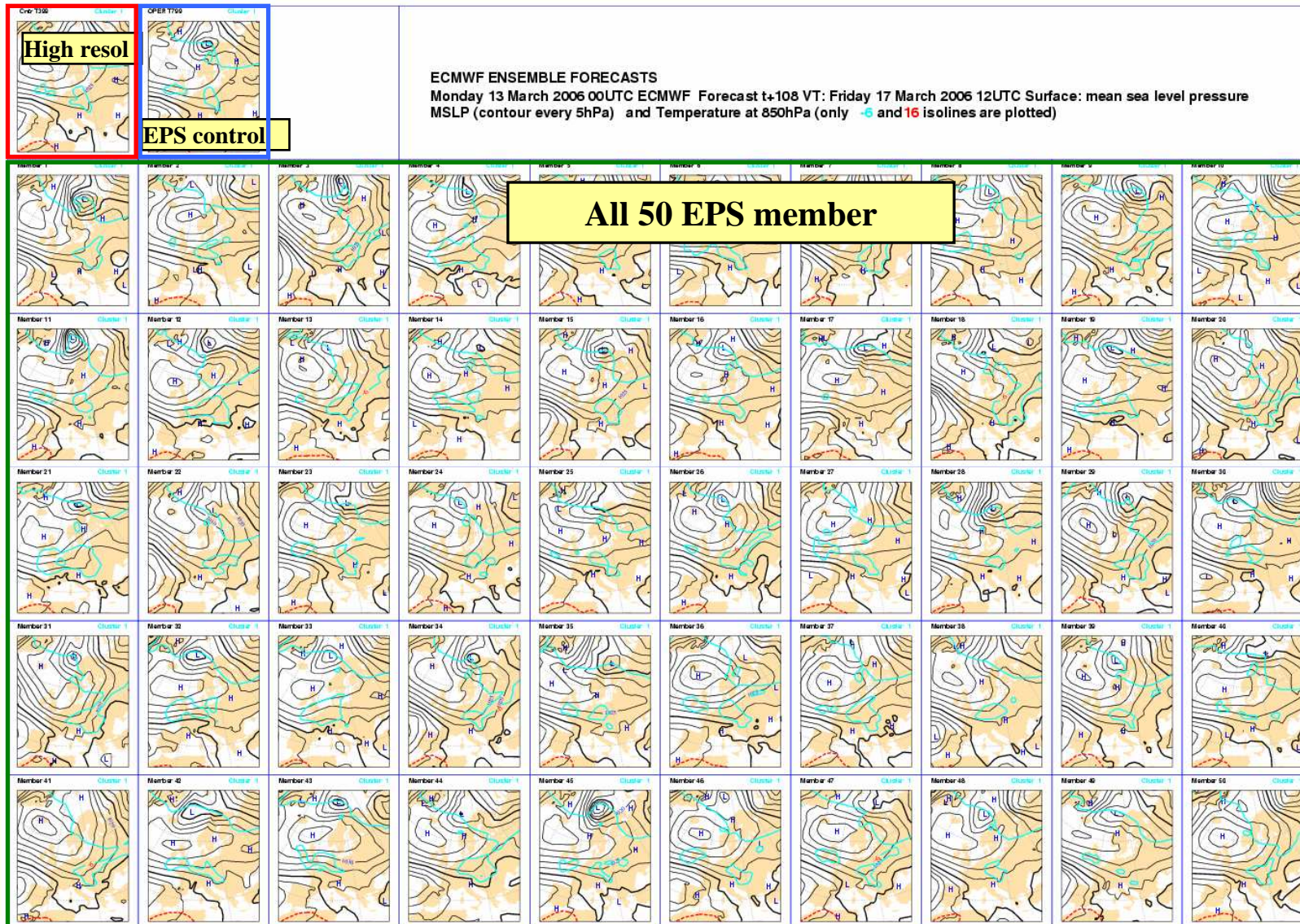# IV Use of probabilities

4. Probability products

EPS products

- Ensemble Members and clusters

- Ensemble Mean and Ensemble Spread

- Probabilities of events

- EPSgrams

- Extreme Forecast Index (EFI)

- Tropical Cyclone Strike Probability Maps

IV.4.1. Ensemble members and clusters (at ECMWF only made for Europe)
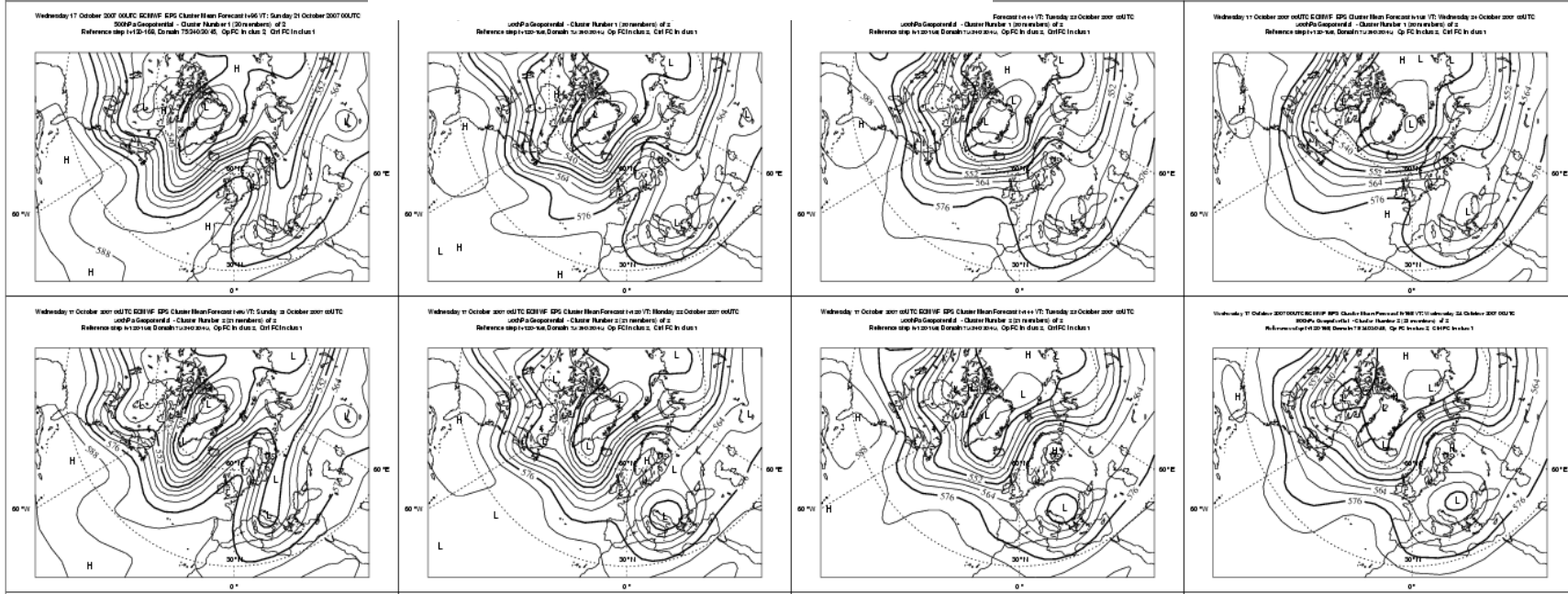
Products: Stamp maps

High resol

EPS control

ECMWF ENSEMBLE FORECASTS
Monday 13 March 2006 00UTC ECMWF Forecast t+108 VT: Friday 17 March 2006 12UTC Surface: mean sea level pressure
MSLP (contour every 5hPa) and Temperature at 850hPa (only -6 and 16 isolines are plotted)

All 50 EPS member

ECMWF Ensemble
Forecast Clusters

Wednesday 17 October 2007 00UTC
500hPa Geopotential

Exp 0001

**Cluster means
1992-2012
Now disbanded**

Cluster 1 : 30 Forecast(s)
Cluster 2 : 21 Forecast(s)
Cluster 3 : 0 Forecast(s)
Cluster 4 : 0 Forecast(s)
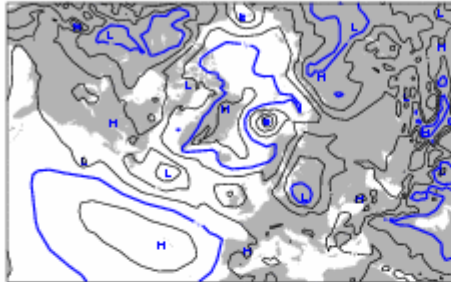Cluster 5 : 0 Forecast(s)
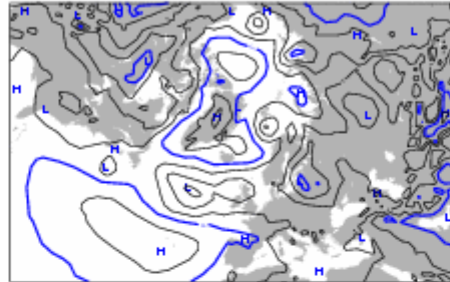Cluster 6 : 0 Forecast(s)

Clustering 2010 - "Typical member"

VI.4.2. Probability maps (outside the tropics)

EPS forecasts (field probabilities)

Thursday 29 January 2015 00UTC ©ECMWF Forecast probability t+144-168 VT: Wednesday 4 February 2015 00UTC - Thursday 5 February 2015 00UTC
Surface: Total precipitation of at least 10 mm
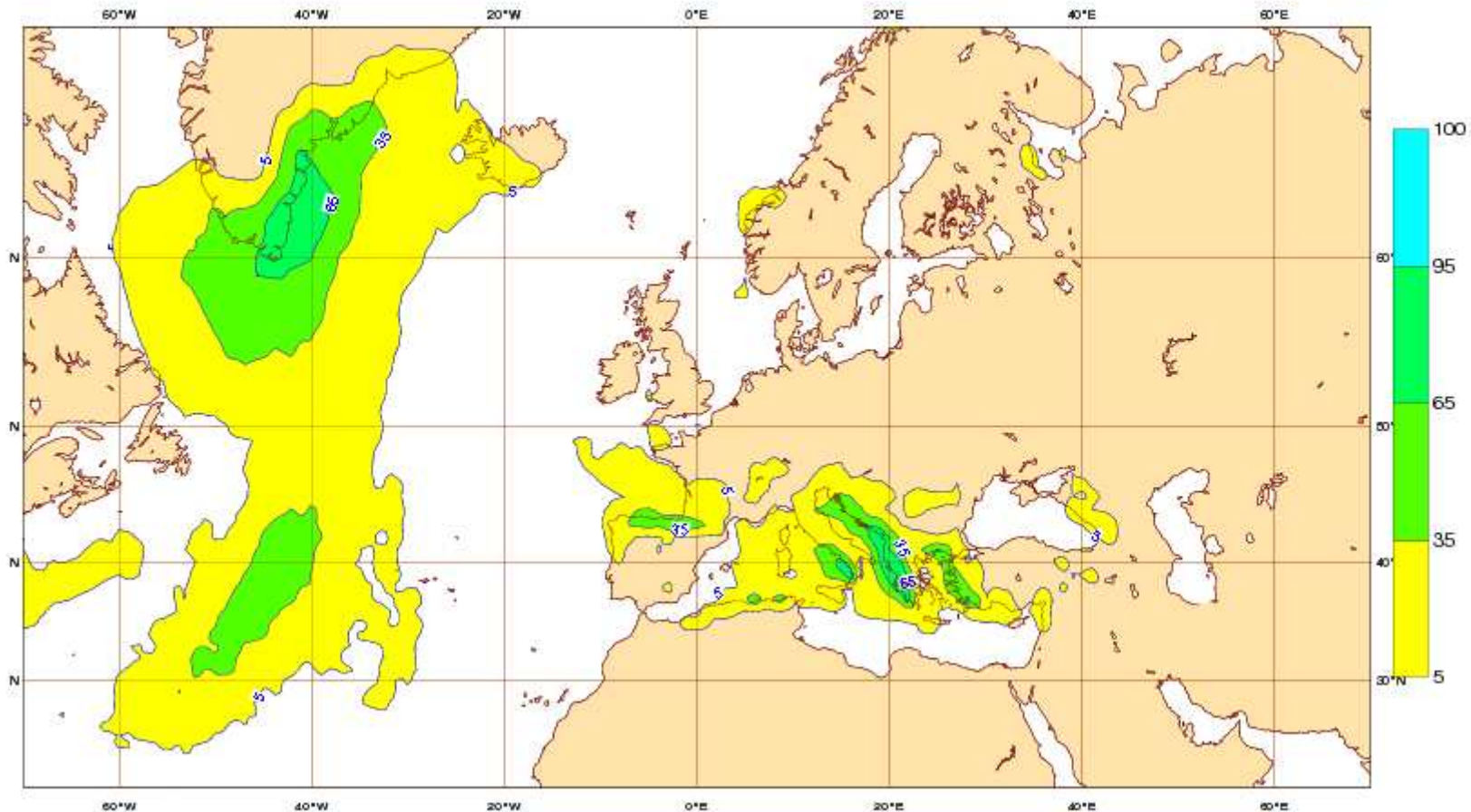
Probability of precipitation more than 10 mm in 24 hours

EPS forecasts (field probabilities)

Thursday 29 January 2015 00 UTC ©ECMWF Forecast probability t+156-180 VT: Wednesday 4 February 2015 12UTC - Thursday 5 February 2015 12UTC
Surface: 10 metre Wind gust of at least 15 m/s

Probability of 10m wind gusts exceeding 15 m/s
over 24 hours

IV.4.3. EPSgrammes

max

90%

median (50%)

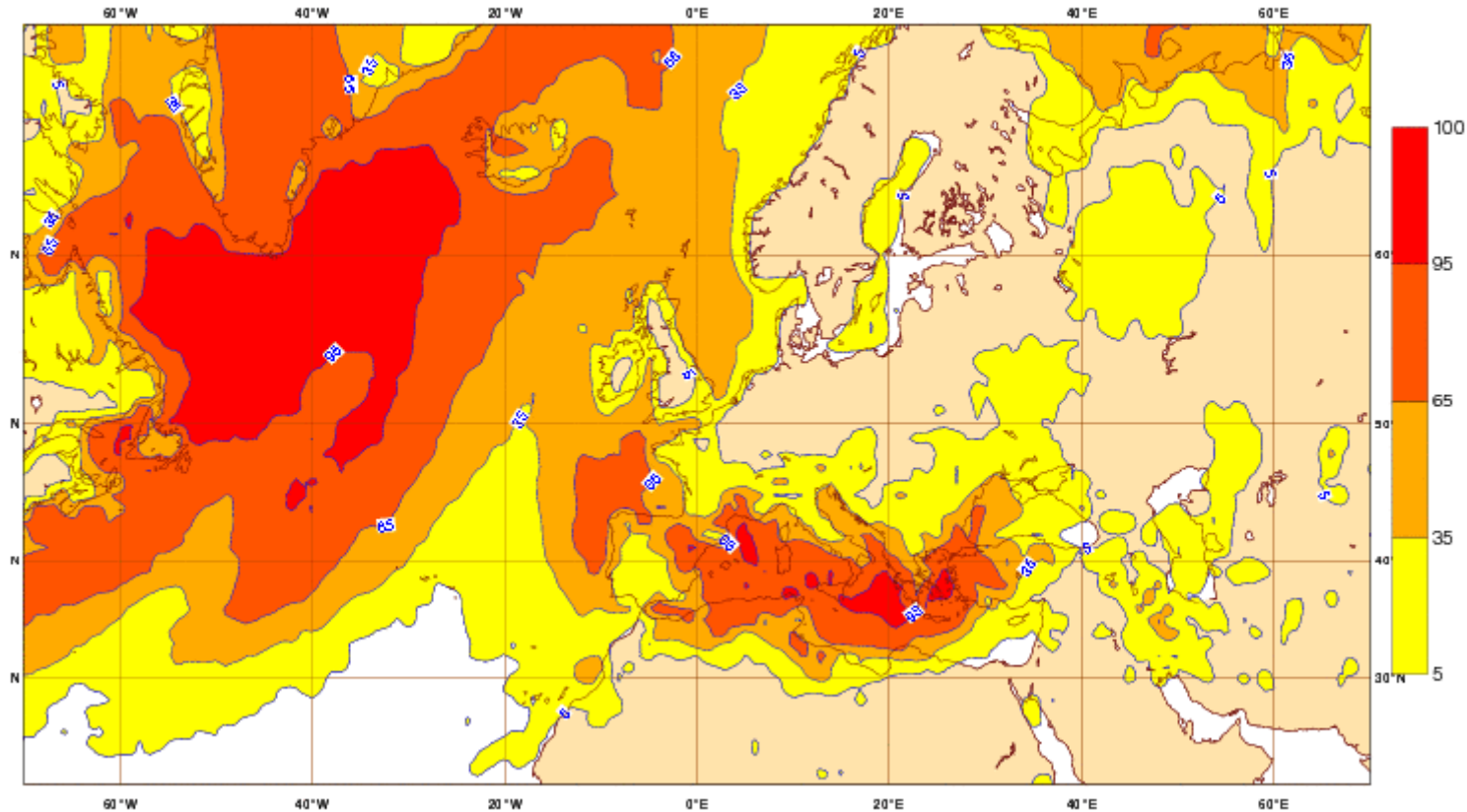Total Cloud Cover (okta)

Total cloud cover

75%

Deterministic

Total Precipitation (mm/6h)

6 hourly precipitation

25%

10m wind speed

EPS control

10%

2m temperature reduced to station height (°C) 1454m (T799) 1420m (T399)

2m temperature

min

Proba

Bol

Fri 7   Sat 8   Sun 9   Mon 10   Tue 11   Wed 12   Thu 13   Fri 14   Sat 15   Sun 16

November 2008

EPS gram for Hong Kong

No column means either 8/8 or 0/8

Y-axis varies depending on forecast values

Probabilities for 6 hour intervals

Misfit between EPS grid point and T1279 grid point

EPS Meteogram
Hong Kong 22.34°N 114.07°E (EPS land point) 0 m
Deterministic Forecast and EPS Distribution Wednesday 29 June 2011 00 UTC

Total Cloud Cover (okta)

Total Precipitation (mm/6h)

10m Wind Speed (m/s)

2m Temperature (°C) reduced to the station height from 82 m (T1279) and 50 m (T639)
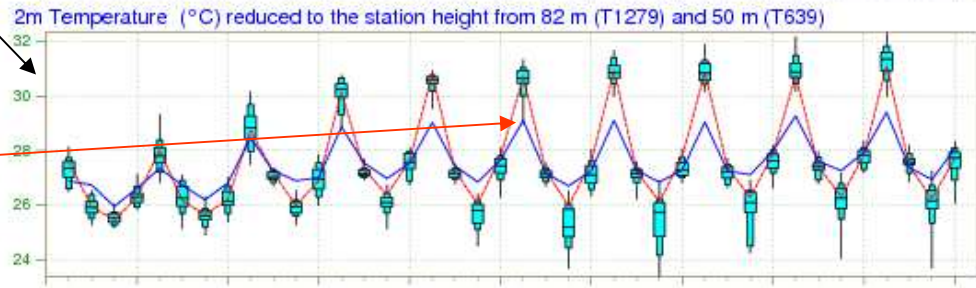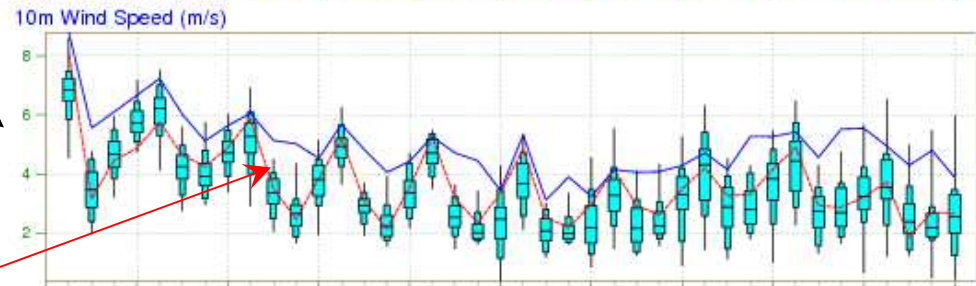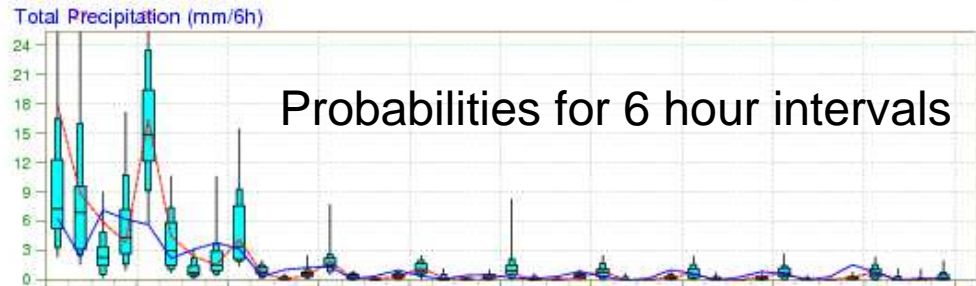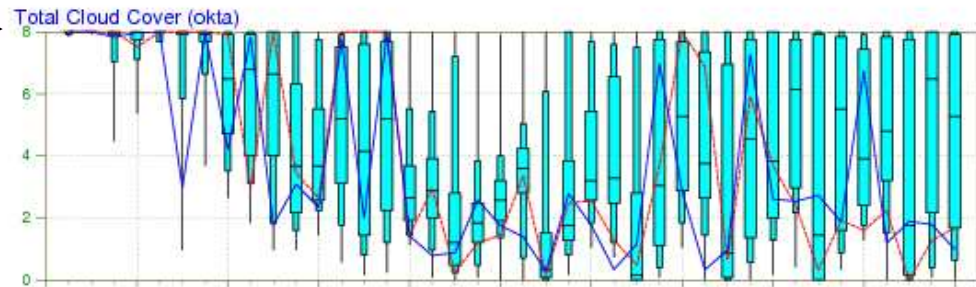
Wed 29   Thu 30   Fri 1   Sat 2   Sun 3   Mon 4   Tue 5   Wed 6   Thu 7   Fri 8
July 2011

Prob
B

max
90%
75%
median
25%
10%
min
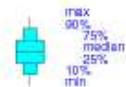
EPS Control(31 km) High Resolution Deterministic(16 km)

ECMWF

Example from Hongkong

Nearest EPS land grid point

T1279 grid point approx.

Hong Kong

Nearest EPS sea grid point

COSMO-LEPS BoxPlot-Meteogram
punto : lat= 44.5 - lon= 11.3 - alt. mod. : 58 m
Distribuzione EPS del 03-02-2015 ore 12 UTC
previsione su : BOLOGNA
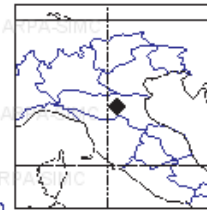
14
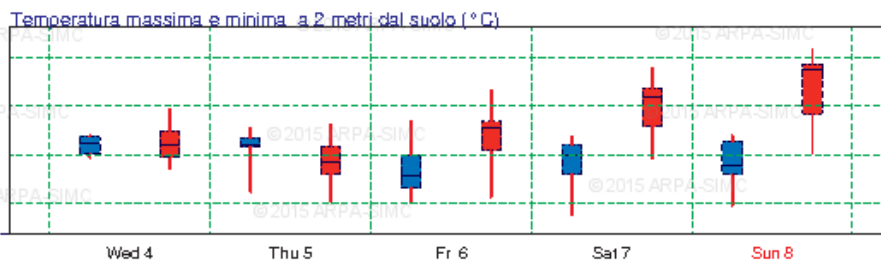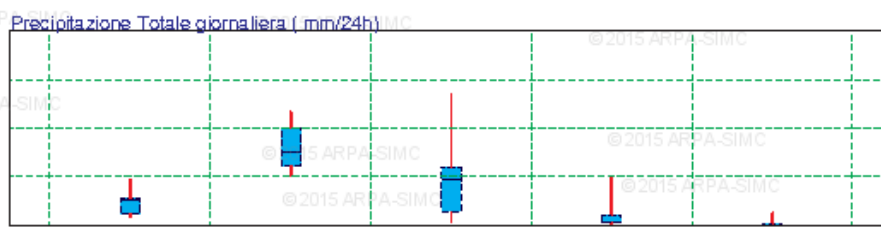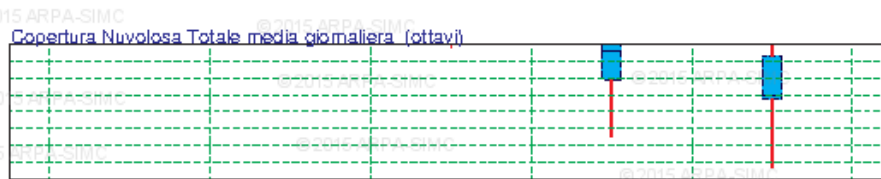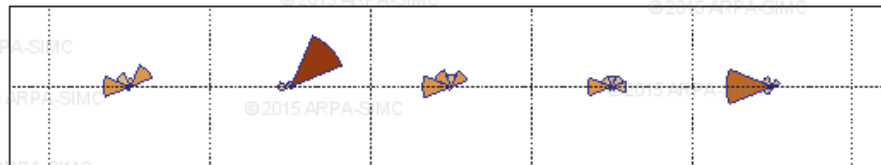
IV.4.4. Tropical cyclones
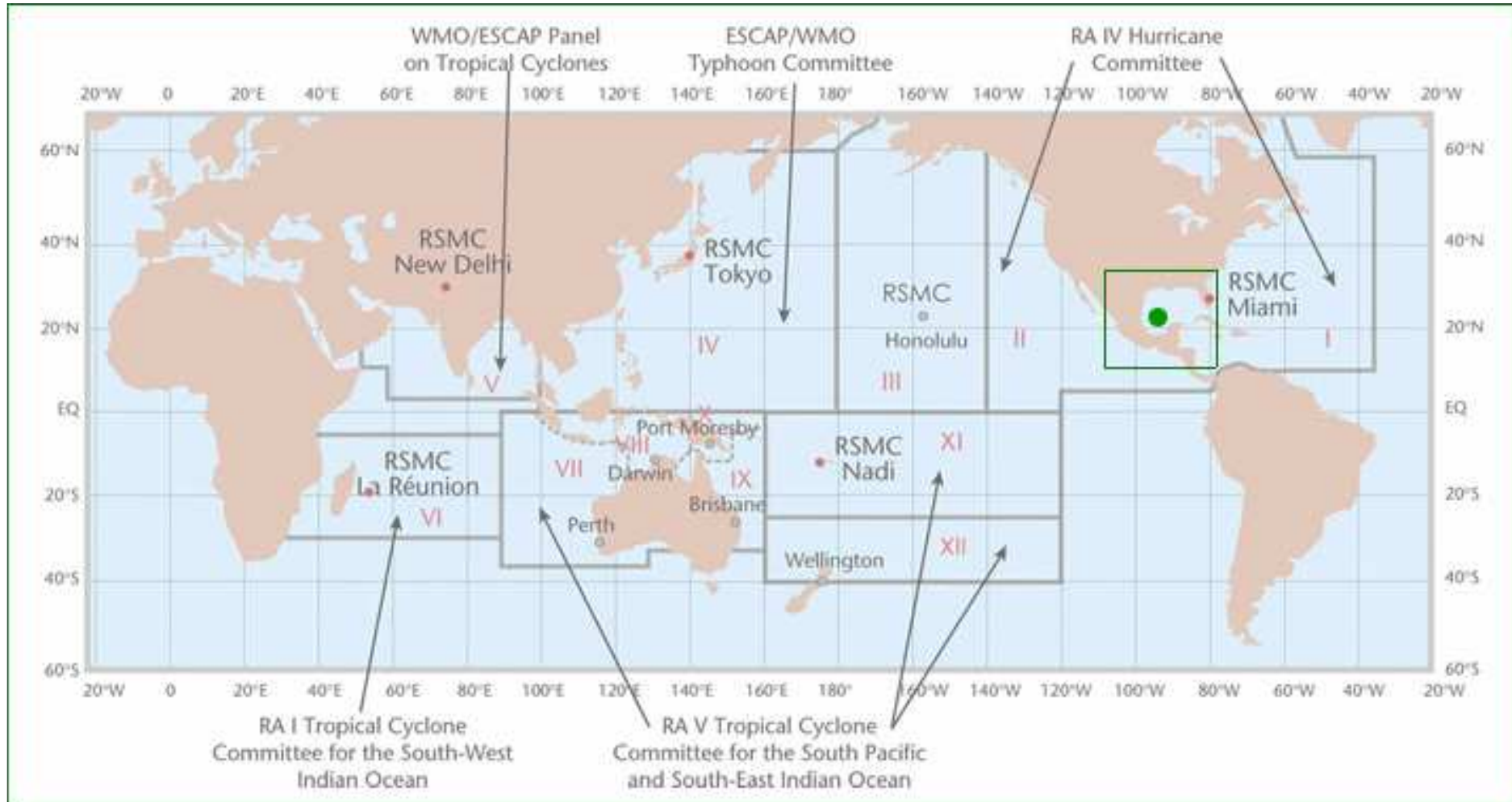
Tropical cyclones

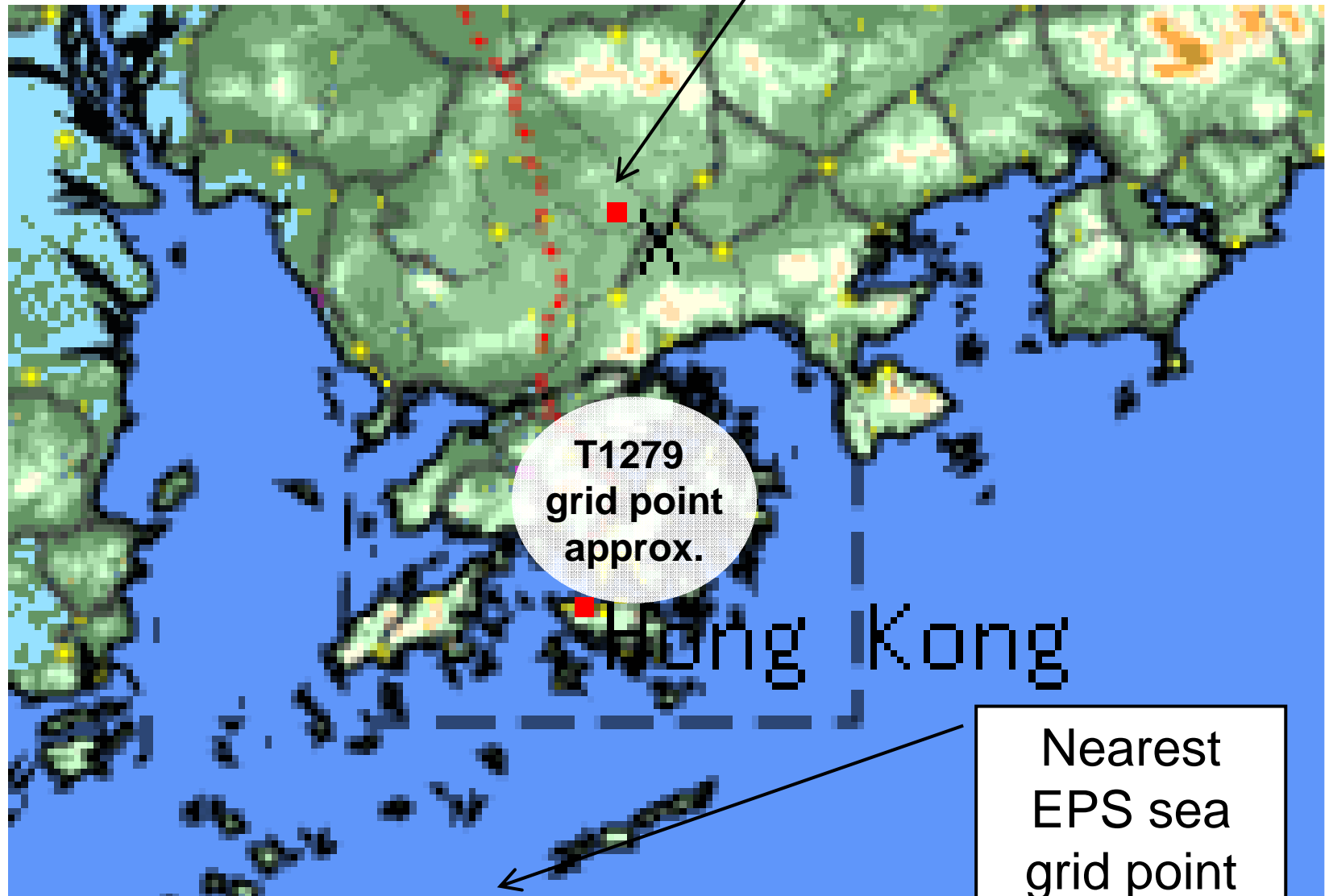Tropical Cyclone Strike Probability Start date:Friday 08 March 2013 at 00 UTC
valid for 48hours from Friday 15 March 2013 at 00 UTC to Sunday 17 March 2013 at 00 UTC
Probability of a Tropical Cyclone passing within 300km radius
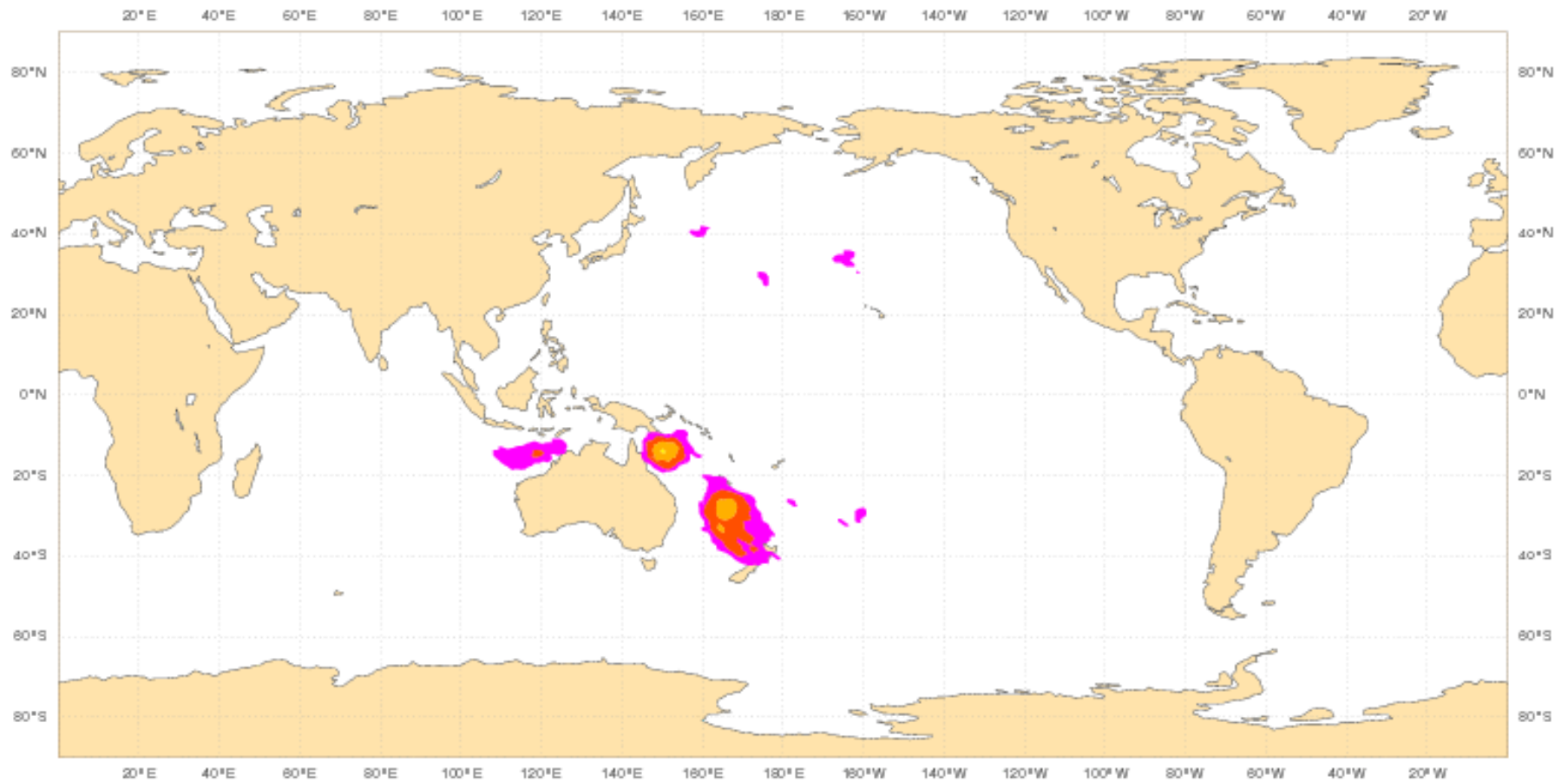
Tropical Storm Strike Probability Start date Thursday 16 June 2011 at 00 UTC
valid for 48hours from Friday 17 June 2011 at 00 UTC to Sunday 19 June 2011 at 00 UTC
Probability of a Tropical Storm passing within 300km radius

| 5-10 | 10-20 | 20-30 | 30-40 | 40-50 | 50-60 | 60-70 | 70-80 | 80-90 | >90% |

Bologna 9-13 February 2015
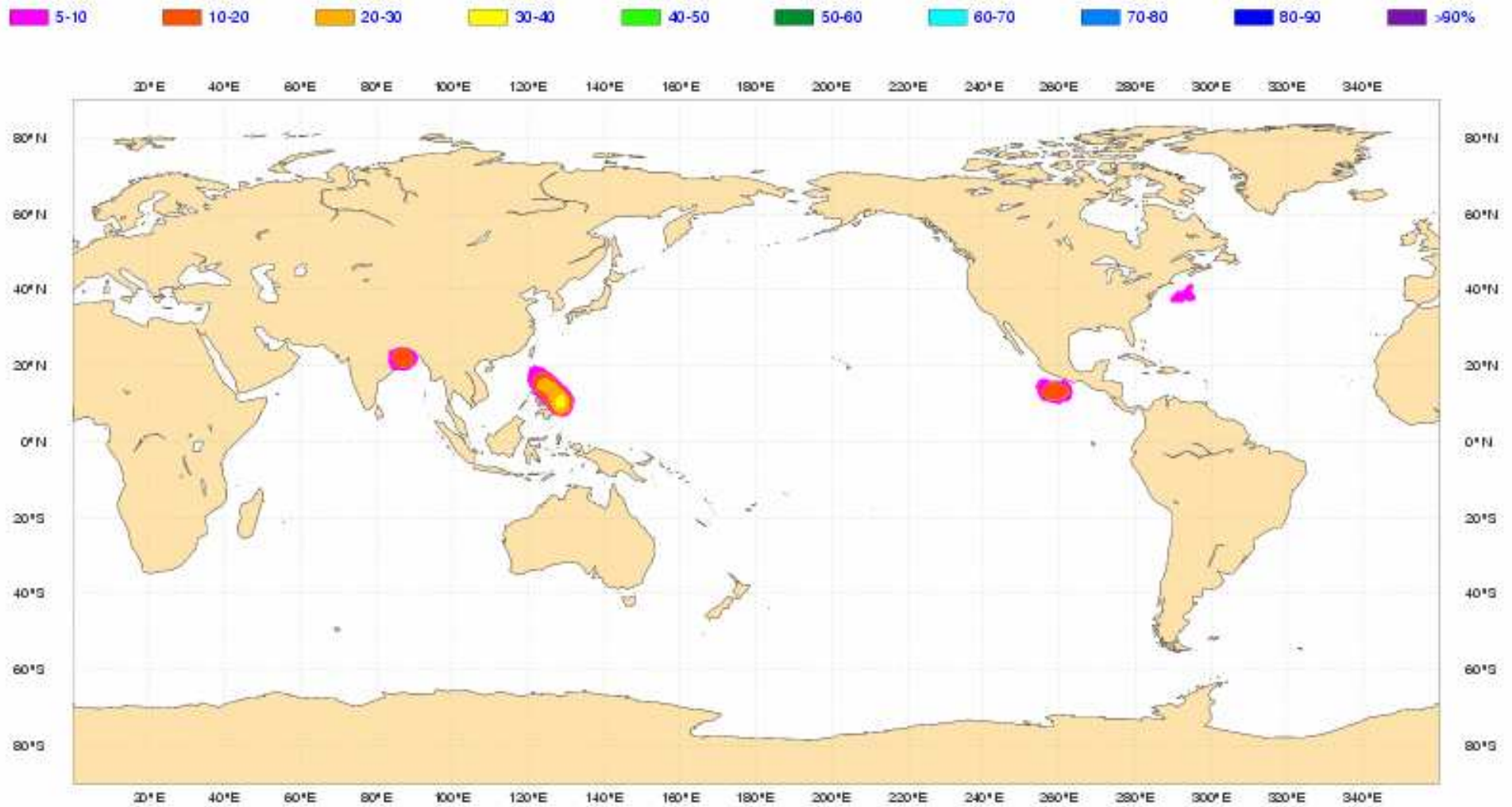
20110617 0 UTC
Probability that 06W will pass within 120km radius during the next 120 hours
tracks: black=OPER, green=CTRL, blue=EPS numbers: observed positions at t+..h

Probability Course IV:1
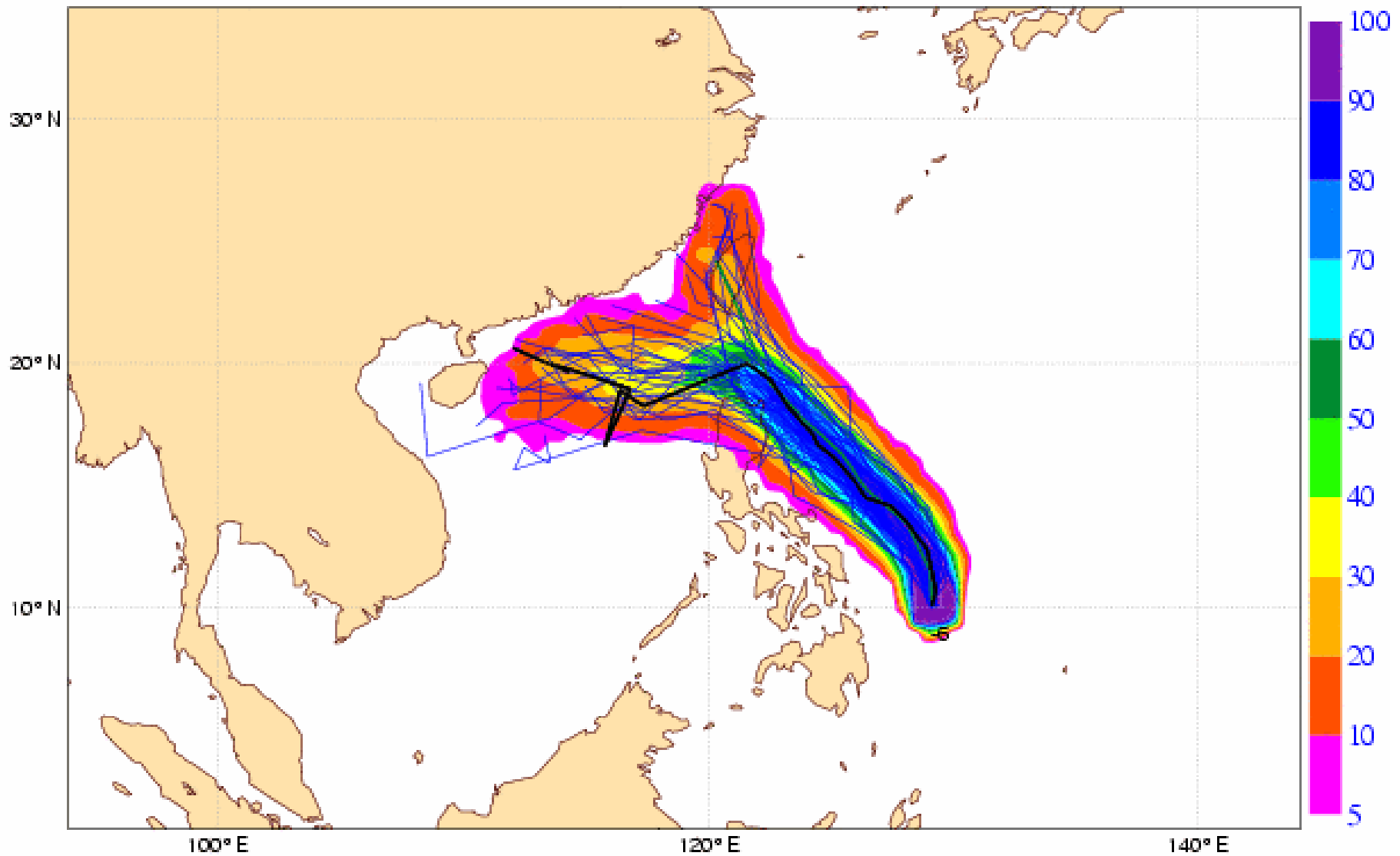
20110621 12 UTC
Probability that 07W will pass within 120km radius during the next 120 hours
tracks: black=OPER, green=CTRL, blue=EPS numbers: observed positions at t+..h
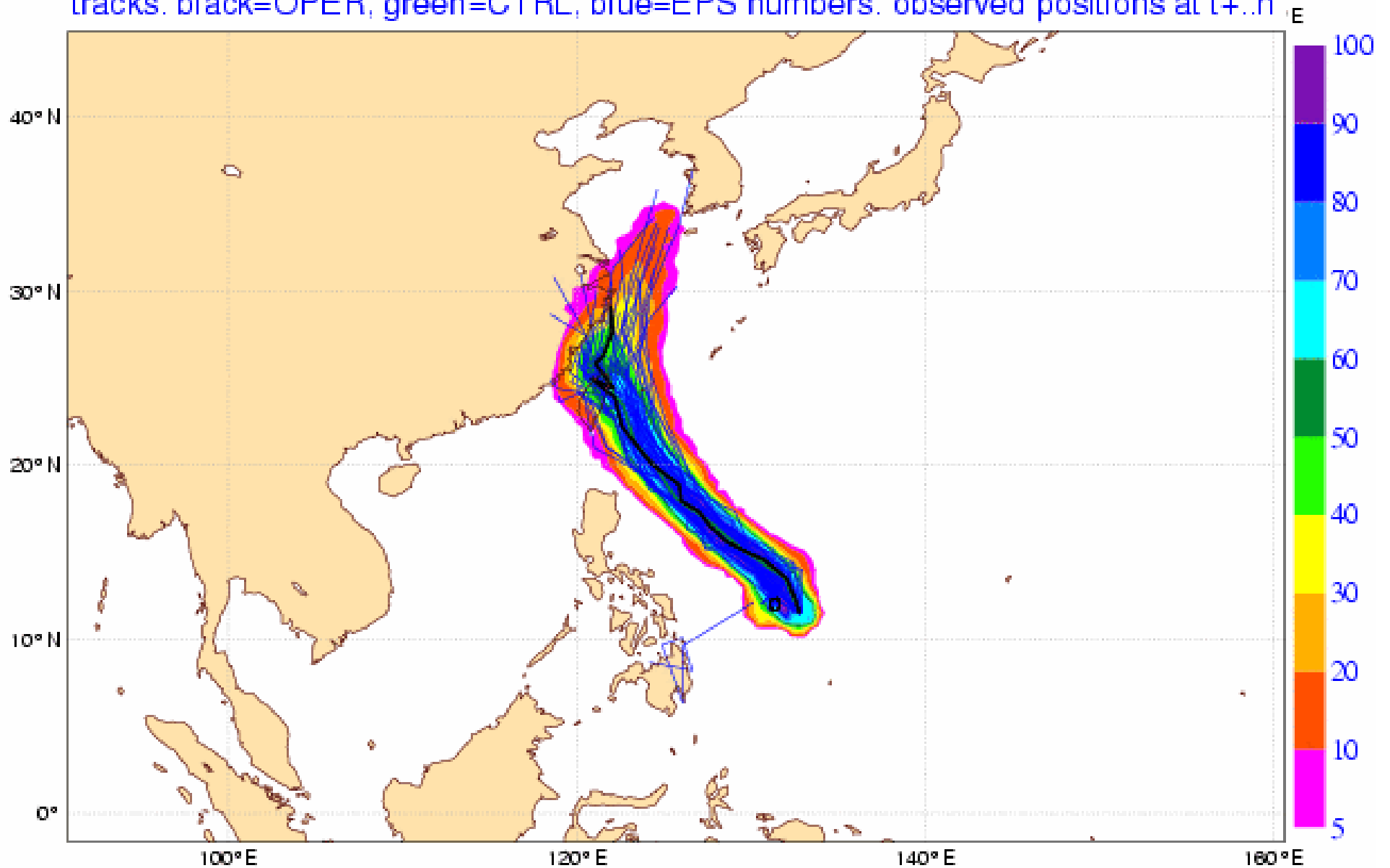
Bologna 9-13 February 2015

EPS Lagrangian Meteogram
Tropical Cyclone 07W (07W) starting from 12 N 131.4 E
Deterministic Forecast and EPS Distribution 21 June 2011 12 UTC
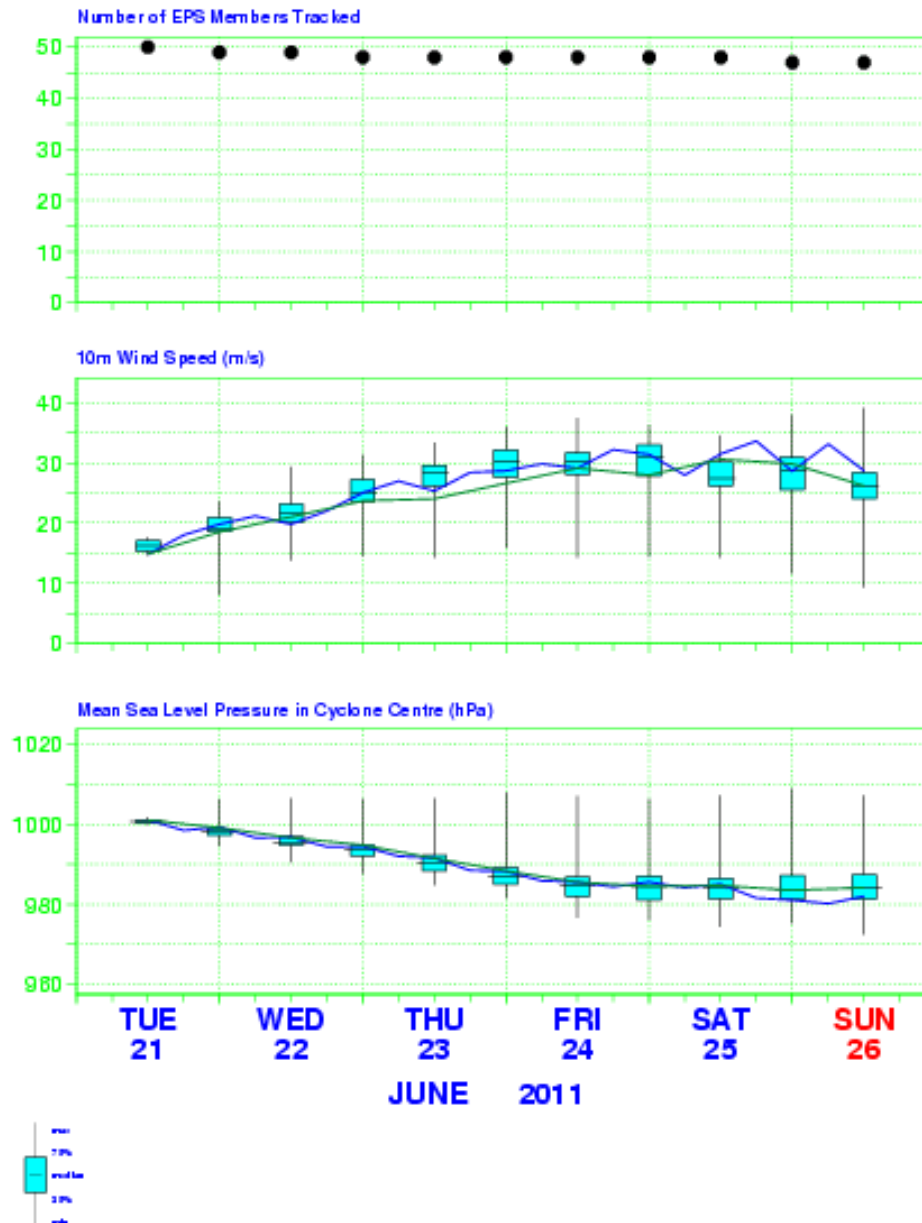
Number of EPS Members Tracked

10m Wind Speed (m/s)

Mean Sea Level Pressure in Cyclone Centre (hPa)

TUE 21   WED 22   THU 23   FRI 24   SAT 25   SUN 26

JUNE 2011

Tuesday 21 June 2011 12UTC ECMWF Forecast t+120 VT: Sunday 26 June 2011 12UTC
1000hPa Geopotential Ensemble Mean and Normalised Standard Deviation (shaded)
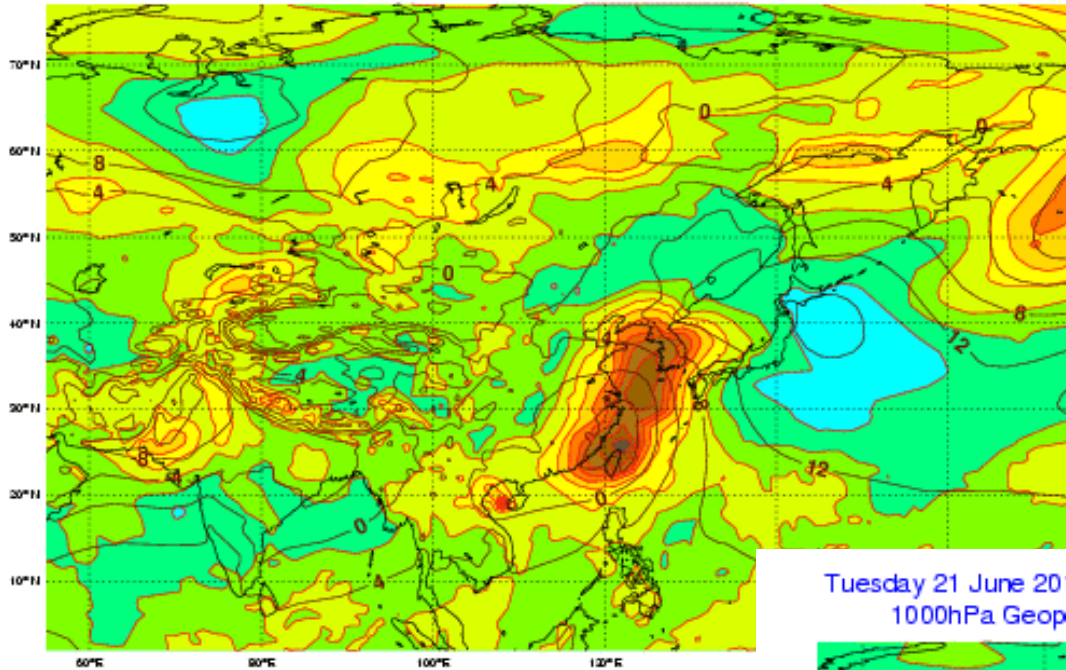
VT Sunday 25 June 2011 00 UTC

Ensemble mean and raw spread charts Tuesday 21 June 2011 12 UTC + 108h

Ensemble mean and normalised spread charts Tuesday 21 June 2011 12 UTC + 108h

Tuesday 21 June 2011 12UTC ECMWF Forecast t+120 VT: Sunday 26 June 2011 12UTC
1000hPa Geopotential Deterministic Forecast and Standard Deviation (shaded)

IV.4.5. Working with the EPS
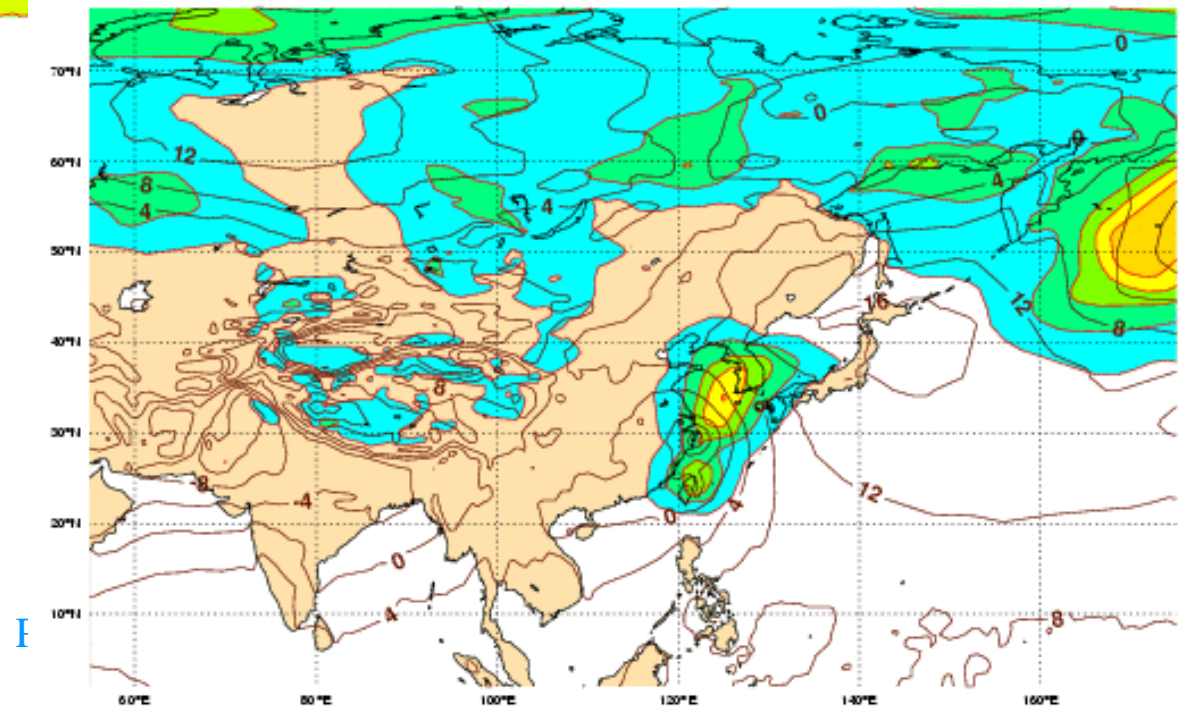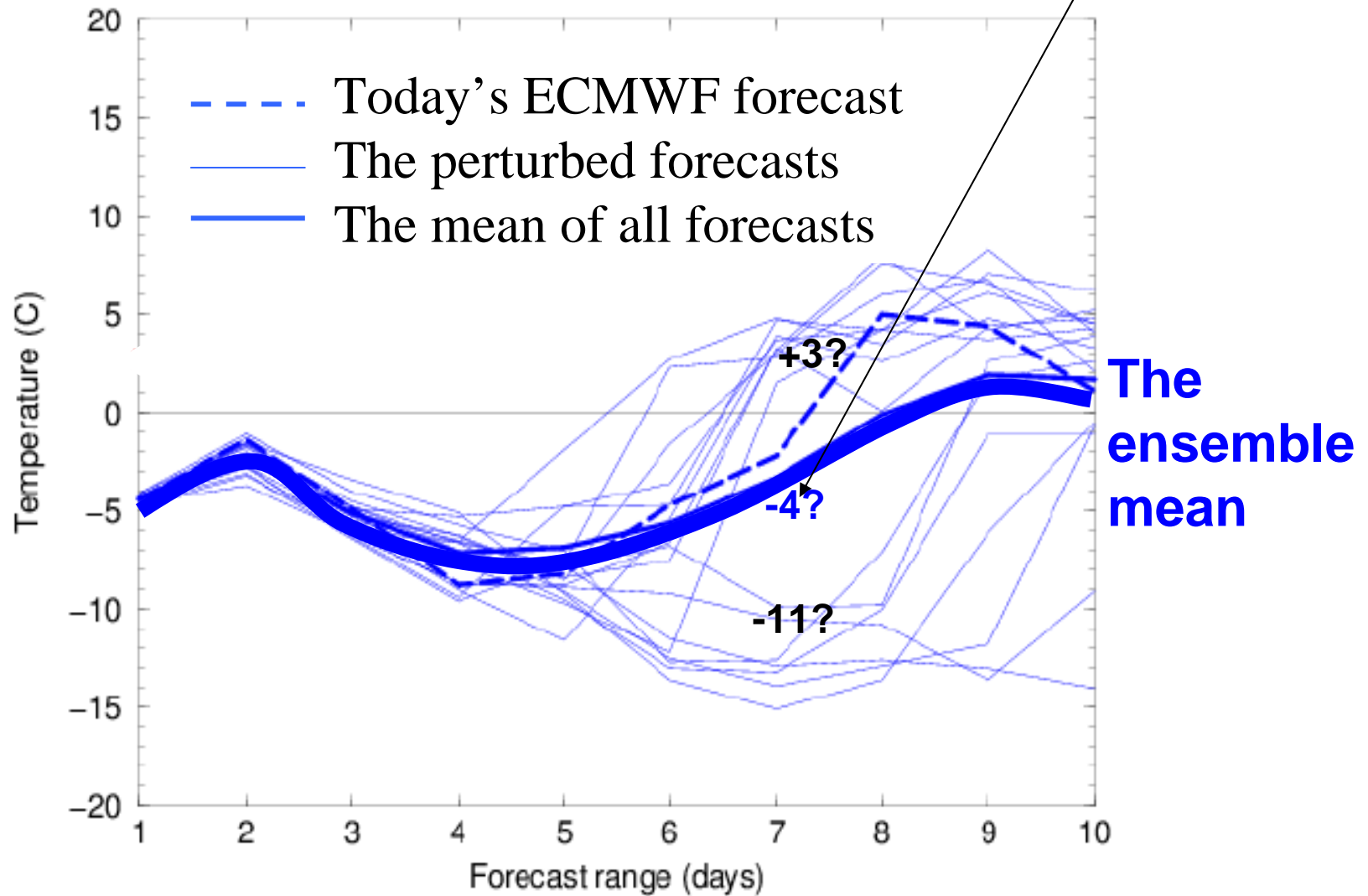
-Ensemble mean acts as a dynamic filter and removes normally unpredictable features
-The removed features are put back in a consistent way as probabilities

Which temperature for day 7?

The relation between synoptic scale and predictability

All forecasts verify 20 August 00 UTC 2010

OPS 13 Aug 2010 12 UTC+156 h

OPS 14 Aug 2010 00 UTC+144 h

OPS 14 Aug 2010 12 UTC+132 h

OPS 15 Aug 2010 00 UTC+120 h

OPS 15 Aug 2010 12 UTC+108 h

OPS 16 Aug 2010 00 UTC+96 h
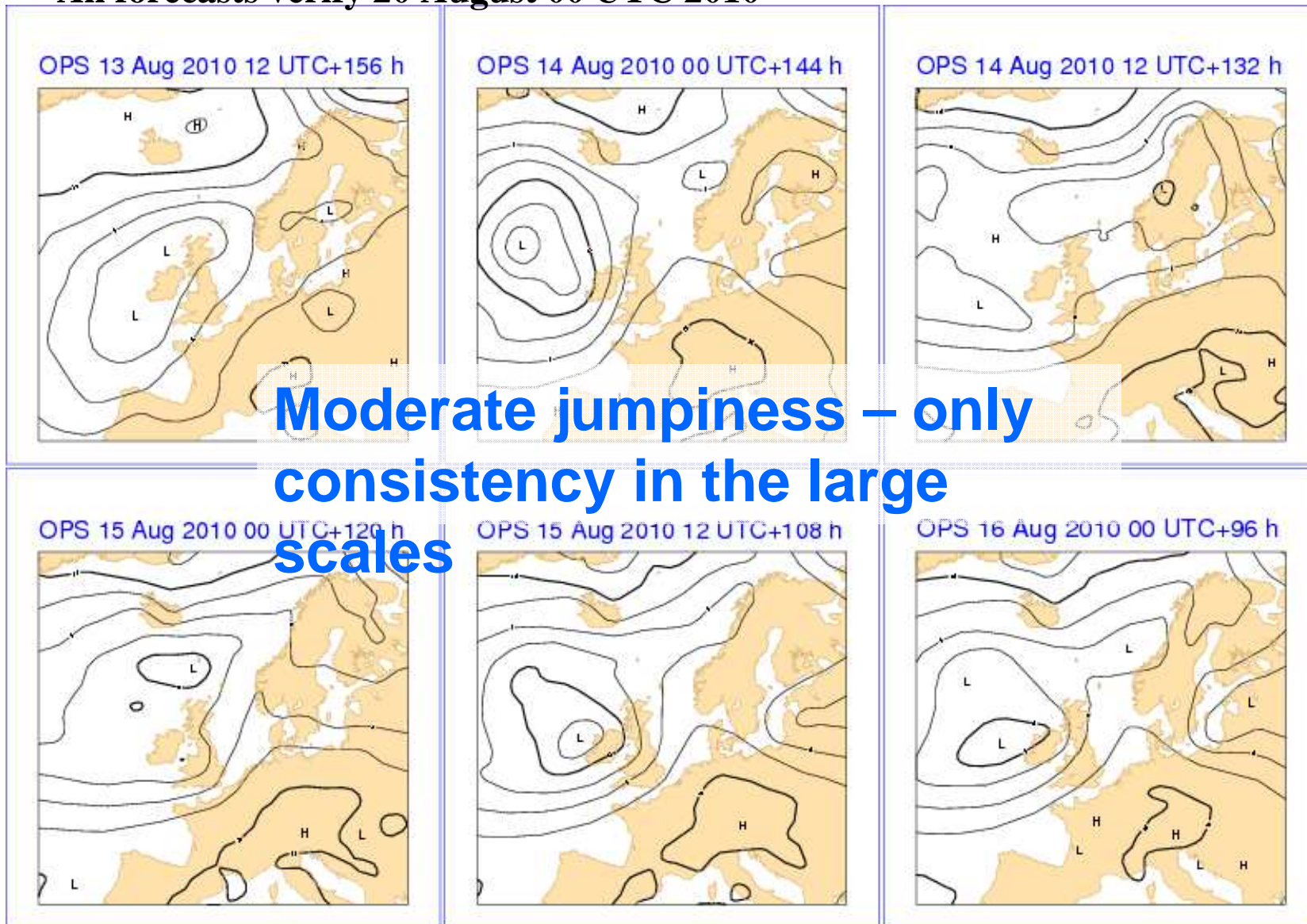
Moderate jumpiness – only consistency in the large scales

The relation between synoptic scale and predictability
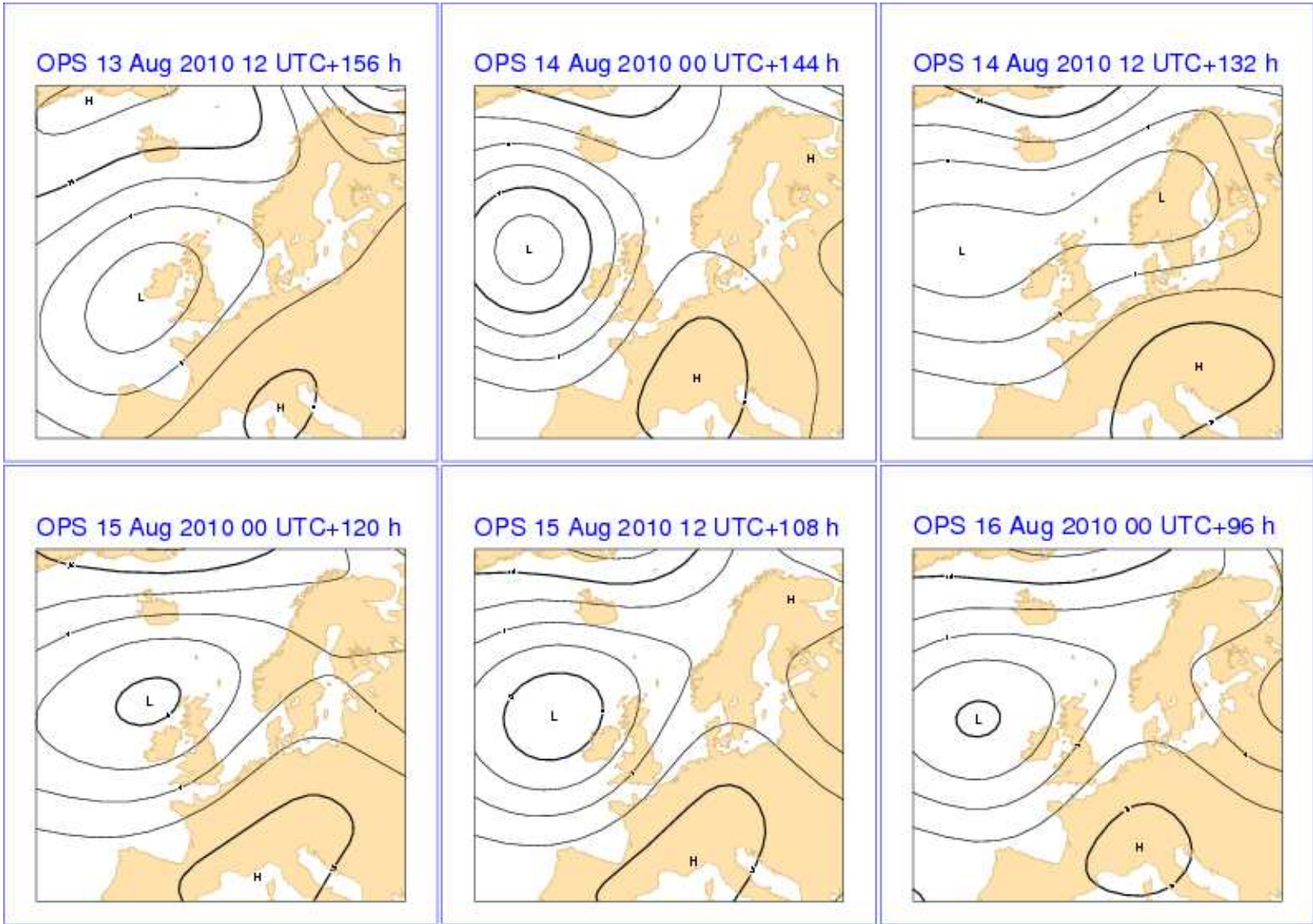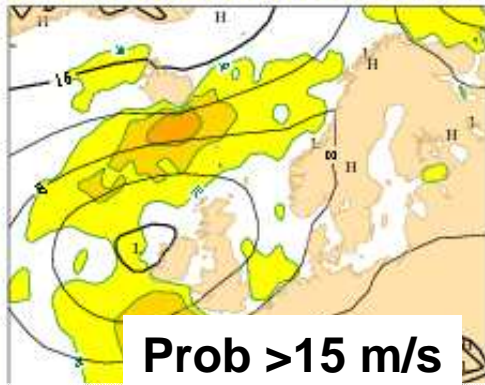## All forecasts verify 20 August 00 UTC 2010

OPS 13 Aug 2010 12 UTC+156 h

OPS 14 Aug 2010 00 UTC+144 h

OPS 14 Aug 2010 12 UTC+132 h
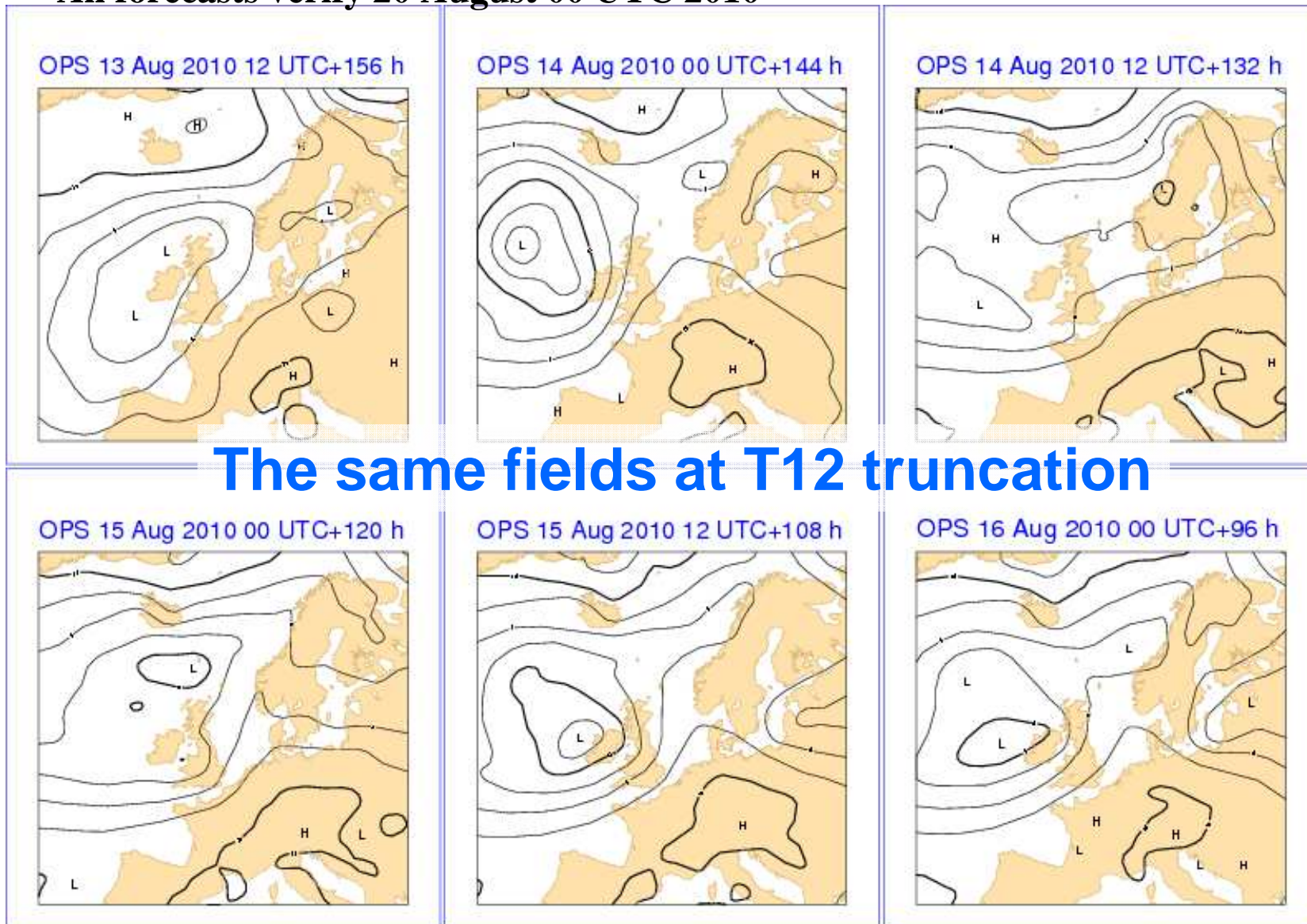
The same fields at T12 truncation

OPS 15 Aug 2010 00 UTC+120 h

OPS 15 Aug 2010 12 UTC+108 h

OPS 16 Aug 2010 00 UTC+96 h

OPS 13 Aug 2010 12 UTC+156 h

OPS 14 Aug 2010 00 UTC+144 h

OPS 14 Aug 2010 12 UTC+132 h

OPS 15 Aug 2010 00 UTC+120 h

OPS 15 Aug 2010 12 UTC+108 h

OPS 16 Aug 2010 00 UTC+96 h
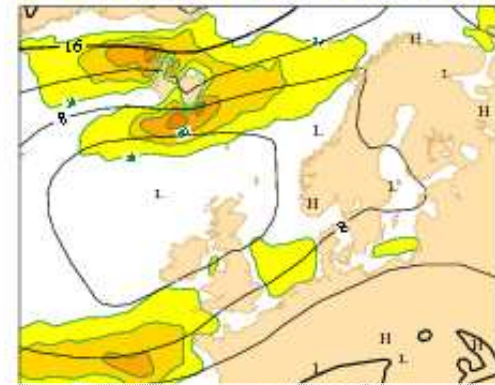
EPS 13 Aug 2010 12 UTC+156 h   EPS 14 Aug 2010 00 UTC+144 h   EPS 14 Aug 2010 12 UTC+132 h
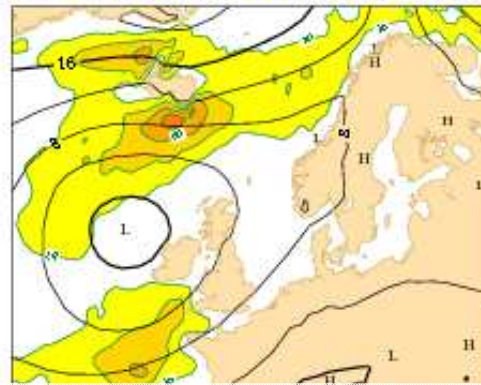
Prob >15 m/s

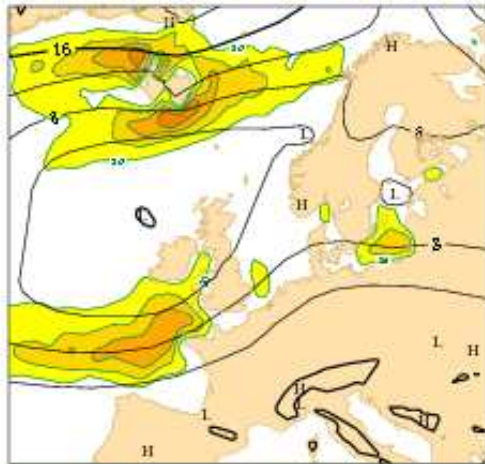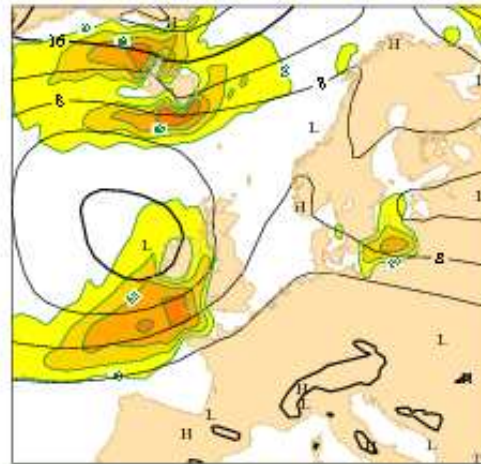**The smooth EM defines the general flow pattern and the probabilities represents what is "lost" in the averaging**
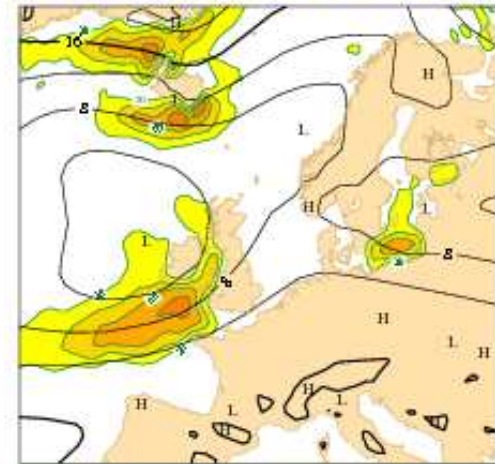
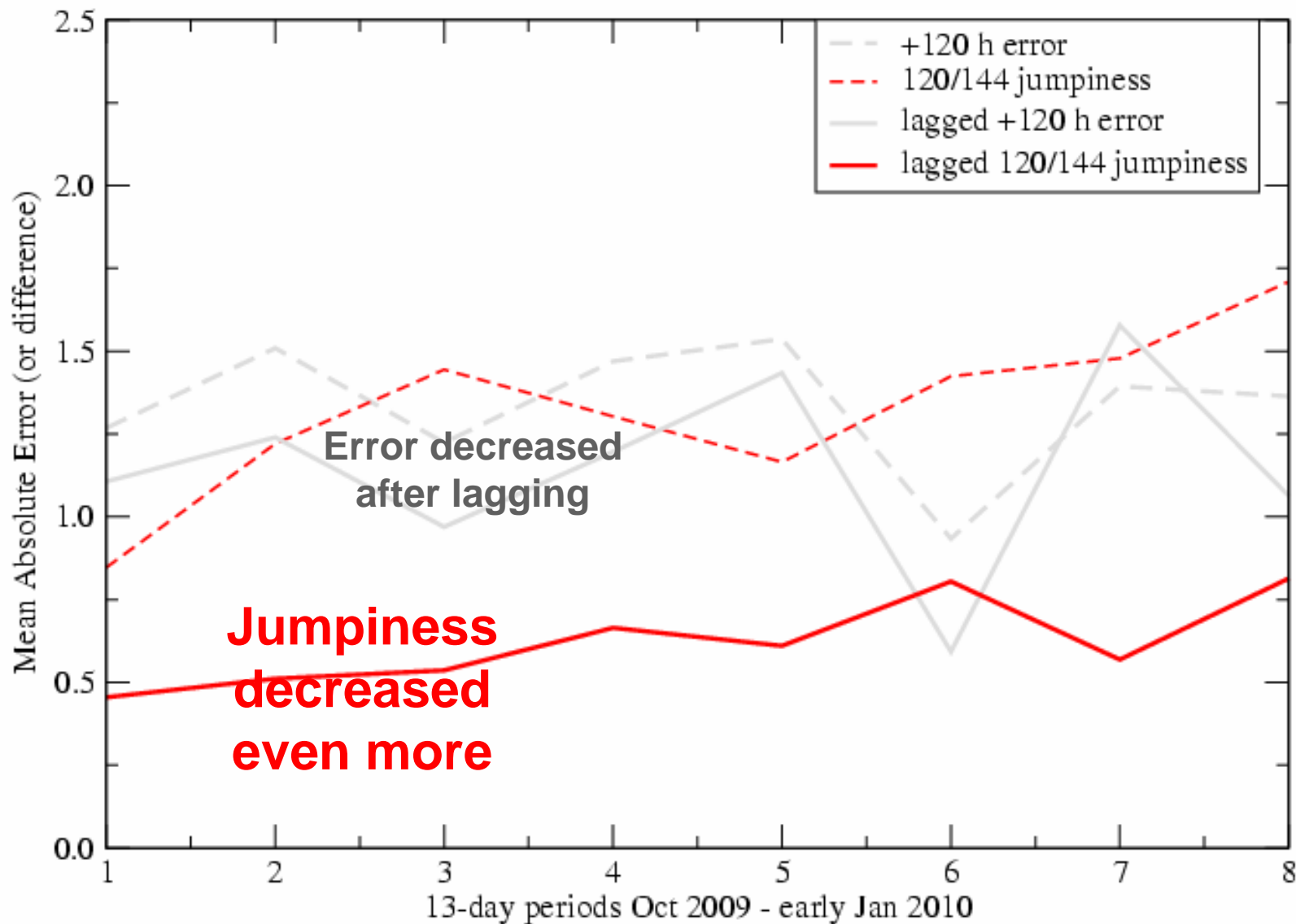EPS 15 Aug 2010 00 UTC+120 h   EPS 15 Aug 2010 12 UTC+108 h   EPS 16 Aug 2010 00 UTC+96 h

The effect of filtering on error and jumpiness

Comparison between single +120 h fcsts and ones lagged with previous two days'

The *perceived* problems with the ensemble mean (EM):

"-EM does not display realistic flow patterns"
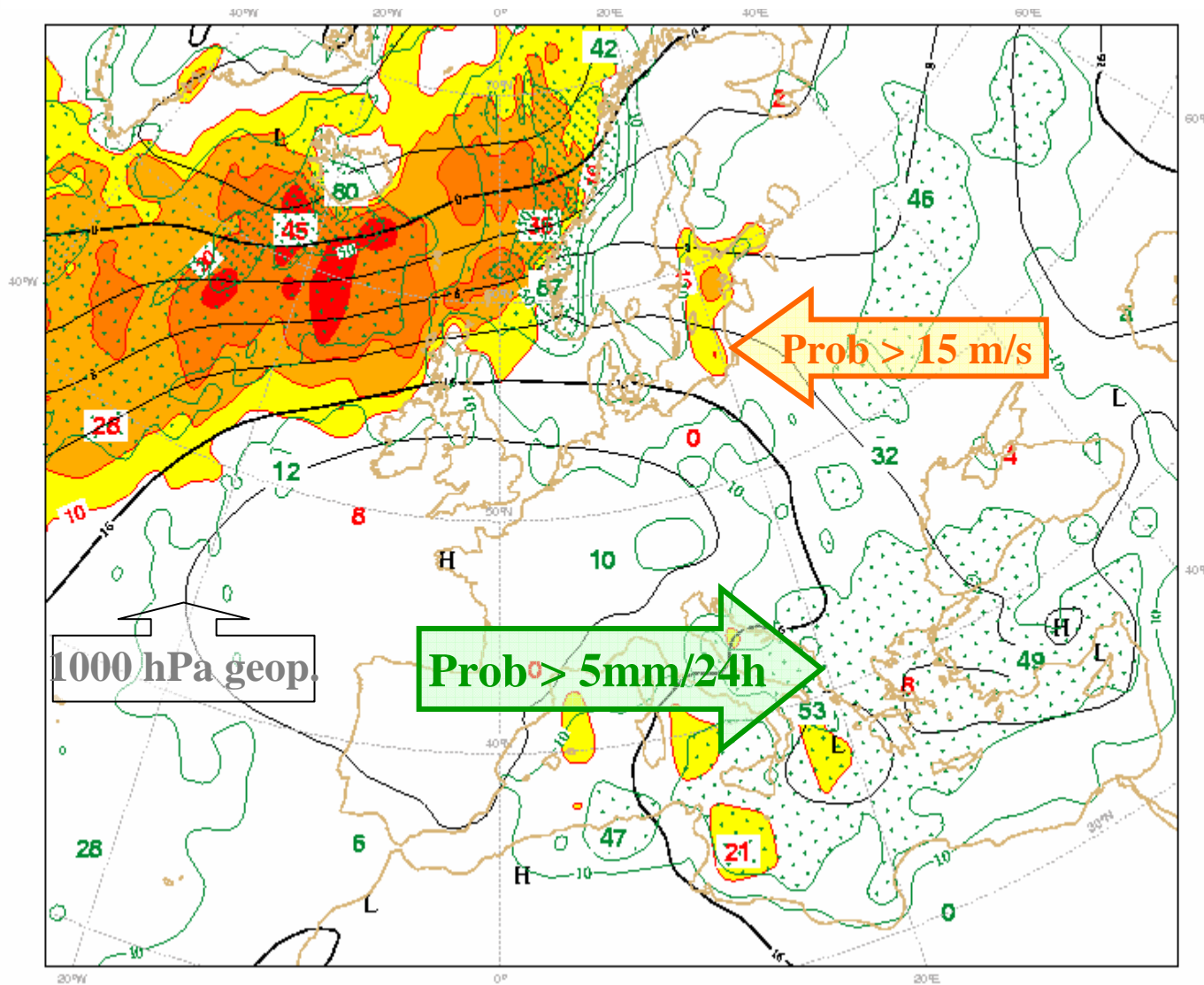Only a problems for meteorological experts

"-EM cannot forecast extremes"
That 's why probabilities are needed to complement the EM
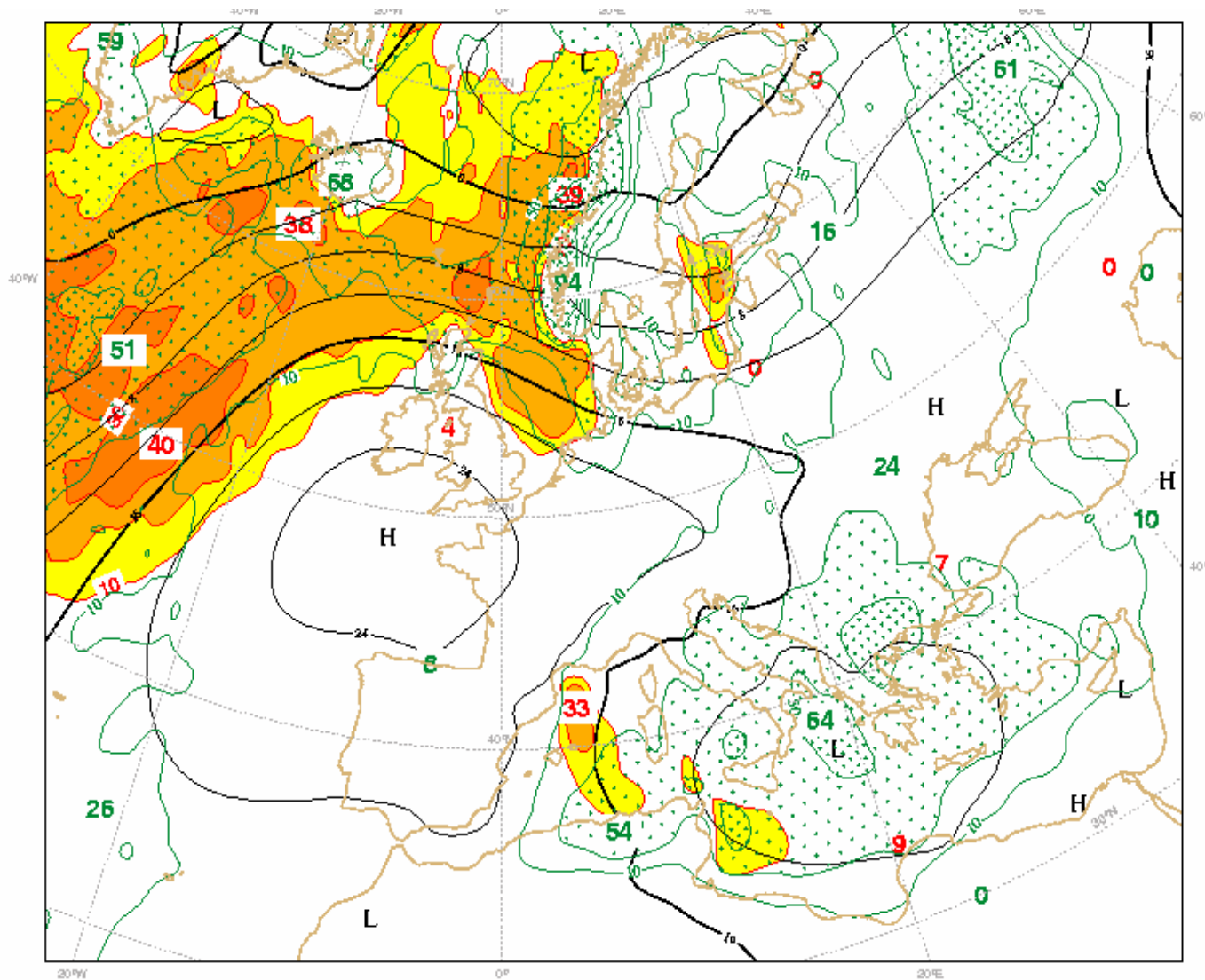
"-EM might provide internally inconsistent weather parameters"
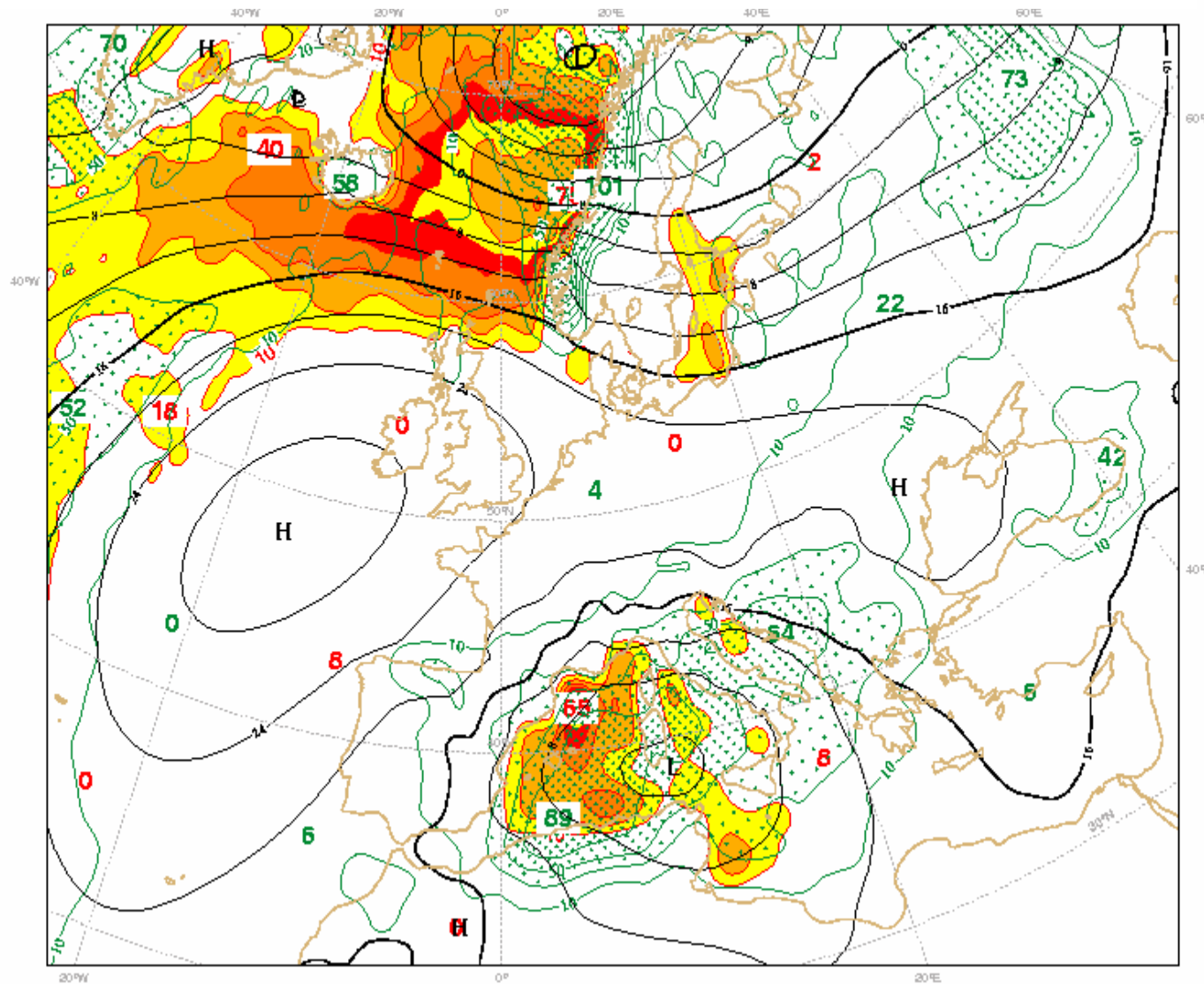So does some of the output from the deterministic system

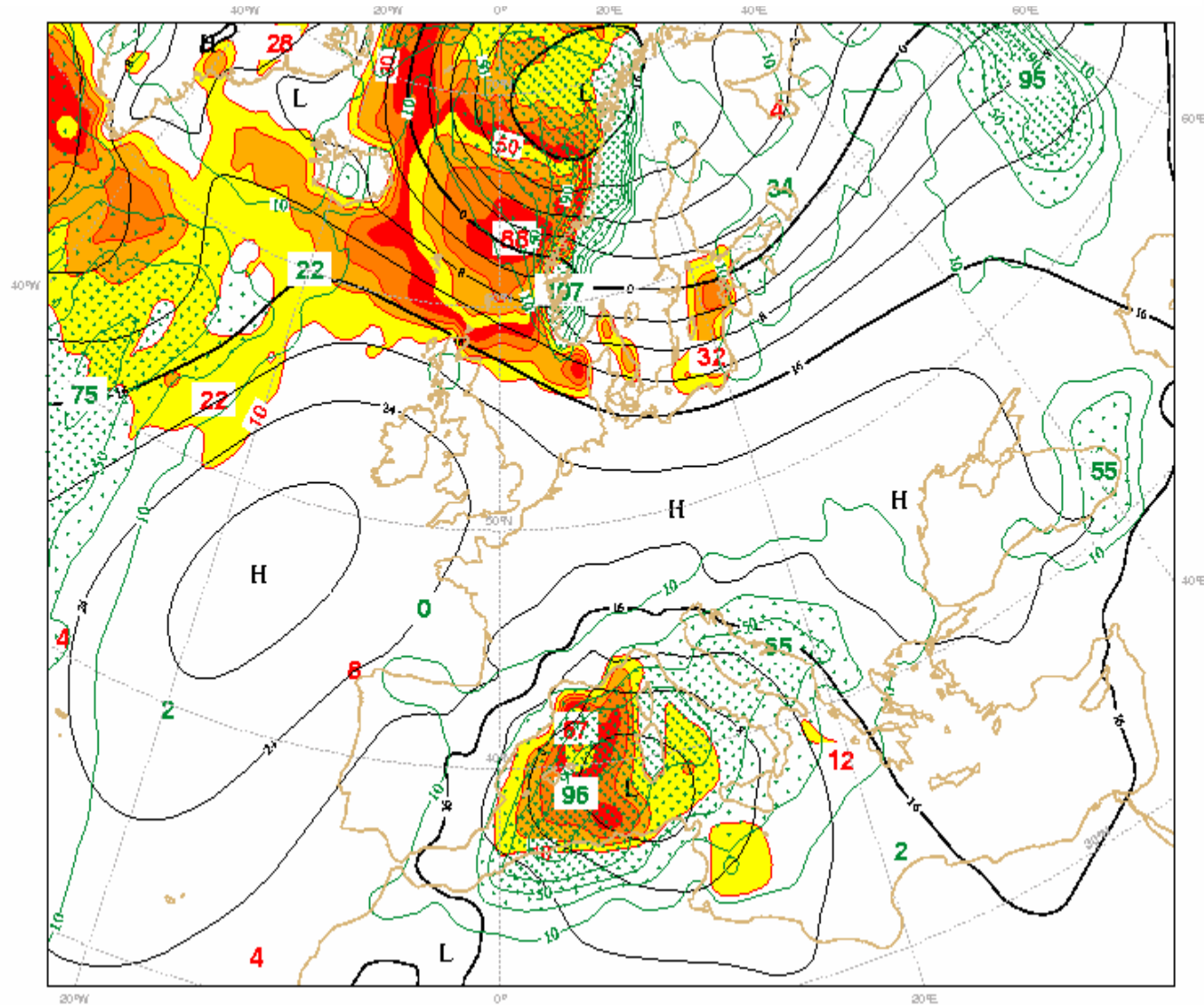# EPS forecast 4 Nov 2001 D+7 verifying 11 November

EPS forecast 5 Nov 2001 D+6 verifying 11 November

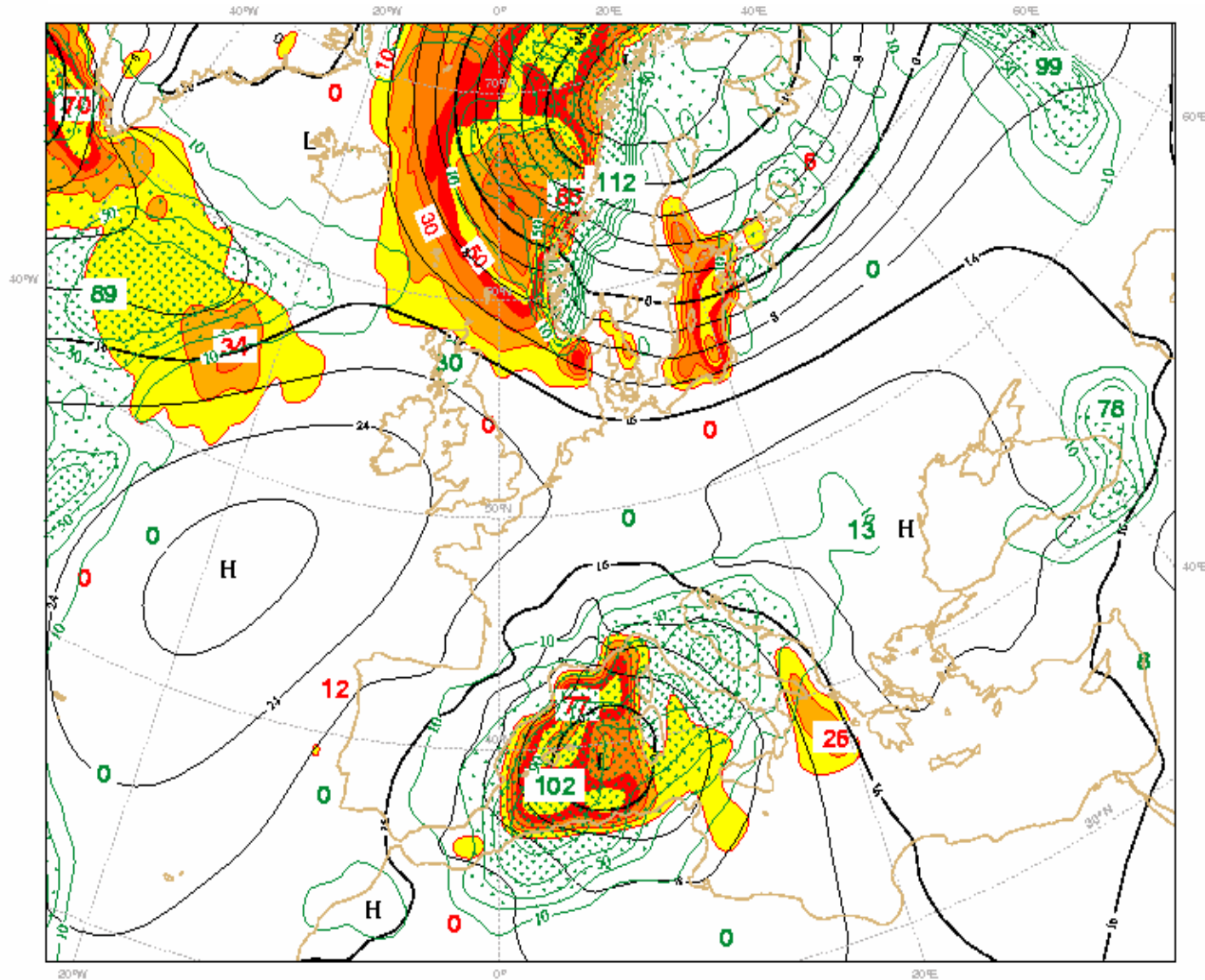# EPS forecast 6 Nov 2001 D+5 verifying 11 November

EPS forecast 7 Nov 2001 D+4 verifying 11 November
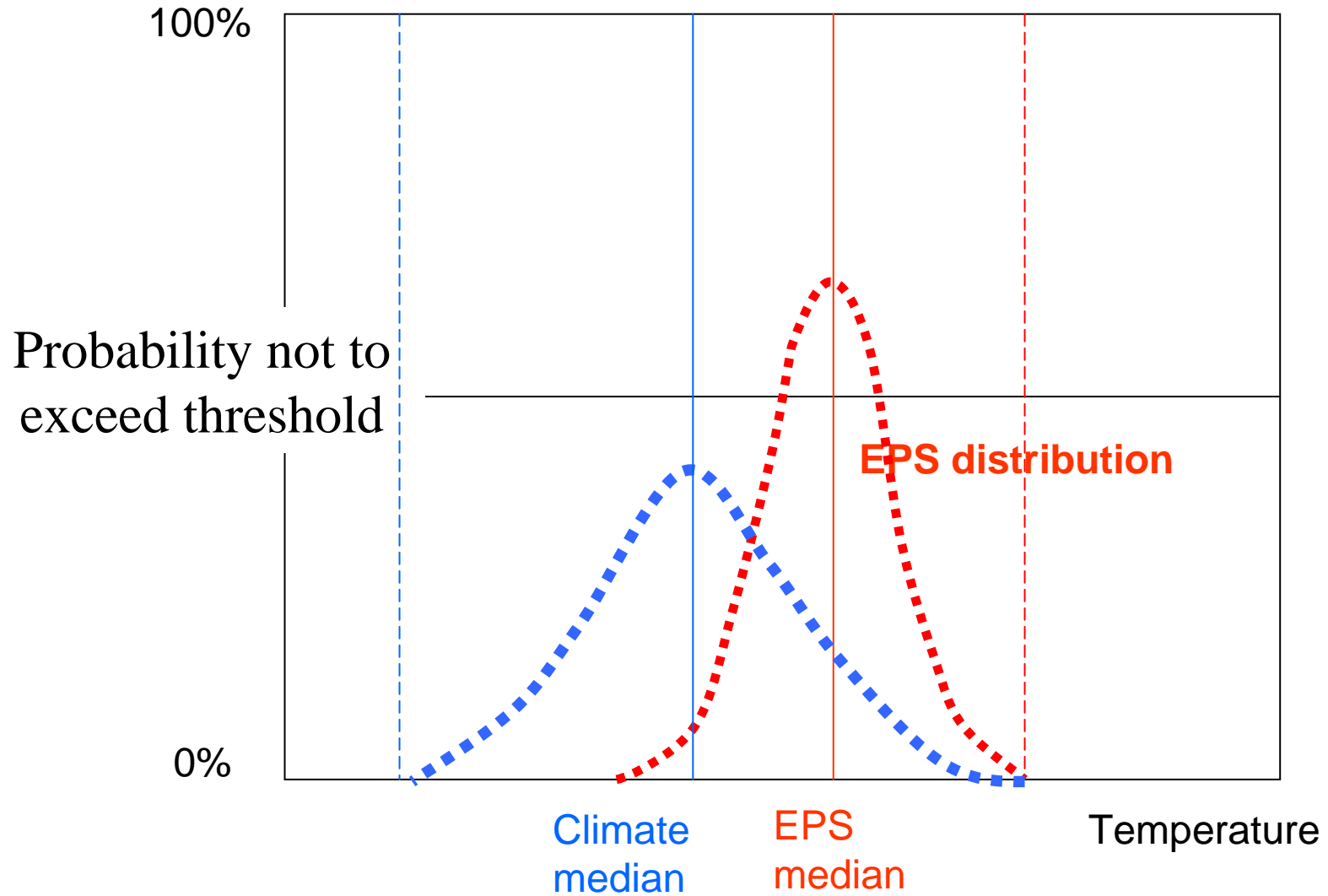
EPS forecast 8 Nov 2001 D+3 verifying 11 November

IV.4.6 The Extreme Forecast Index

Probability density functions (PDF)
Means and asymmetric variances are easily spotted

100%

Probability not to
exceed threshold

EPS distribution

0%
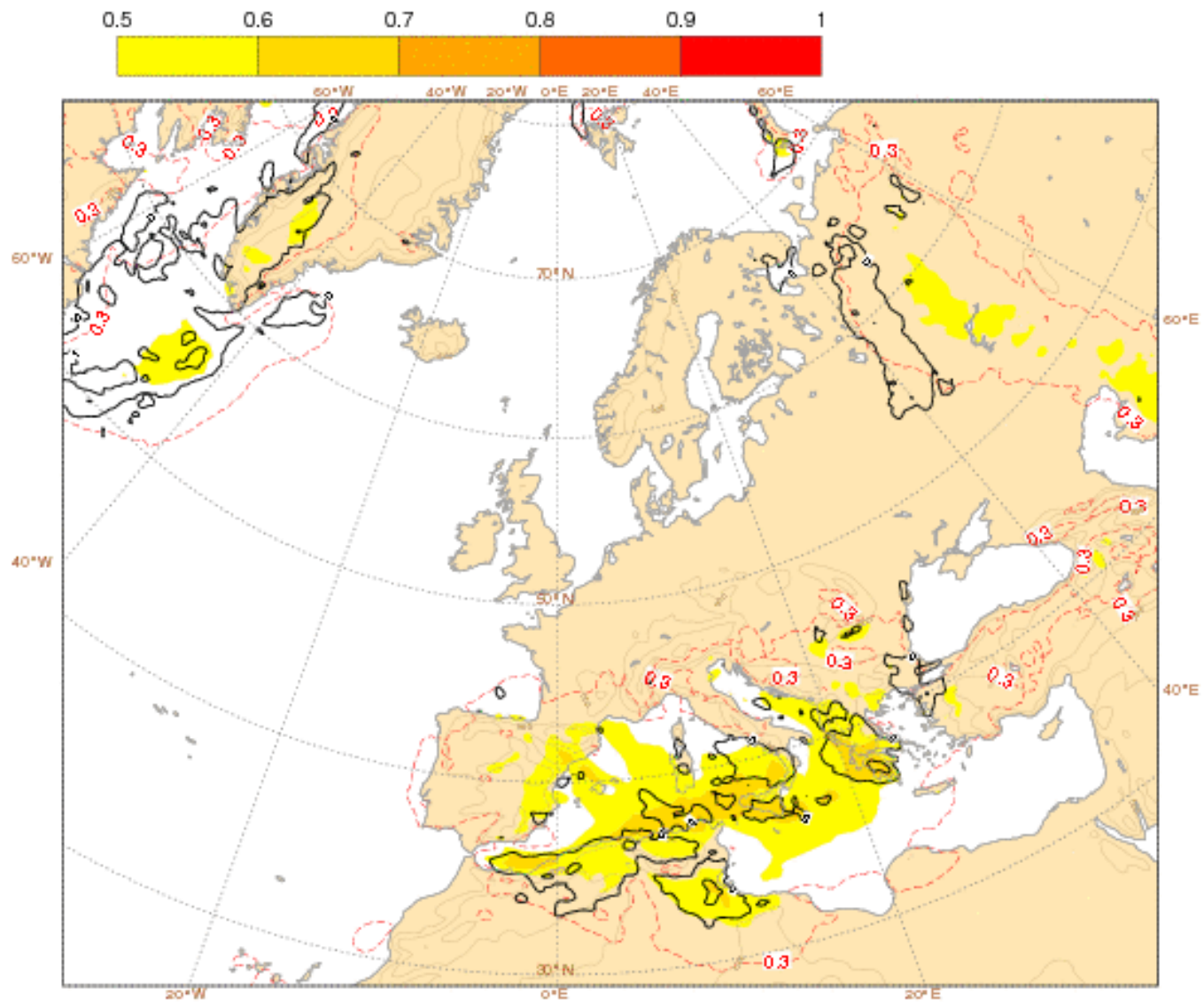
Climate
median

EPS
median

Temperature

Probability density functions (PDF)
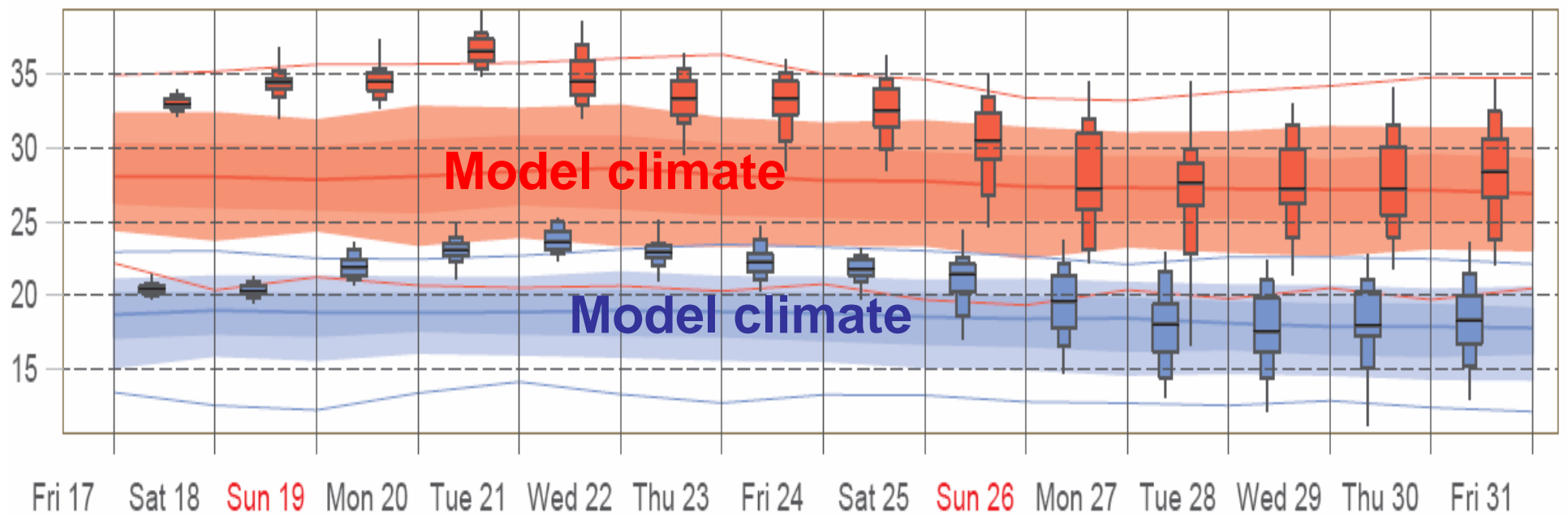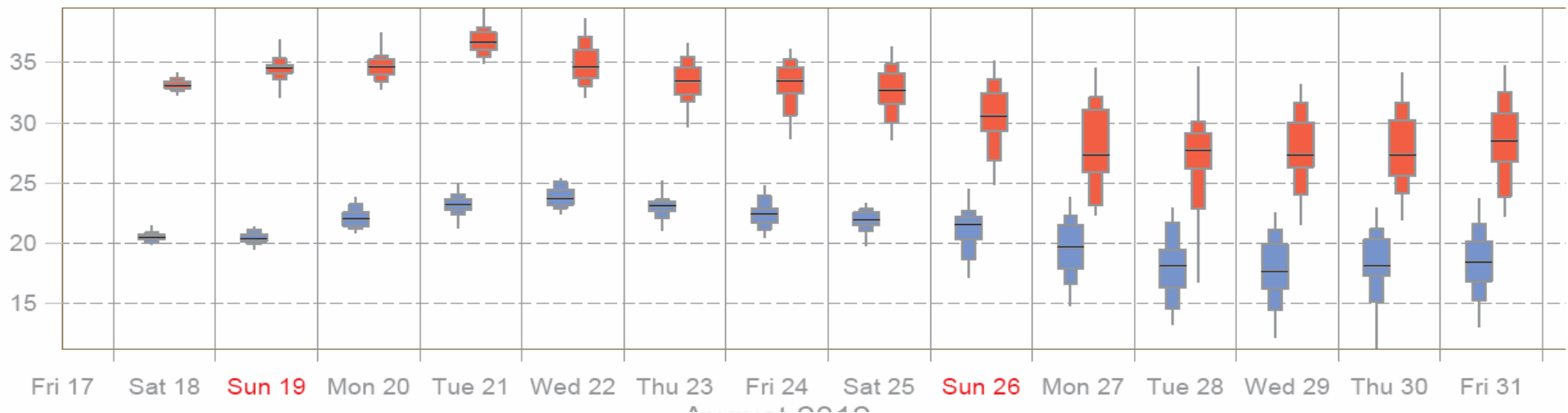## Means and asymmetric variances are easily spotted
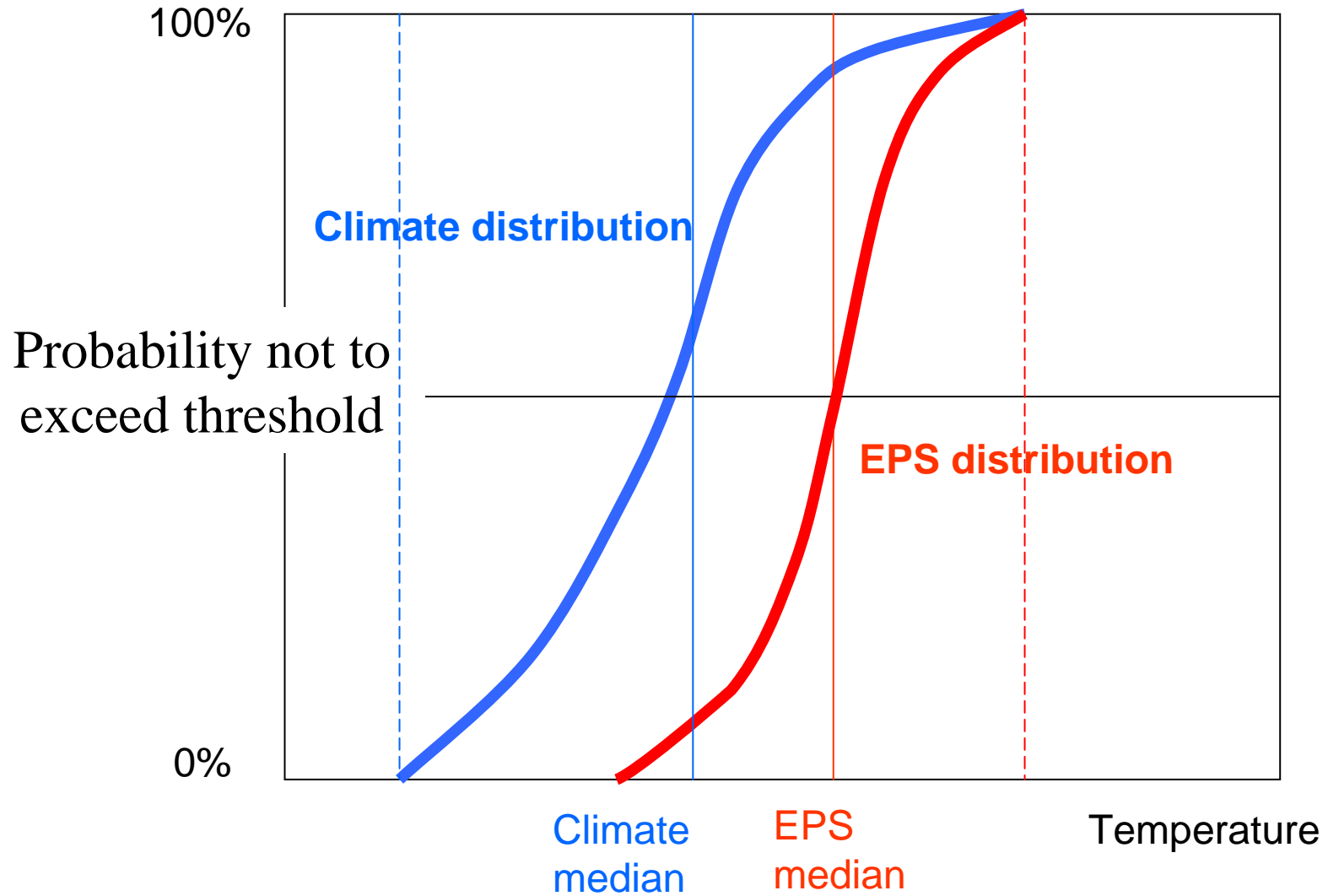
Thu 29 Jan 2015 00UTC ©ECMWF t+144-168h VT: Wed 04 Feb 2015 00UTC - Thu 05 Feb 2015 00UTC
Extreme forecast index and Shift of Tails (black contours 0,1,5,10,15) for 10m wind gusts

Probability Course IV:1
Bologna 9-13 February 2015

Anomalous weather predicted by EPS: Thursday 29 January 2015 at 00 UTC
1000 hPa Z ensemble mean (Monday 02 February 2015 at 12 UTC)
and EFI values for Total precipitation, maximum 10m wind gust and mean 2m temperature (all 24h)
valid for 24hours from   Monday 02 February 2015 at 00 UTC   to   Tuesday 03 February 2015 at 00 UTC

| extreme cold | cold | warm | extreme warm | wind | extreme wind | precip | extreme precip |
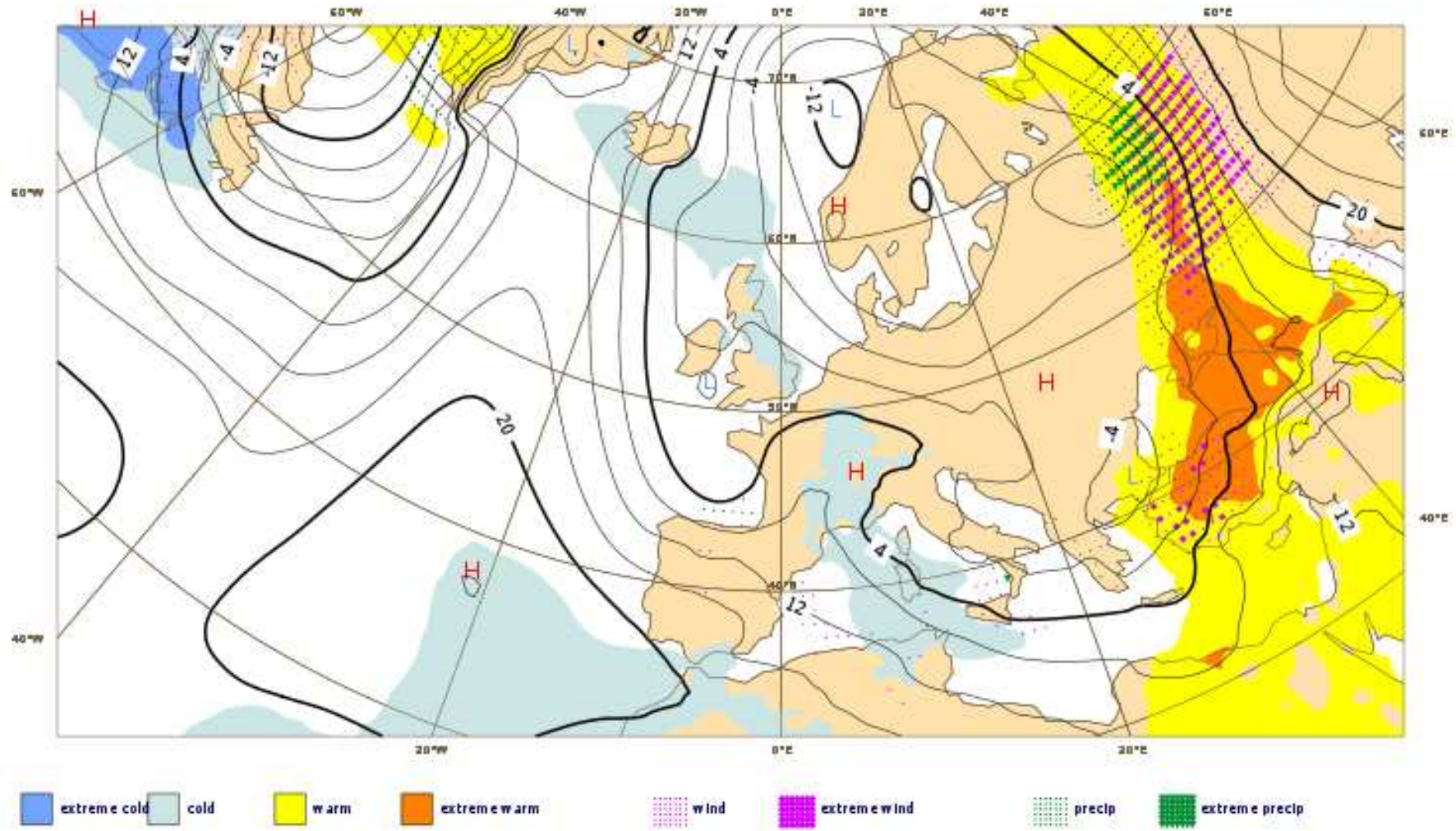
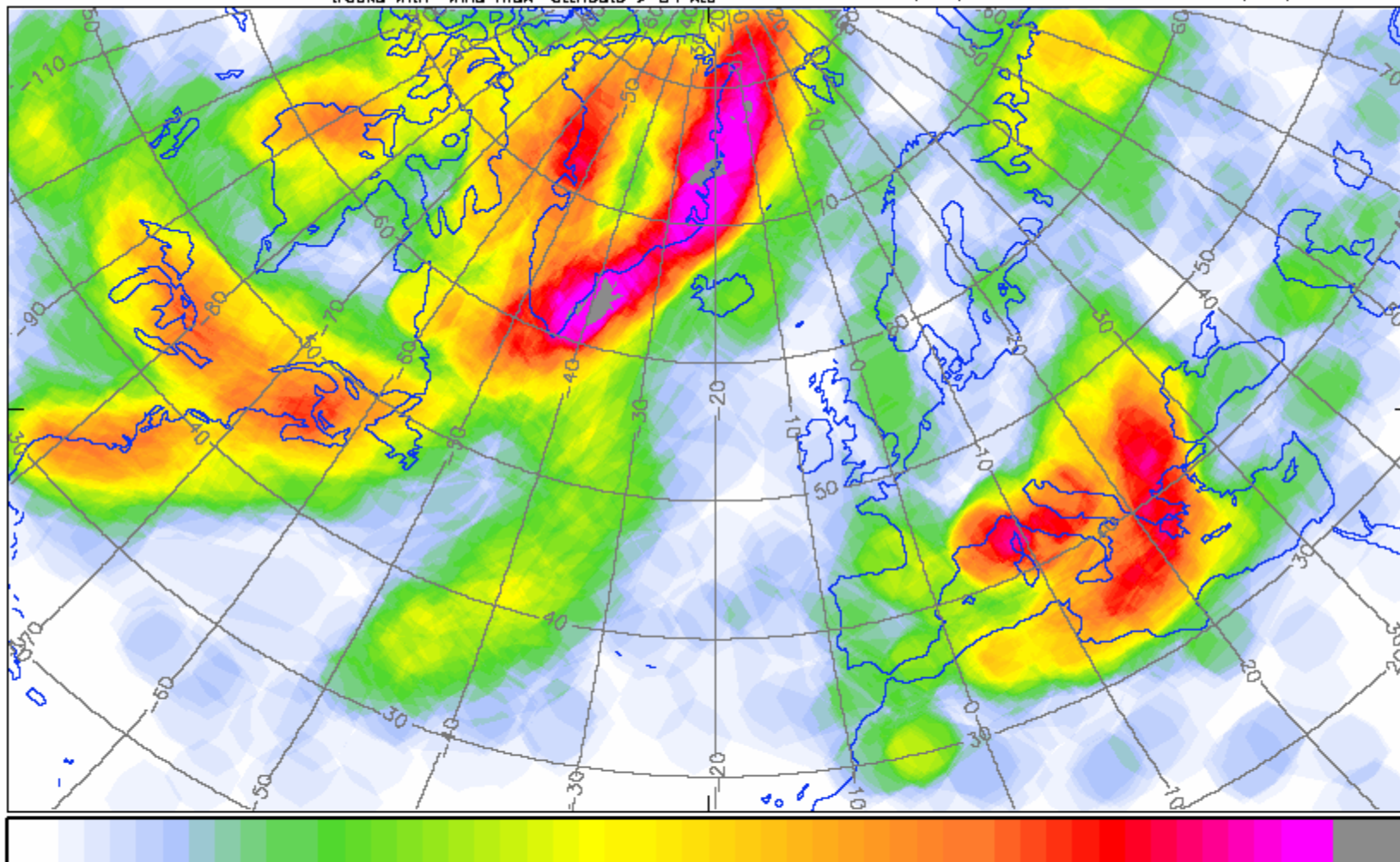# "Clickable" epsgrams provide model climate

Model climate

Model climate

IV.4.7 Extra-tropical storm site (Tim Hewson)

Feature Point Strike Probability, for feature tracks with "wind max" attribute > 34 kts

156 (+/−12h window)   DT: Thu 29/01/2015 12Z   VT: Thu 05/02/2015 00Z

Maps show percentage of members predicting that a cyclonic feature point will track within 300km in a 24-hour period.
Only cyclonic features reaching a certain intensity threshold at some point in the 24h period are included.
Here the threshold is that the max 1km wind speed within 300km must exceed 34kts.

<< | STOP | >> | |< | TOGGLE | >| | Frame: 13 | SPEED: - | + | OPTIONS: continuous ▼

Probability Course IV:1

Bologna 9-13 February 2015

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END