# Seamless use of ECMWF and Met Office NWP

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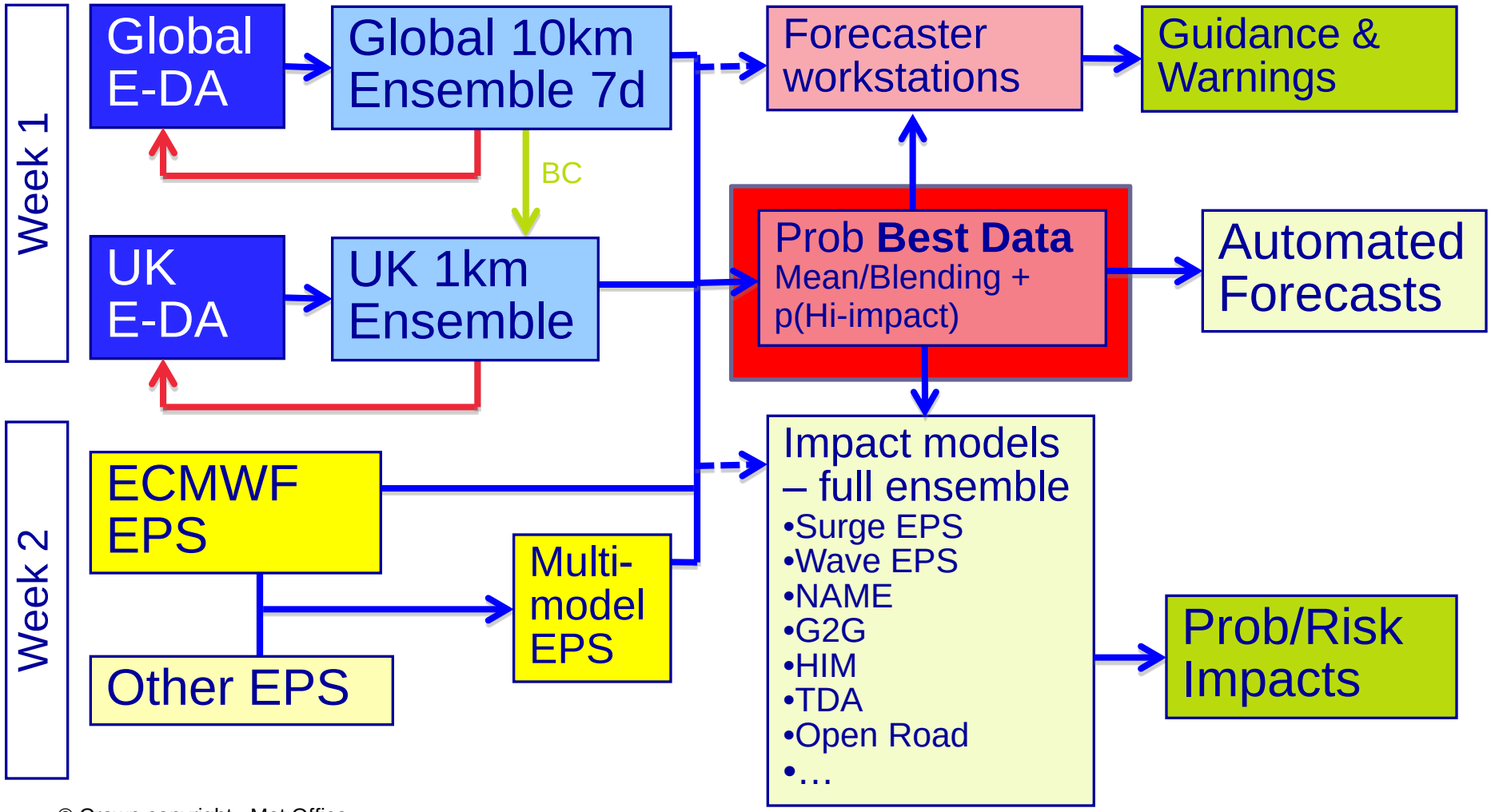
James Canvin, Ian Pearman and Simon Jackson

# Outline

- Seamless forecast production for *Best Data*
- New products from ECMWF EPS for seamless production with Met Office models
  - Example – UV Index
- Weather Regime clustering
- First-guess warnings – verification update

# Forecast Production Strategy - Best Data



# Seamless Challenge

- Combine outputs from several systems to provide seamless forecasts for users:
  - STEPS Nowcast ensemble 1-6h
  - UKV and MOGREPS-UK 1-2d
  - Global Model and MOGREPS-G Week 1
  - ECMWF EPS Week 2
  - Monthly forecast based on ECMWF
  - Glosea Seasonal

  - Additional components to be added in future for multi-model ensemble benefits
- ***Best Data*** aims to provide seamless forecast

# Additional complexity…

- 15000+ sites → 1M+
- Gridded fields
- Multi-level eg for wind farms
- Probability distributions
  - temp, wind & precip
  - 13 Percentile thresholds, plus min, max, mean & standard deviation.

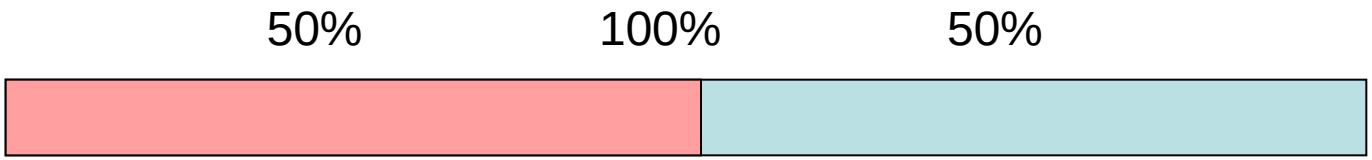
- Many variables:
  - Temperature (hourly, day max, night min)
  - ‘Feels Like Temperature’
  - Wind (speed, direction, gust)
  - Visibility
  - Relative Humidity
  - Pressure
  - UV Index
  - Precipitation (amount, rate)
  - Snow (amount, depth)
  - Sunshine Duration
  - Dew Point Temperature
  - Surface Temperature
  - Cloud Base Height (3, 5, 7 Okta)
  - Cloud Amount (<200ft, Low, Medium, High, Total)
  - Short Wave Down Radiation (Instantaneous/Intergrated, Direct/Diffuse)
  - Freezing level (Wet Bulb & Dry Bulb)
  - Probablities (Precip, Snow, Heavy Snow, Rain, Heavy Rain, Hail, Lightning, Mist, Fog, Sunshine/Clear Skys)

- Over 1.1 Billion pieces of site forecast per day!
- Working with ECMWF to get all variables from EPS

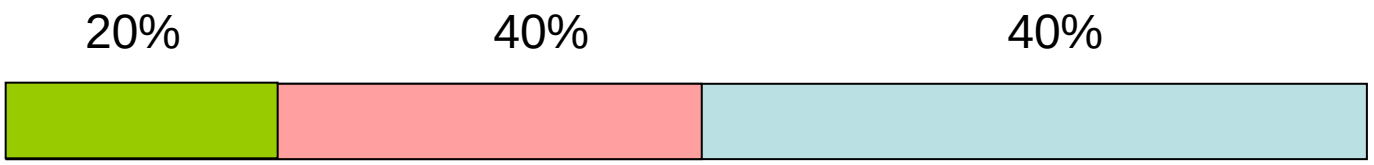
# Blending

- Up to 2509 model forecasts from T+15 days to T+0

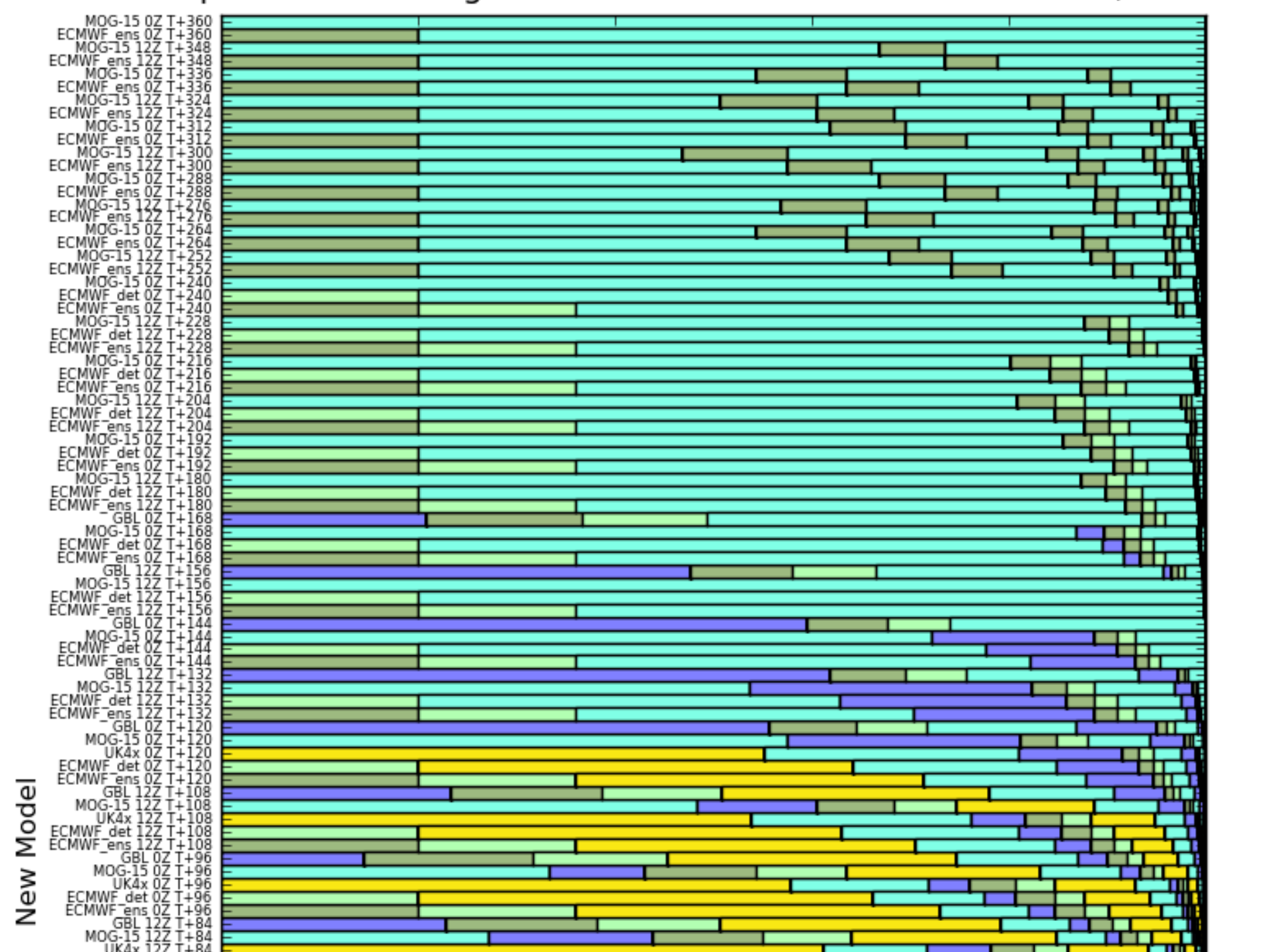
# Blending Example



# Blending Example



# Blending Example


MOG-15 0Z T+360
ECMWF_ens 0Z T+360
MOG-15 12Z T+348
ECMWF_ens 12Z T+348
MOG-15 0Z T+336
ECMWF_ens 0Z T+336
MOG-15 12Z T+324
ECMWF_ens 12Z T+324
MOG-15 0Z T+312
ECMWF_ens 0Z T+312
MOG-15 12Z T+300
ECMWF_ens 12Z T+300
MOG-15 0Z T+288
ECMWF_ens 0Z T+288
MOG-15 12Z T+276
ECMWF_ens 12Z T+276
MOG-15 0Z T+264
ECMWF_ens 0Z T+264
MOG-15 12Z T+252
ECMWF_ens 12Z T+252
MOG-15 0Z T+240
ECMWF_det 0Z T+240
ECMWF_ens 0Z T+240
MOG-15 12Z T+228
ECMWF_det 12Z T+228
ECMWF_ens 12Z T+228
MOG-15 0Z T+216
ECMWF_det 0Z T+216
ECMWF_ens 0Z T+216
MOG-15 12Z T+204
ECMWF_det 12Z T+204
ECMWF_ens 12Z T+204
MOG-15 0Z T+192
ECMWF_det 0Z T+192
ECMWF_ens 0Z T+192
MOG-15 12Z T+180
ECMWF_det 12Z T+180
ECMWF_ens 12Z T+180
GBL 0Z T+168
MOG-15 0Z T+168
ECMWF_det 0Z T+168
ECMWF_ens 0Z T+168
GBL 12Z T+156
MOG-15 12Z T+156
ECMWF_det 12Z T+156
ECMWF_ens 12Z T+156
GBL 0Z T+144
MOG-15 0Z T+144
ECMWF_det 0Z T+144
ECMWF_ens 0Z T+144
GBL 12Z T+132
MOG-15 12Z T+132
ECMWF_det 12Z T+132
ECMWF_ens 12Z T+132
GBL 0Z T+120
MOG-15 0Z T+120
UK4x 0Z T+120
ECMWF_det 0Z T+120
ECMWF_ens 0Z T+120
GBL 12Z T+108
MOG-15 12Z T+108
UK4x 12Z T+108
ECMWF_det 12Z T+108
ECMWF_ens 12Z T+108
GBL 0Z T+96
MOG-15 0Z T+96
UK4x 0Z T+96
ECMWF_det 0Z T+96
ECMWF_ens 0Z T+96
GBL 12Z T+84
MOG-15 12Z T+84
UK4x 12Z T+84
New Model

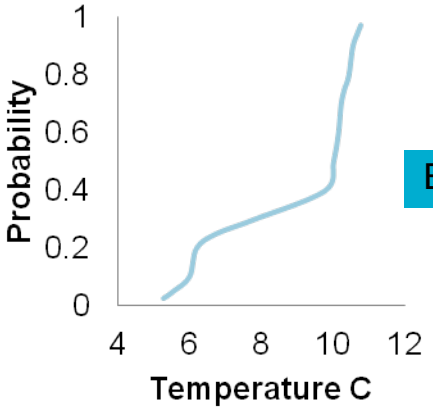
# Percentile Blending

- Blending deterministic forecasts is relatively simple

*blended = weight1*model1+weight2*model2*

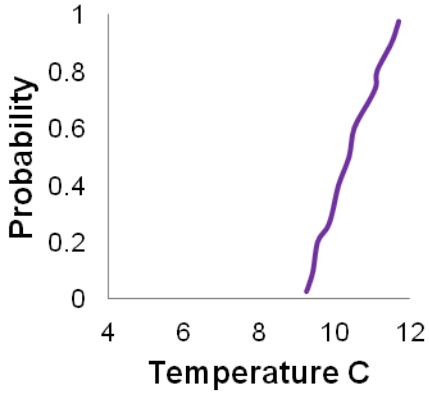
Where the weights depend on the relative skill of the two models at that forecast time

- Blending probabilistic data is more complicated




Ensemble 1

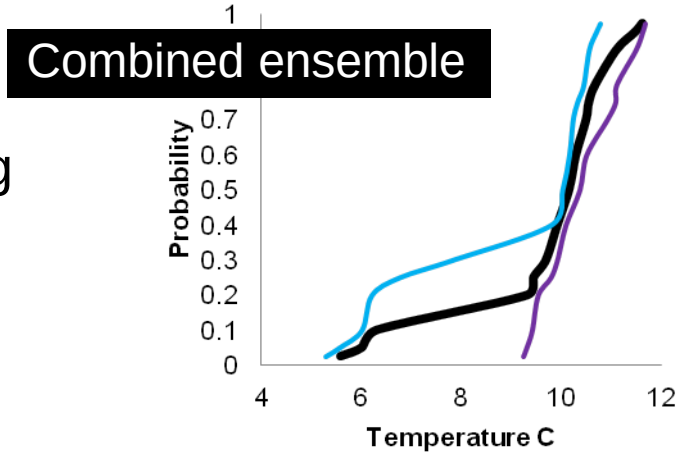
Ensemble 2



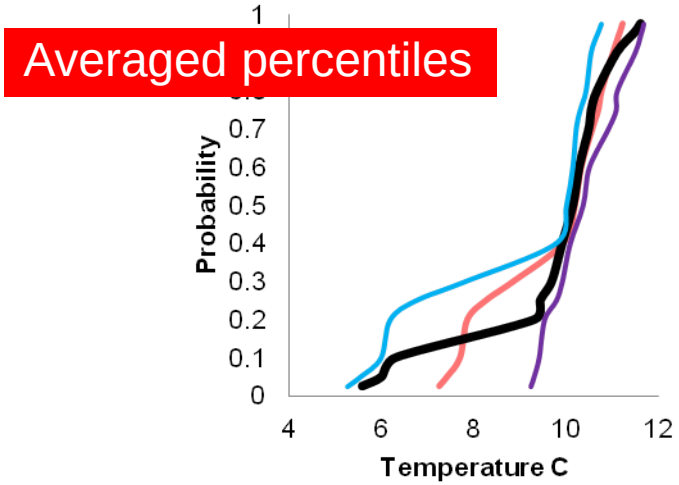
# Percentile Blending

- Blending two ensembles with equal weight can be done simply by combining them into one super-Ensemble

Not practical in best-data - Data stored as percentiles



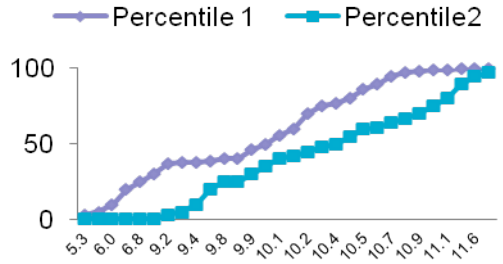

- Blending two sets of percentiles will not work



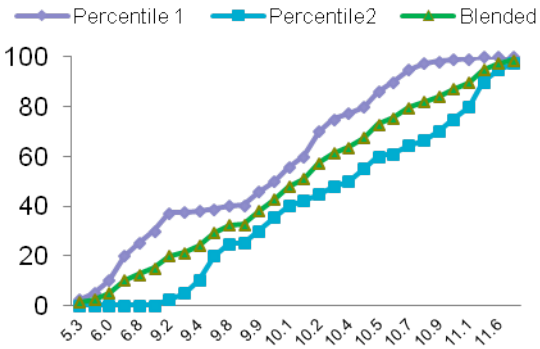
# Blending Percentiles

Caroline Jones

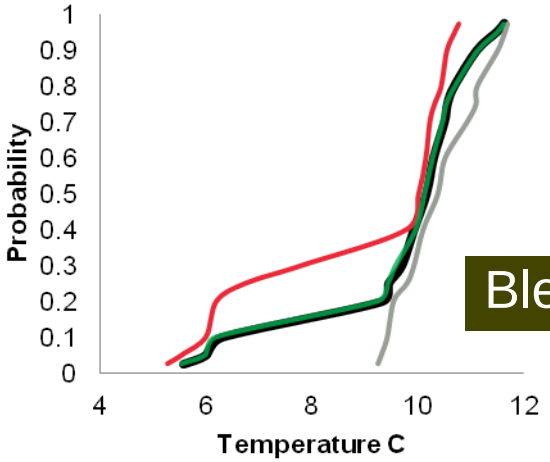
- We start by calculating where the percentile values from each ensemble would exist in the other probability distribution




- Probability spaces can then be combined with different weights depending on model skill.



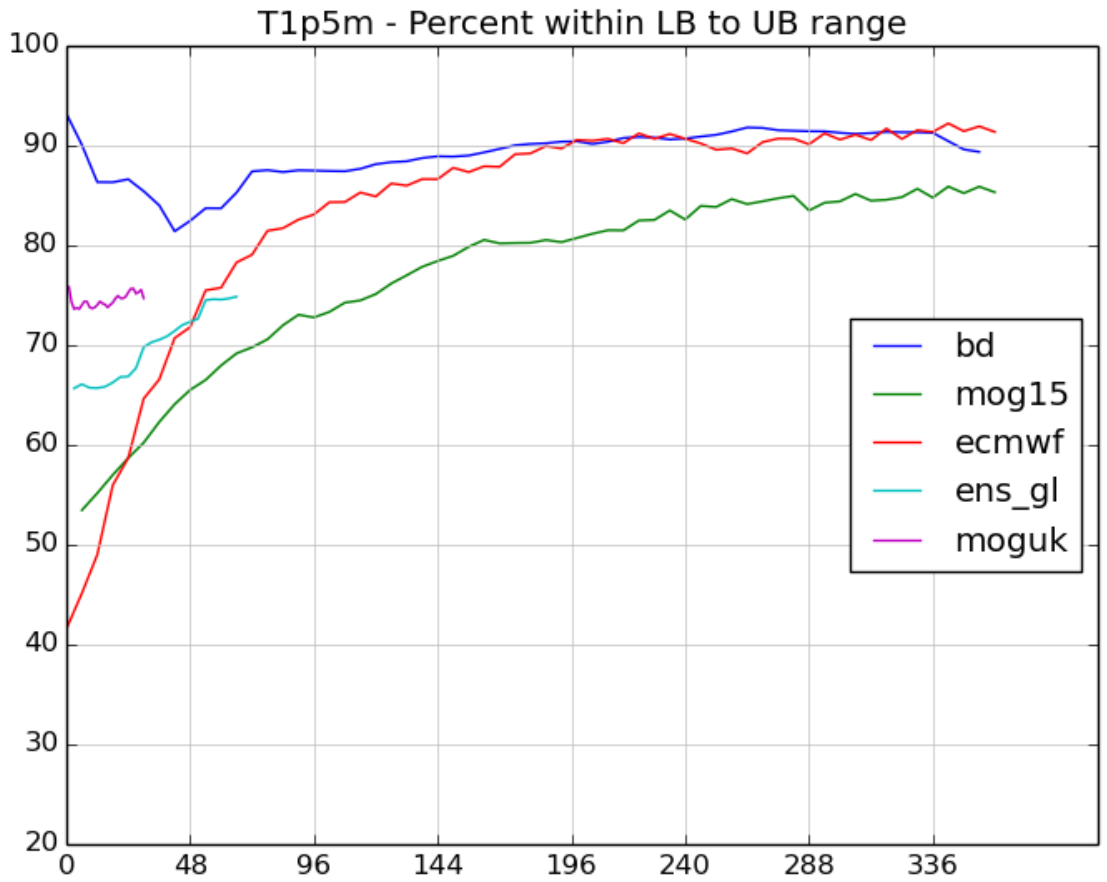

We then calculate the percentile values in the new blended distribution to produce our new blended percentiles




Blended Percentile

Deterministic forecasts can be similarly blended in

# UK Temperatures (Sep'13-Apr'14) %age within LB to UB range

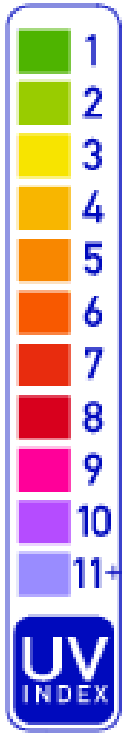


# UV Index from EPS

Nina Schuhen

# The UV index

Example of Met Office variable to be produced from EPS




- Global measure for surface ultraviolet radiation and its effects on human skin
- Standardised by the World Health Organisation
- Weighting of the solar spectral irradiance according to a reference action spectrum
- Goal: UV index forecasts for up to 15 days

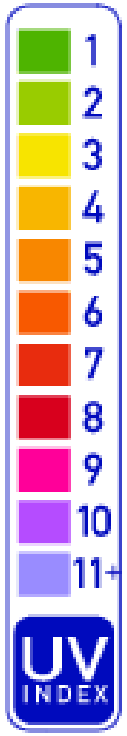
**Downward UV radiation at the surface (UVB)**

Available from the ECMWF high-resolution model

Wavelength range: 200 – 440 nm

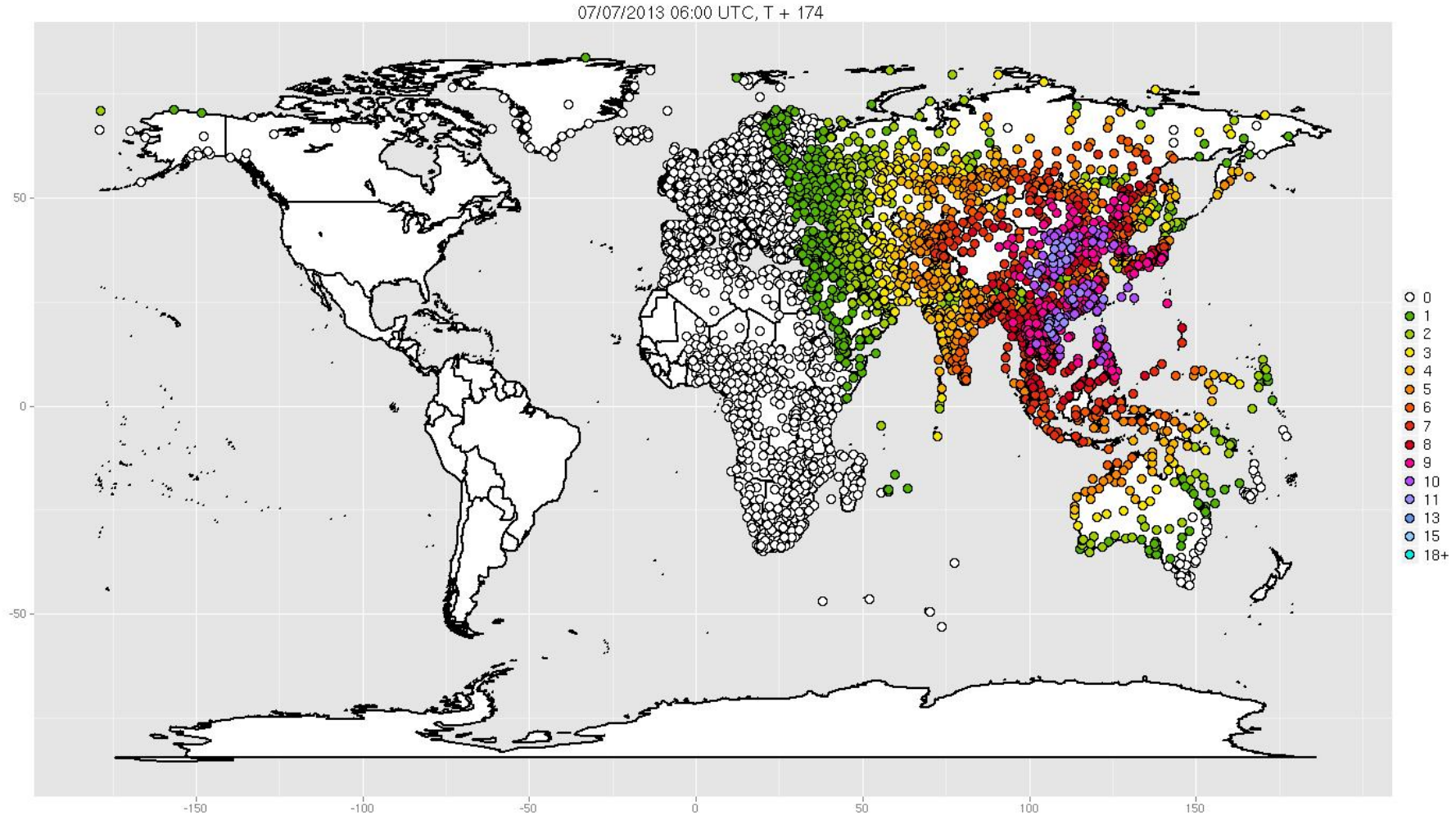
Accumulated field

# Challenges and current work



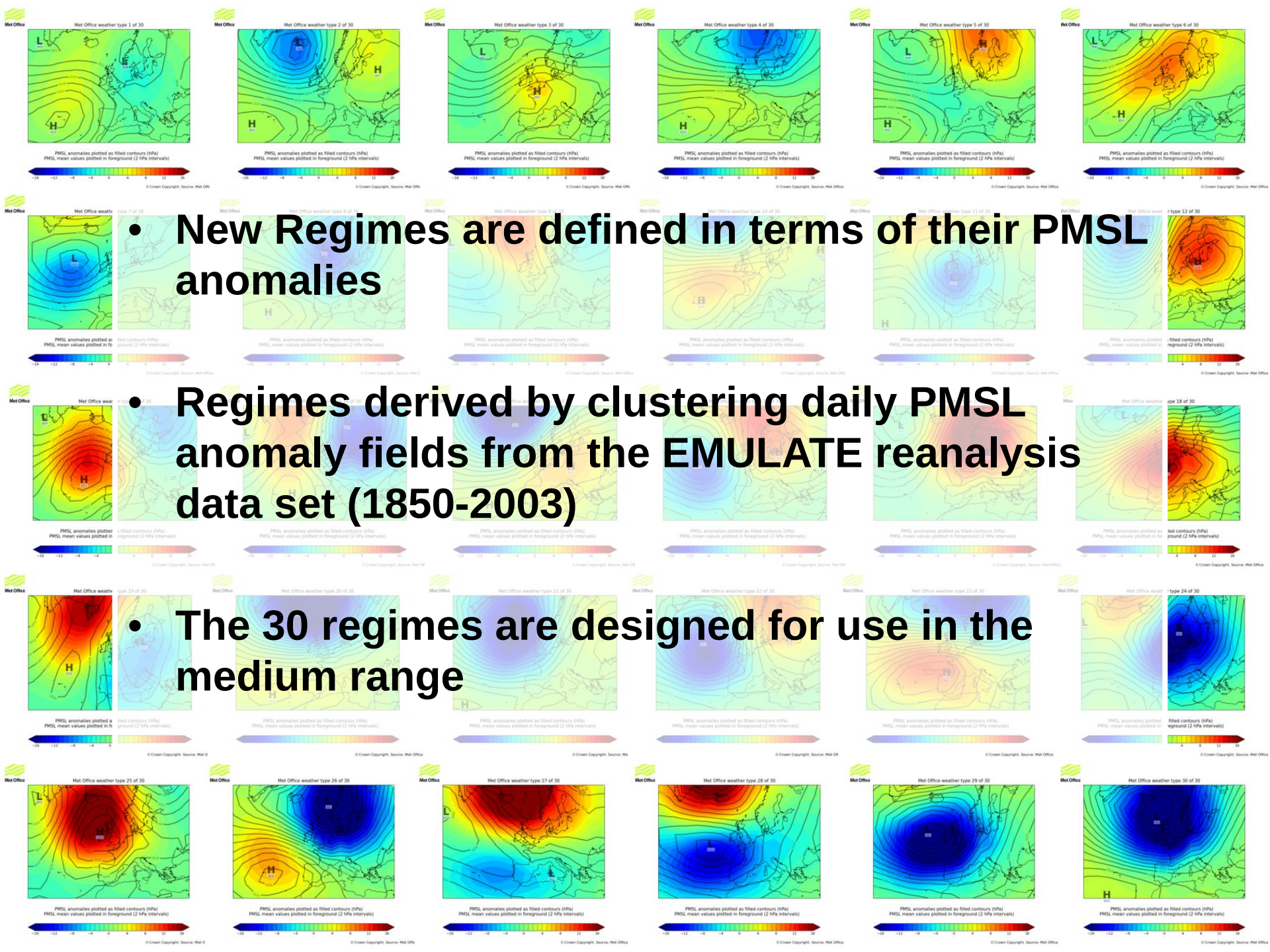

- UVB parameter will also be added to the ensemble (Q3 2014)
  - Providing probabilistic forecasts
  - Extending the lead time to T + 15 days
- ECMWF and UM radiation fields are similar, but differ in wavelength range covered
  - Diagnostics scheme has to be adapted
  - Now involves the solar zenith angle
- Hourly forecasts have to be obtained from 6-hourly time steps
  - Current approach will be revisited
  - New techniques are being developed – may benefit UM work too
- Verification proves difficult, as there is not much observation data available

# First result for ≈ 16,000 sites

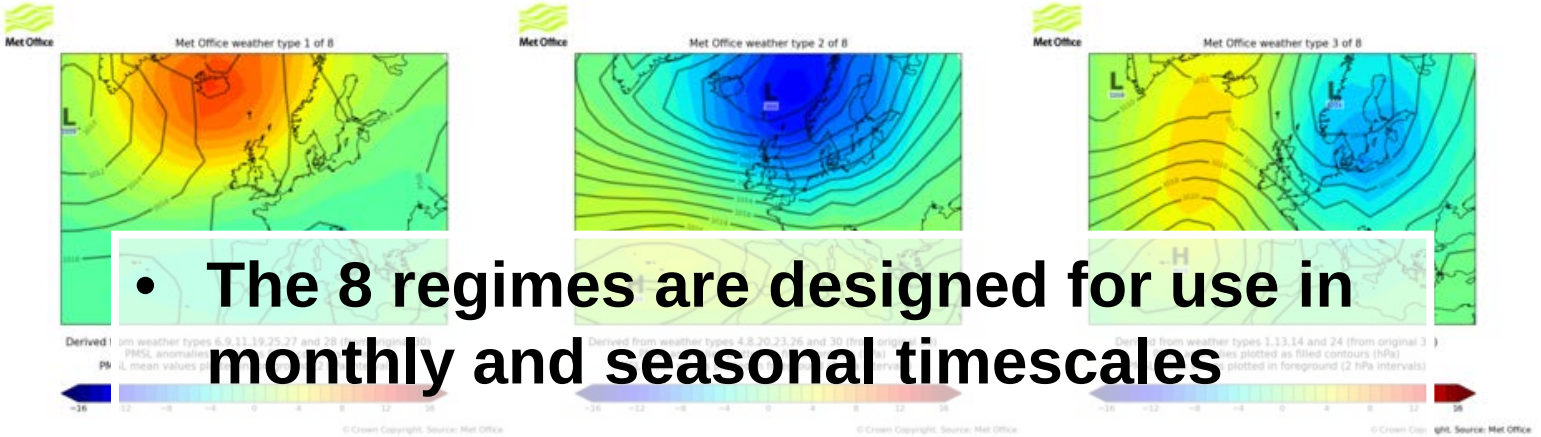


# New weather regime forecast capability

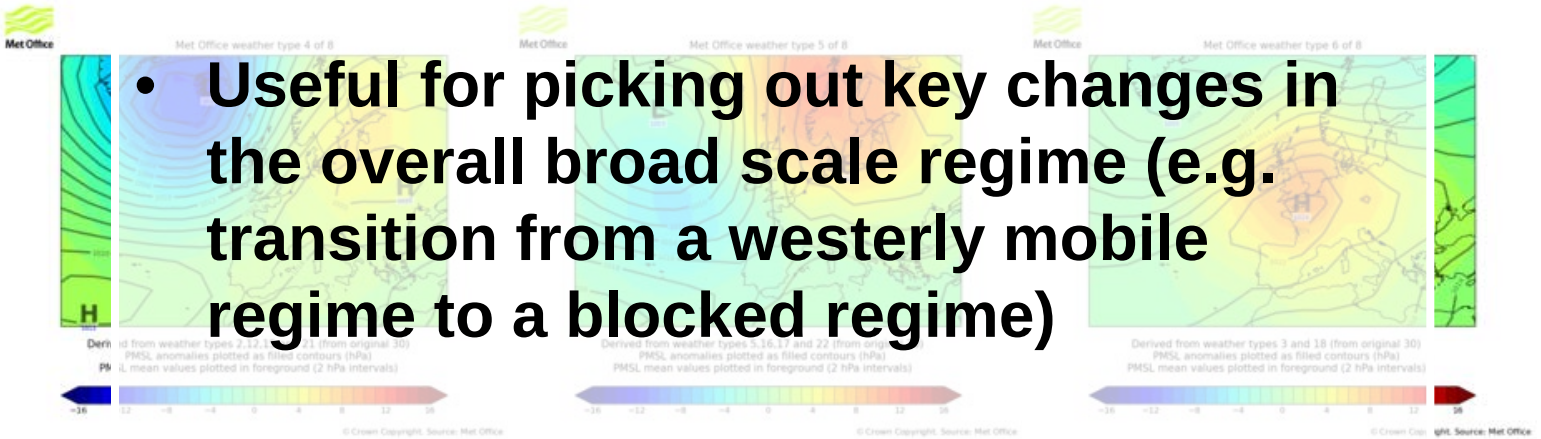
Rob Neal



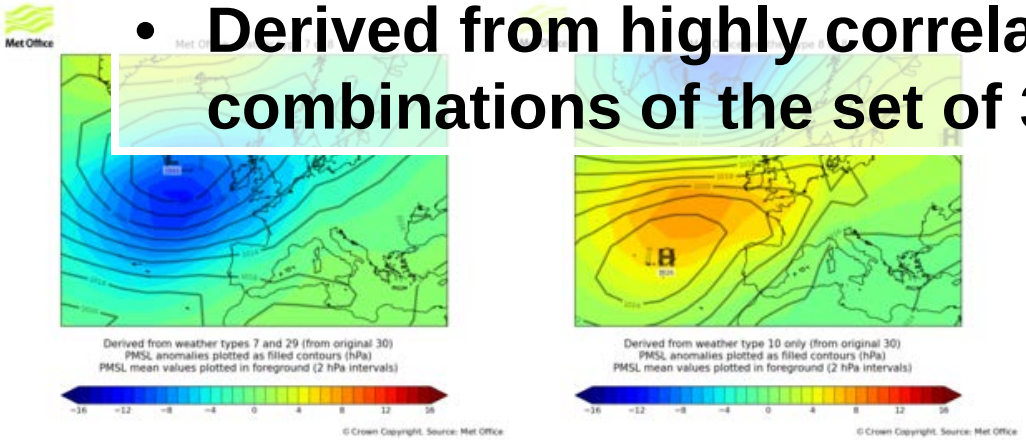
- New Regimes are defined in terms of their PMSL anomalies
- Regimes derived by clustering daily PMSL anomaly fields from the EMULATE reanalysis data set (1850-2003)
- The 30 regimes are designed for use in the medium range




- **The 8 regimes are designed for use in monthly and seasonal timescales**

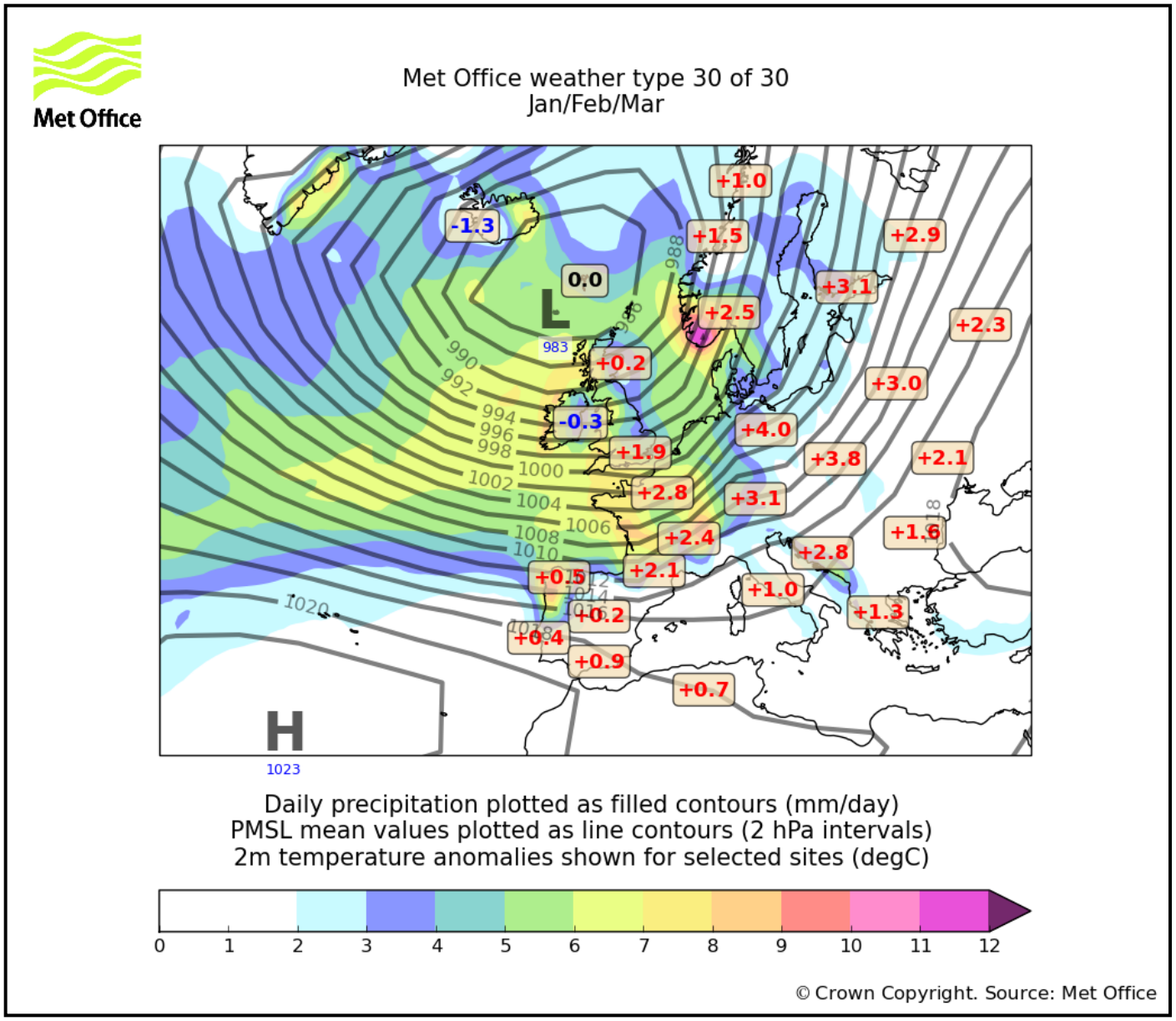



- **Useful for picking out key changes in the overall broad scale regime (e.g. transition from a westerly mobile regime to a blocked regime)**




- **Derived from highly correlated combinations of the set of 30**

# Climatologies derived for each regime using ERA-Interim




→ Quick view regime climate maps show temperature anomalies and mean daily precip relevant for the time of year

→ Regime 30 is 0 to 2°C warmer than average for the time of year with 4 to 6mm rainfall/day

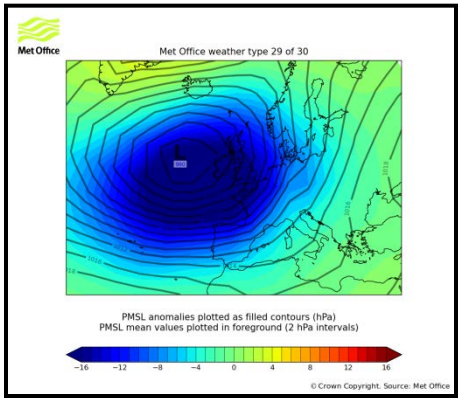
# ECMWF 00Z run 04/02/2014 (30 regimes)

Regimes are listed according to their annual historic occurrence (1850 – 2003), which is the period used to generate the regimes.

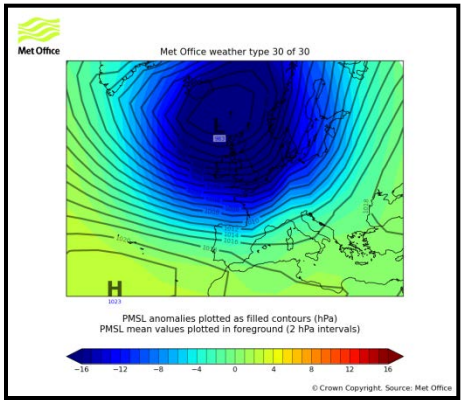
| | Tue 4 Feb | Wed 5 Feb | Thu 6 Feb | Fri 7 Feb | Sat 8 Feb | Sun 9 Feb | Mon 10 Feb | Tue 11 Feb | Wed 12 Feb | Thu 13 Feb | Fri 14 Feb | Sat 15 Feb | Sun 16 Feb | Mon 17 Feb | Tue 18 Feb | Regime description | Historic occurrence J/F/M (1850-2012) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Regime 1 | | | | | | | | | | | | | 1 | 1 | 1 | Unbiased NWly | 1.9% |
| Regime 2 | | | | | | | | | | | | | | 1 | 1 | Cyclonic W-SWly, returning Pm airmass | 2.5% |
| Regime 3 | | | | | | | | | | | | | | | | Anticyclonic SWly, ridge over N France | 1.9% |
| Regime 4 | | | | | | | | | | | | 1 | 1 | | 1 | Unbiased Wly | 2.4% |
| Regime 5 | | | | | | | | | | | | | | | | Unbiased S-SEly, high over Scandinavia | 2.3% |
| Regime 6 | | | | | | | | | | | | | | | | Anticyclonic W-SWly, Azores high extension | 3.1% |
| Regime 7 | | | | | | | | | | | | 1 | | | 2 | Cyclonic SWly, low WNW of Ireland | 2.7% |
| Regime 8 | | | | | | | | | | | 1 | 5 | 2 | 1 | 4 | Cyclonic NWly, low near Shetland | 2.6% |
| Regime 9 | | | | | | | | | | | | | 1 | | | Anticyclonic N-NWly, high near Iceland | 2.3% |
| Regime 10 | | | | | | | | | | | | | | 2 | 3 | Unbiased W-SWly, slight Azores ridge SW of UK | 3.1% |
| Regime 11 | | | | | | | | | 1 | | | 1 | 2 | 2 | 1 | Cyclonic S-SEly, low near W Wales | 2.5% |
| Regime 12 | | | | | | | | | | | | | | | | Anticyclonic Sly, high over Poland | 3.9% |
| Regime 13 | | | | | | | | | | | | | 1 | | | Anticyclonic NWly, high SW of Ireland | 3.9% |
| Regime 14 | | | | | | | | | | | | 2 | | 2 | | Cyclonic N-NWly, low near S Sweden | 3.6% |
| Regime 15 | | | | | | | | | | | | | 2 | 1 | 1 | Unbiased SWly, very windy NW Britain | 4.5% |
| Regime 16 | | | | | | | | | | | | | | | | Unbiased S-SEly, high E of Denmark, windy | 3.2% |
| Regime 17 | | | | | | | | | | | | | | | | Anticyclonic E-SEly high over Denmark | 4.0% |
| Regime 18 | | | | | | | | | | | | | | | 2 | Anticyclonic SWly, high over N France | 5.0% |
| Regime 19 | | | | | | | | | | | | | 1 | | | Cyclonic Nly, low E of Denmark | 3.8% |
| Regime 20 | | | | | | | | | | | 2 | 5 | 1 | 3 | 1 | Cyclonic Wly, intense low near Iceland | 4.4% |
| Regime 21 | | | | | | | | 3 | 4 | 6 | 5 | 3 | 6 | 8 | 9 | Cyclonic S-SWly, deep low S of Iceland | 3.5% |
| Regime 22 | | | | | | | | | | 1 | | 1 | 2 | | 1 | Cyclonic Sly, low W of Ireland | 3.5% |
| Regime 23 | | | | | | | | | | | | 1 | 1 | 2 | 1 | Unbiased Wly, windy in N | 5.0% |
| Regime 24 | | | | | | | | 3 | 5 | 1 | 4 | 5 | 7 | 5 | 4 | Cyclonic Nly, low in N Sea | 3.3% |
| Regime 25 | | | | | | | | | | | | | | 1 | | Anticyclonic Nly, high centred in Irish Sea | 3.9% |
| Regime 26 | | | | | | | | | | | 1 | 4 | 3 | | 1 | Cyclonic NWly, low near Norway, windy | 3.3% |
| Regime 27 | | | | | | | | | | | | | | | | Anticyclonic Ely, high in Norwegian Sea | 3.8% |
| Regime 28 | | | | | | | | | | | | | | | 2 | Cyclonic SEly, low SW of UK | 3.8% |
| Regime 29 | 51 | 48 | 8 | 4 | | | 5 | 15 | 15 | 16 | 9 | 7 | 11 | 13 | 8 | Cyclonic S-SEly, deep low W of Ireland, windy | 3.2% |
| Regime 30 | | 3 | 43 | 47 | 51 | 51 | 46 | 30 | 26 | 27 | 29 | 15 | 9 | 9 | 8 | Cyclonic SWly, deep low SE of Iceland, windy | 2.8% |

**High forecast confidence**

## Regime 29




## Regime 30

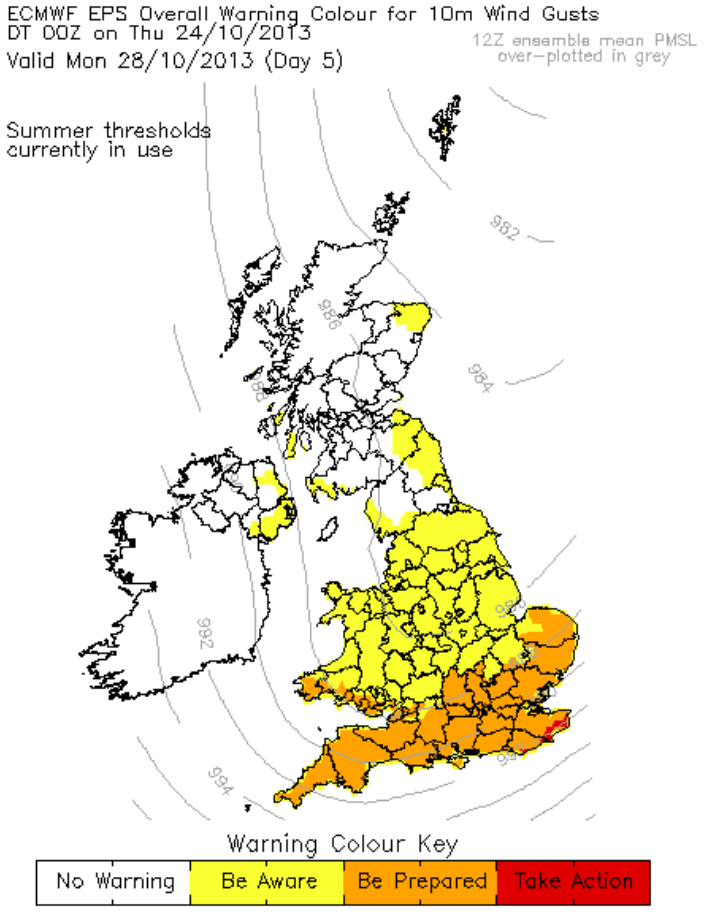


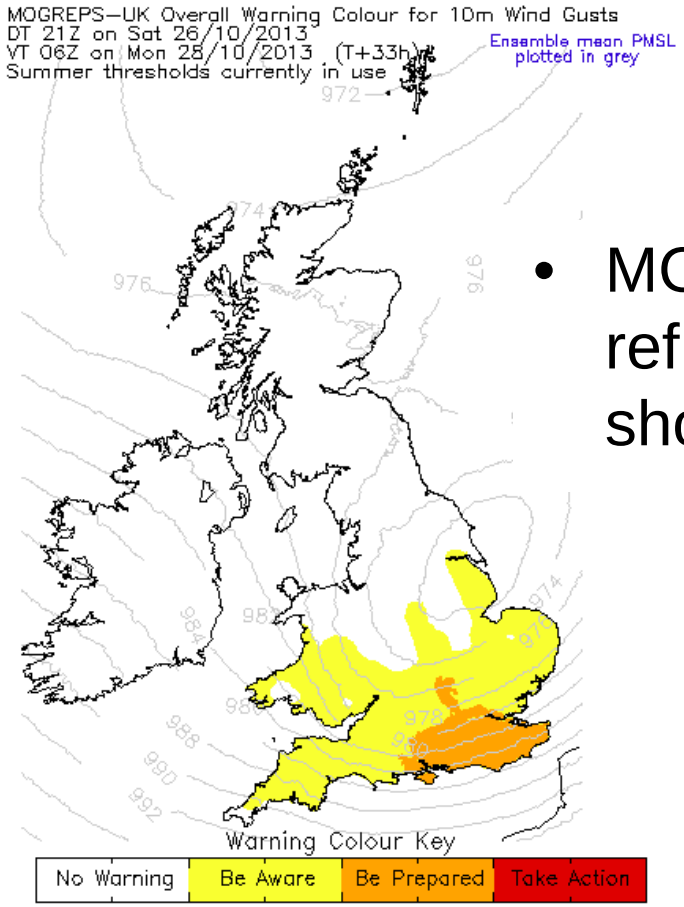
# Ensemble prediction system first guess warnings

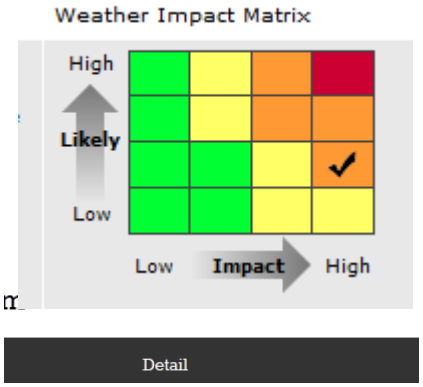
Rob Neal

# Day 5 Amber warning

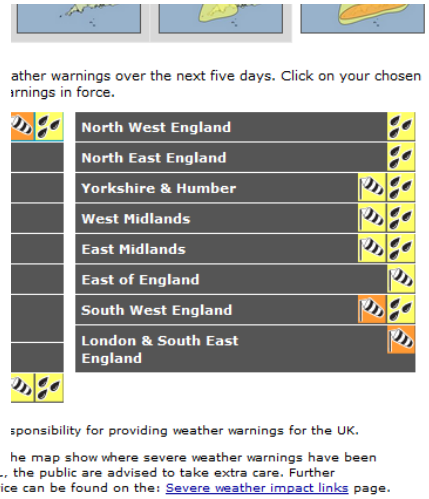
- First-guess warning based on ECMWF EPS, and issued warning




- MOGREPS-UK refines detail at short range

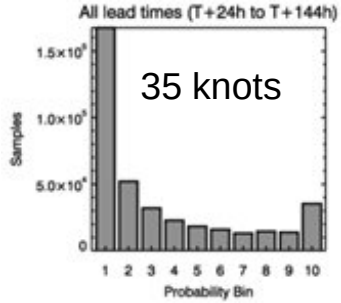


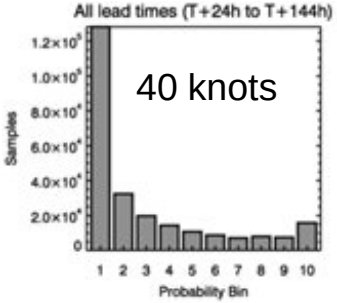
# ECMWF probability 10m wind gust ≥ 35,40,45 knots

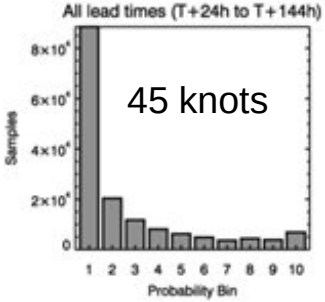
Verification covering a 2 year period (1 March 2012 to 28 February 2014)

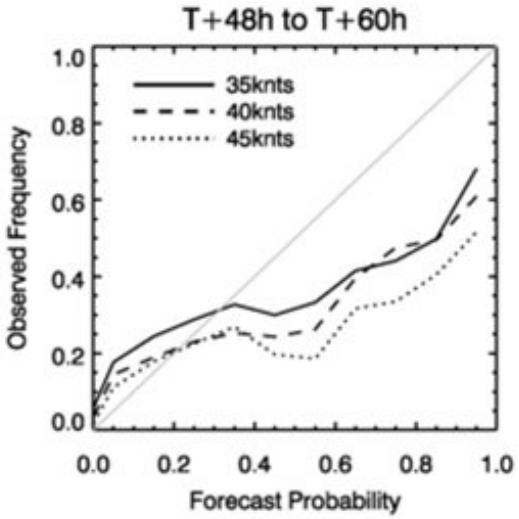
## Reliability diagrams for four different forecast periods

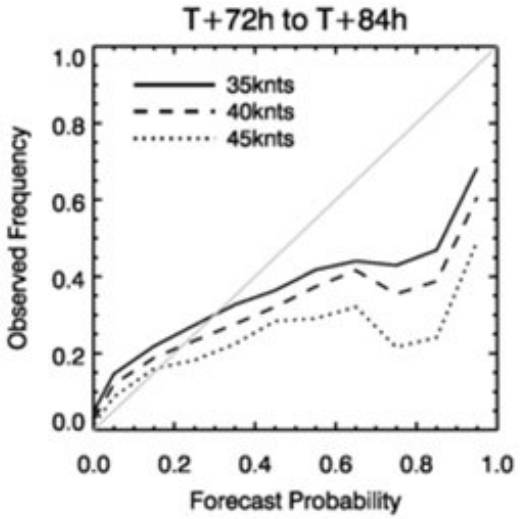
Sharpness for all lead times combined

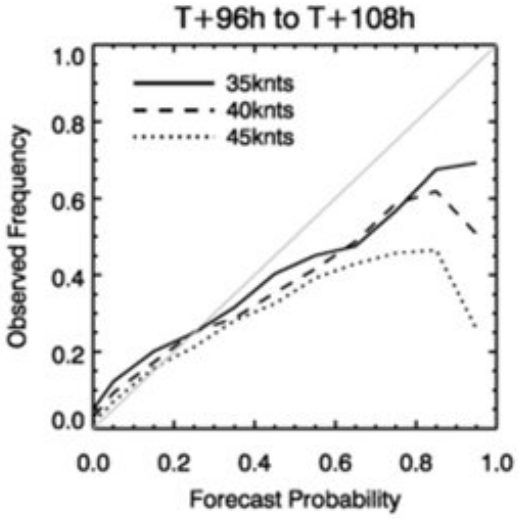


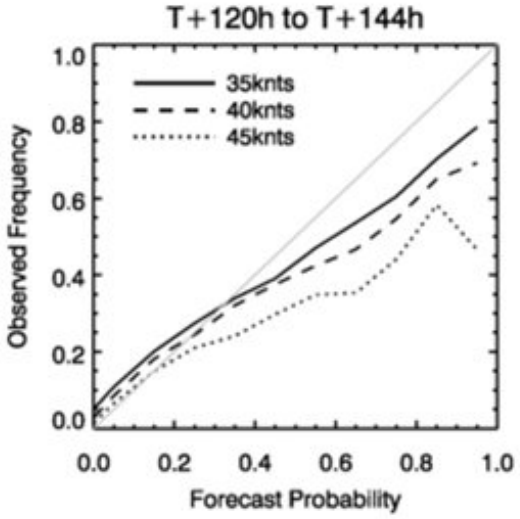



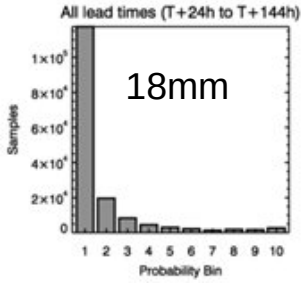



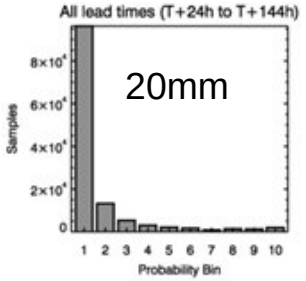



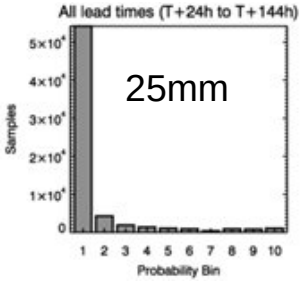
# ECMWF probability 24hr precip ≥ 18,20 and 25mm

Verification covering a 2 year period (1 March 2012 to 28 February 2014)

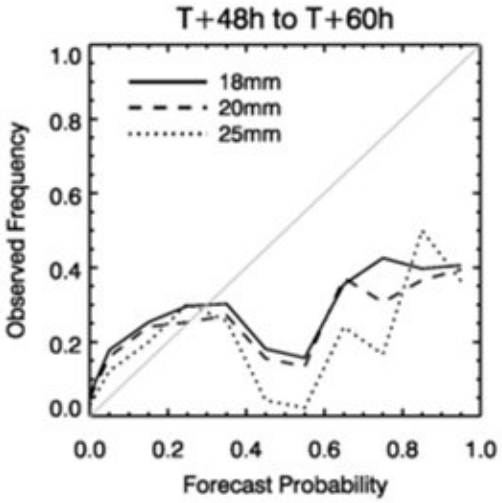
## Sharpness for all lead times combined

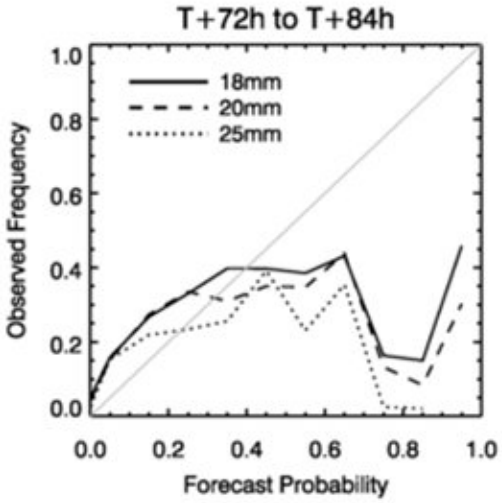


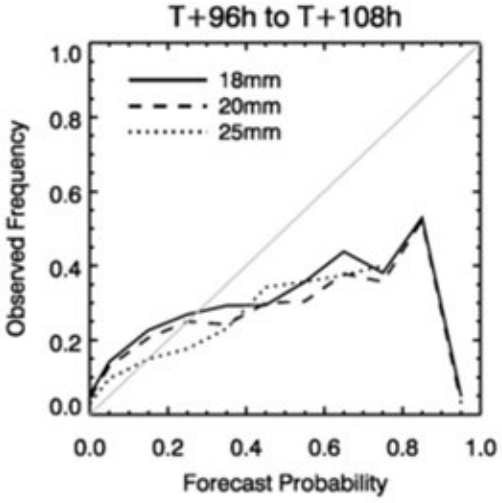



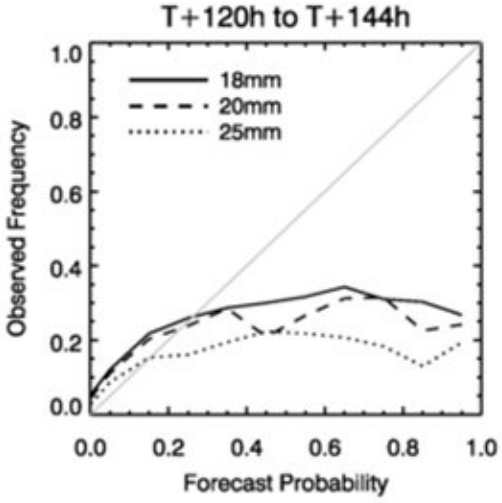




## Reliability diagrams for four different forecast periods



# Questions and answers