



The Met Office Short-Range Ensemble System – MOGREPS

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Outline

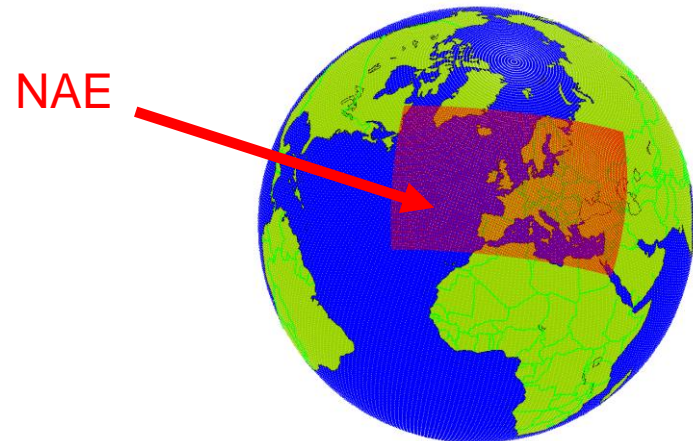
- Overview of MOGREPS
- Recent science upgrades
 - Forthcoming resolution increase
 - Localisation of the ETKF
 - Horizontal
 - Vertical
 - SKEB-2
- One high-impact weather example



Met Office

MOGREPS – The Met Office short-range ensemble

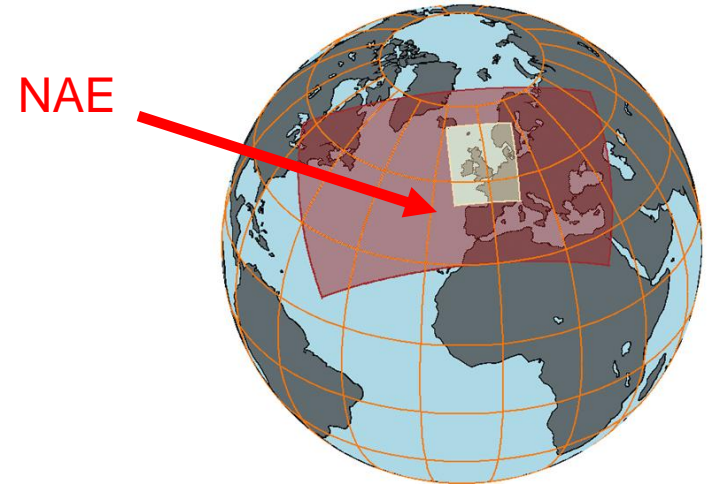
- 24-member ensemble designed for short-range forecasting
 - Regional ensemble over N. Atlantic and Europe (NAE) (24km resolution, 38 levels) to T+54
 - Global ensemble (~90km resolution, 38 levels) to T+72
 - MOGREPS-15 runs to 15 days at ECMWF for TIGGE
 - ETKF for initial condition perts (global only)
 - Stochastic physics – SKEB (global only) and Random Parameters
 - MOGREPS-G run at 0Z and 12Z
MOGREPS-R run at 6Z & 18Z
- Built using many US research ideas!



MOGREPS became fully operational in Sep 2008 after 3 years of trials

2009-10 Resolution Upgrades

- Global
 - 90km L38 to **60km L70**
 - T+72
 - 00 and 12UTC
 - MOGREPS-15 mirrors
- Regional
 - 24 km L38 to **18km L70**
 - T+54
 - 06 and 18UTC
- Due to go operational mid-January 2010



Further ahead:

- Surface perturbations
- 1.5km convective scale UK EPS
- Rapid update etc
- Wave ensemble

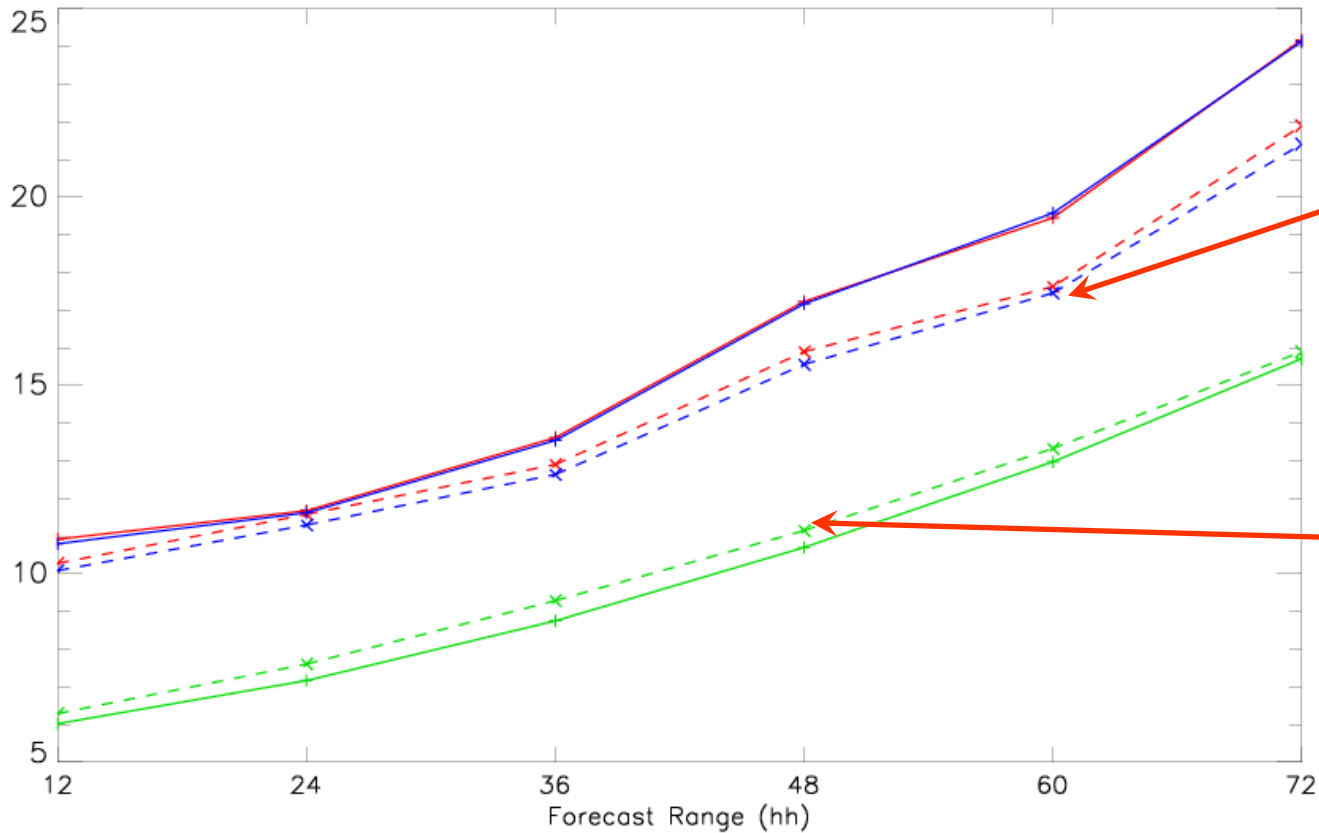


Resolution upgrade in global

Height (metres) at 500.0 hPa: Sonde Obs
Europe CBS station list
Meaned from 10/6/2008 00Z to 30/6/2008 12Z

Cases: + —+ N144L38 × - - × N216L70

Stats: — FC-Obs RMS Error — EM-Obs RMS Error — FC(j)-EM Ensemble Spread



On resolution upgrade:

- decreased error in control and ensemble mean

- increased spread

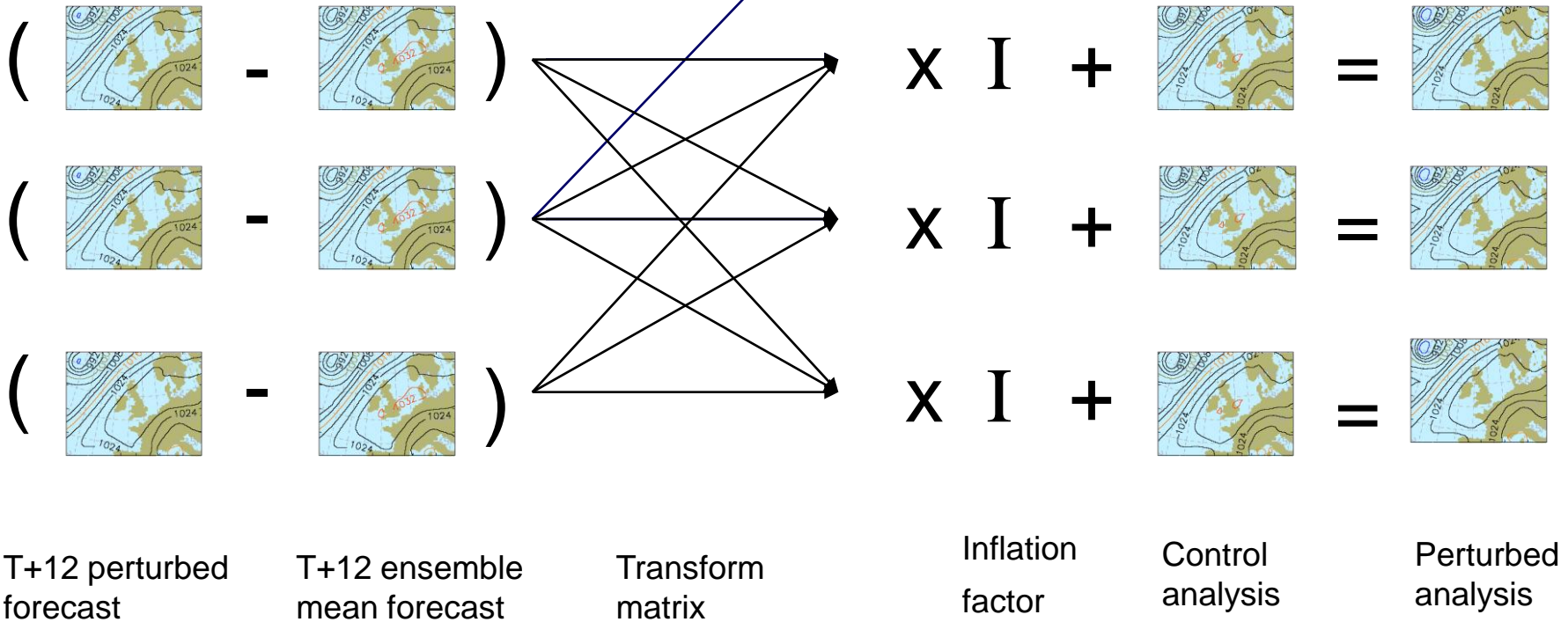


Initial Condition Perturbations



Ensemble Transform Kalman Filter (ETKF)

$$X^a = X^f T \Pi_n$$

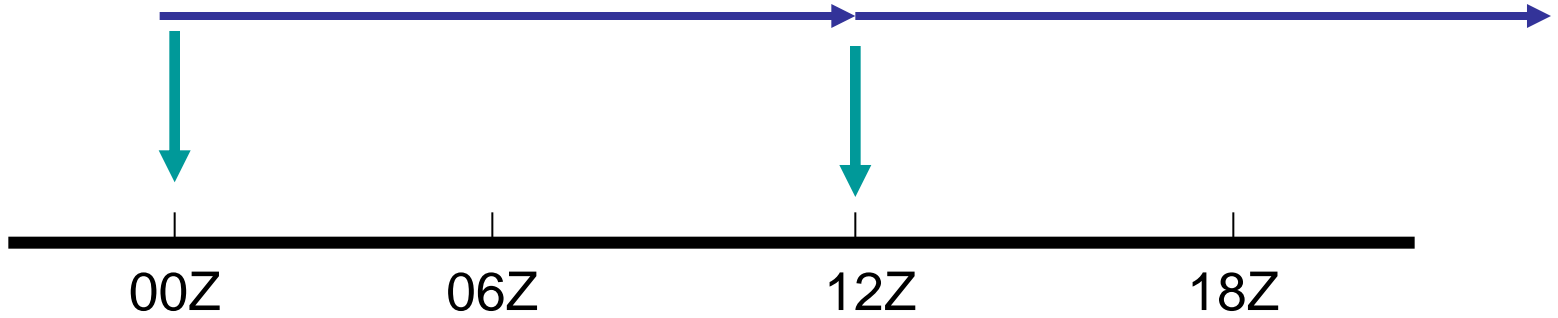




ETKF for regional..

$$X^a = X^f T \Pi_n$$

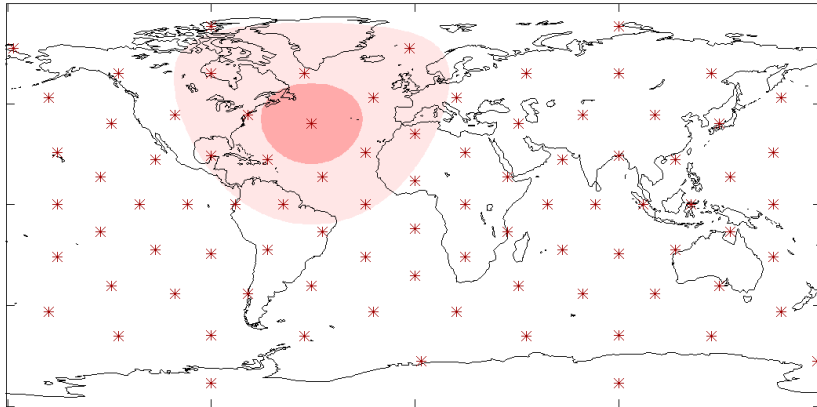
Global Ensemble



Regional Ensemble

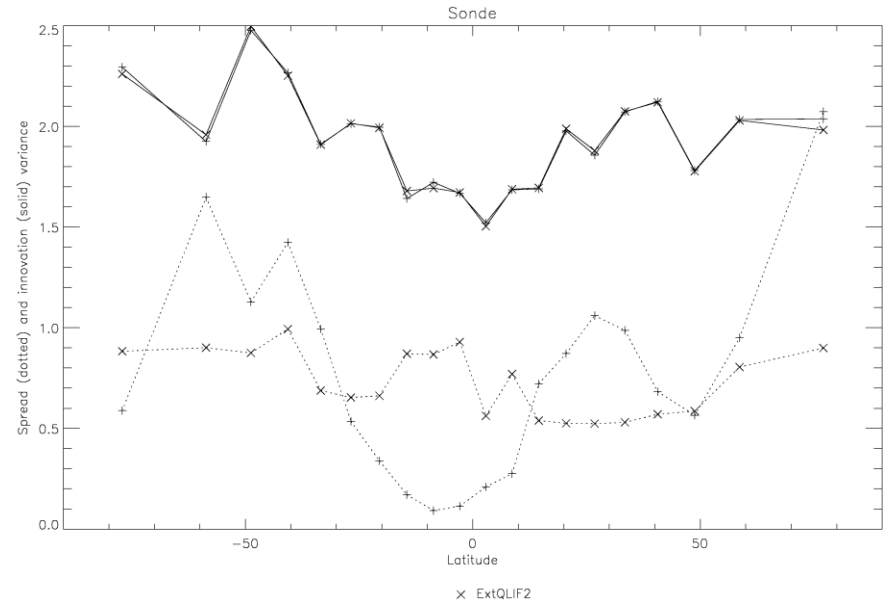
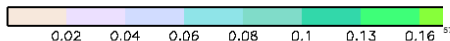
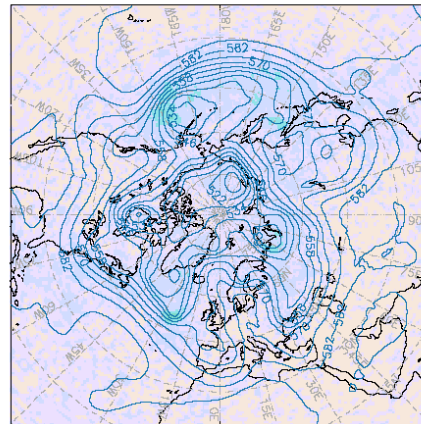
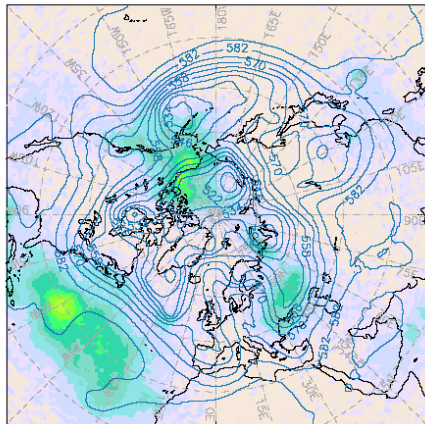


Horizontal localisation



MOGREPS (Global) Mean and spread at T+0
DT 00Z on 02/06/2008 500hPaHeight (dam)

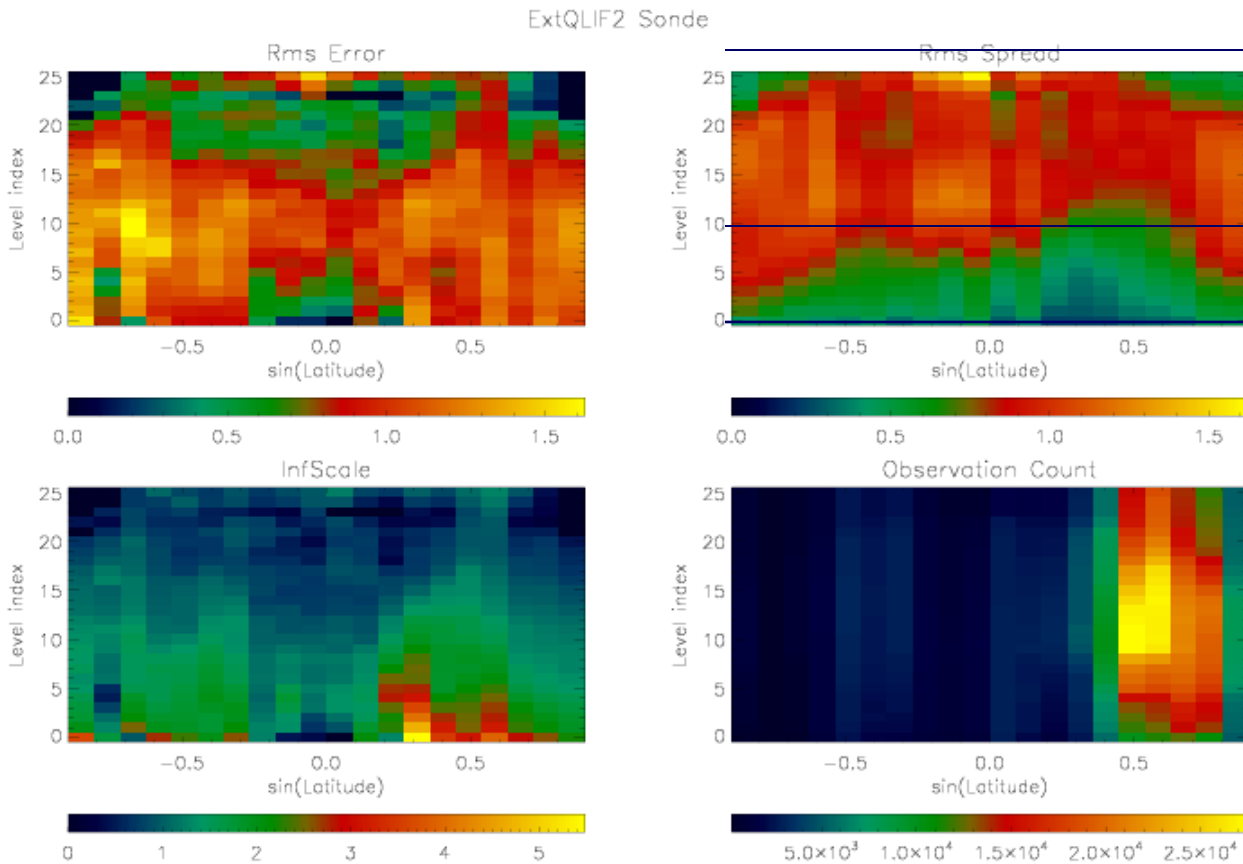
MOGREPS (Global) Mean and spread at T+0
DT 00Z on 02/06/2008 500hPaHeight (dam)



- Inflation-factor calculation uses Sondes & A-TOVS soundings
- Improves spread (latitude)
- Reduced domain overlap
- Impact on scores generally positive but small
 - Tropics?



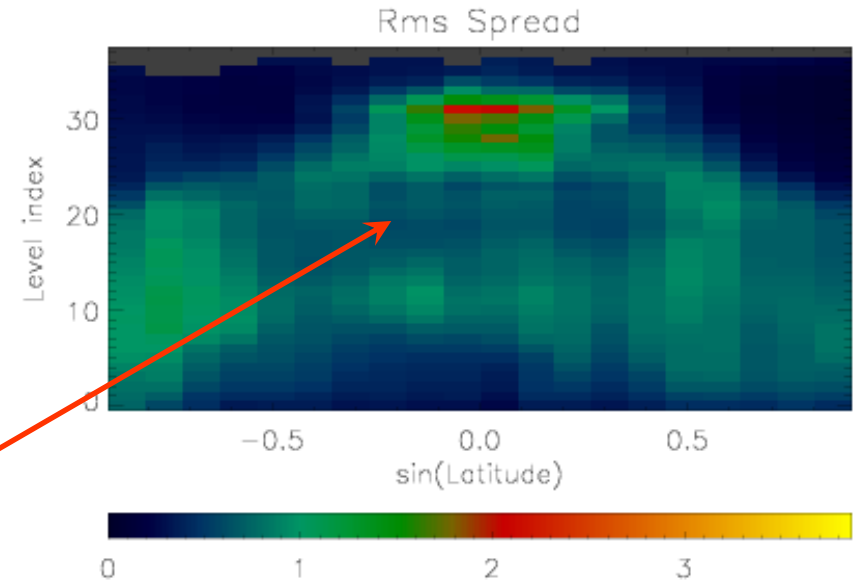
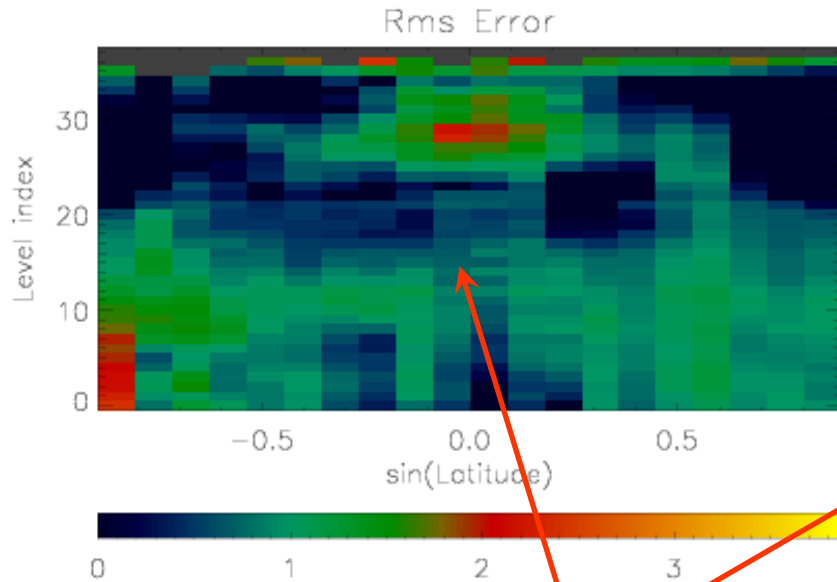
Need for vertical localisation



- Underspread near the surface
- Centres with no sonde obs
- Large perts near model top

Effect of vertical localisation

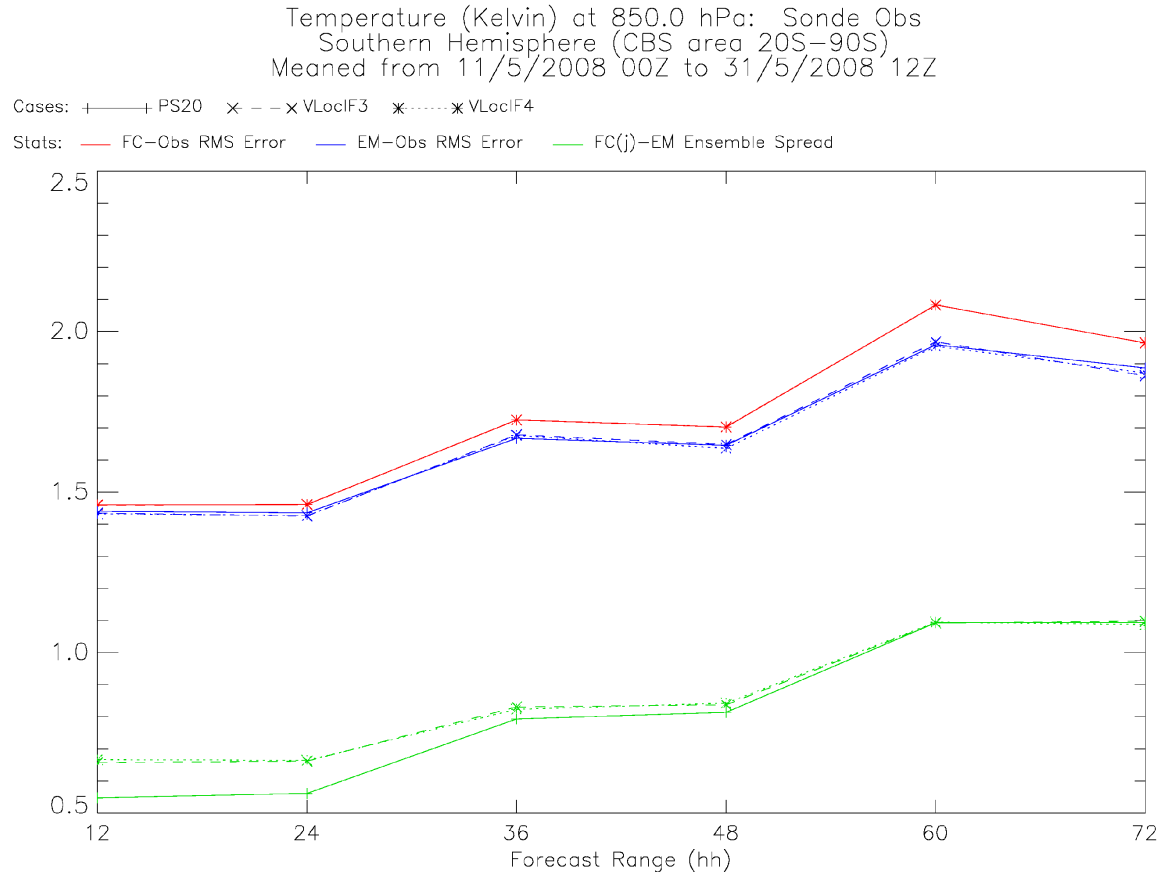
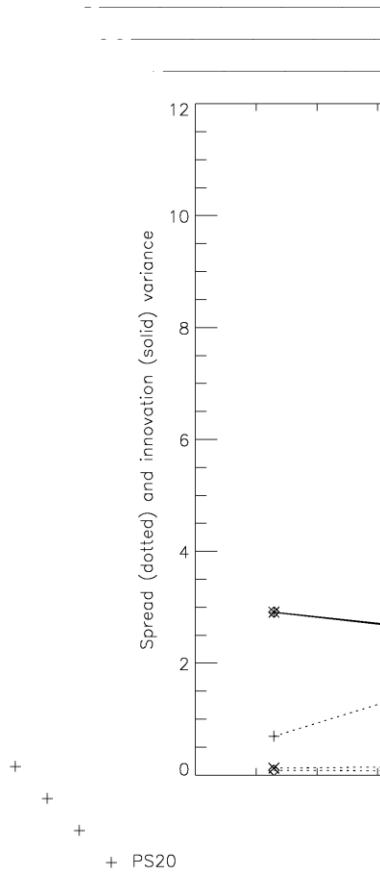
VLocIF4 Sonde / Var error



Pattern of spread and error (at T+12h)
match well at most locations



Vertical localisation – spread





Model Perturbations



Random parameters

Parameter	Scheme	min/std/Max
Entrainment rate	CONVECTION	2.75 / 3 / 4
Rhcrit (on level 3)	LRG. S. CLOUD	0.875 / 0.9 / 0.91
Ice fall Speed multiplication factor	LRG. S. CLOUD	0.6 / 1.0 / 1.4
Flux profile param.	BOUNDARY L.	5 / 10 / 20
Neutral mixing length	BOUNDARY L.	0.05 / 0.15 / 0.5
Charnock Parameter	BOUNDARY L.	0.01/0.018/0.026
Gravity wave const.	GRAVITY W.D.	2.5xE3 / 3.3xE3 / 4.4xE3
Froude number	GRAVITY W.D.	2 / 4 / 6

▪ Regional Values

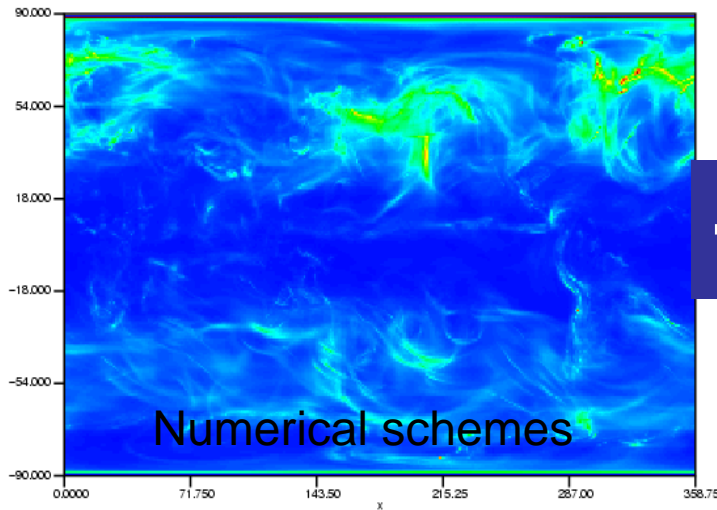
▪ Global extra parameter

Parameter	Scheme	min/std/Max
Cape Closure Timescale	CONVECTION	30/30/60 mins

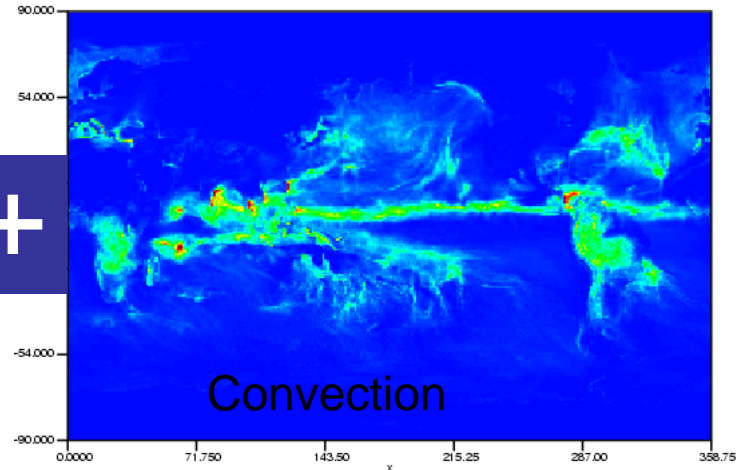


SKEB2

Calculate energy dissipation from:-



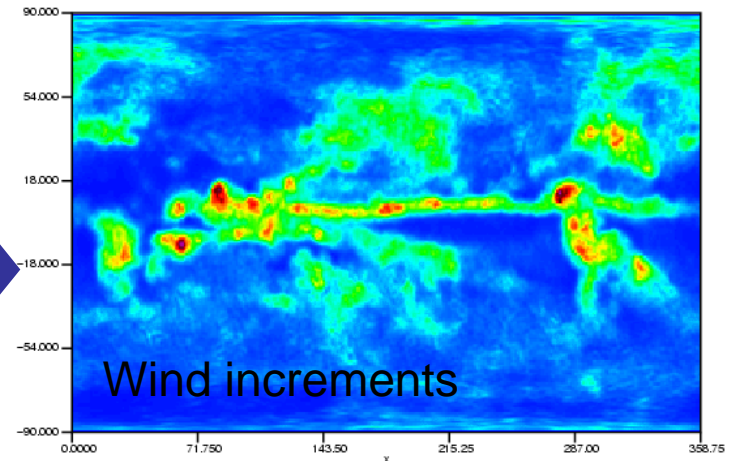
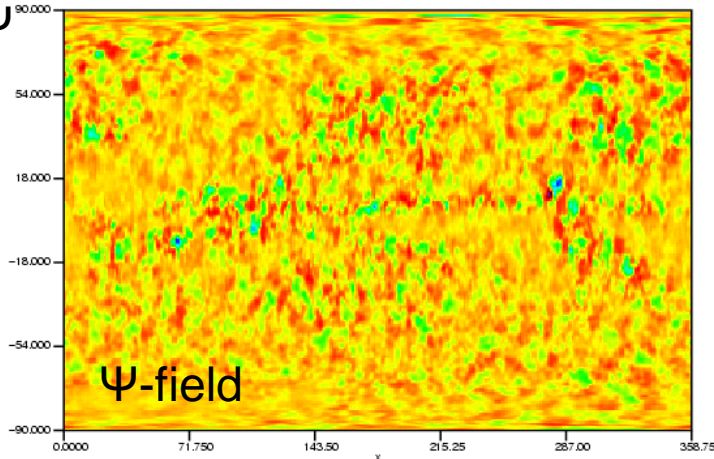
+



Modulate with random stream-function forcing field Ψ

Add as wind increments

Final version has improved vertical distribution

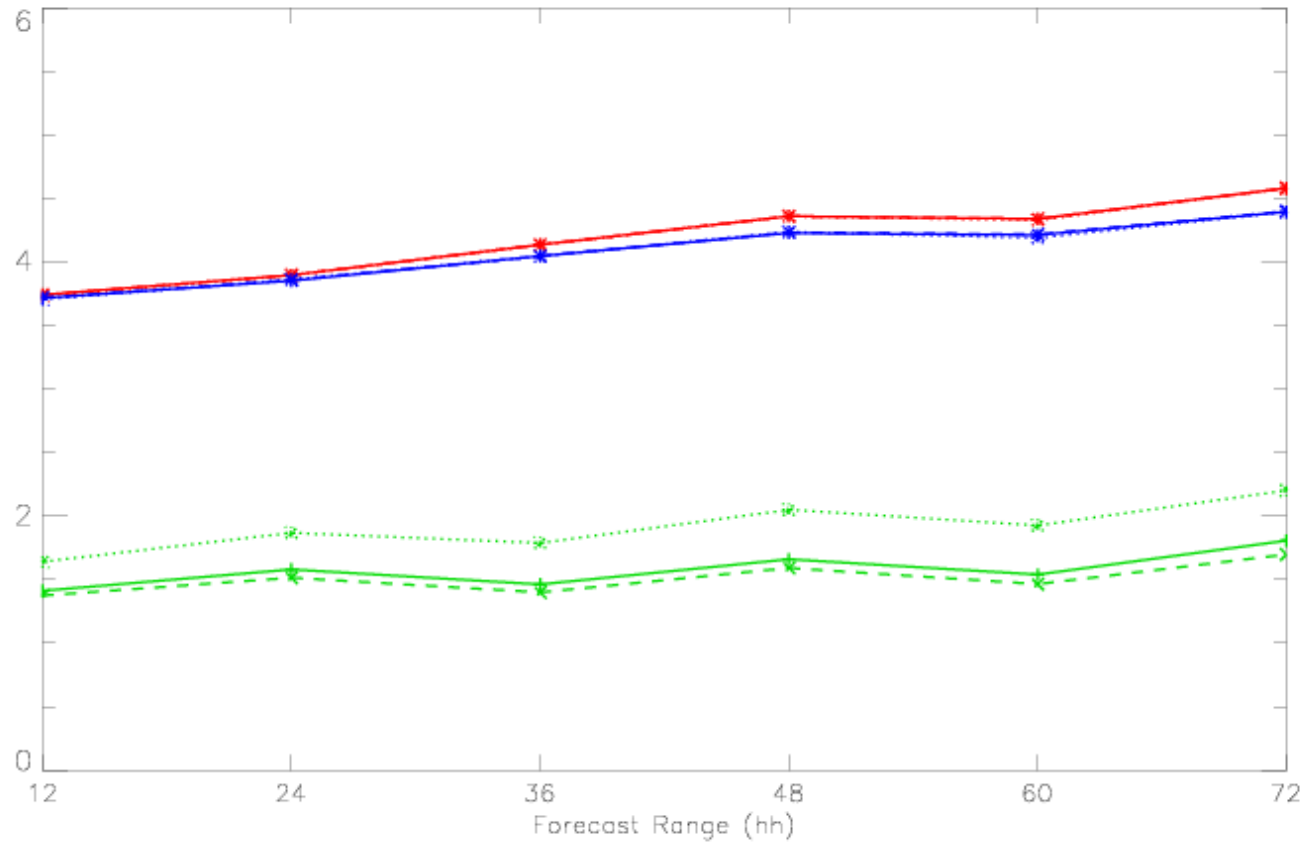




Tropics 850hPa Winds

Meaned from 1/5/2008 00Z to 30/5/2008 12Z

Cases: \blacktriangle Control EPS \times - - \times EPS with SKEB2 \ast \ast EPS with SKEB2a
Stats: — FC-Obs RMS Vector Error — EM-Obs RMS Vector Error — FC(j)-EM Ensemble Spread Vector





High-Impact Weather example



Summer Floods Sep 2008

Prob >20mm in 6h

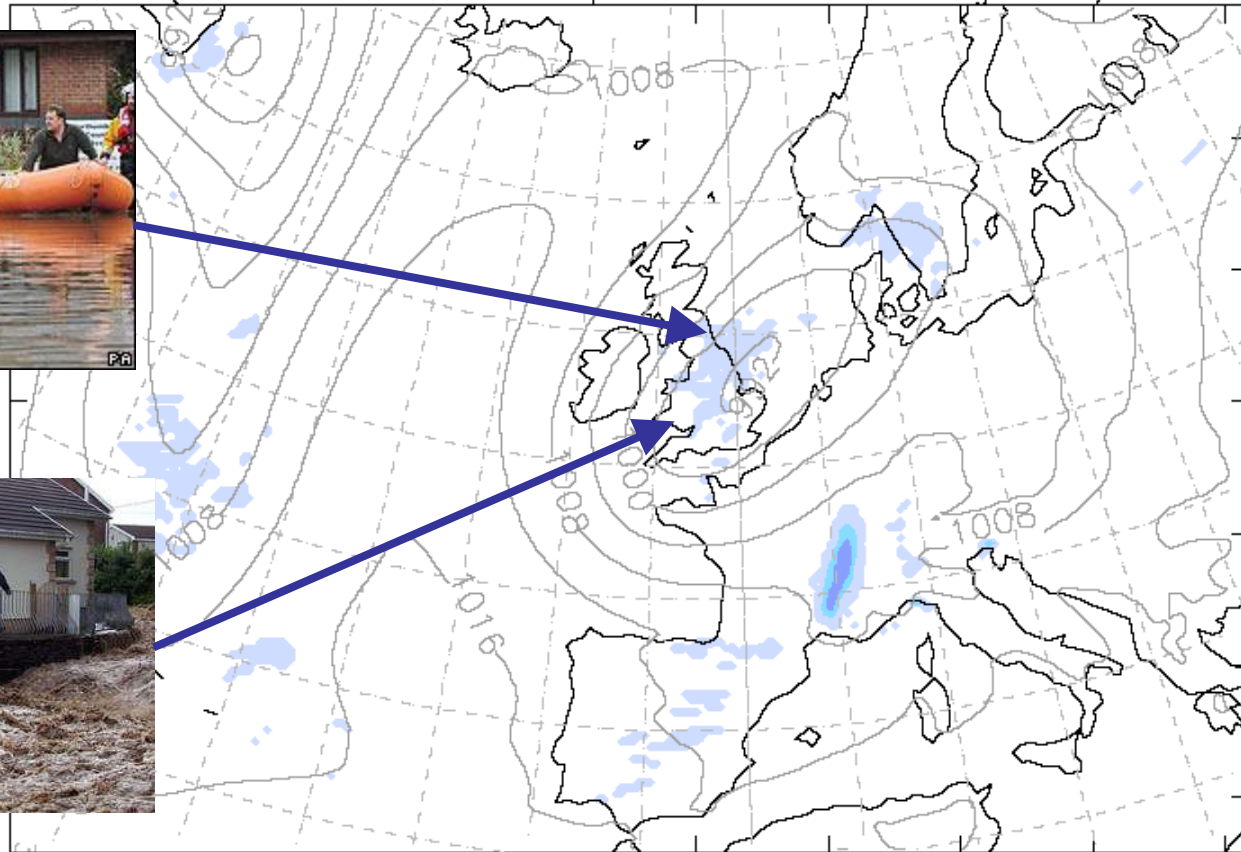
MOGREPS (Regional) Probability map for 6HourPrecip > 20.0mm
DT 06Z on Thu 04/09/2008 VT 12Z on Sat 06/09/2008 lead time 54h
(Ensemble Mean PMSL plotted as faint background)



Morpeth



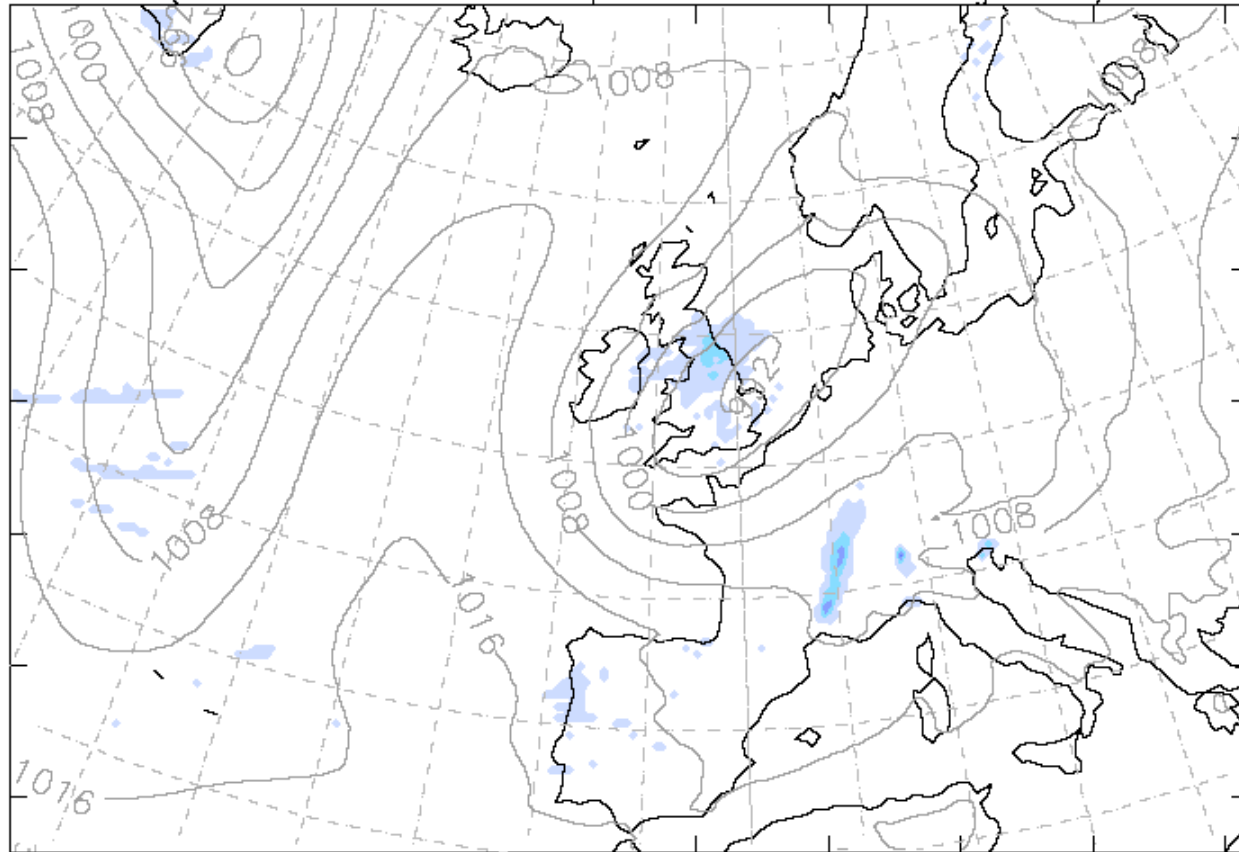
Swansea





Prob >50mm in 24h 2-day forecast

MOGREPS (Regional) Probability map for 24HourPrecip > 50.0mm
DT 06Z on Thu 04/09/2008 VT 12Z on Sat 06/09/2008 lead time 54h
(Ensemble Mean PMSL plotted as faint background)

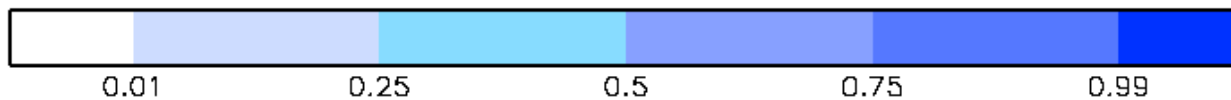
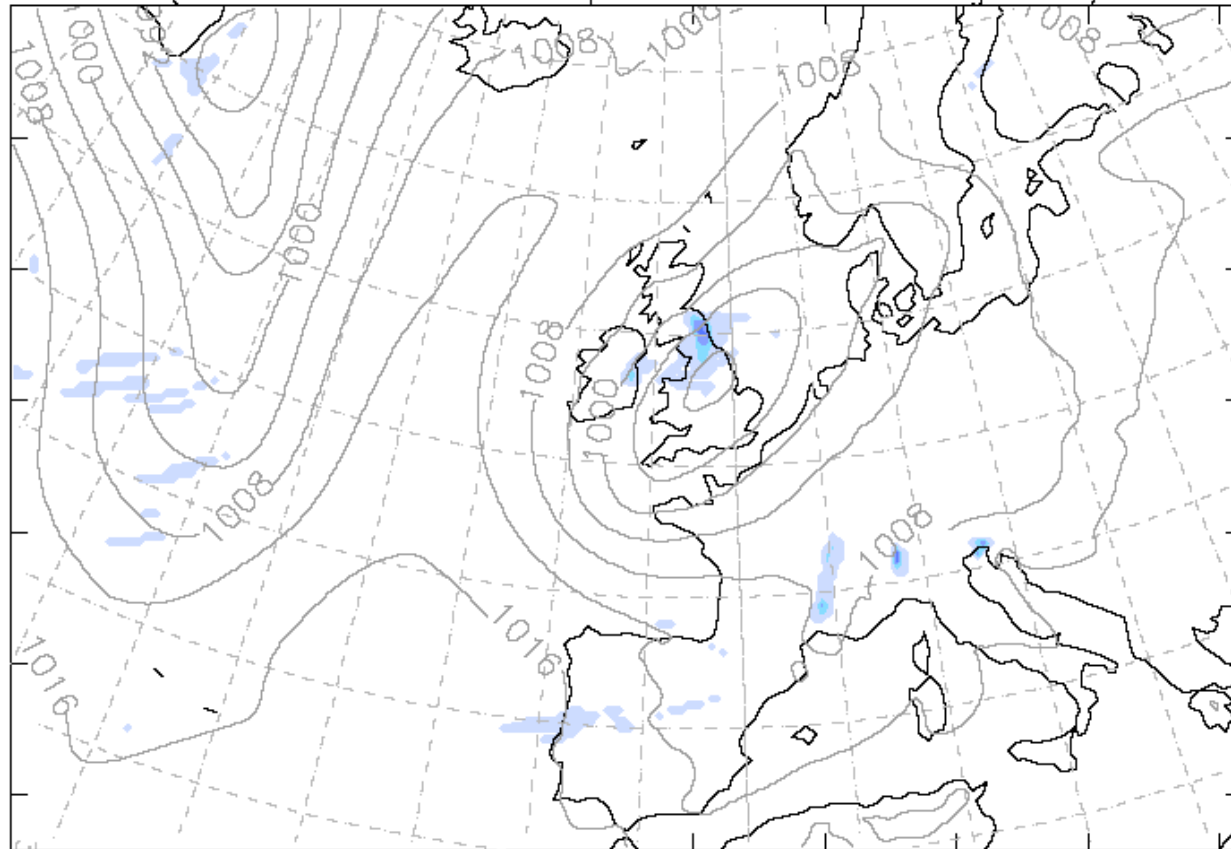


0.01 0.25 0.5 0.75 0.99



Prob >50mm in 24h 1-day forecast

MOGREPS (Regional) Probability map for 24HourPrecip > 50.0mm
DT 06Z on Fri 05/09/2008 VT 12Z on Sat 06/09/2008 lead time 30h
(Ensemble Mean PMSL plotted as faint background)



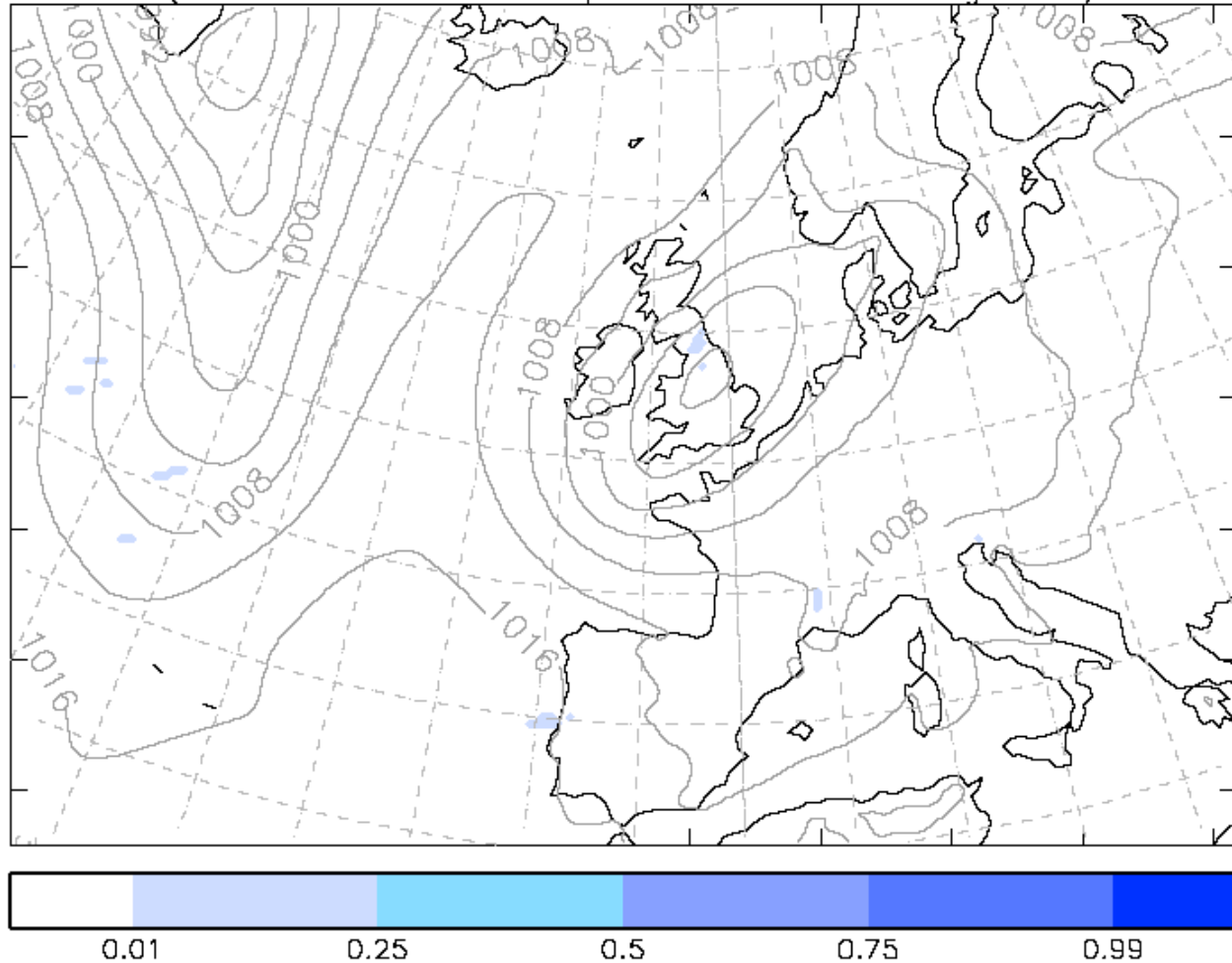


And even >100mm in 24h 1-day forecast

MOGREPS (Regional) Probability map for 24HourPrecip >100.0mm
DT 06Z on Fri 05/09/2008 VT 12Z on Sat 06/09/2008 lead time 30h
(Ensemble Mean PMSL plotted as faint background)

Product was not available operationally but has now been added

Forecast office reviewing warning process to use it





Future...



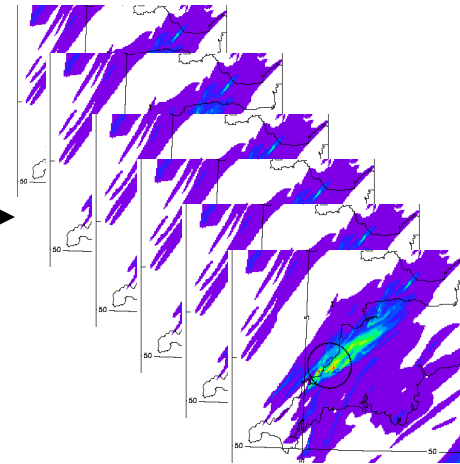
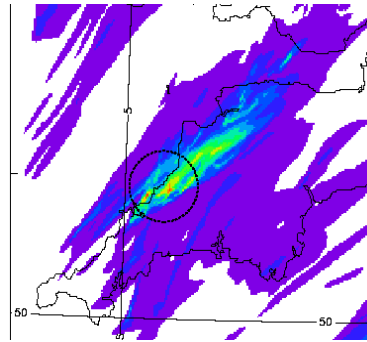
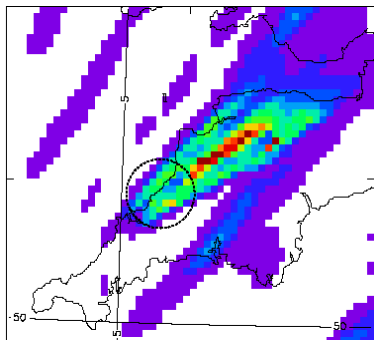
Our longer term Forecasting Strategy...

Now

2009/10

2011/12

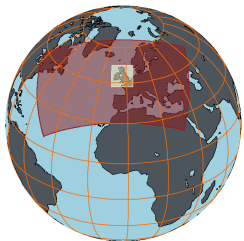
2014



4km UK

1.5km UK

1.5km UK Ensemble



•40km Global
•12km NAE
•24km NAE Ensemble



•25km Global
•12km NAE
•16km NAE Ensemble



•16km Global
•(12km NAE)
•12km NAE Ensemble



Questions?

Thanks to all the Ensemble Forecasting Team at the Met Office