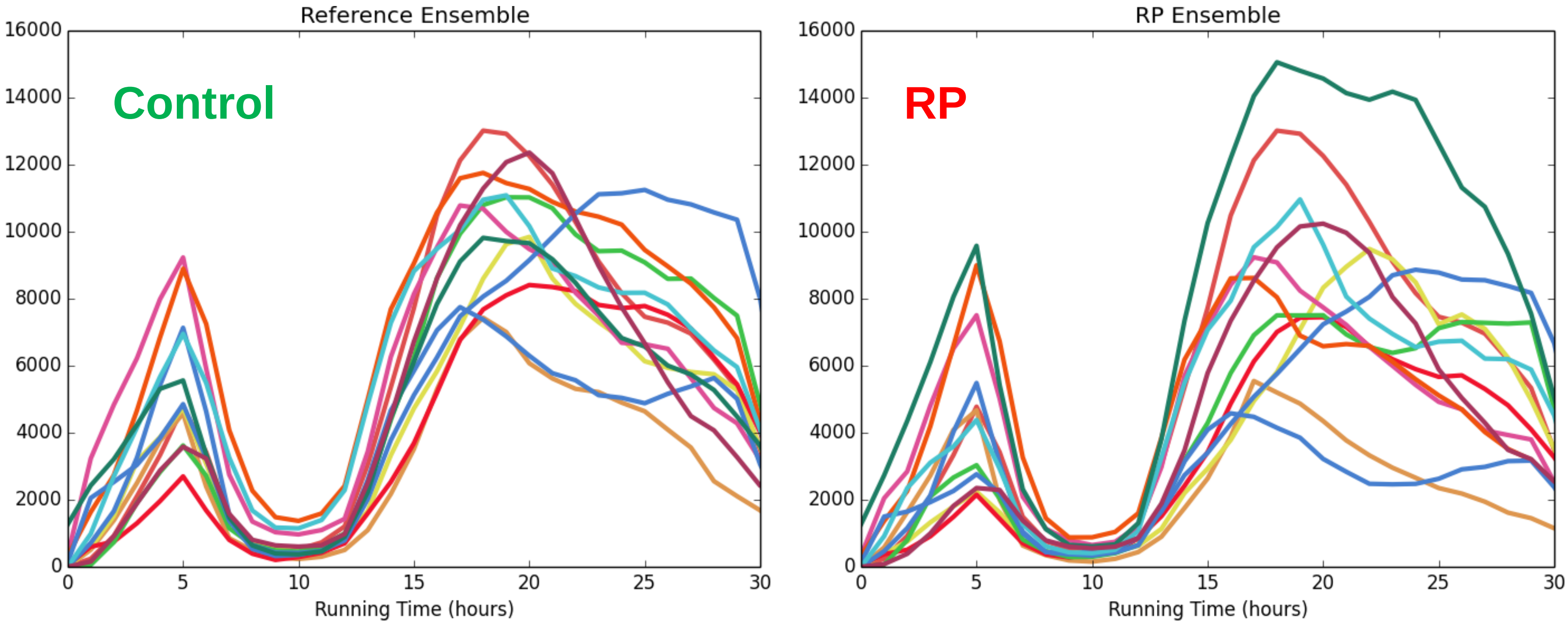


Parameters are chosen to target uncertainty at the small-scales



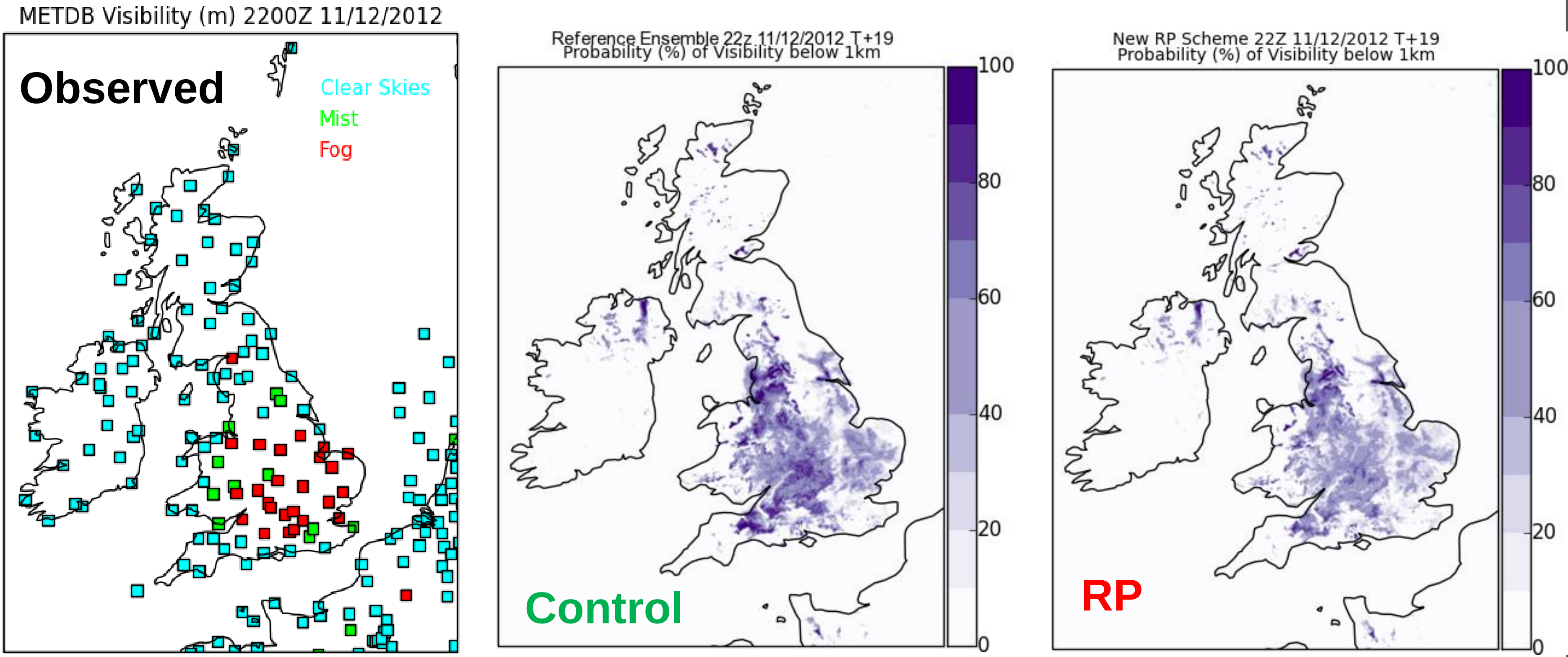
RP scheme increases variability in fog forecasts

Number of points with visibility < 1km, for each member



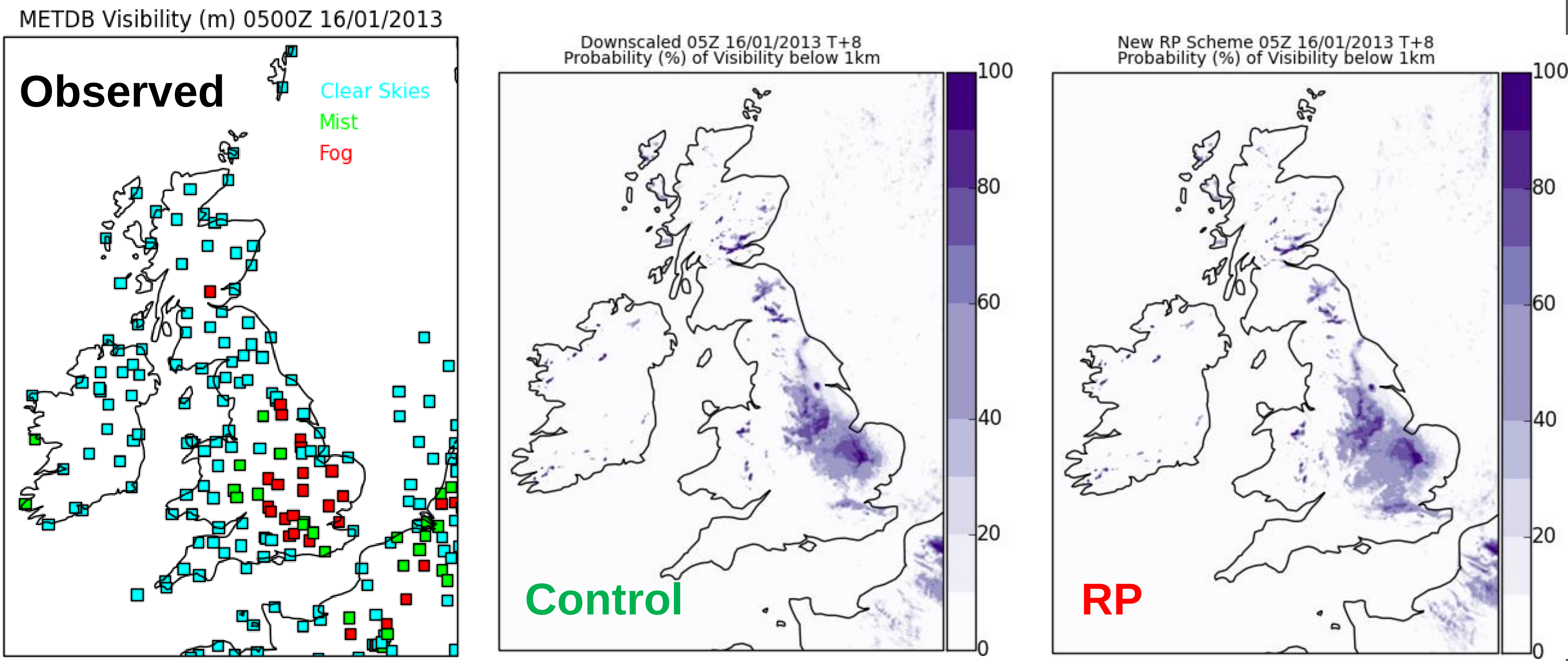
RP scheme reduces over-confident fog forecasts

Probability of fog. Winter case study.
11th – 12th December. T+19



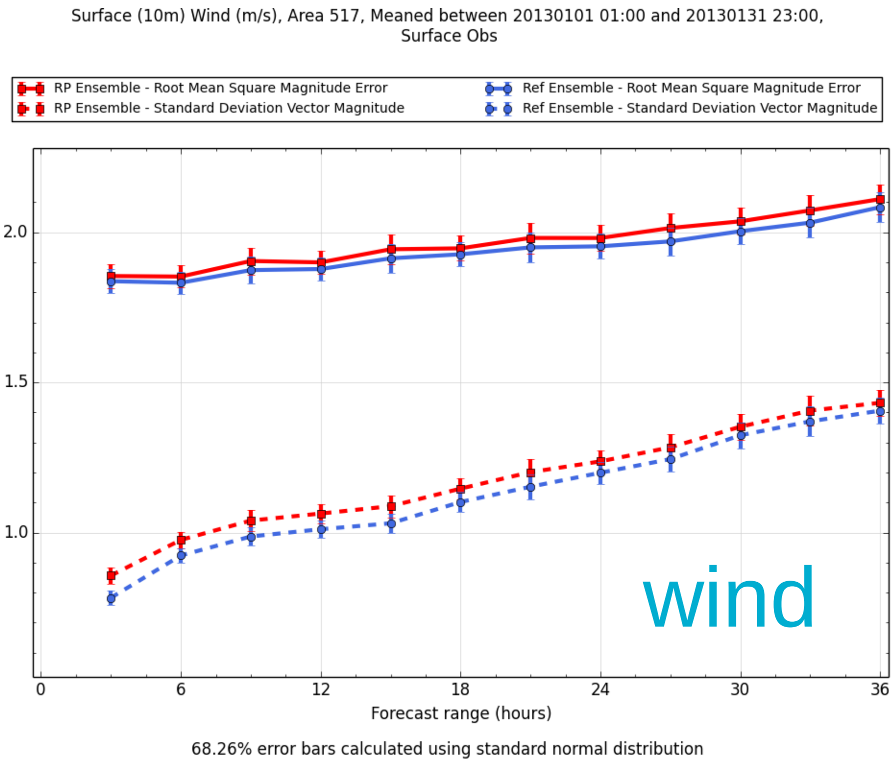
RP ensemble captures observed fog missed by control forecast

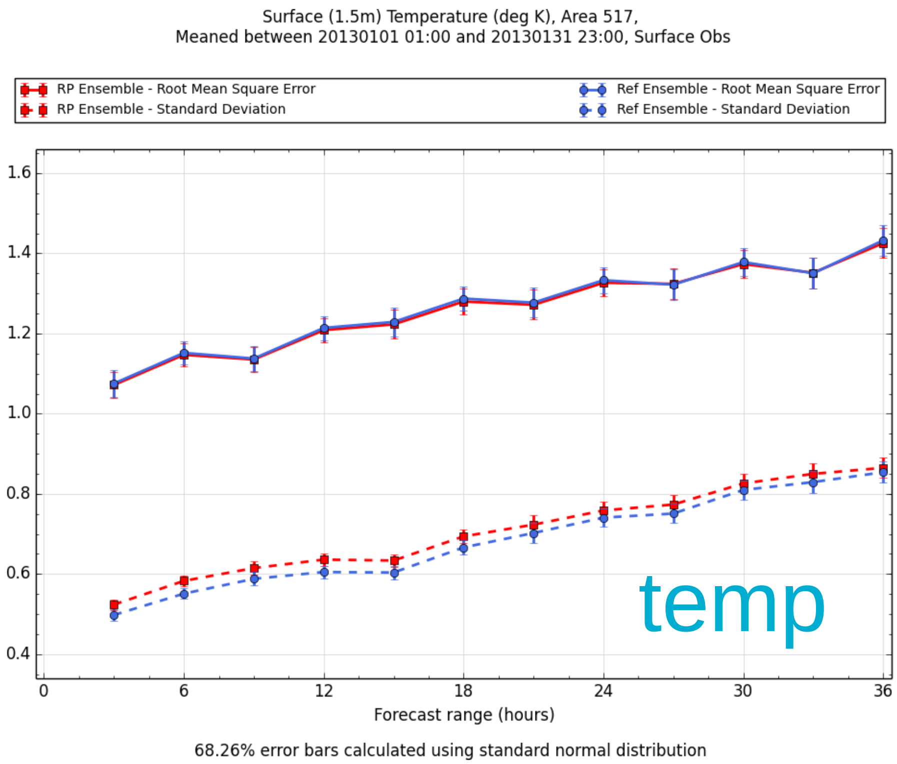
Probability of fog. Winter case study.
15th – 16th January. T+8



RP scheme increases spread in surface wind and temperature

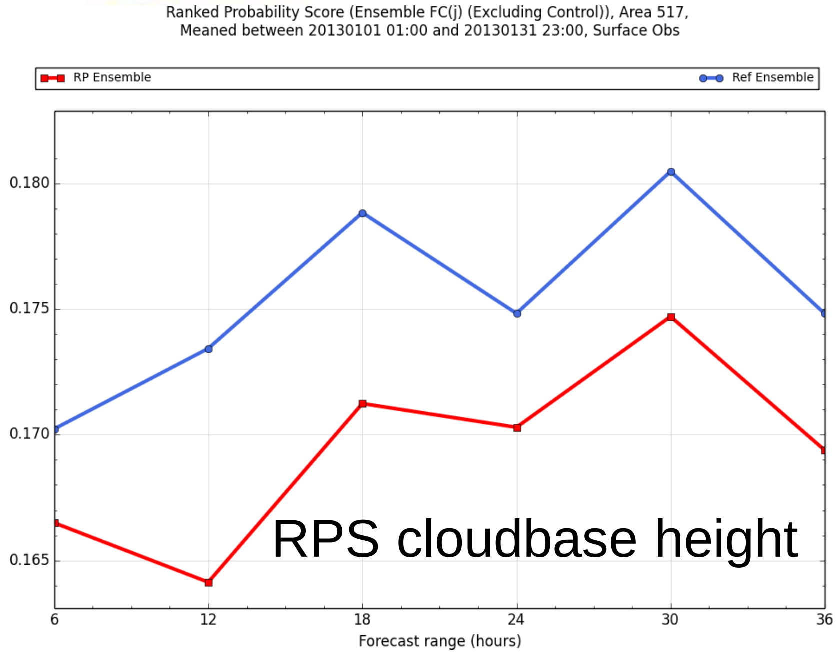
Increase in spread is small and the ensemble remains underspread

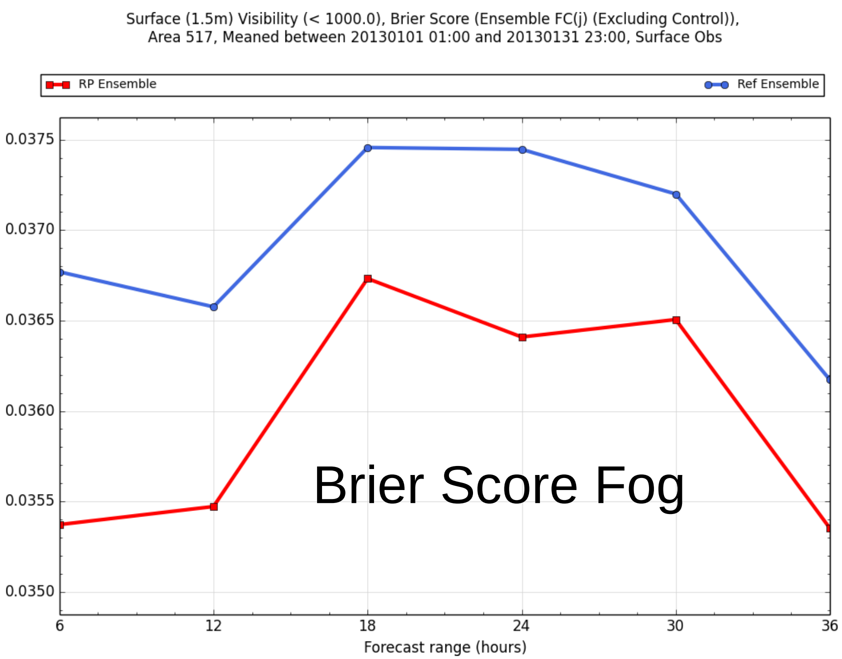


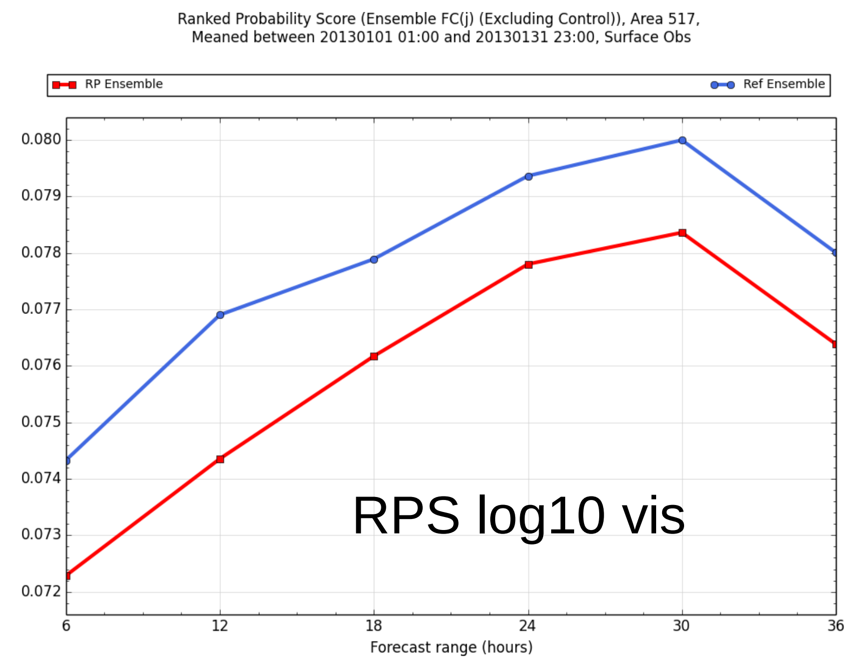


RP ensemble gives improved verification scores over month long trial for visibility and cloud base height

Plots compare RP and control ensembles







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Summary

- Improved RP scheme applied to convective scale ensemble prediction system
- Practical method to tackle known areas of model uncertainty
- Shown to be effective at increasing variability in fog forecasts in a physically realistic way
- Limited effect on verification scores – MOGREPS-UK remains underspread

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Ongoing & future work

Verification of fog forecasts – replace month long trials with a series of interesting fog case studies

Extensions of RP work:

- uncertainty in the **land-surface**
- **RP3** for global ensemble – see Warren Tennant's poster

Refinements to BL perturbations – **Adrian Lock** (Met Office), **Peter Clark** (Reading University) and **Carol Haliwell** (Met Office)

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Thank you for listening