MOGREPS status and activities

by Warren Tennant

with contributions from Rob Neal, Sarah Beare, Neill Bowler & Richard Swinbank

Contents

- New MOGREPS-W system
- Verification results of regional upgrade to 18kmL70
- Boundary-layer addition to Random Parameters scheme
- Early tests with Plant-Craig stochastic deep convection scheme
- Plans of future configurations

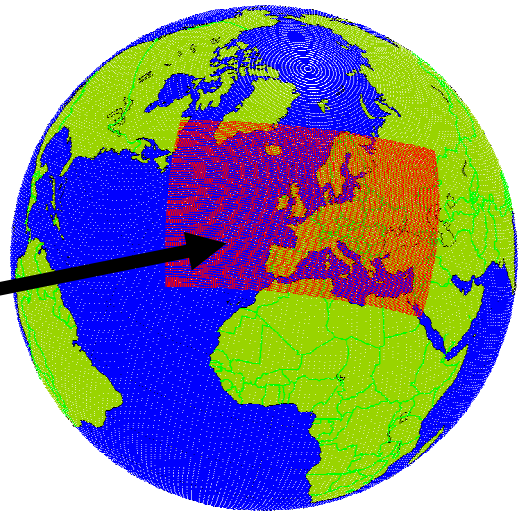
MOGREPS

Met Office Global and Regional Ensemble Prediction System

24 members | Operational since Sept 2008 after 3-years of trials

Global Component (MOGREPS-G)

- 60km, 70 Levels
- T+72h (mainly to drive MOGREPS-R)
- Run at 00Z and 12Z
- ETKF for IC perturbations
- Stochastic physics: SKEB2 and random parameters
- Also a run at ECMWF out to 15 days **(MOGREPS-15)**



Regional Component (MOGREPS-R)

- Runs over the North Atlantic and Europe (NAE)
- 18km, 70 Levels (operational since summer 2010)
- T+54h
- Run at 06Z and 18Z with boundary conditions from MOGREPS-G

MOGREPS-W

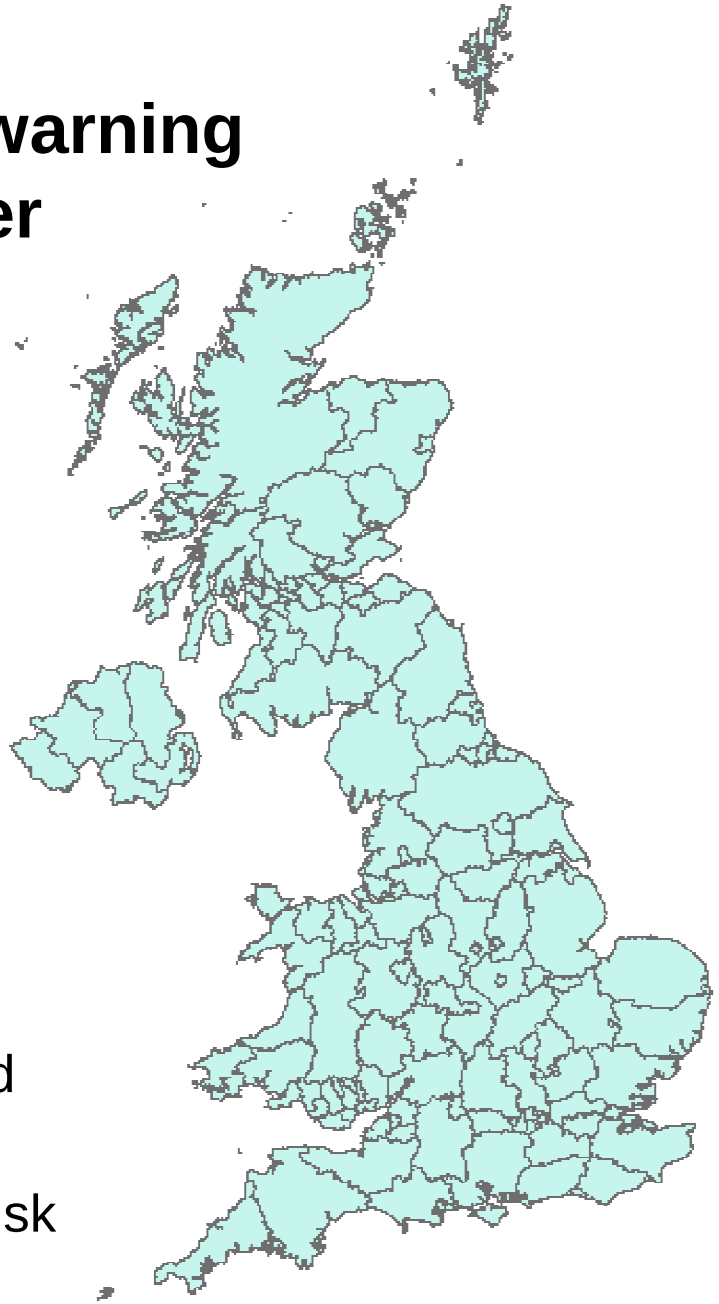
MOGREPS probabilistic warning system for severe weather

Introduction

- Running in trial mode since February 2010
- Uses MOGREPS-R
- Issues warnings for both severe and extreme rainfall, snowfall, and wind gusts, using criteria from the National Severe Weather Warning Service (NSWWS)

Aims of the system

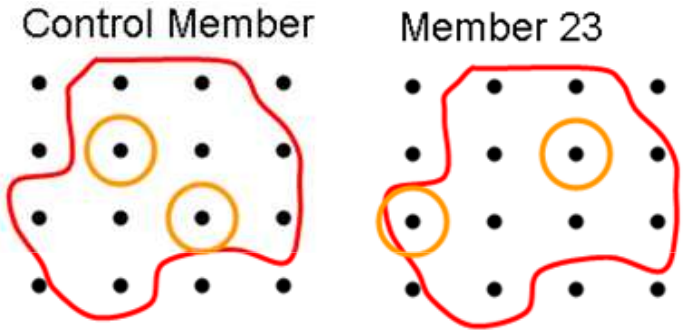
- Give forecasters advanced warning on upcoming severe weather, thus increasing lead time of any publicly issued weather warnings
- Provide a more objective basis for assessing risk and making probability statements



147 county/unitary authority areas in the UK

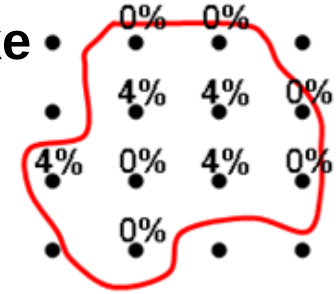
Area Probability Calculations

Example: In this county, assume only the control and member 23 contain grid points which exceed the parameter threshold (e.g. 40mph wind gusts)



Method 1 → Calculate probability at each grid point and then take the highest probability in each county

- ❑ No grid points exceed more than 1 member ensemble frequency (~ 4% area probability)



Method 2 → Calculate probability that the event will occur at any grid point within the county

- ❑ 2 out of 24 members exceed the parameter threshold at one or more grid points (~ 8% area probability)

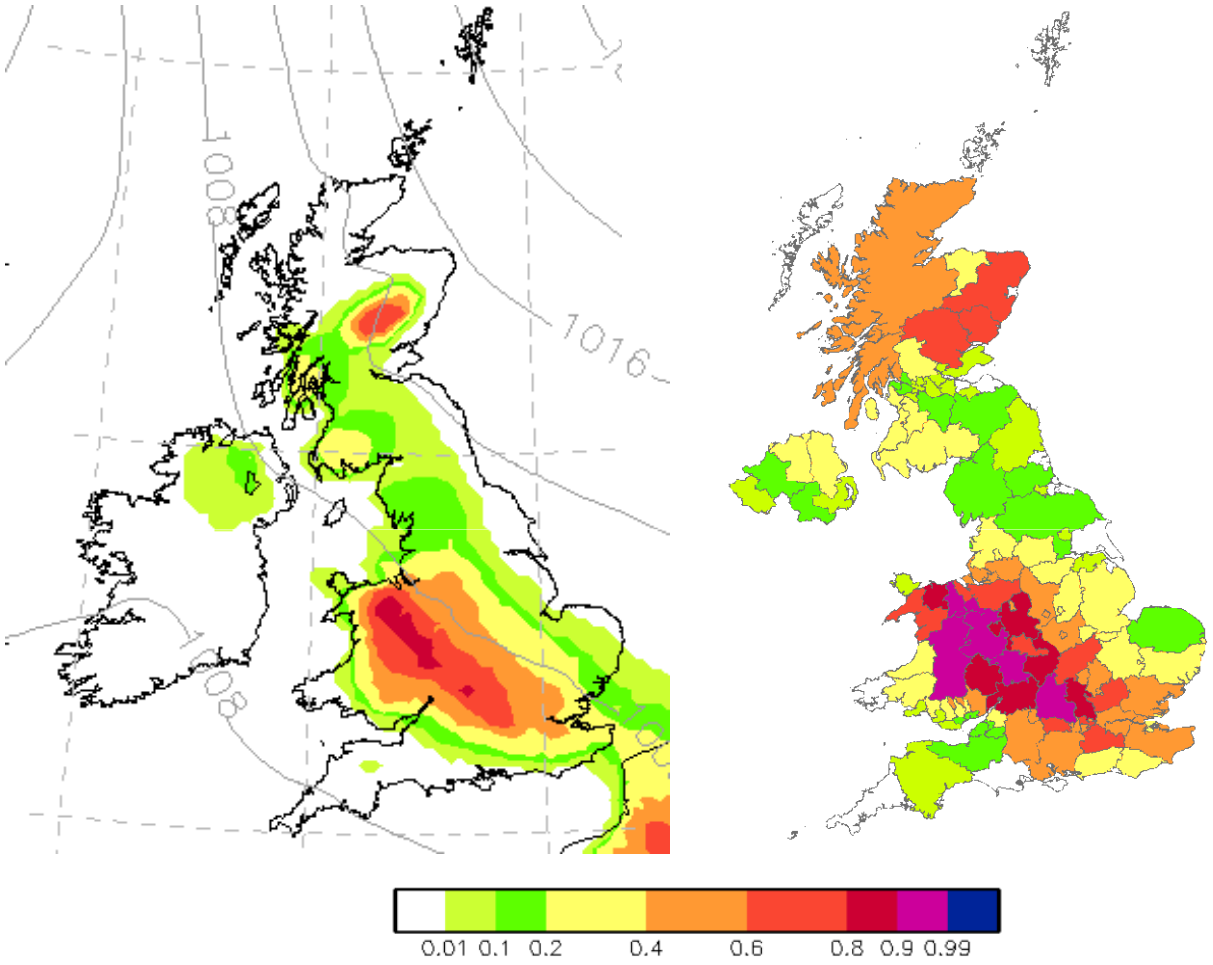
Method 2 chosen as it demonstrated greater utility for probabilities of events occurring within the county area.

DT 18Z 18/01/2010 (T+42h)

Probability 6hr Snowfall ≥ 1cm

Contoured grid-point probabilities

MOGREPS-W Area probabilities



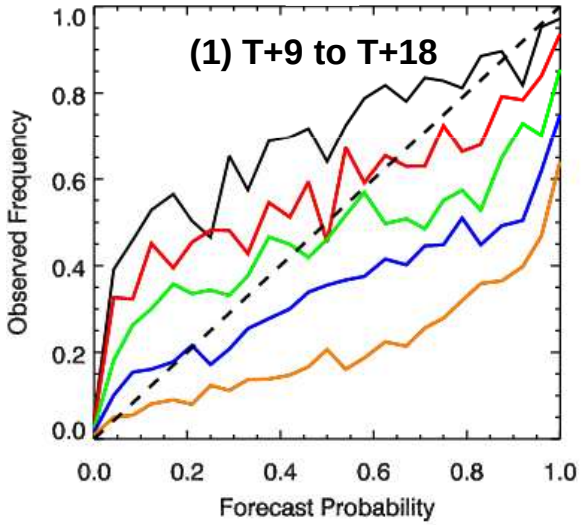
- **Larger counties trigger more warnings**
  - Highlands is shaded orange. Contains more grid points than any other county (397)
- **Higher probabilities generated from area calculations**
  - Some counties in Wales and England are coloured in a higher probability shade compared to the contour plot
- **It's useful to view these plots side-by-side**
  - A forecaster may issue a warning for the Highlands, but in the descriptive text say that only the far south-east will be affected

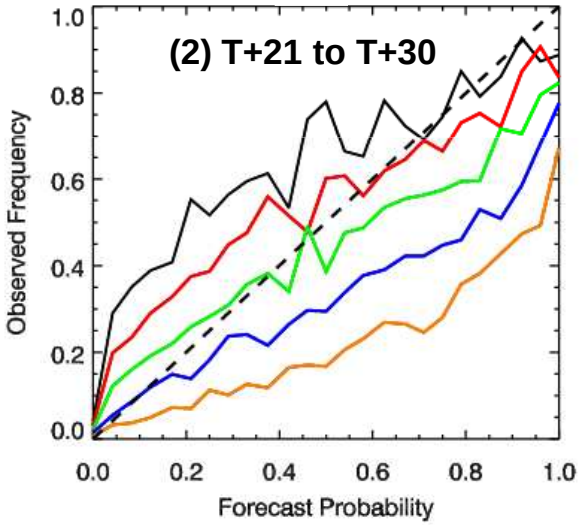
Calibration of 40mph wind gust forecasts

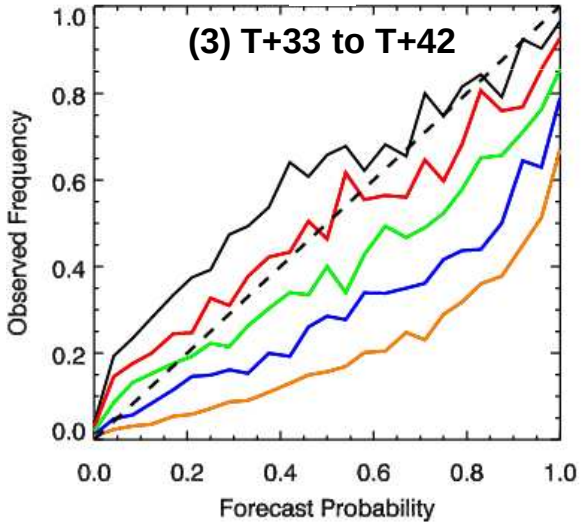
Period: *Feb & Mar 2010*

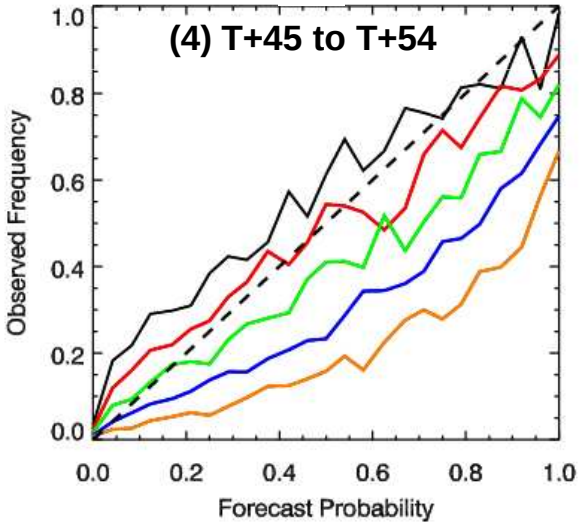
Verif score: *Reliability*

	43mph
	40mph
	37mph
	34mph
	31mph

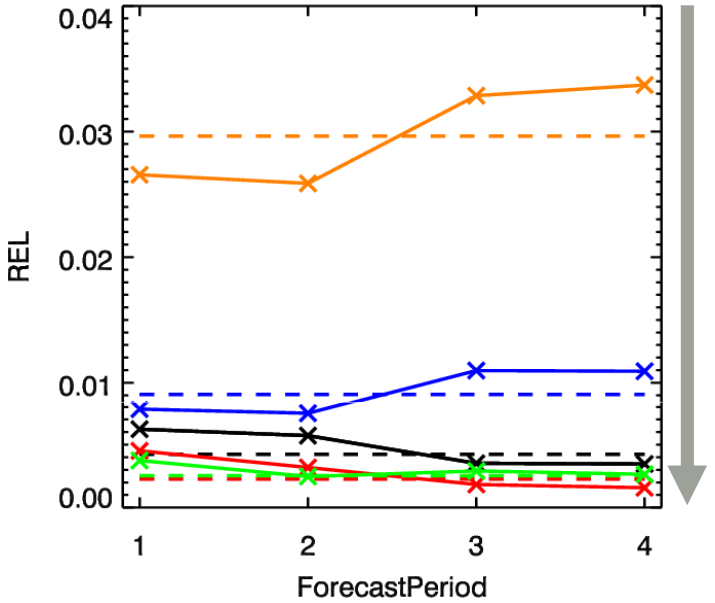








Reliability Score



$$REL = \frac{1}{N}\sum_{i=1}^{I} n_i (f_i - o_i)^2$$

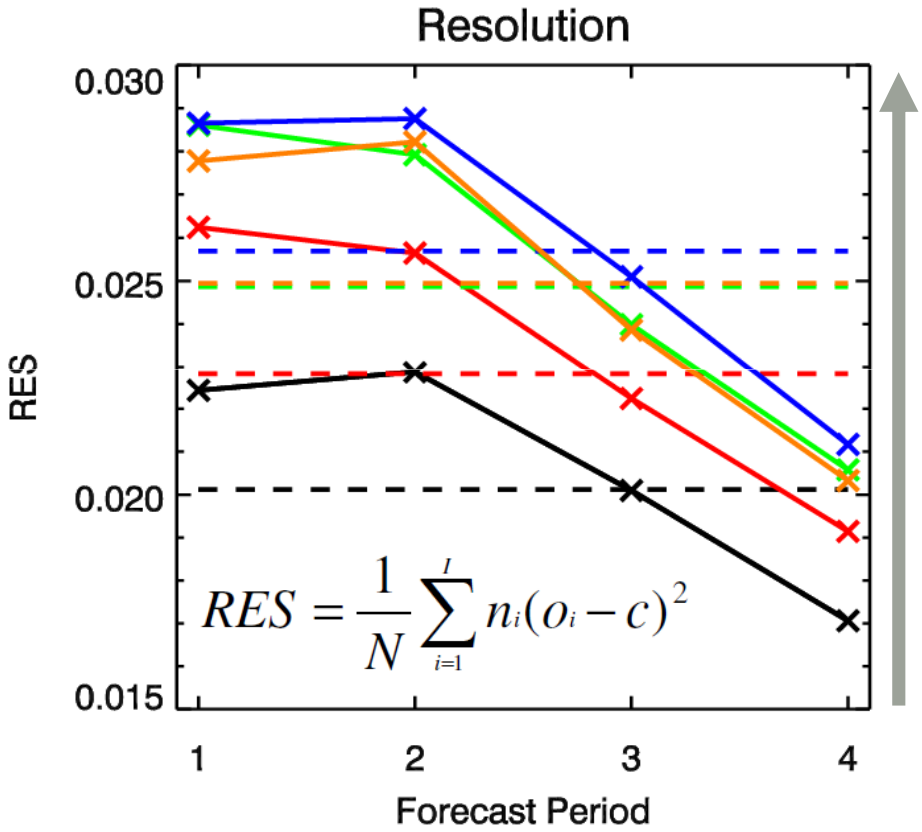
Calibration of 40mph wind gust forecasts

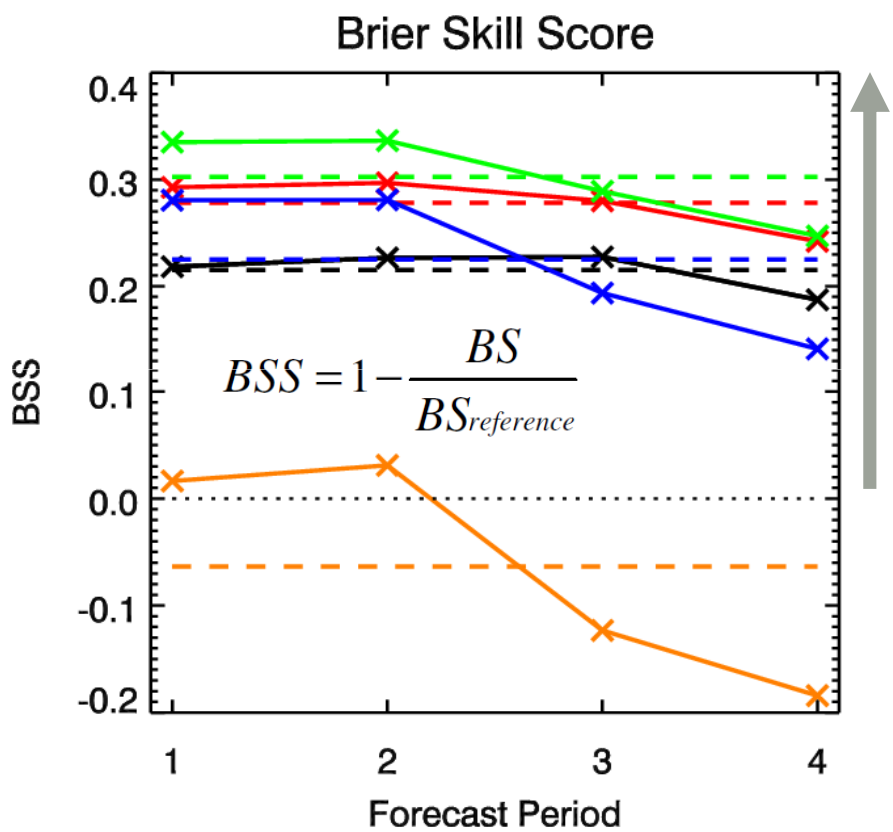
Period: *Feb & Mar 2010*

Verif score: *Resolution and BSS*

- Lower thresholds have better resolution
- Higher thresholds best reliability
- Mid-ranges have and BSS – e.g. use 37mph

43mph
40mph
37mph
34mph
31mph

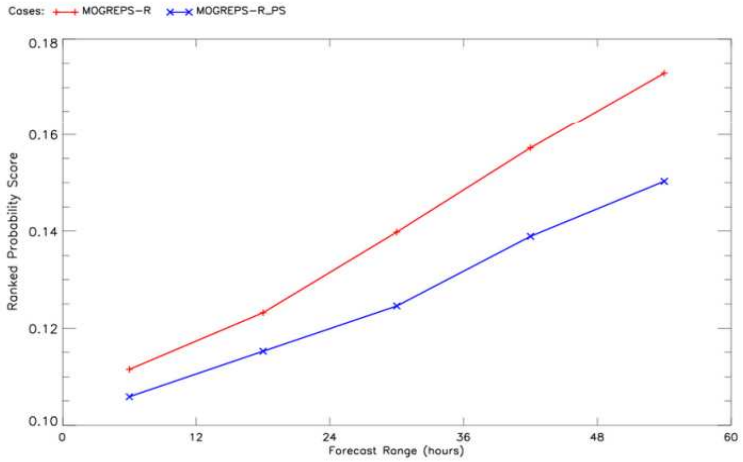




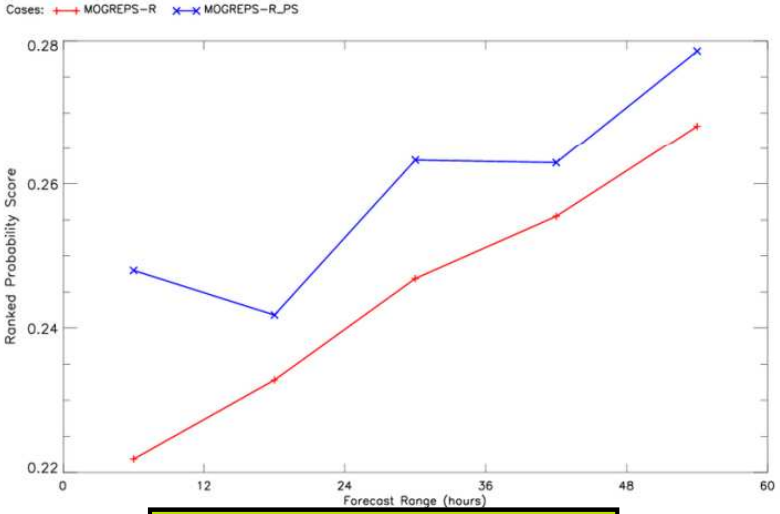
MOGREPS-R upgrade to 70 levels

Ranked Probability Score
Area: Full NAE domain

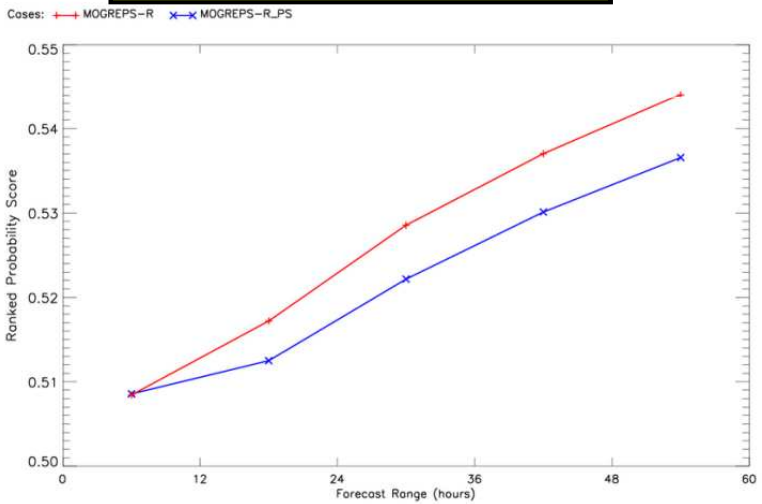
850hPa Temperature



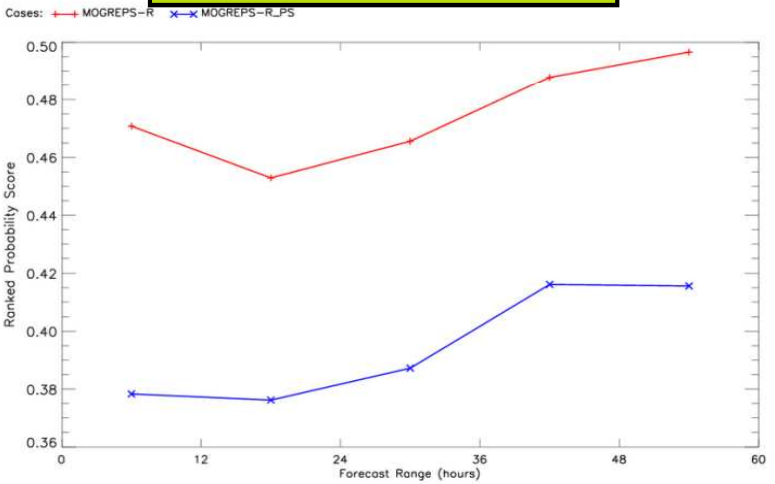
2m Temperature



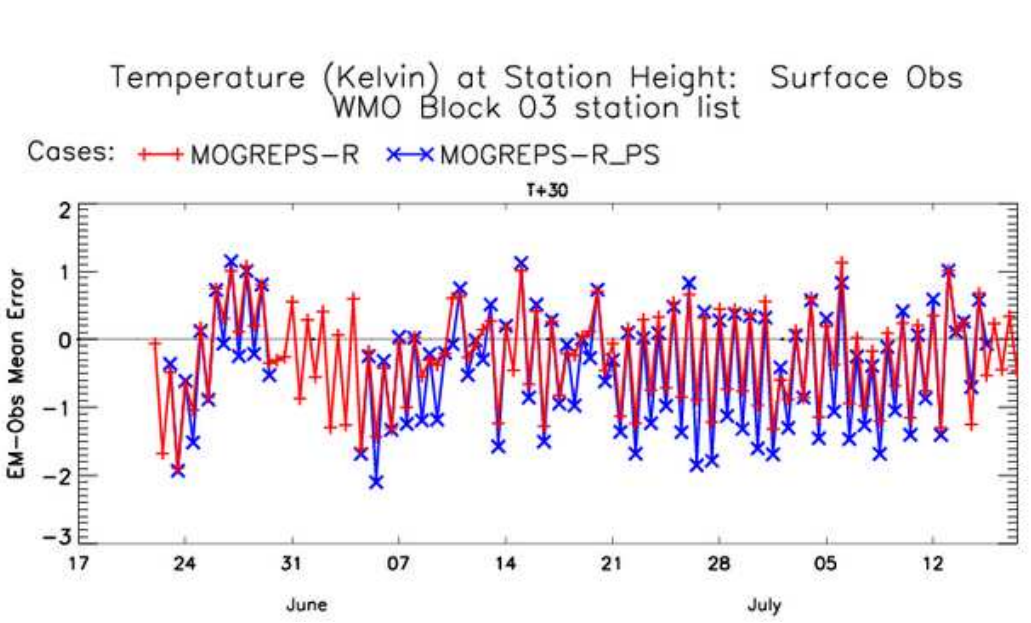
10m wind speed

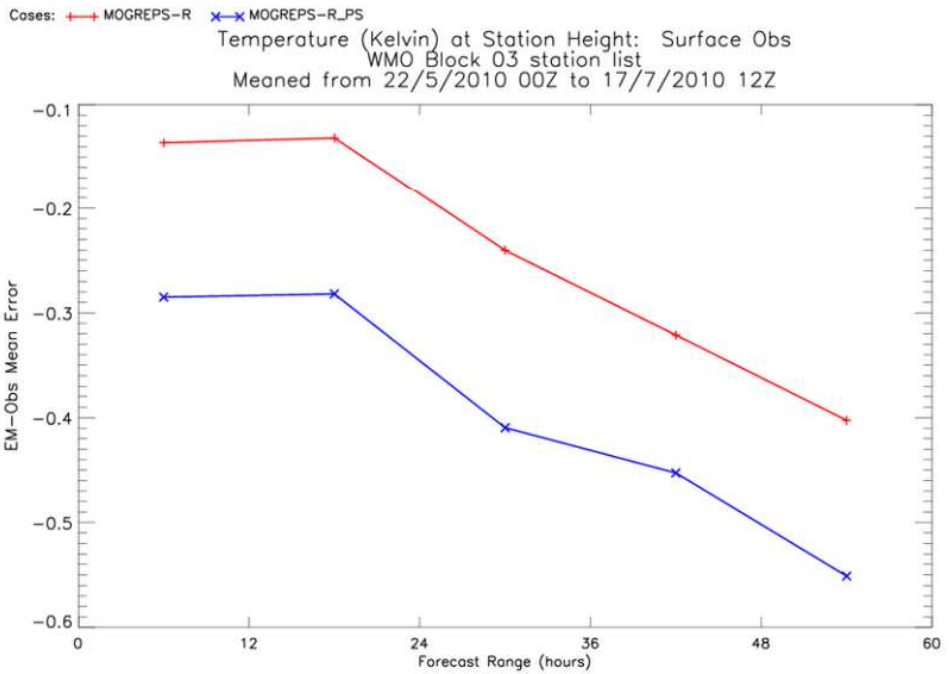


6hrly Precipitation



MOGREPS-R upgrade to 70 levels





- Increasing negative systematic error in surface temperature at 12Z
- Possibly related to:
  - increased cloud in 70L model
  - need for re-calibration of T-sfc diagnostics

Low-level Cloud :: Additional Boundary-Layer Random Parameters

- Forecasters identified an acute problem with stratocumulus cloud representation in the UM during Dec 2008 – created a problem for surface temperatures
- One factor was the strength of the capping inversion above the boundary layer
- An increase from 38 to 70 levels made a significant improvement
- Some work was also done on expanding the Random Parameter scheme

Low-level Cloud :: Additional Boundary-Layer Random Parameters

Parameter	Expected impact
g_0	varies Louis stability function
g_{mezcla}	modifies the neutral mixing lengths
λ_{min}	defines minimum mixing length
Ri_c	varies critical Richardson number for long-tails and Louis functions
A_1	vary the entrainment rate calculation at the top of the boundary layer
g_1	varies the diffusion coefficient at cloud-top driven turbulence

Low-level Cloud :: Additional Boundary-Layer Random Parameters

Station: 56.90N 3.35E (North Sea Oil Rig)

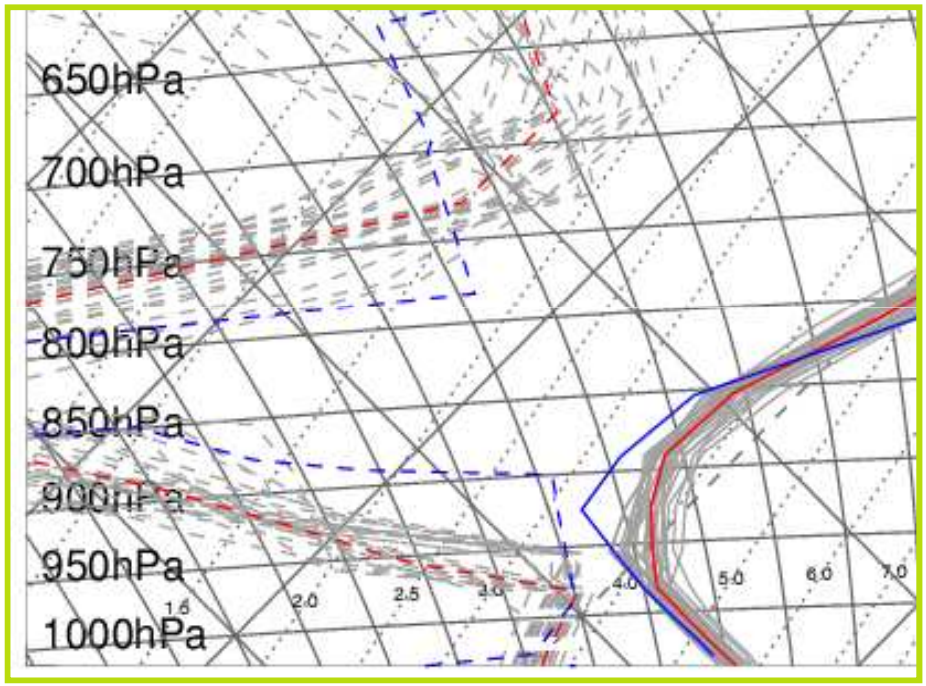
38-level

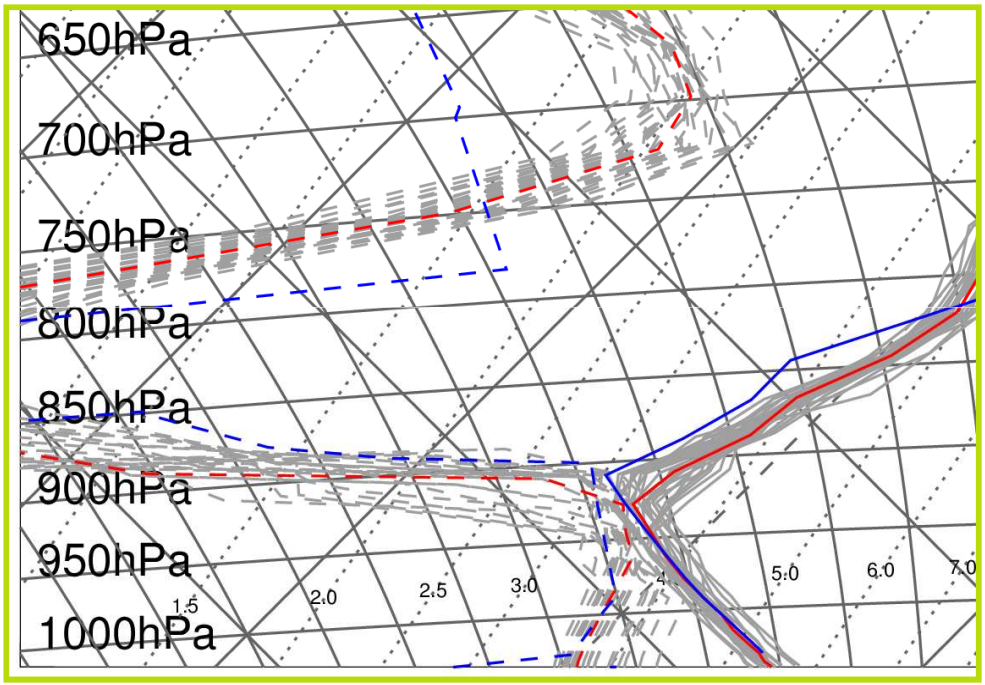
– weak inversion

– bndy-layer too shallow

70-level

– inversion better resolved





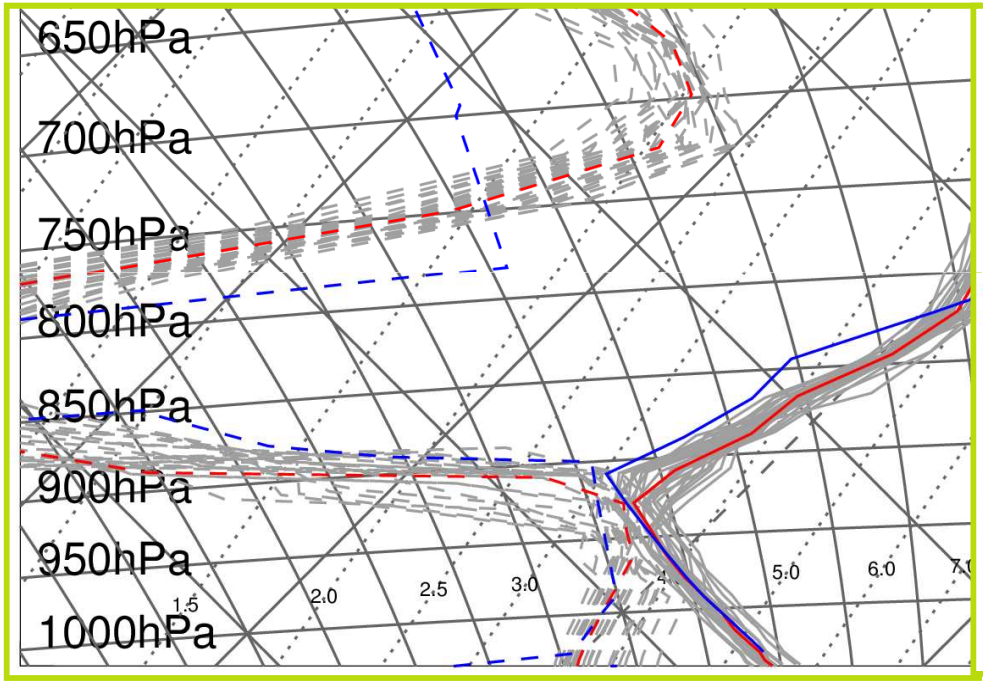
Low-level Cloud :: Additional Boundary-Layer Random Parameters

Station: 56.90N 3.35E (North Sea Oil Rig)

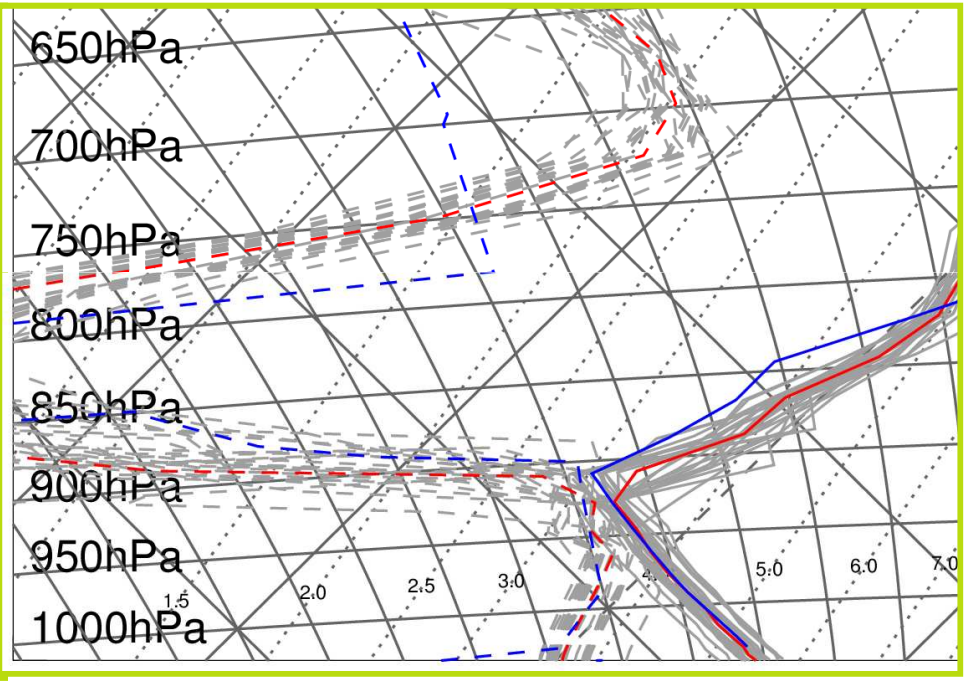
– sharper temperature inversion in perturbed members

– increased spread in dew point around level of inversion suggesting increased spread in depth of boundary layer

70L Control

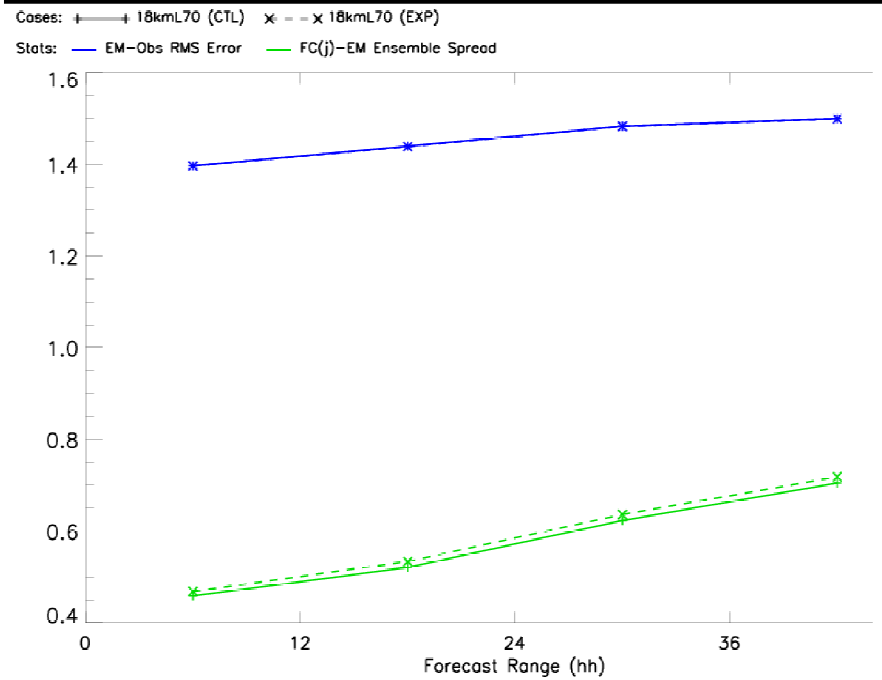


70L Experiment (RP2+)

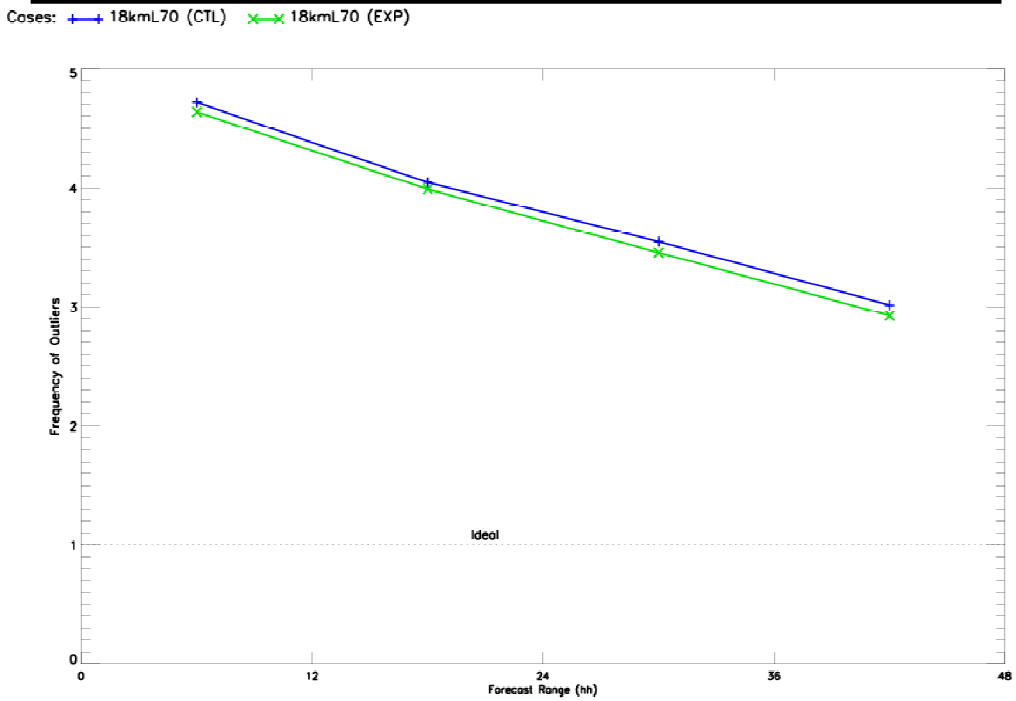


Low-level Cloud :: Additional Boundary-Layer Random Parameters

SfcT Ens Mean Error & Ens Spread



T850 frequency of outliers

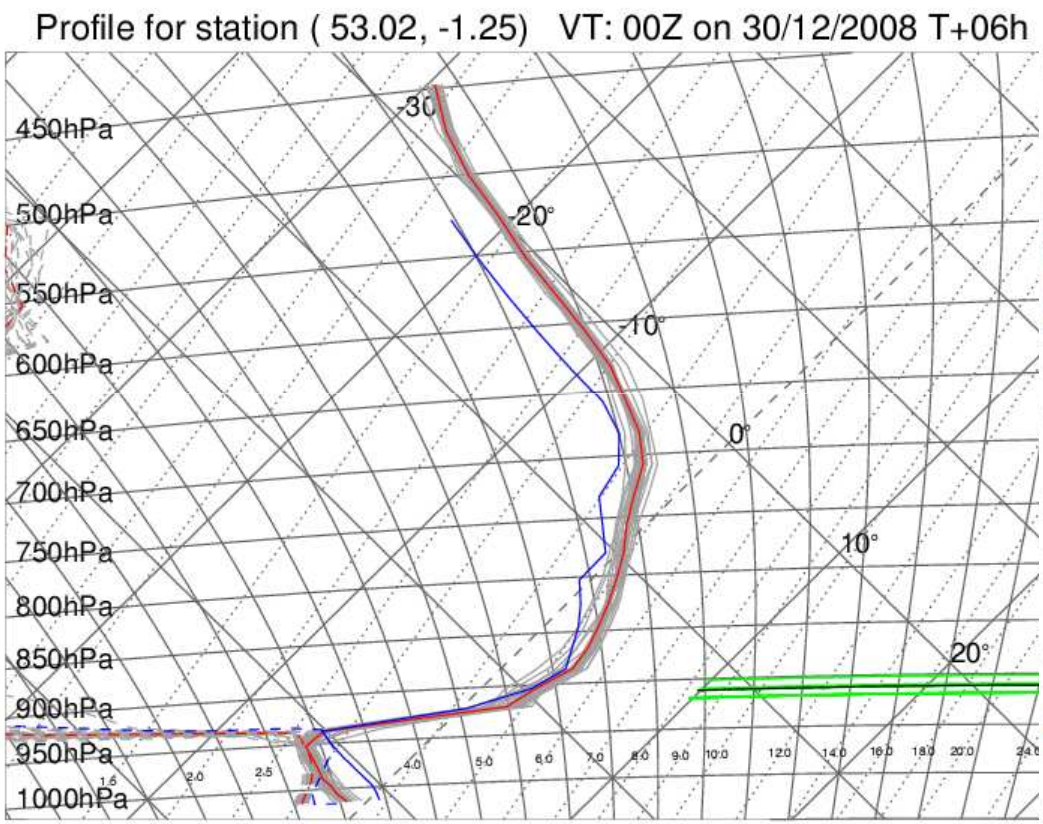


- Only a small (but positive!) impact on time-area average statistics with increased spread and reduced outliers in sfc and 850T

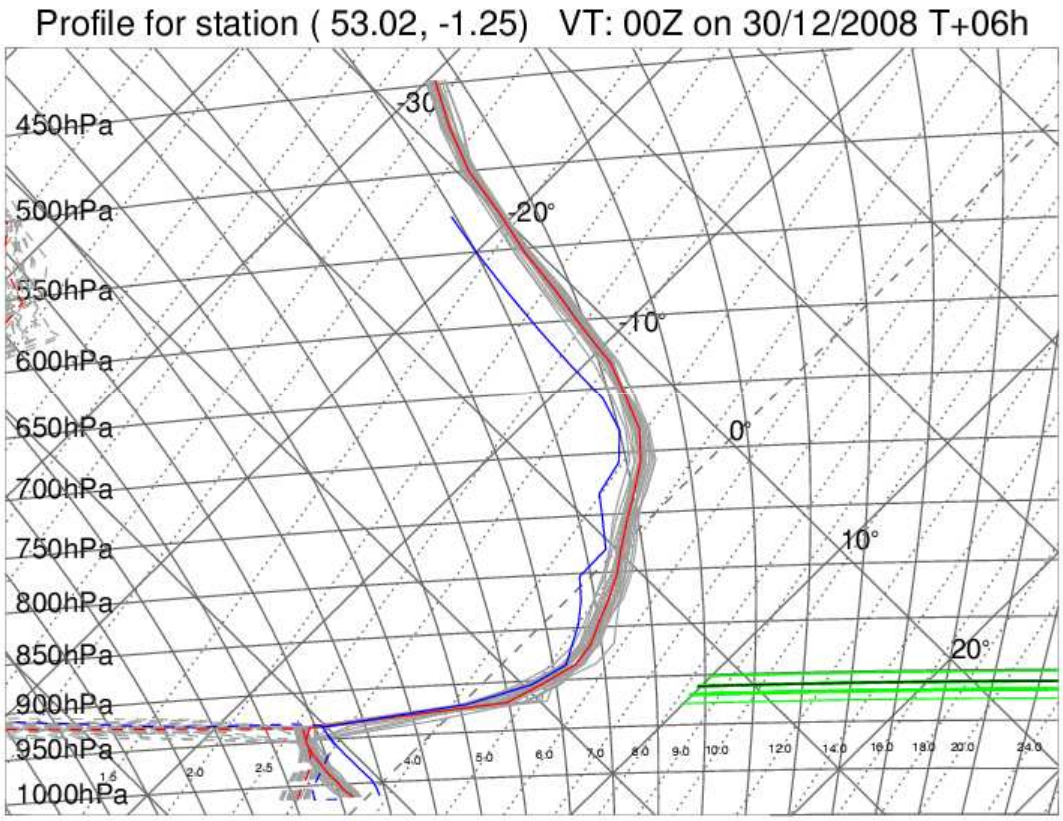
Systematic errors :: boundary layer too cold

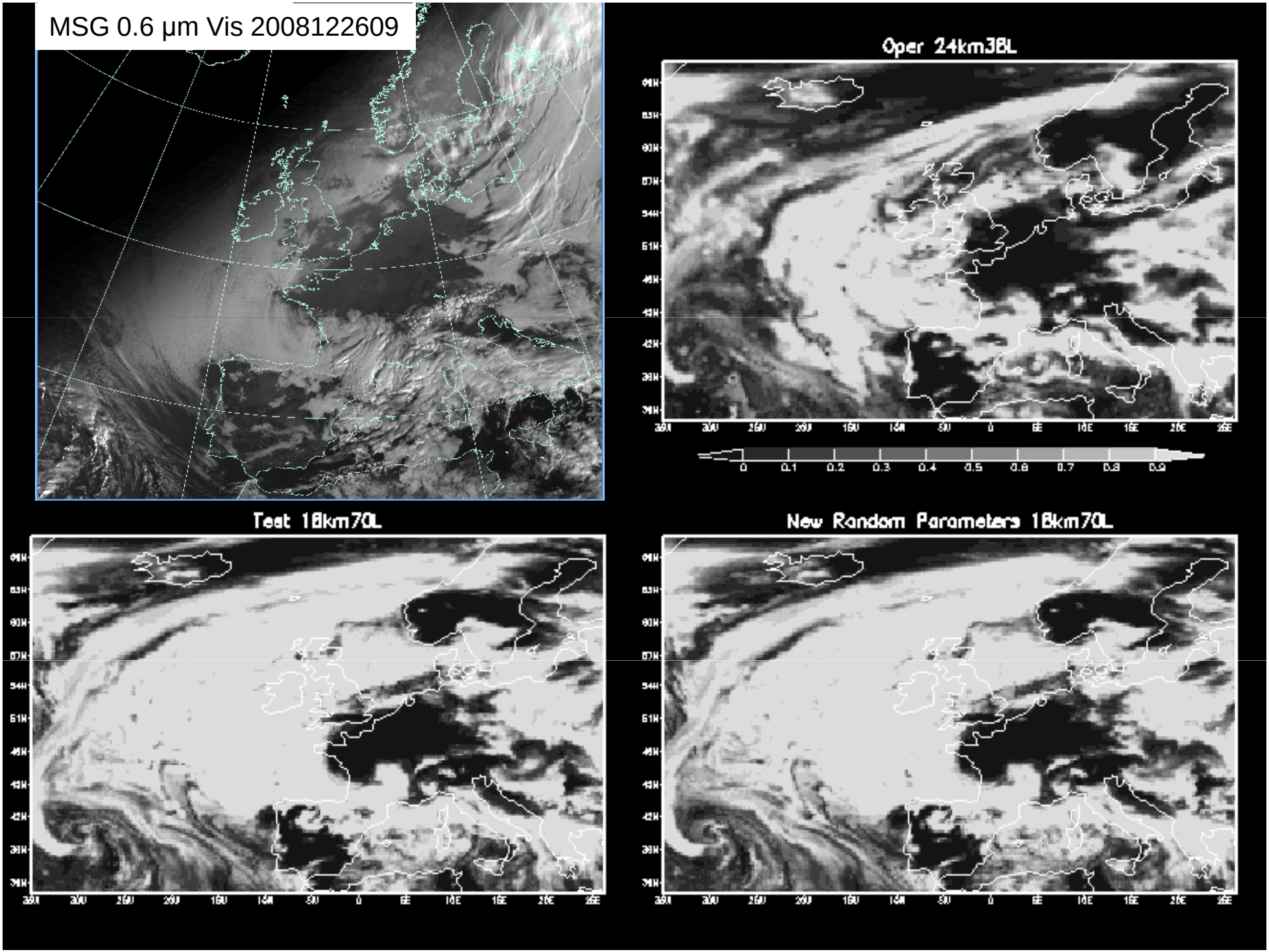
– despite increased spread in height of inversion, the cold error in the boundary layer remains

Control



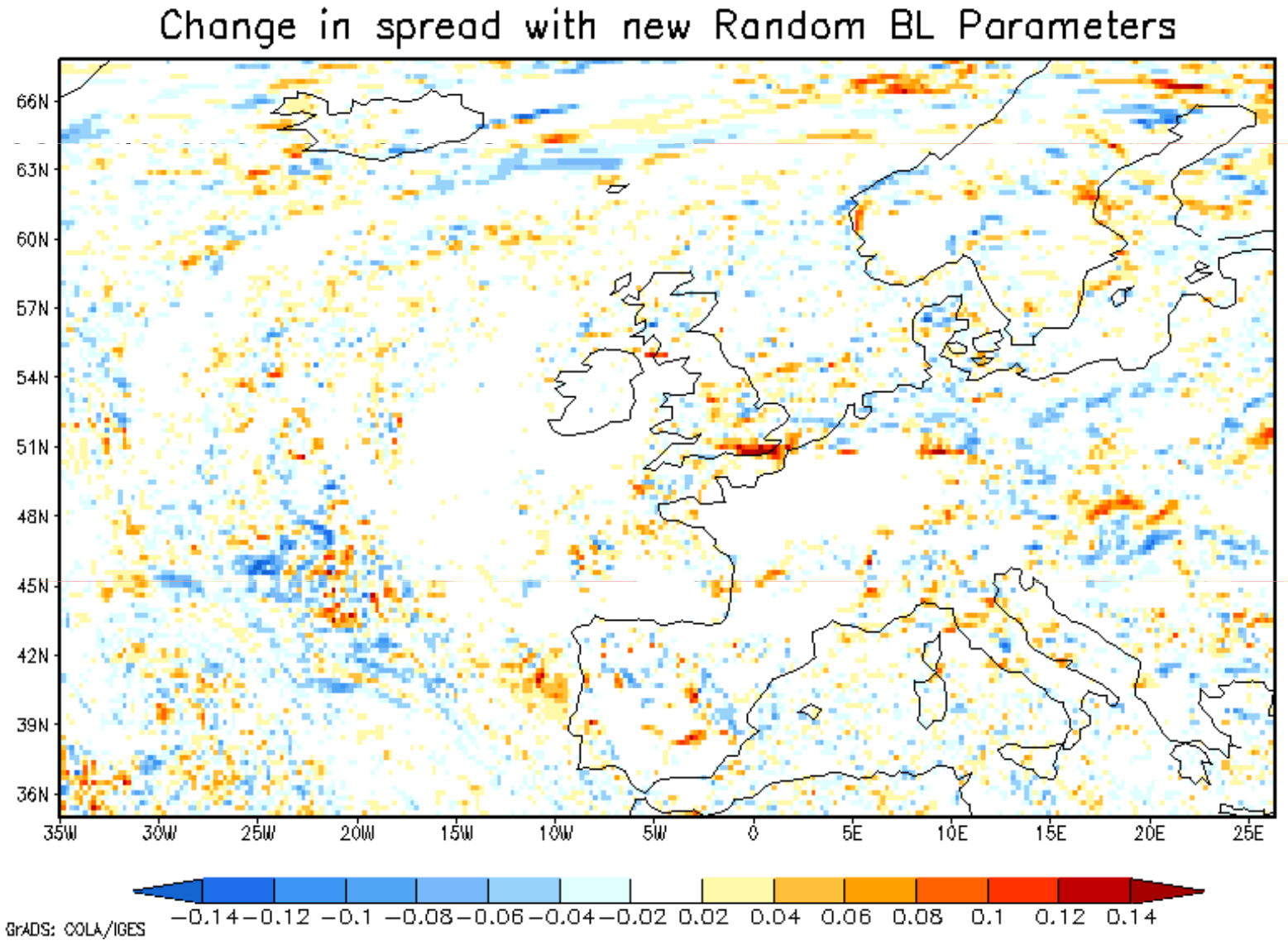
Experiment (RP2+)




MSG 0.6 µm Vis 2008122609
Oper 24km38L
Test 18km70L
New Random Parameters 18km70L

Low-level Cloud :: Additional Boundary-Layer Random Parameters

- 70-level
  significa
  reduced
- Addition
  increase
  uncertai

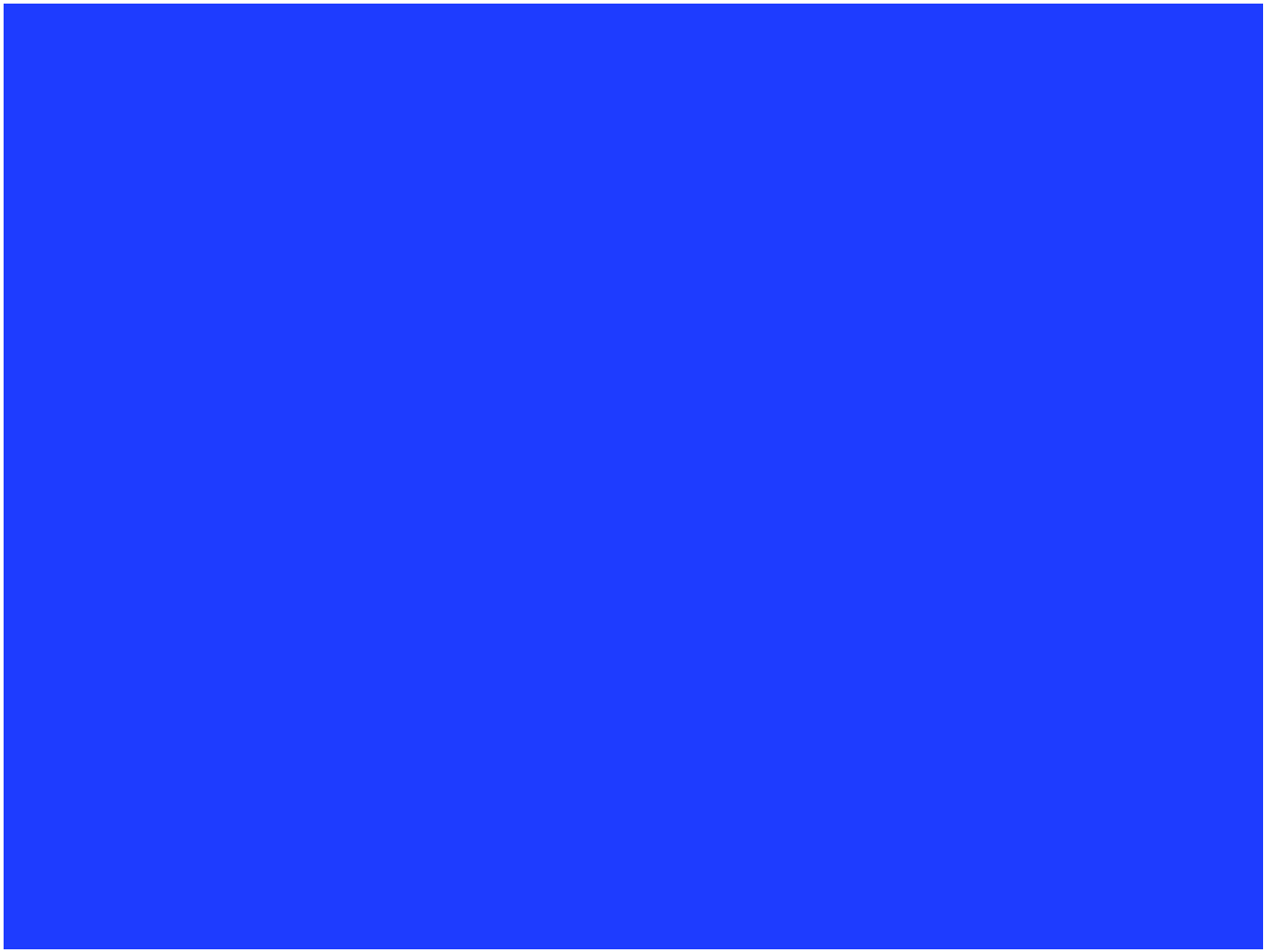


Plant-Craig Stochastic Convection Scheme

- Stochastic variability describes local fluctuations around a large-scale mean state
- Plumes are drawn randomly from a PDF of plume likelihood (of a given size) in a grid box
- PDF is normalised using ensemble mean mass flux using a CAPE closure method
- Developed in research environments and tested on single column version of the UM
- Implemented in the UM at the Met Office to trial in a MOGREPS-R suite

Plant-Craig Stochastic Convection Scheme

- 1 month trial in July 2009 of MOGREPS-R at 24kmL38
- Some stability issues which need further work
- Stochastic scheme demonstrates more variability
- Accumulations still too stochastic



MOGREPS PLANS (2011-2012)

...changes following HPC upgrade in late 2011...

Global Component (MOGREPS-G)

- 40km, 70 Levels (or whatever set is used in the deterministic model)
- T+72h *... [15-day forecasts will continue as is at ECMWF for TIGGE]*
- 12-members run at 00Z, 06Z, 18Z and 12Z (lagged combination)
- ETKF for IC perturbations *... [new EnDA group is assessing options]*
- Stochastic physics: SKEB2, random parameters, **SPPT, surface schemes**

Regional Component (MOGREPS-R)

- Reduced NAE domain (Euro4M grid) [or to match public spending cuts!]
- 12km, 70 Levels (testing other vertical levelsets)
- T+54h
- Run at 03Z, 09Z, 15Z and 21Z with LBCs from MOGREPS-G

Convective-Scale Component (MOGREPS-UK)

- 1.5km, 3 perturbed members, T+36

Questions and Answers