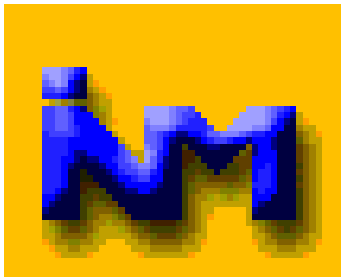


Short-Range Ensemble Prediction System at INM

García-Moya, J.A., Callado, A., Santos, C., Santos, D., Simarro, J. (NWP – Spanish Met Service INM)

ECMWF 10th Workshop on Meteorological Operational Systems

Reading, November 2005

Outline

- Motivation
- Features
- Post-processing & outputs
- Validation
- Conclusions

Outline

- **Motivation**
- Features
- Post-processing & outputs
- Validation
- Conclusions

Introduction

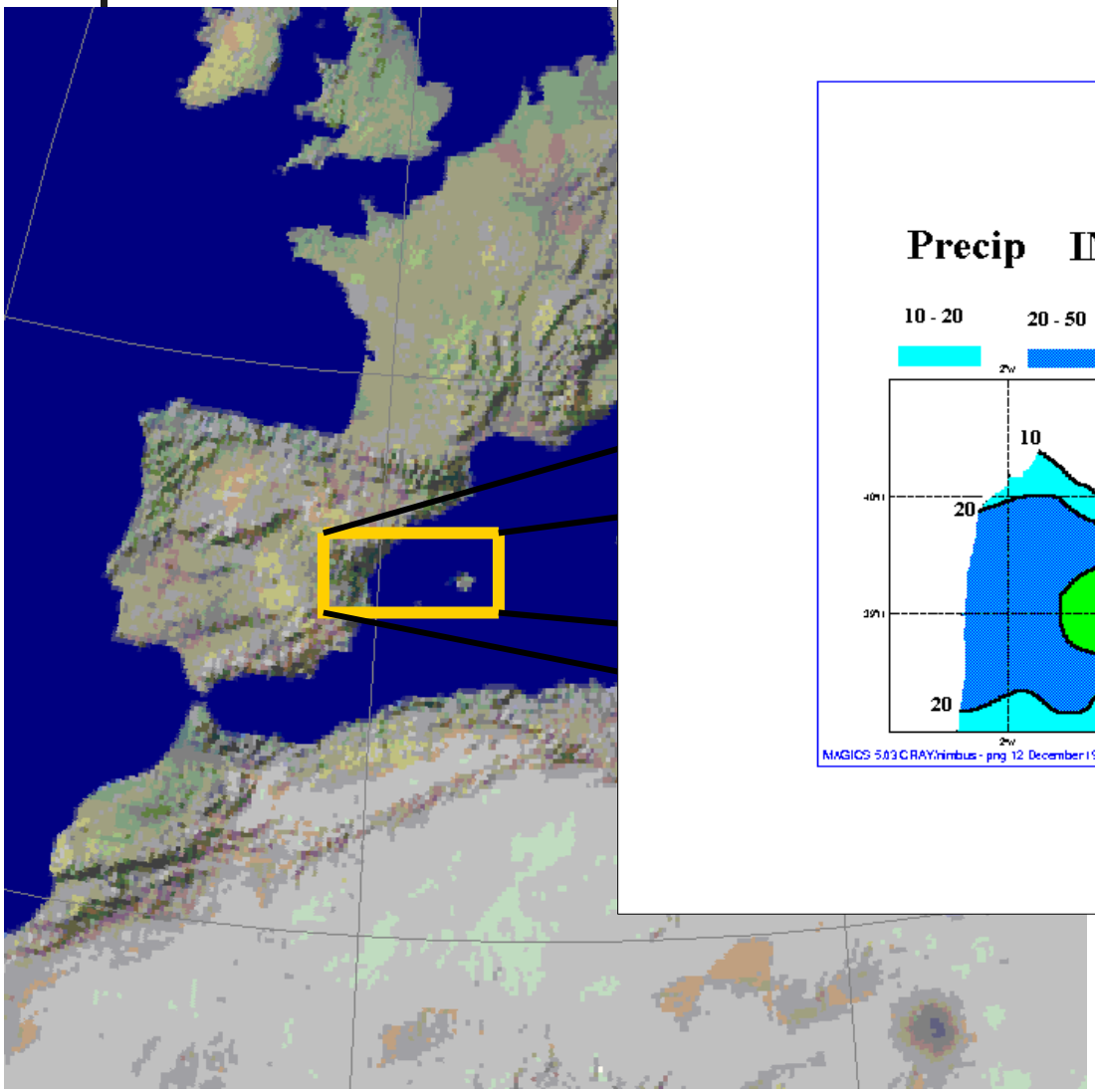
- Predictability is flow dependent
- Extreme weather events have a low predictability, uncertainties can grow critically even in the Short Range (less than 72 hours),
- Convection is highly non-linear and it shows a chaotic behaviour.
- Then a probabilistic apprach may help to improve the prediction of such phenomena.

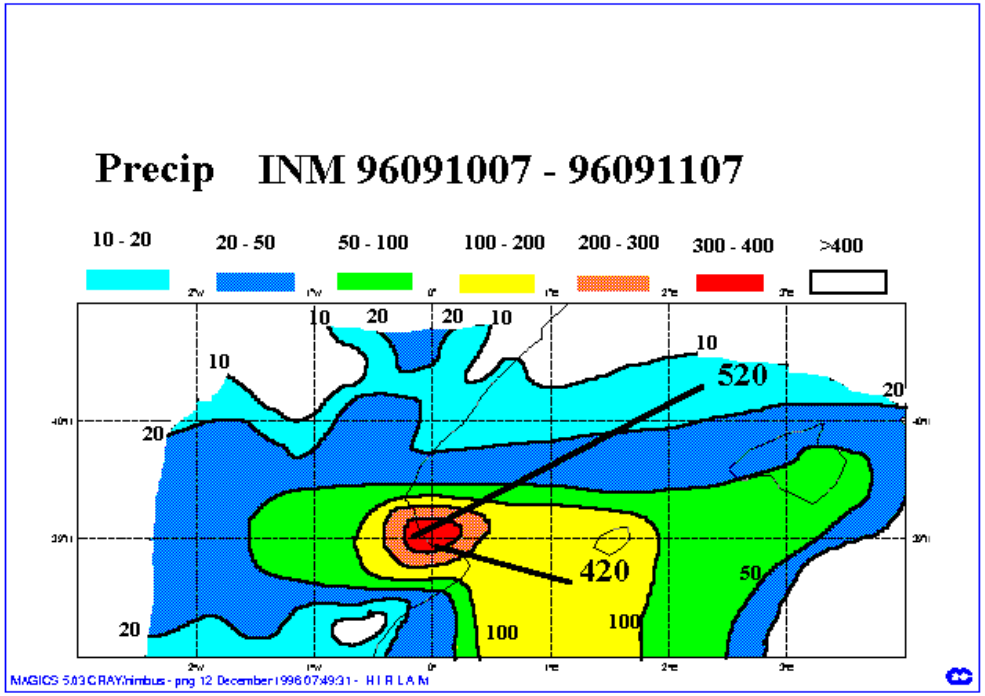
Ensemble for Short Range

- Surface parameters are the most important ones for weather forecast.
- Forecast of extreme events (convective precip, gales,…) is probabilistic.
- Short Range Ensemble prediction can help to forecast these events.
- Forecast risk (Palmer, ECMWF Seminar 2002) is the goal for both Medium- and, also, Short-Range Prediction.

Meteorological Framework

- Main Weather Forecast issues are related with Short-Range extreme events.
- Convective precipitation is the most dangerous weather event in Spain.
- Western Mediterranean is a close sea rounded by high mountains, in autumn sea is warmer than air.
- Several cases of more than 200 mm/few hours every year. Some fast cyclogenesis like "tropical cyclones".




Precip INM 96091007 - 96091107
10 - 20
20 - 50
50 - 100
100 - 200
200 - 300
300 - 400
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10
10
520
20
20
10
420
50
20
100
100
MAGICS 5.03 CRAY/nimbus - png 12 December 1996 07:49:31 - HIRLAM

Outline

- Motivation
- **Features**
- Post-processing & outputs
- Validation
- Conclusions

Multi-model

- Hirlam.
- HRM
  - from DWD (German Weather Service).
- MM5
- UM
  - Unified Model from UKMO (Great Britain Weather Service).

Multi-Boundaries

From different global deterministic models:

- **ECMWF**
- **UM**
  - UM from Met Office
- **AVN**
  - NCEP
- **GME**
  - DWD (Germany Met Inst.) global model.

Planned Ensemble

- 72 hours forecast four times a day (00, 06, 12 y 18 UTC).
- Features:
  - **4 models**.
  - **4 initial & boundary conditions**.
  - 4 last ensembles (HH, HH-6, HH-12, HH-18).
- 16 member ensemble every 6 hours
- Time-lagged Super-Ensemble of 64 members every 6 hours.

Actual Ensemble

- 72 hours forecast once a day (00 UTC).
- Features :
  - 4 models.
  - 4 boundary conditions.
- **14** (of 16 expected) members ensemble every 24 hours

Road Map

2003-2004	Research to find best ensemble for the Short Range	
Jun2004-Jun2005	Building the System Multimodel&Multiboundaries	
Jun2005-Dec2005	Mummub n/16 members	Daily run non-operational
Mar2006	**Mummub** **16/16 members**	**Full operations**
Jun2006	Mummub+4lag 64 members	First try

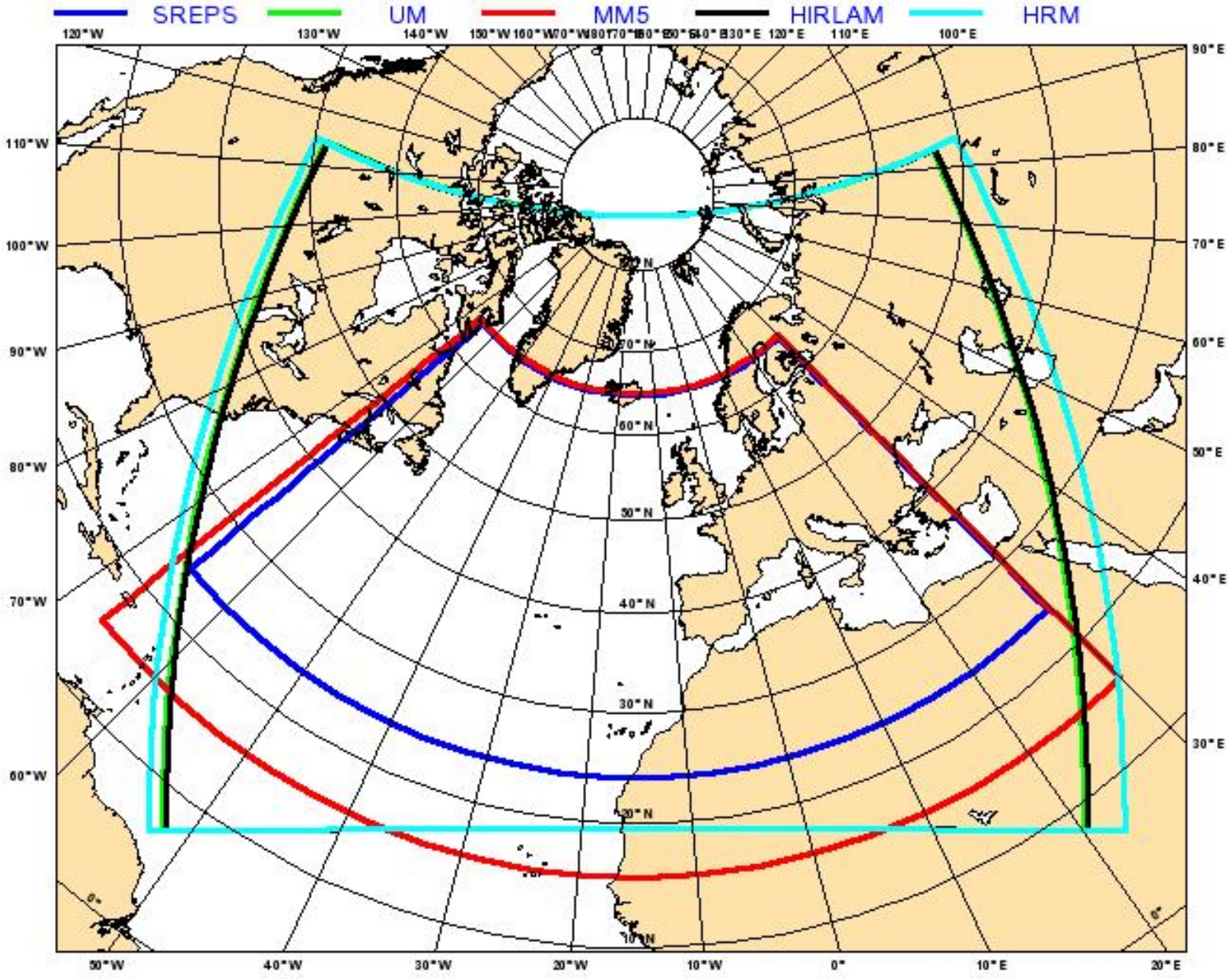
Outline

- Motivation
- Features
- **Post-processing & outputs**
- Validation
- Conclusions

Post-processing

- Interpolation to a common area
  - ~ North Atlantic + North Africa + Europe
  - Grid 380x184, **0.25°**
- Software
  - Enhanced PC + Linux
  - ECMWF Metview + Local developments
- Outputs
  - Deterministic
  - Ensemble probabilistic

Coverage


SREPS
UM
MM5
HIRLAM
HRM
120°W
130°W
140°W
150°W
160°W
170°W
180°
170°E
160°E
150°E
140°E
130°E
120°E
110°E
100°E
90°E
80°E
70°E
60°E
50°E
40°E
30°E
110°W
100°W
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60°W
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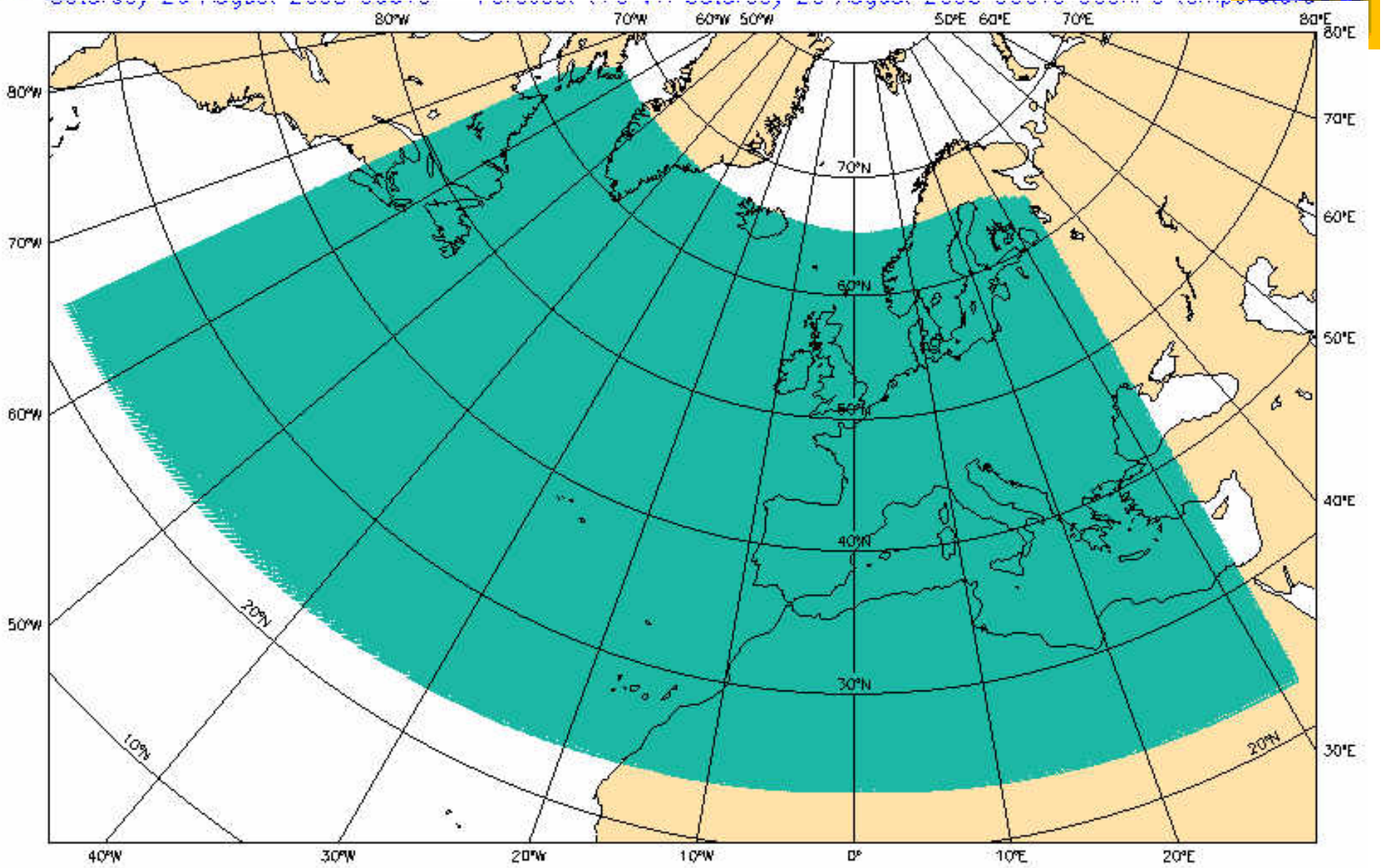
80°W
70°W
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50°W
40°W
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80°N
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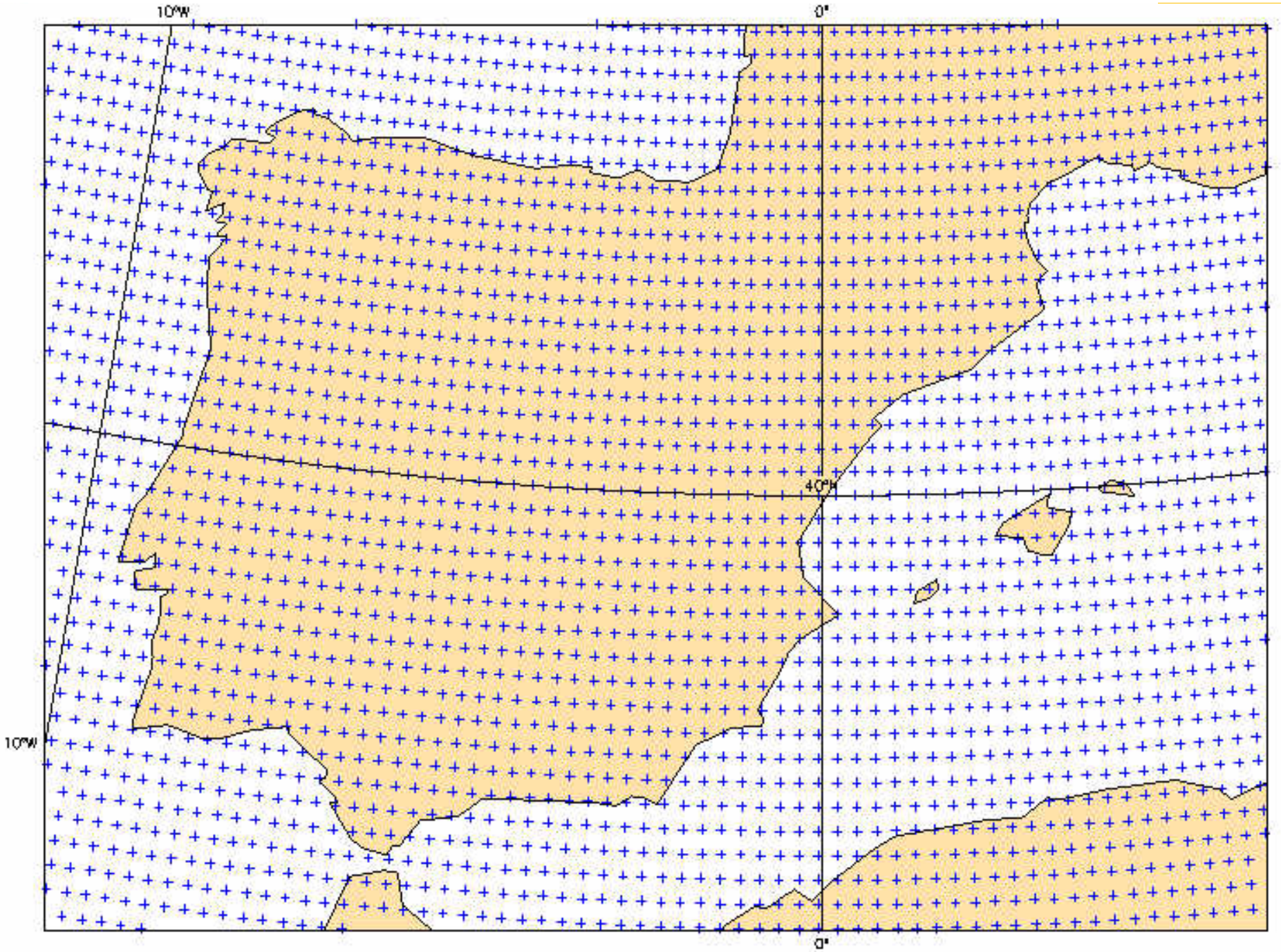
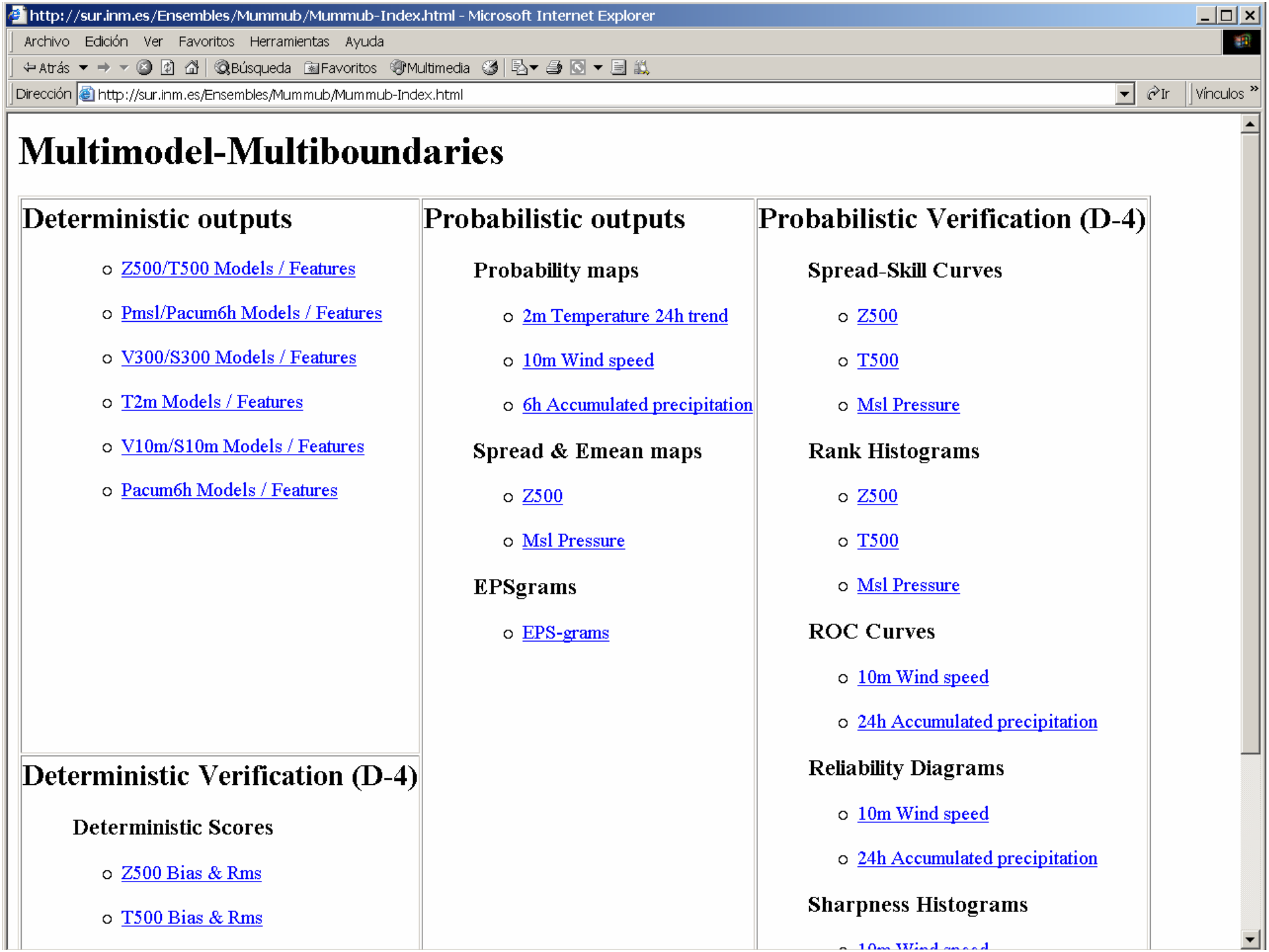
60°N
50°N
40°N
30°N
20°N
10°N


10°W
0°
40°N
10°W
0°

Monitoring in real time

- Intranet web server
- Deterministic outputs
  - Postage stamps charts (Models X BCs)
  - Maps for each member
- Ensemble probabilistic outputs
  - Postage stamps charts (Time [X Thresholds])
  - **Probability maps**: 6h accumulated precipitation, 10m wind speed, 24h 2m temperature trend
  - **Ensemble mean & Spread maps**
  - **EPSgrams** (not fully-operational)
- Verification

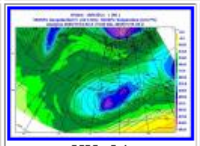
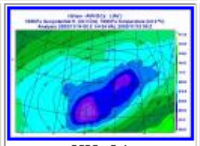
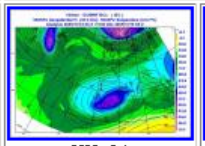
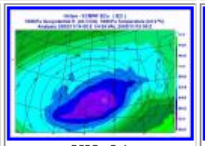
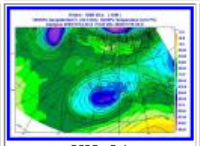
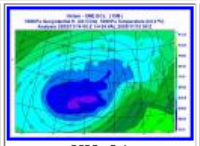
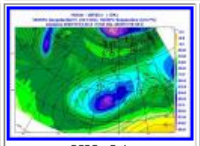
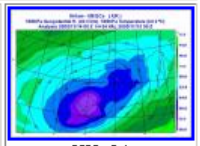
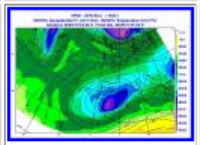
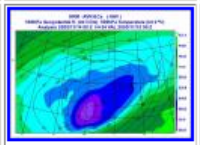
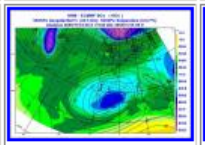
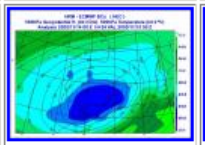
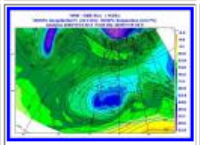
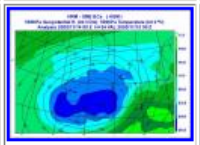
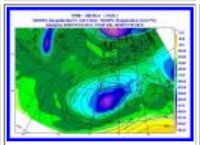
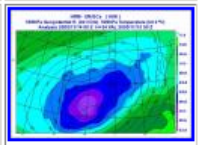
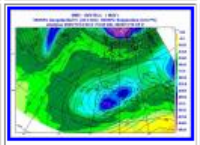
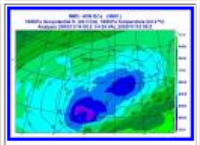
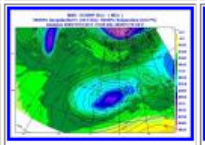
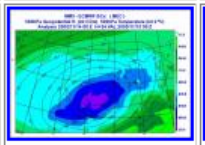
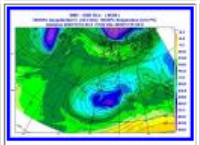
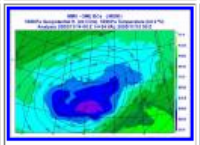
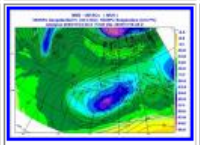
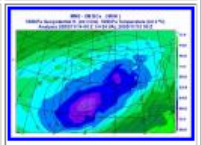
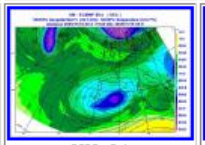
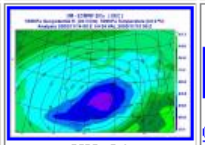
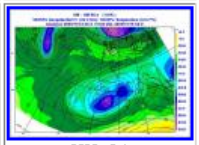
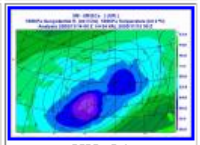

http://sur.inm.es/Ensembles/Mummub/Mummub-Index.html - Microsoft Internet Explorer
Archivo Edición Ver Favoritos Herramientas Ayuda
Atrás Búsqueda Favoritos Multimedia
Dirección http://sur.inm.es/Ensembles/Mummub/Mummub-Index.html
Ir Vínculos
Multimodel-Multiboundaries
Deterministic outputs
Z500/T500 Models / Features
Pmsl/Pacum6h Models / Features
V300/S300 Models / Features
T2m Models / Features
V10m/S10m Models / Features
Pacum6h Models / Features
Probabilistic outputs
Probability maps
2m Temperature 24h trend
10m Wind speed
6h Accumulated precipitation
Spread & Emean maps
Z500
Msl Pressure
EPSgrams
EPS-grams
Probabilistic Verification (D-4)
Spread-Skill Curves
Z500
T500
Msl Pressure
Rank Histograms
Z500
T500
Msl Pressure
ROC Curves
10m Wind speed
24h Accumulated precipitation
Reliability Diagrams
10m Wind speed
24h Accumulated precipitation
Sharpness Histograms
Deterministic Verification (D-4)
Deterministic Scores
Z500 Bias & Rms
T500 Bias & Rms

Multimodel-Multiboundaries

Run: D0, 00UTC, HH+00..HH+24..HH+72

500hPa Geopotential height & Temperature

Models X Boundaries

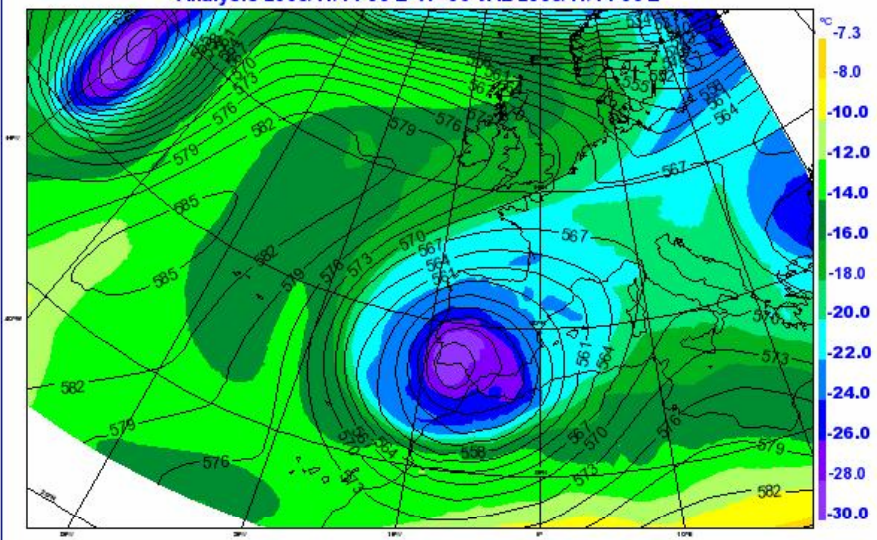
Models / Features	AVN-BCs (NCEP)		ECMWF-BCs		GME-BCs (DWD)		UM-BCs (Met Office)	
Hirlam	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop
HRM	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop
MM5 (Community Model)	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop
UM (Met Office)	HH+24 Graphics Loop	HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop	HH+24 Graphics Loop	HH+24 Graphics Loop	 HH+24 Graphics Loop	 HH+24 Graphics Loop

Archivo Edición Ver Favoritos Herramientas Ayuda

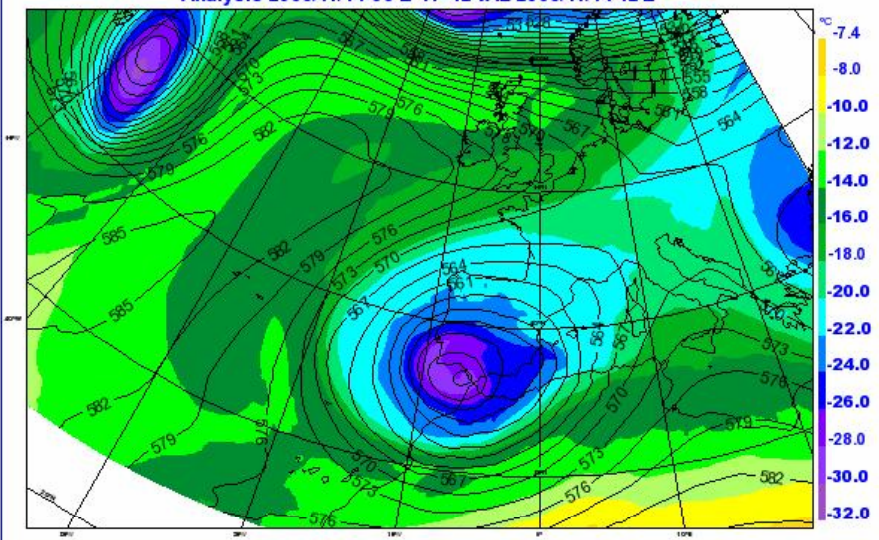
Atrás Búsqueda Favoritos Multimedia

Dirección http://sur.inm.es/Experiments/html/IEC-SREPSg-Z500T500.html Ir Vínculos

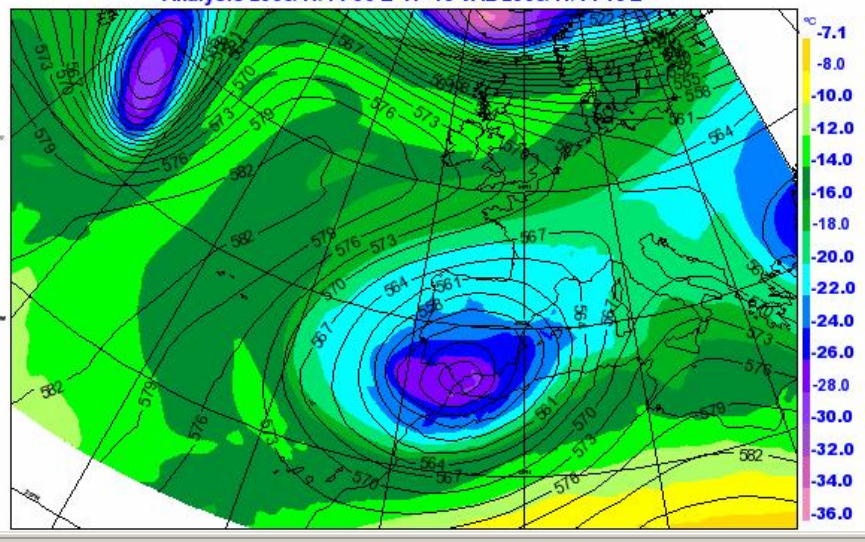
Hirlam - ECMWF BCs (IEC)
500hPa Geopotential H. (int 3 Dm) 500hPa Temperature (int 2 ºC)
Analysis 2005/11/14 00 Z H+06 VAL 2005/11/14 06 Z



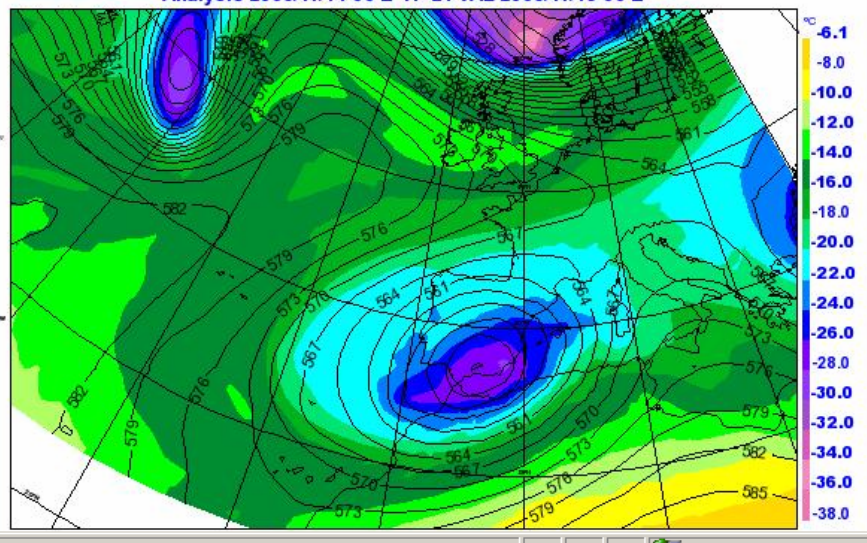
Hirlam - ECMWF BCs (IEC)
500hPa Geopotential H. (int 3 Dm) 500hPa Temperature (int 2 ºC)
Analysis 2005/11/14 00 Z H+12 VAL 2005/11/14 12 Z



Hirlam - ECMWF BCs (IEC)
500hPa Geopotential H. (int 3 Dm) 500hPa Temperature (int 2 ºC)
Analysis 2005/11/14 00 Z H+18 VAL 2005/11/14 18 Z



Hirlam - ECMWF BCs (IEC)
500hPa Geopotential H. (int 3 Dm) 500hPa Temperature (int 2 ºC)
Analysis 2005/11/14 00 Z H+24 VAL 2005/11/15 00 Z

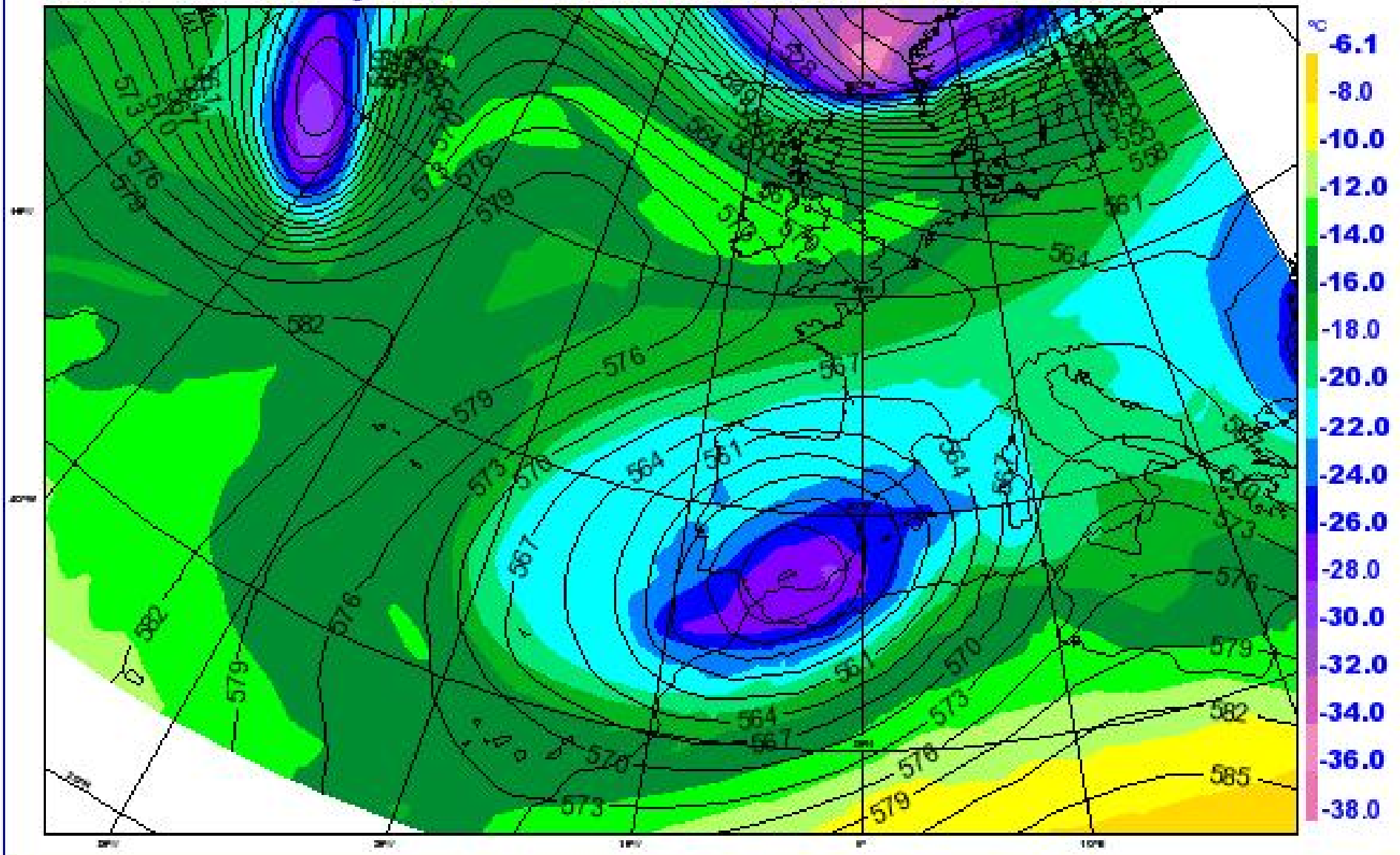


Listo Intranet local

Hirlam - ECMWF BCs (IEC)

500hPa Geopotential H. (int 3 Dm) 500hPa Temperature (int 2 ºC)

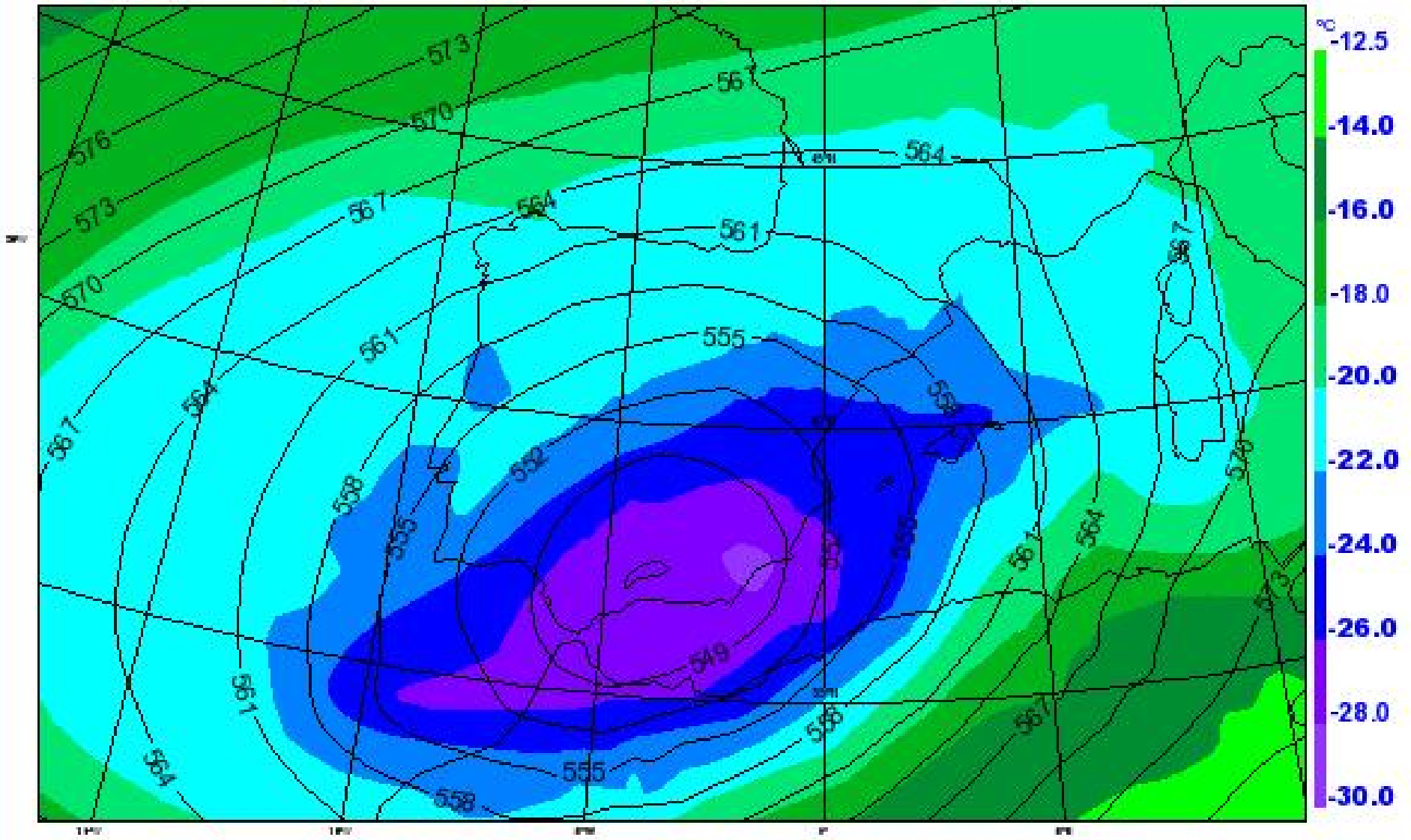
Analysis 2005/11/14 00 Z H+24 VAL 2005/11/15 00 Z

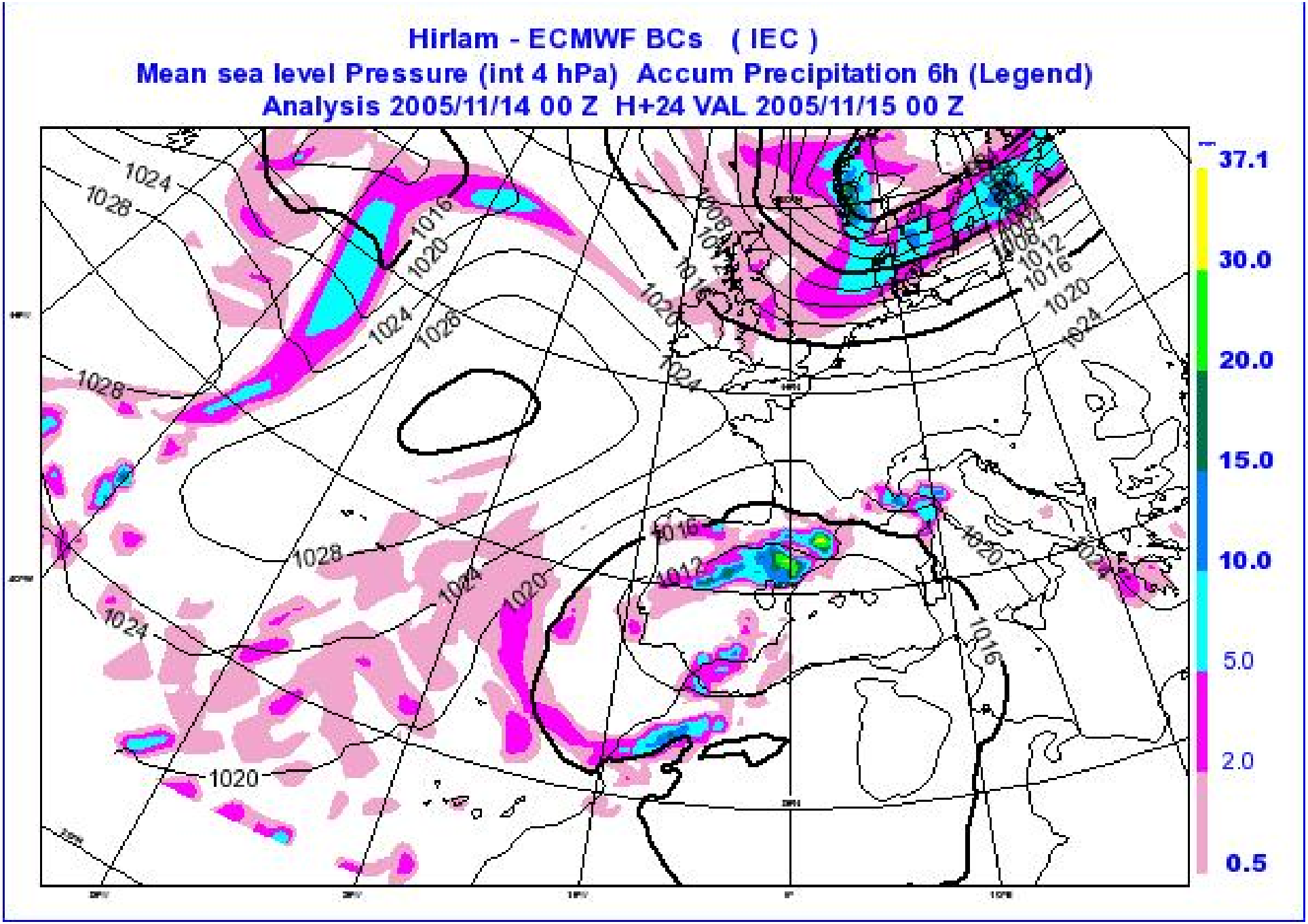


Hirlam - ECMWF BCs (IEC)

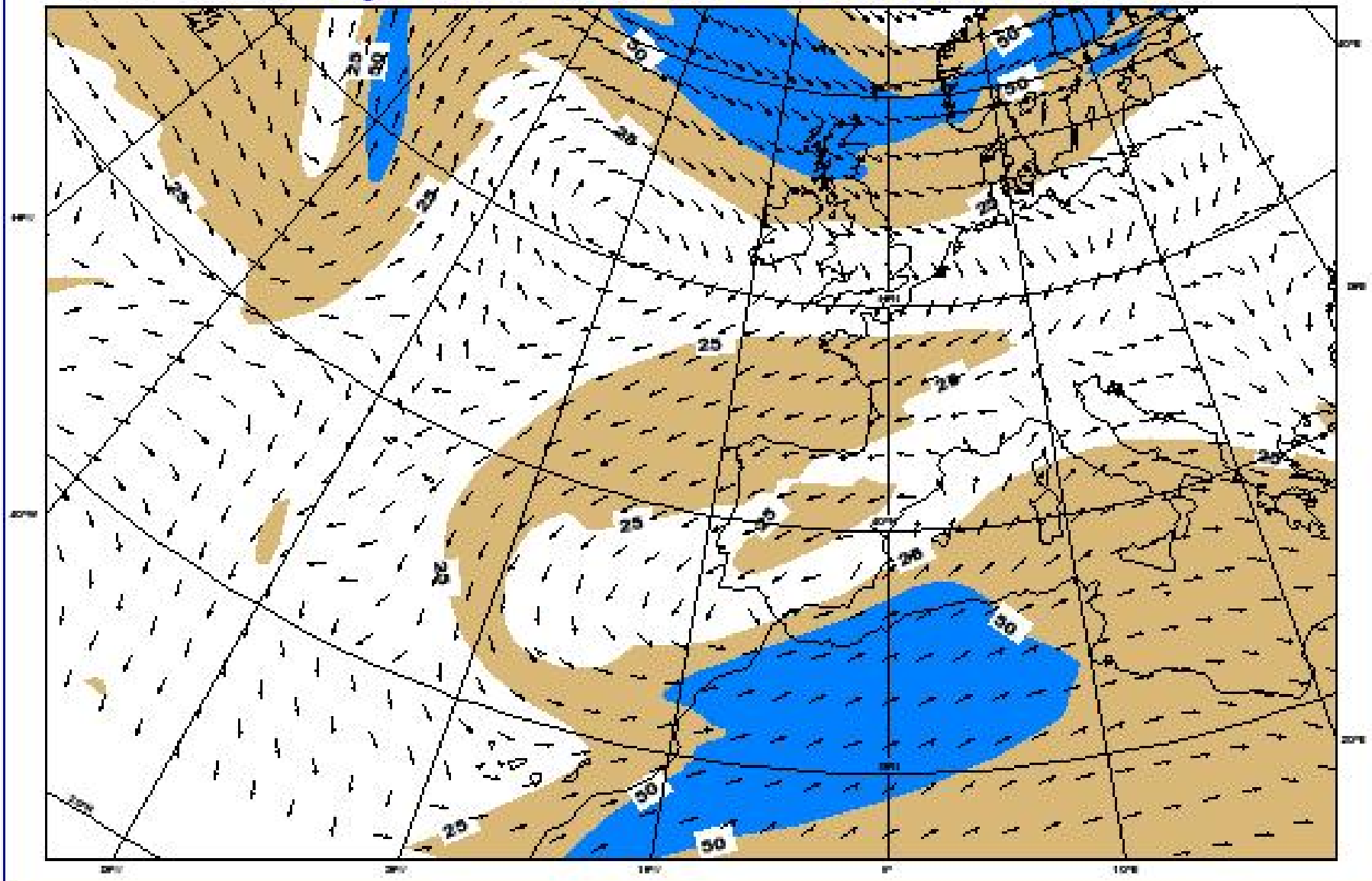
500hPa Geopotential H. (int 3 Dm) 500hPa Temperature (int 2 °C)

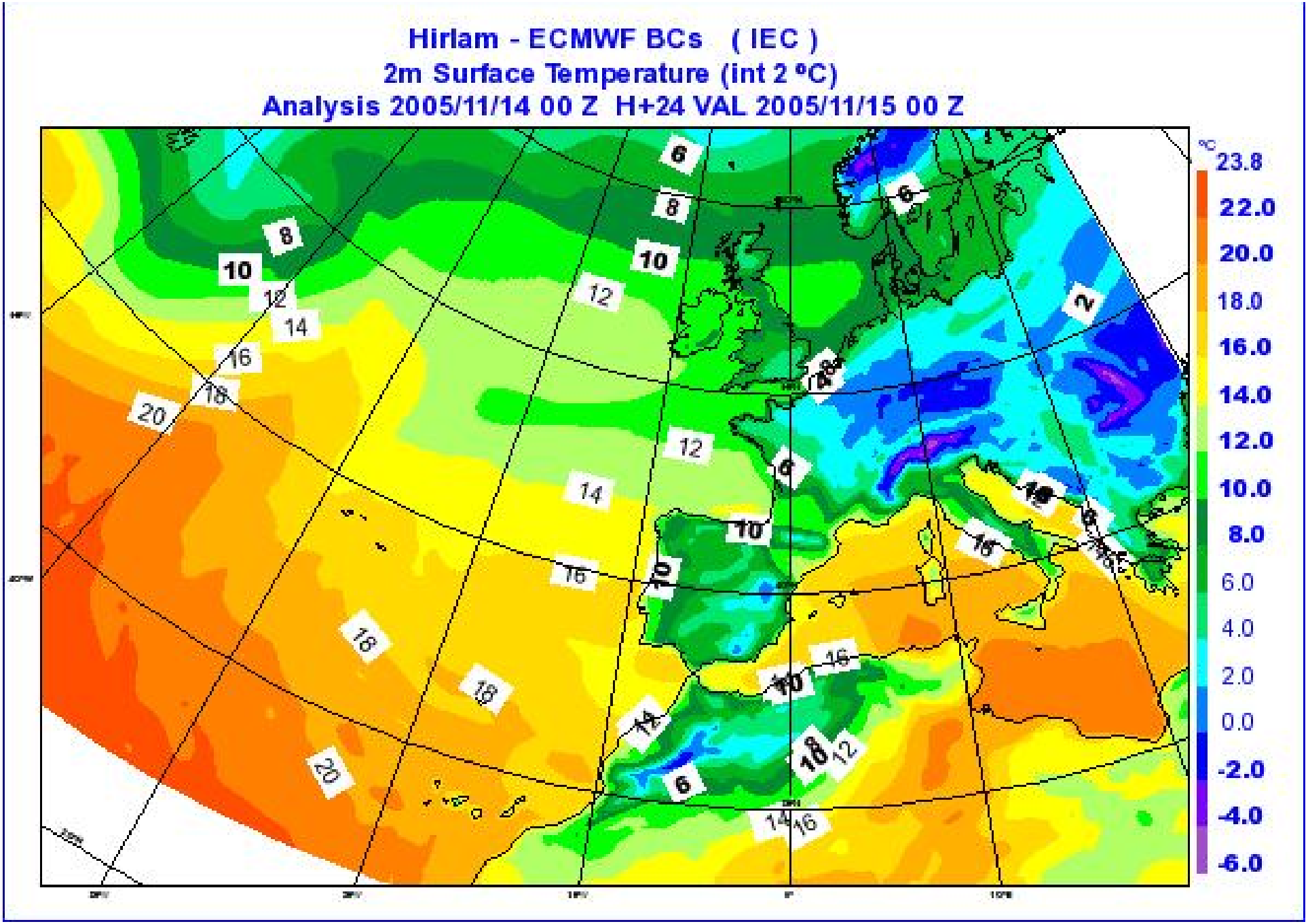
Analysis 2005/11/14 00 Z H+24 VAL 2005/11/15 00 Z




Hirlam - ECMWF BCs (IEC)
Mean sea level Pressure (int 4 hPa) Accum Precipitation 6h (Legend)
Analysis 2005/11/14 00 Z H+24 VAL 2005/11/15 00 Z
37.1
30.0
20.0
15.0
10.0
5.0
2.0
0.5

Hirlam - ECMWF BCs (IEC)
300hPa Wind 300hPa Wind Speed (int 25m/s)
Analysis 2005/11/14 00 Z H+24 VAL 2005/11/15 00 Z

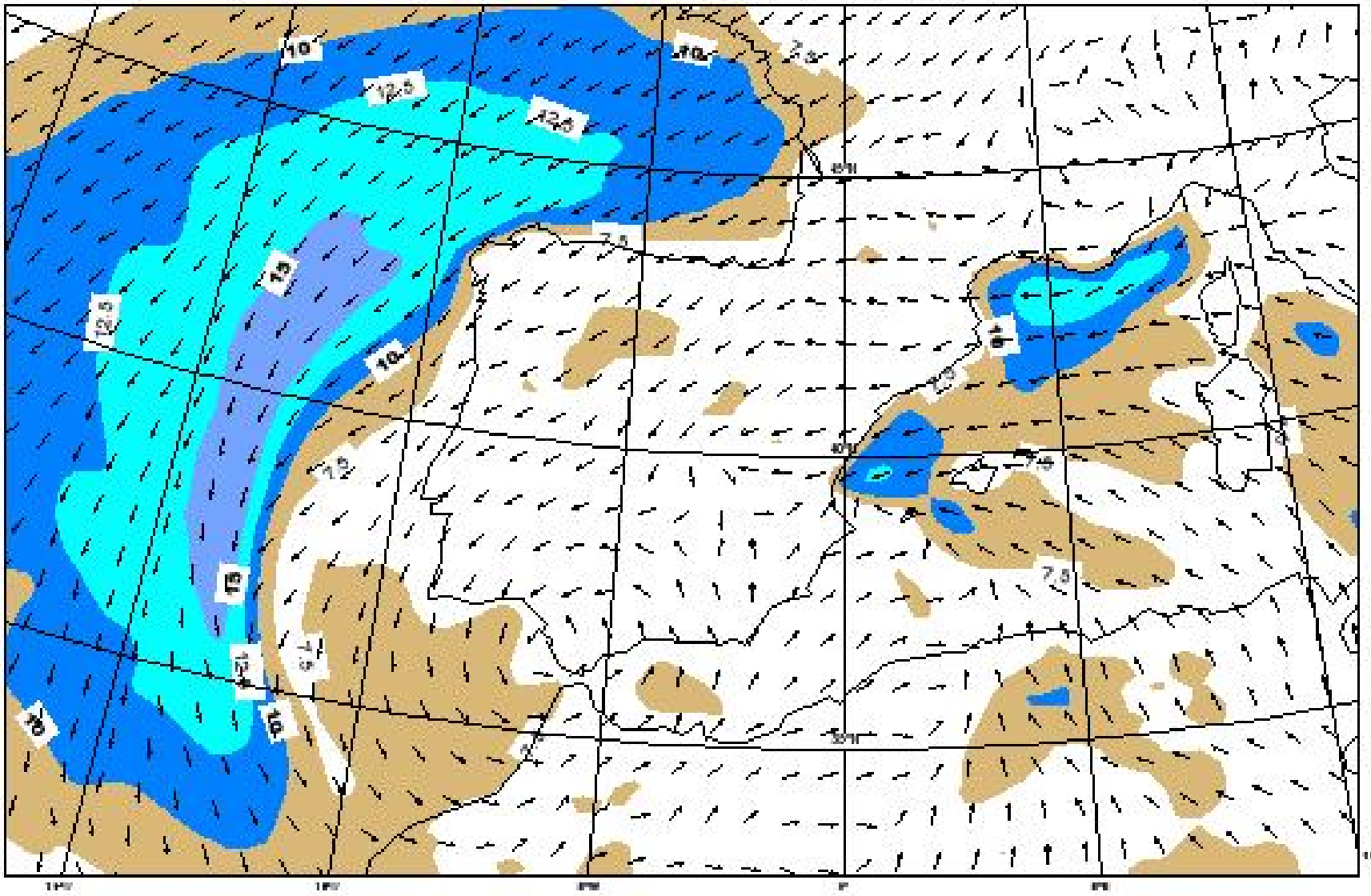


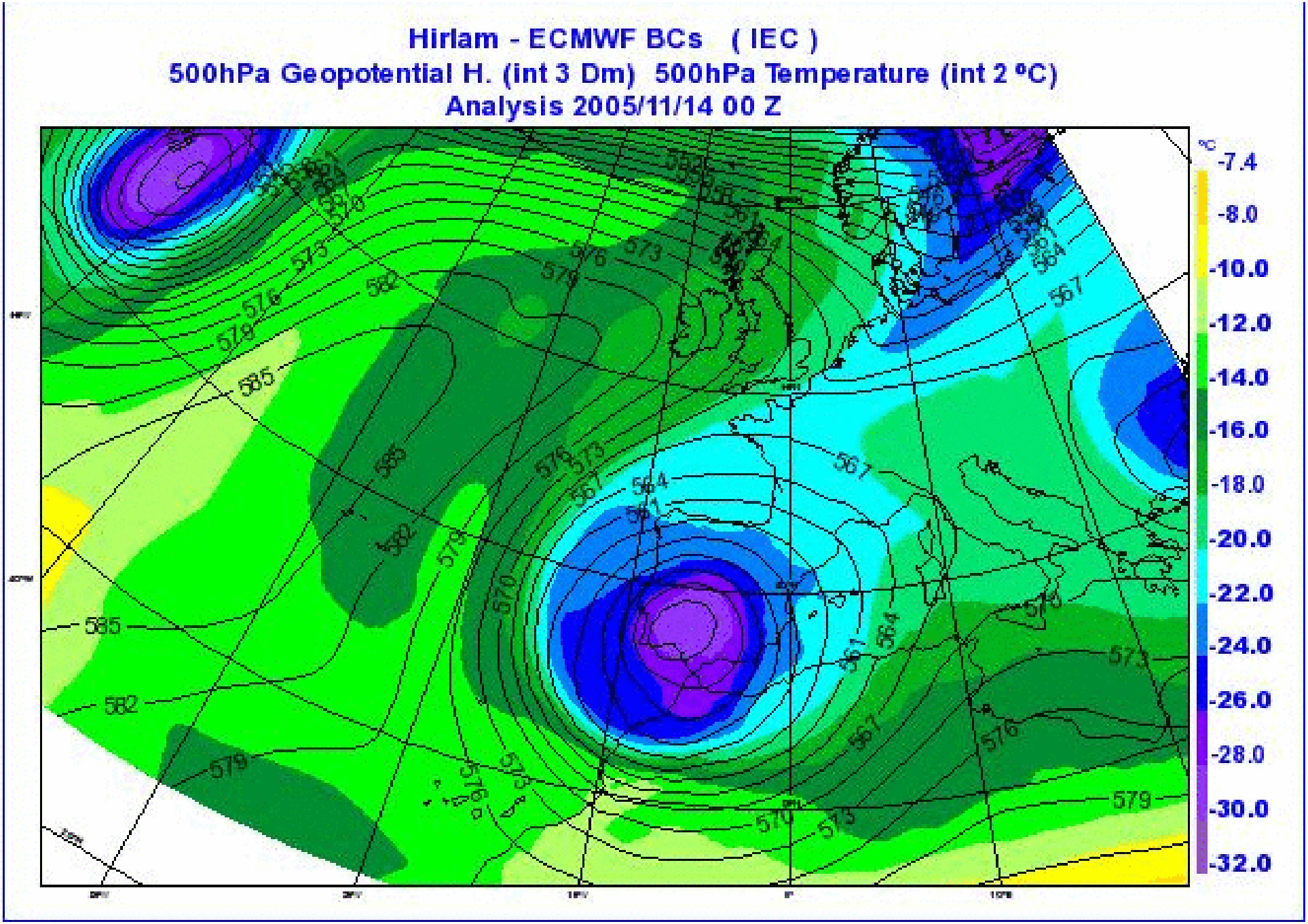

Hirlam - ECMWF BCs (IEC)
2m Surface Temperature (int 2 ºC)
Analysis 2005/11/14 00 Z H+24 VAL 2005/11/15 00 Z
°C
23.8
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0

Hirlam - ECMWF BCs (IEC)

10m Surface Wind 10m Surface Wind Speed (int 2.5m/s)

Analysis 2005/11/14 00 Z H+12 VAL 2005/11/14 12 Z




Hirlam - ECMWF BCs (IEC)
500hPa Geopotential H. (int 3 Dm) 500hPa Temperature (int 2 ºC)
Analysis 2005/11/14 00 Z
ºC
-7.4
-8.0
-10.0
-12.0
-14.0
-16.0
-18.0
-20.0
-22.0
-24.0
-26.0
-28.0
-30.0
-32.0

http://sur.inm.es/Ensembles/Mummub/html/Mummub-Tinc2m24hProb.html - Microsoft Internet Explorer

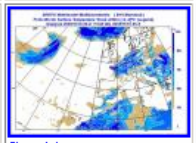
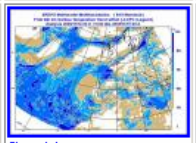
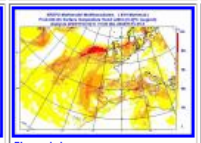
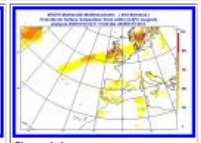
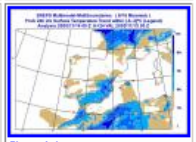
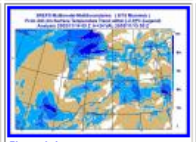
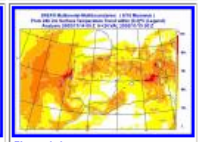
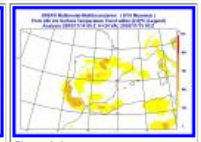
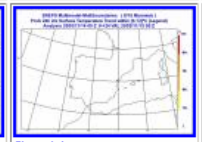
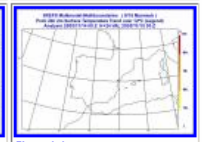
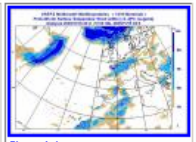
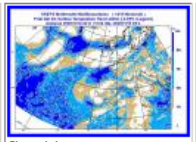
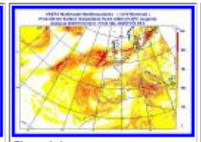
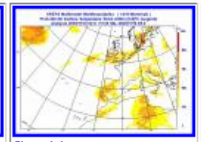
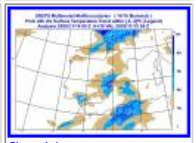
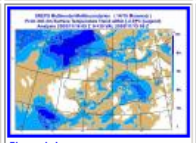
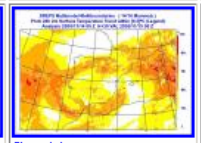
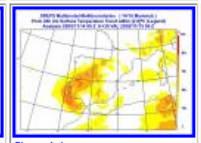
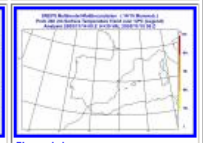
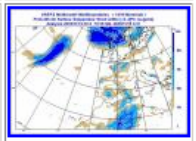
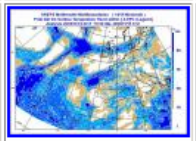
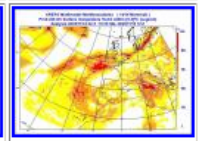
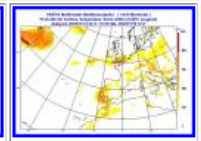
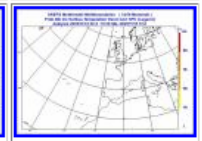
Archivo Edición Ver Favoritos Herramientas Ayuda

Atrás Búsqueda Favoritos Multimedia

Dirección http://sur.inm.es/Ensembles/Mummub/html/Mummub-Tinc2m24hProb.html Ir Vínculos

2m Temperature 24h Trend

Forecast range (HH+24..HH+72) X Thresholds ([,-12] , [-12,-6] , [-6,-2] , [-2,0] , [0,2] , [2,6] , [6,12] , [12,])

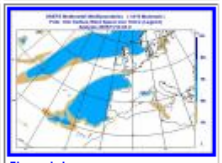
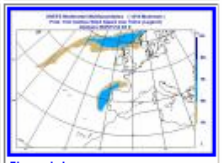
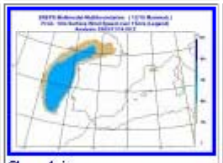
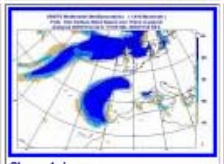
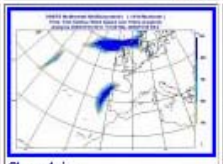
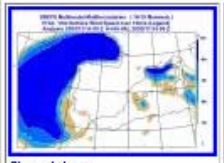
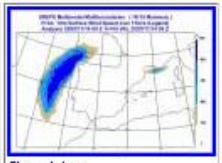
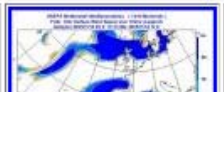
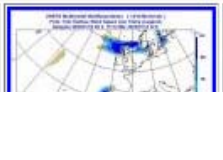
Last run forecast range	Thresholds							
	[,-12]	[-12,-6]	[-6,-2]	[-2,0]	[0,2]	[2,6]	[6,12]	[12,]
24	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop
	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop
30	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop
	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop
36	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop

http://sur.inm.es/Ensembles/Mummub/html/Mummub-SREPSg-Tinc2m24hProb24.html

Intranet local

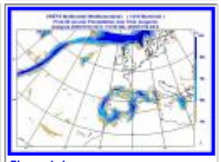
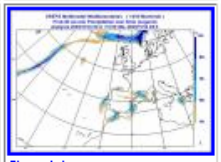
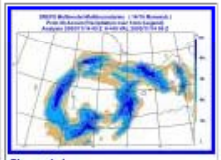
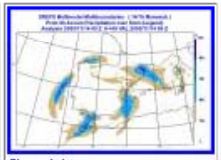
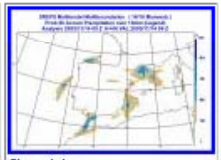
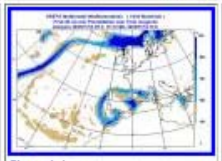
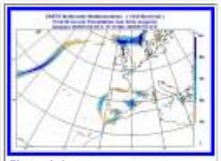
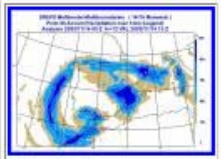
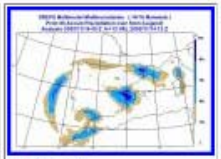
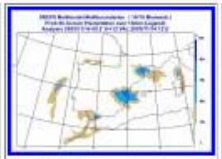
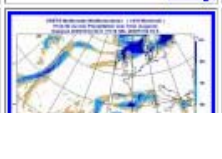
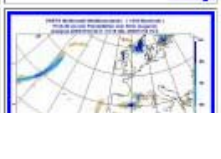
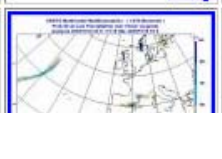
10m Wind Speed

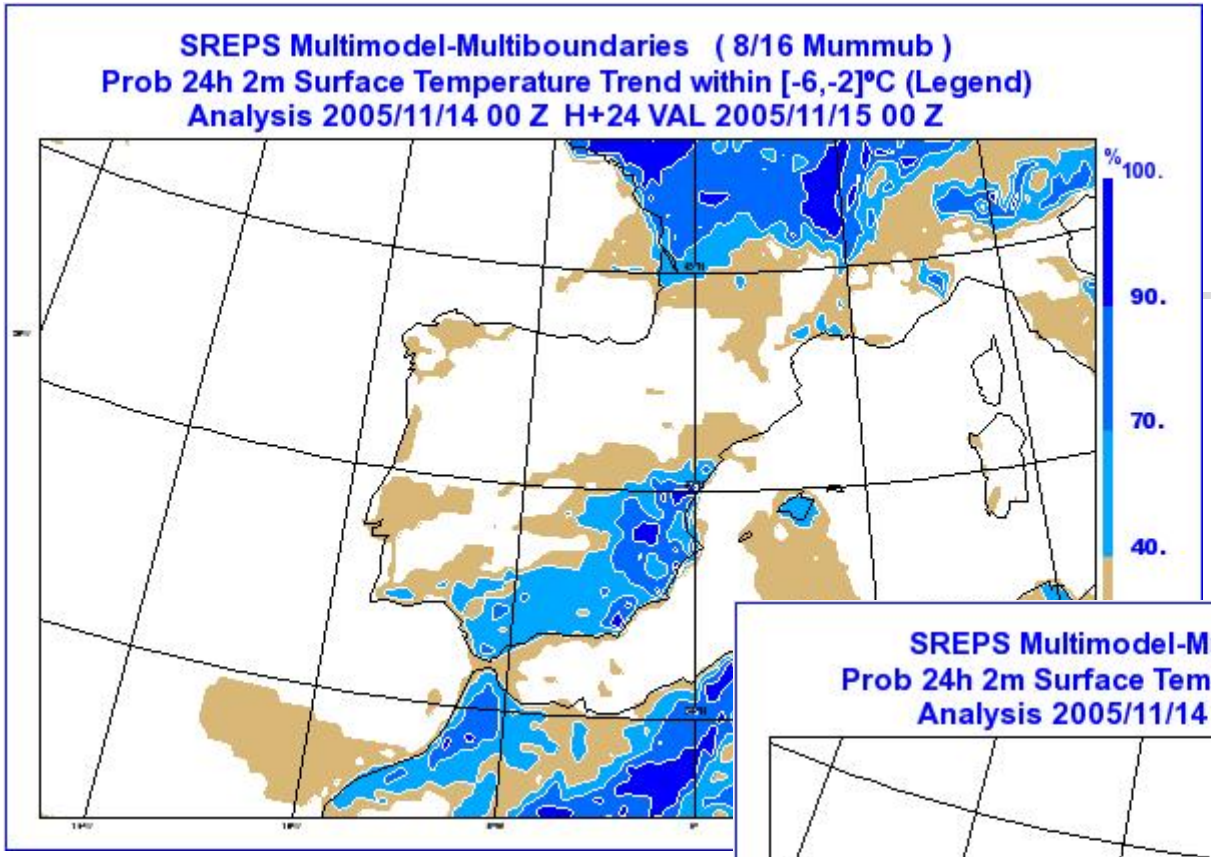
Forecast range (HH+00..HH+72) X Thresholds (10,15,20)

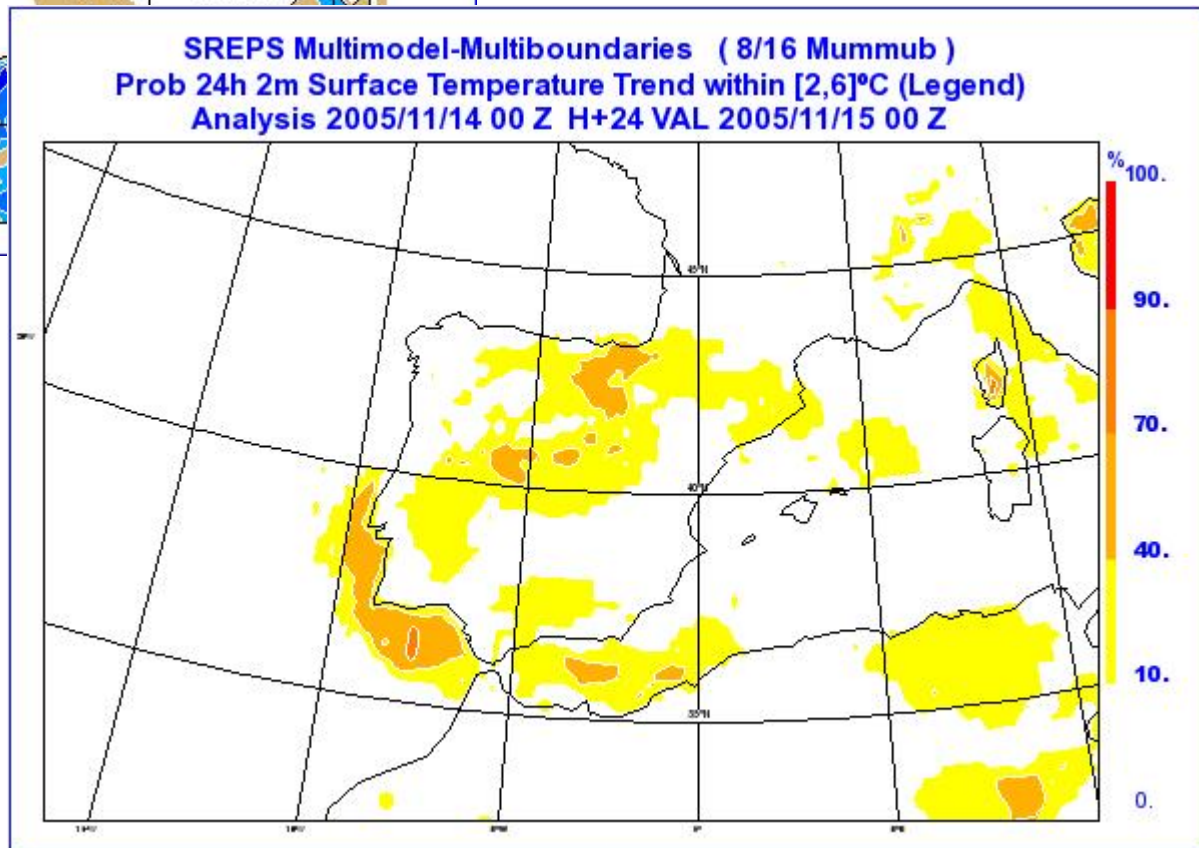
	Thresholds		
Last run forecast range	10	15	20
00	 Graphics Loop	 Graphics Loop	 Graphics Loop
	 Graphics Loop	 Graphics Loop	 Graphics Loop
06	 Graphics Loop	 Graphics Loop	 Graphics Loop
	 Graphics Loop	 Graphics Loop	 Graphics Loop
			

6h Accumulated Precipitation

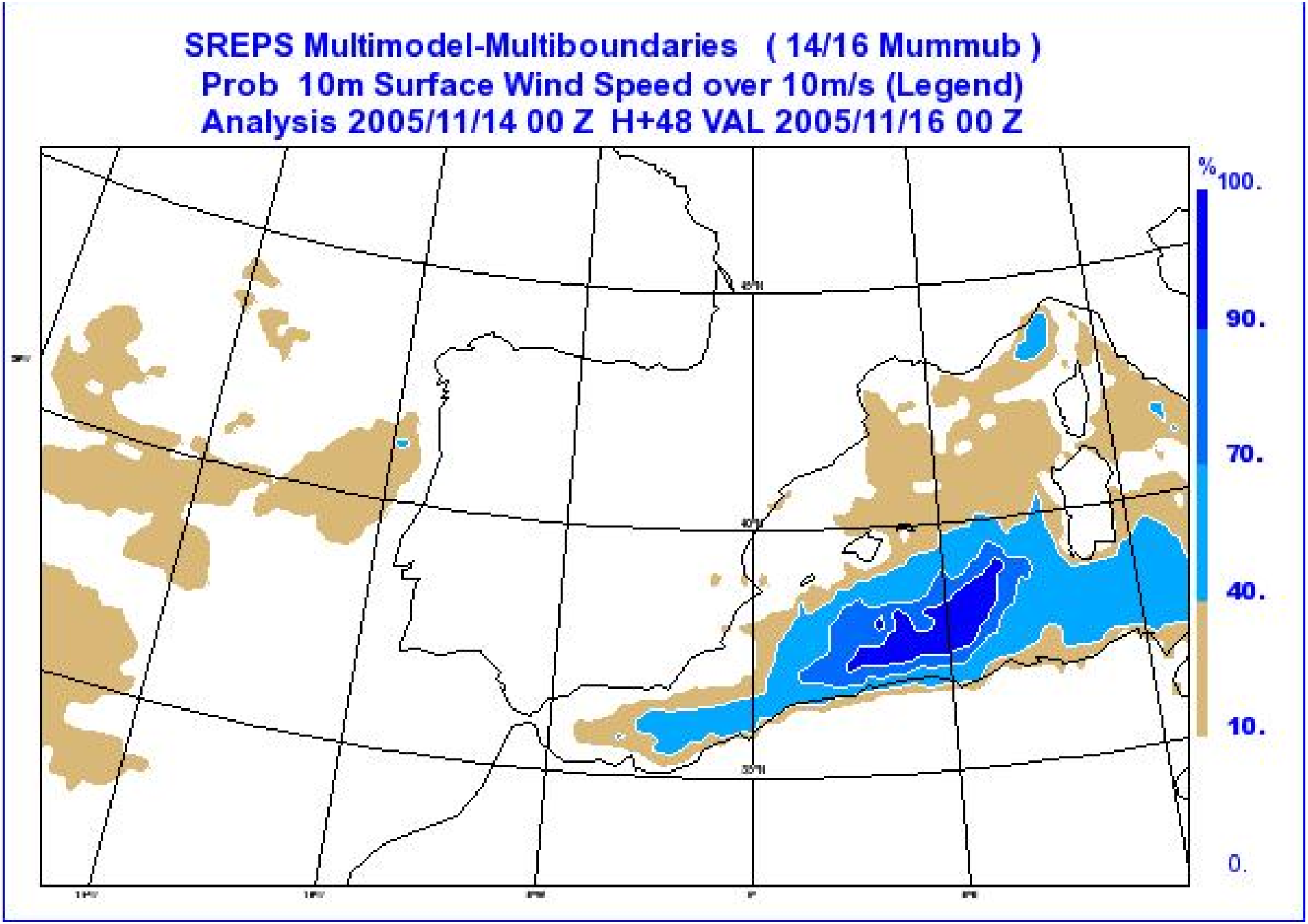
Forecast range (HH+06..HH+72) X Thresholds (1,5,10,20)

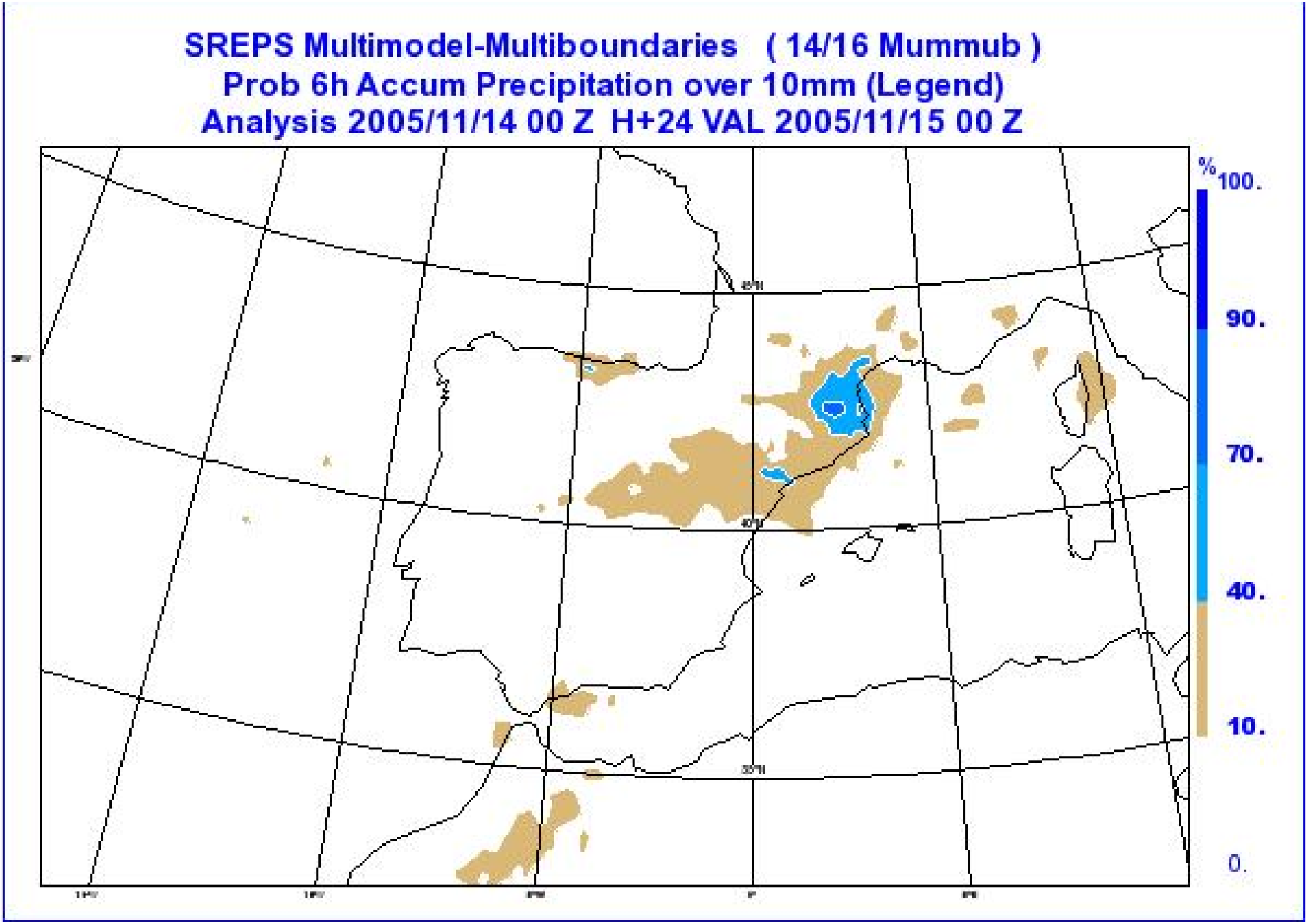
	Thresholds			
Last run forecast range	1	5	10	20
06	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop
	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop
12	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop
	 Graphics Loop	 Graphics Loop	 Graphics Loop	 Graphics Loop
				





November 2005

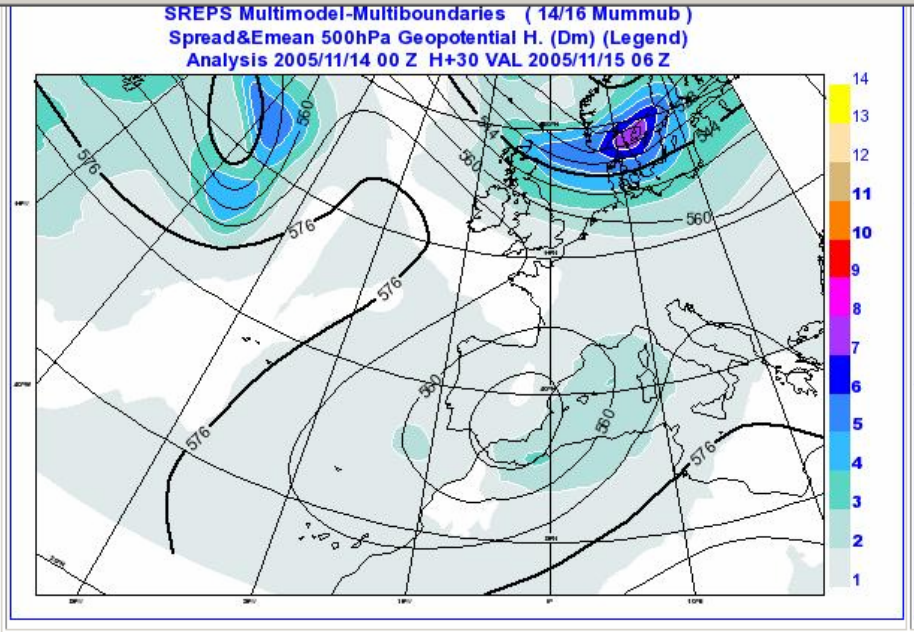

SREPS Multimodel-Multiboundaries (14/16 Mummub)
Prob 10m Surface Wind Speed over 10m/s (Legend)
Analysis 2005/11/14 00 Z H+48 VAL 2005/11/16 00 Z
%
100.
90.
70.
40.
10.
0.

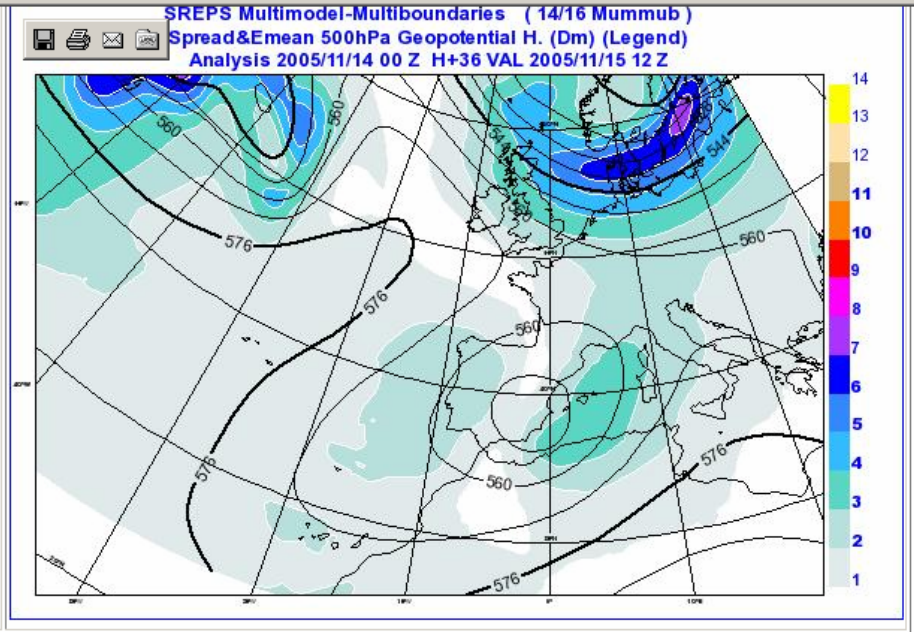

SREPS Multimodel-Multiboundaries (14/16 Mummub)
Prob 6h Accum Precipitation over 10mm (Legend)
Analysis 2005/11/14 00 Z H+24 VAL 2005/11/15 00 Z
%
100.
90.
70.
40.
10.
0.

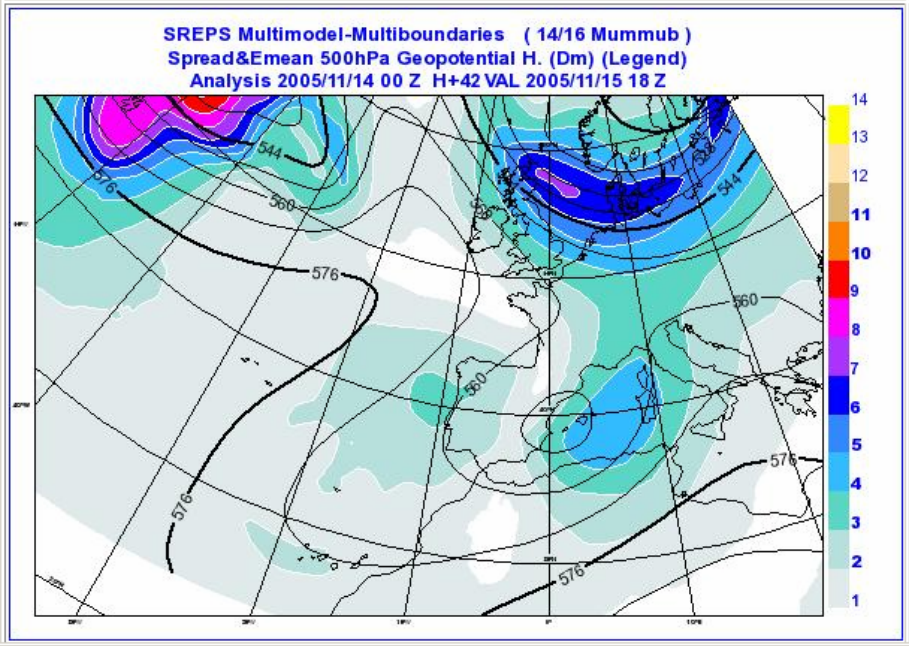
Archivo Edición Ver Favoritos Herramientas Ayuda

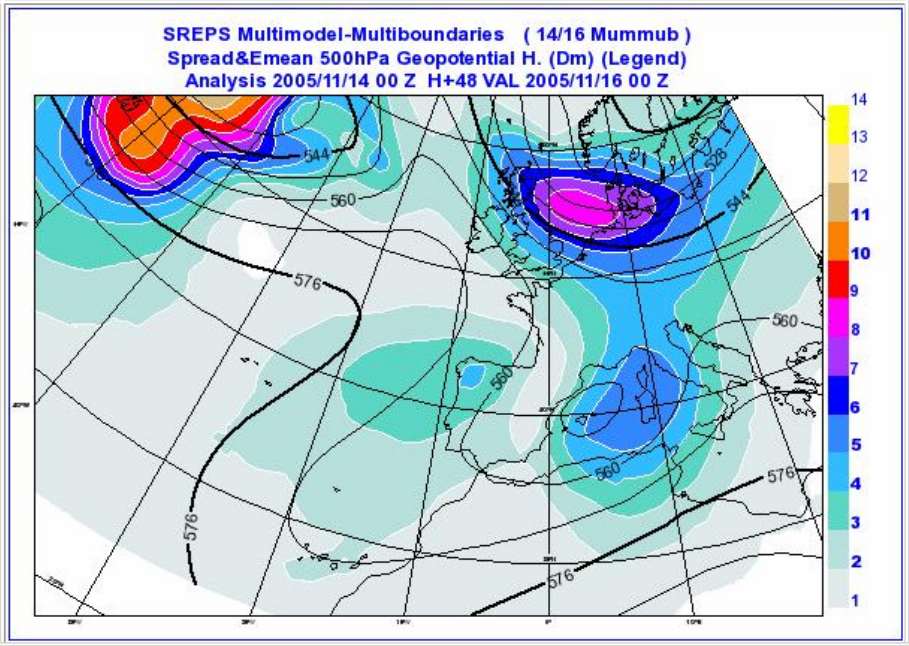
Atrás Búsqueda Favoritos Multimedia

Dirección http://sur.inm.es/Ensembles/Mummub/html/Mummub-SREPSg-Z500SpreadEmean.html Ir Vínculos

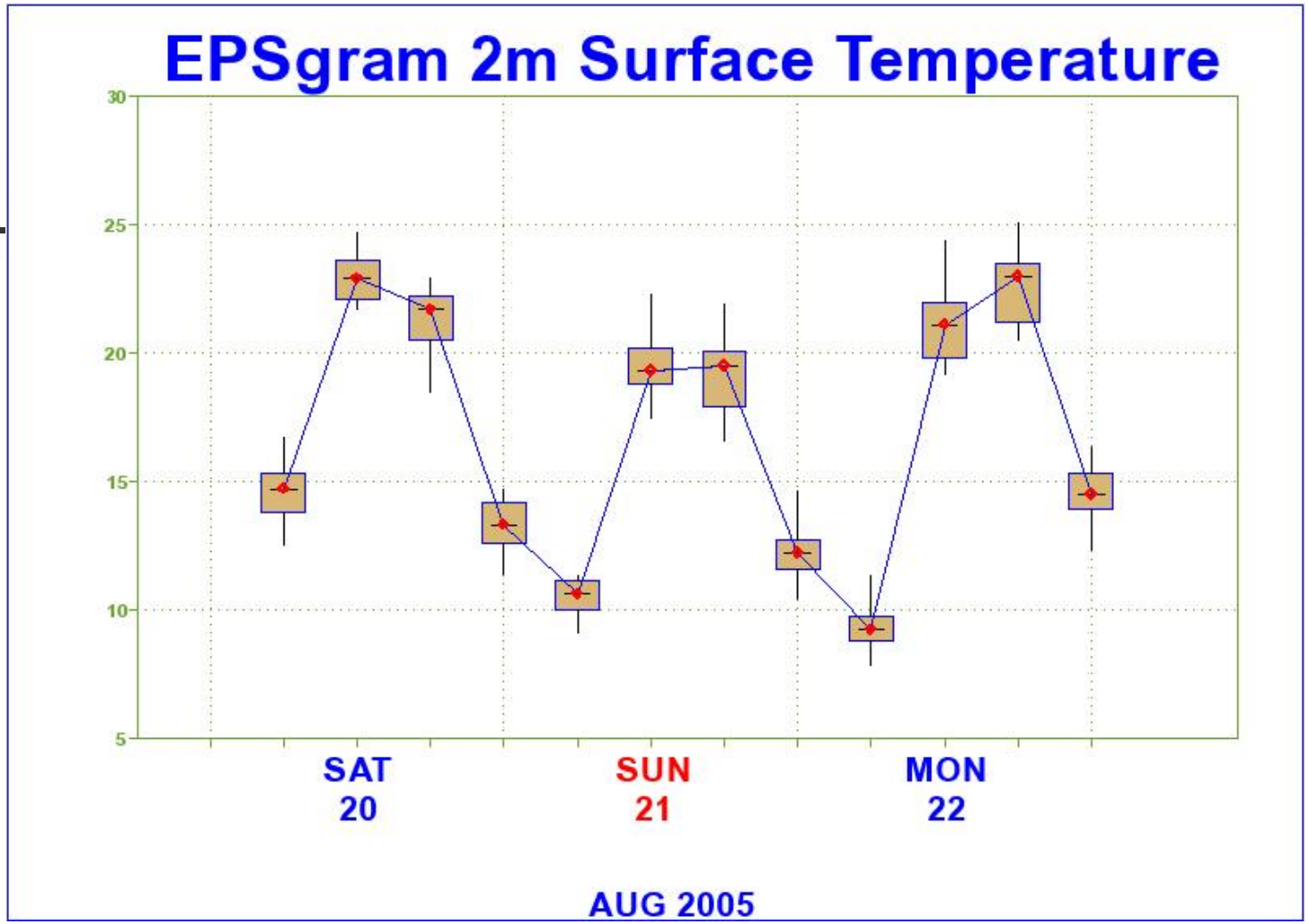






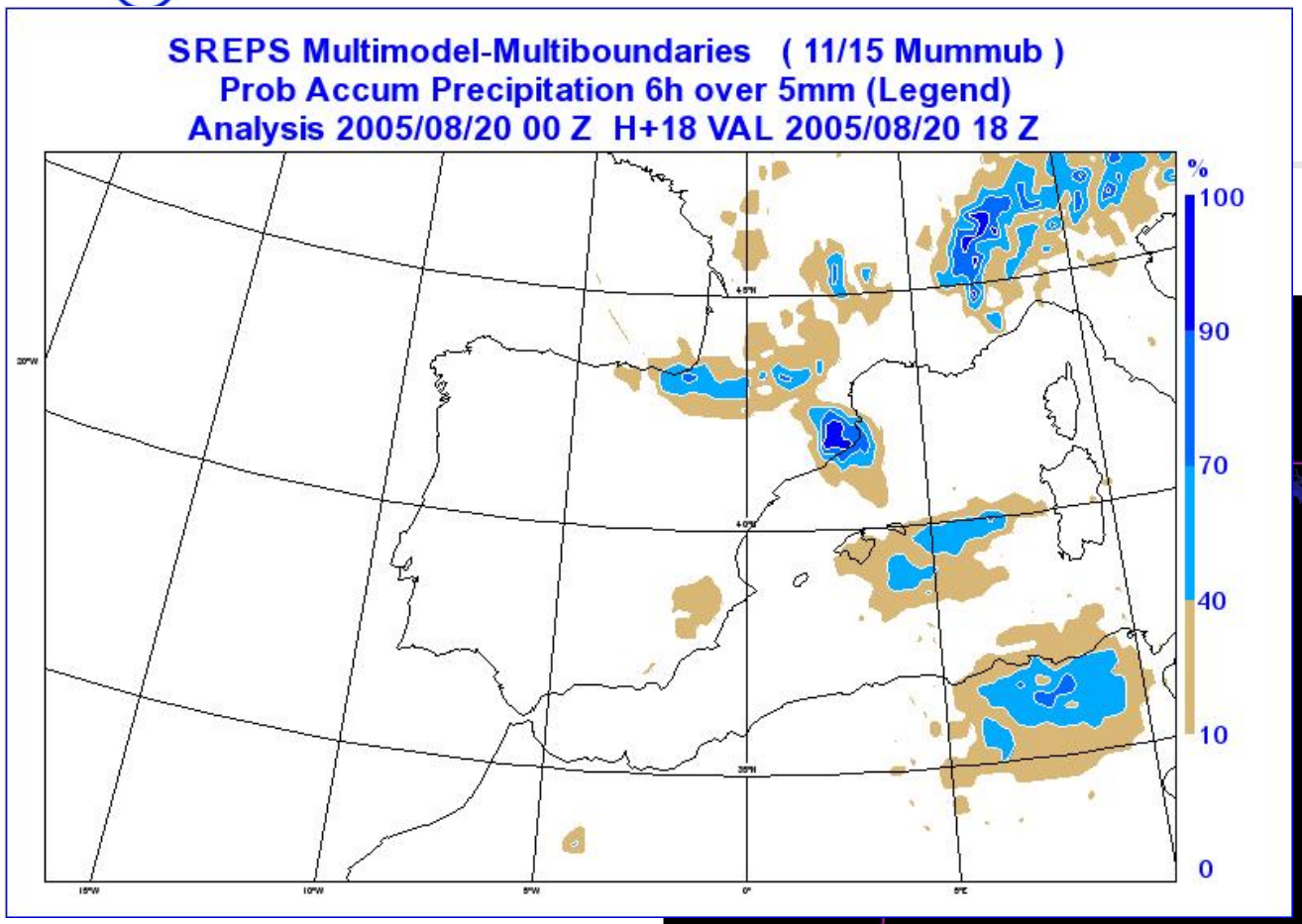


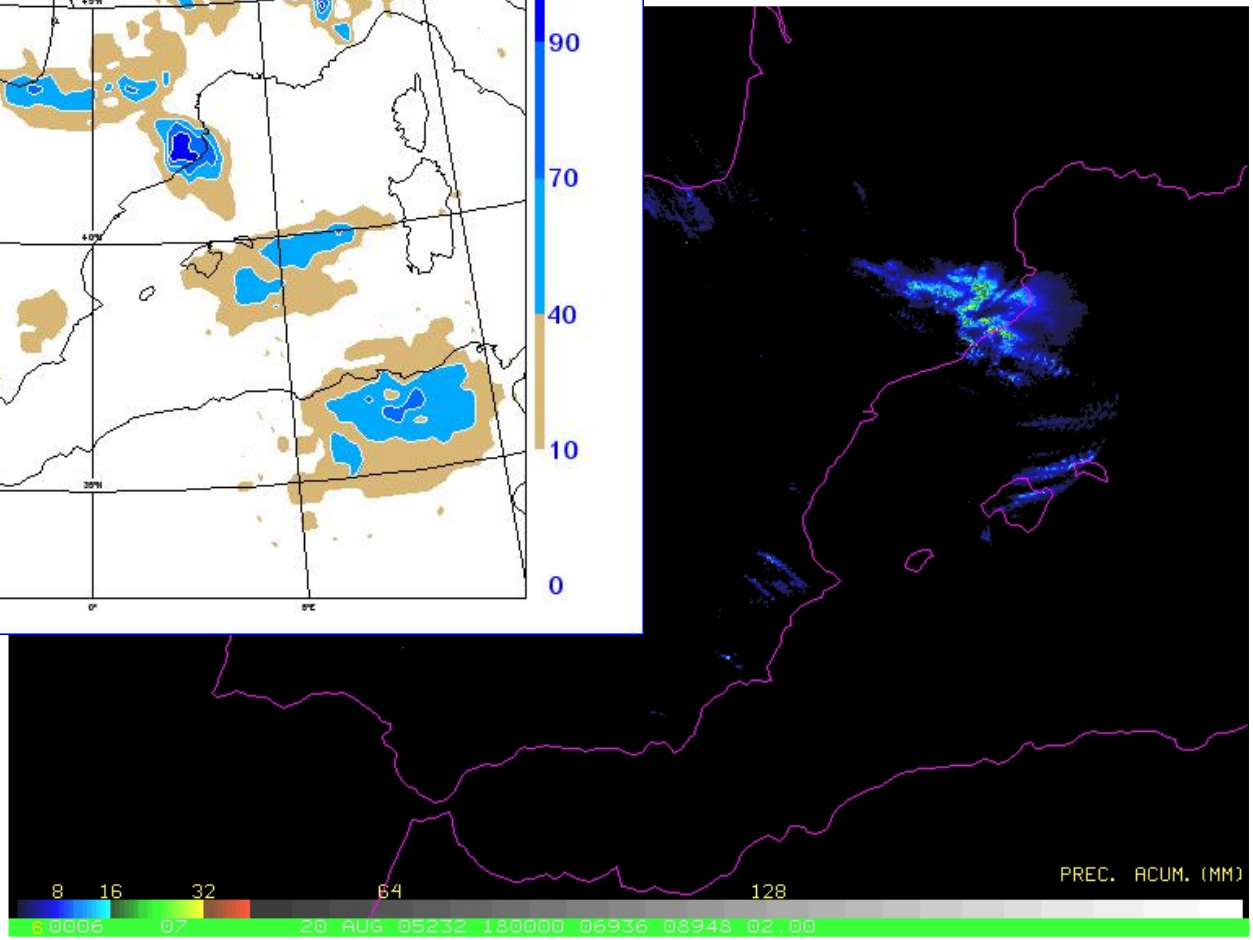
Listo Intranet local



- EPSgrams
  - Not fully operational

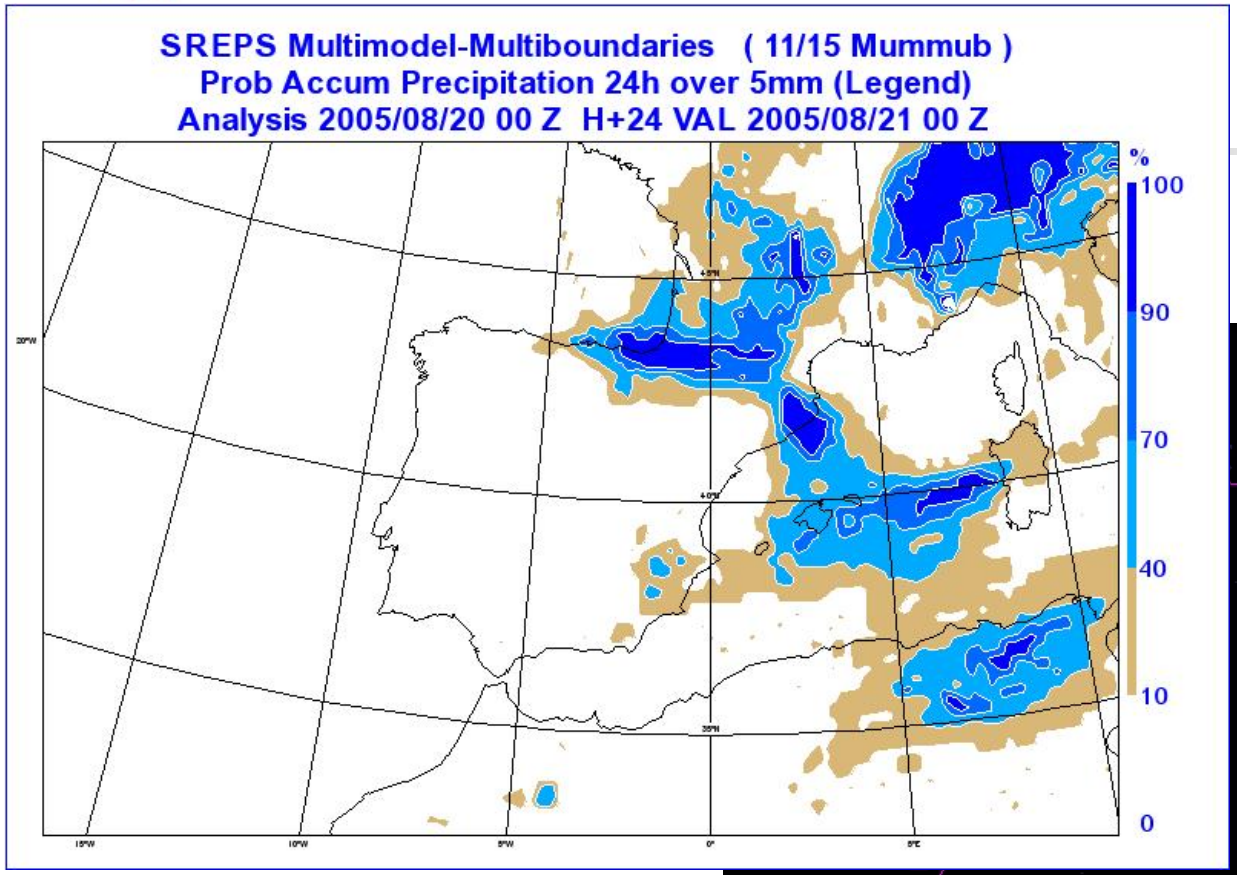
Case study: Aug, 20, 2005

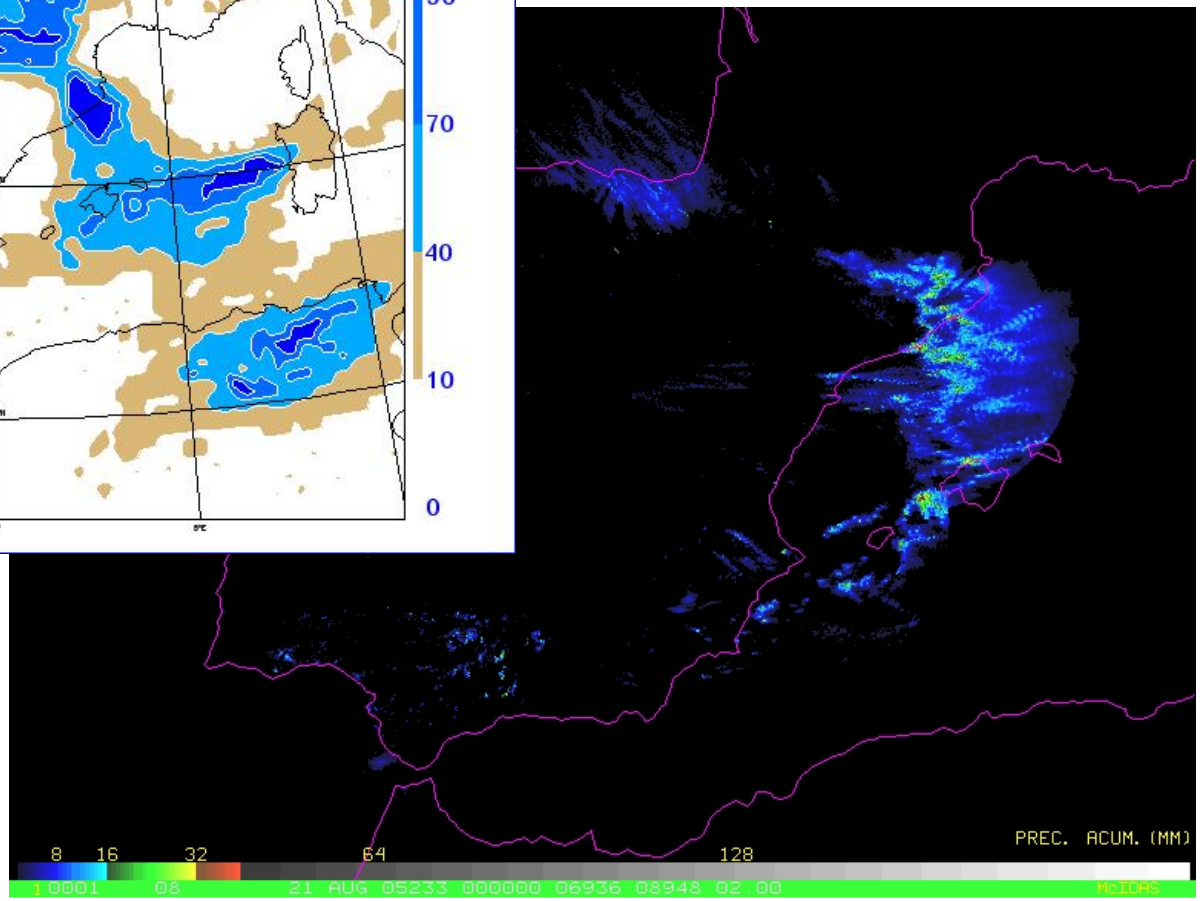




- Prob. Map & RADAR 12-18Z

Case study: Aug, 20, 2005





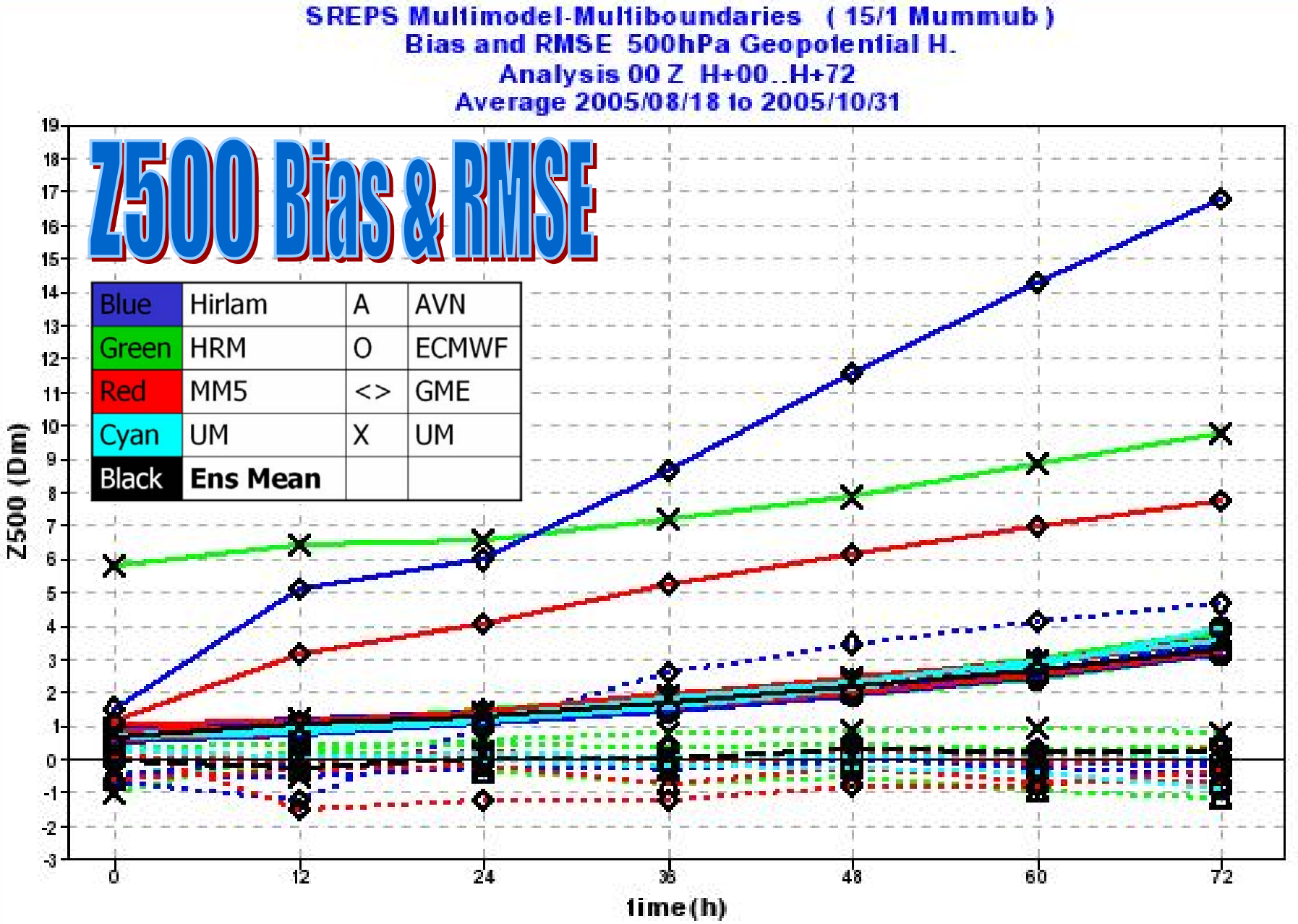
- Prob. Map & RADAR 00-24Z

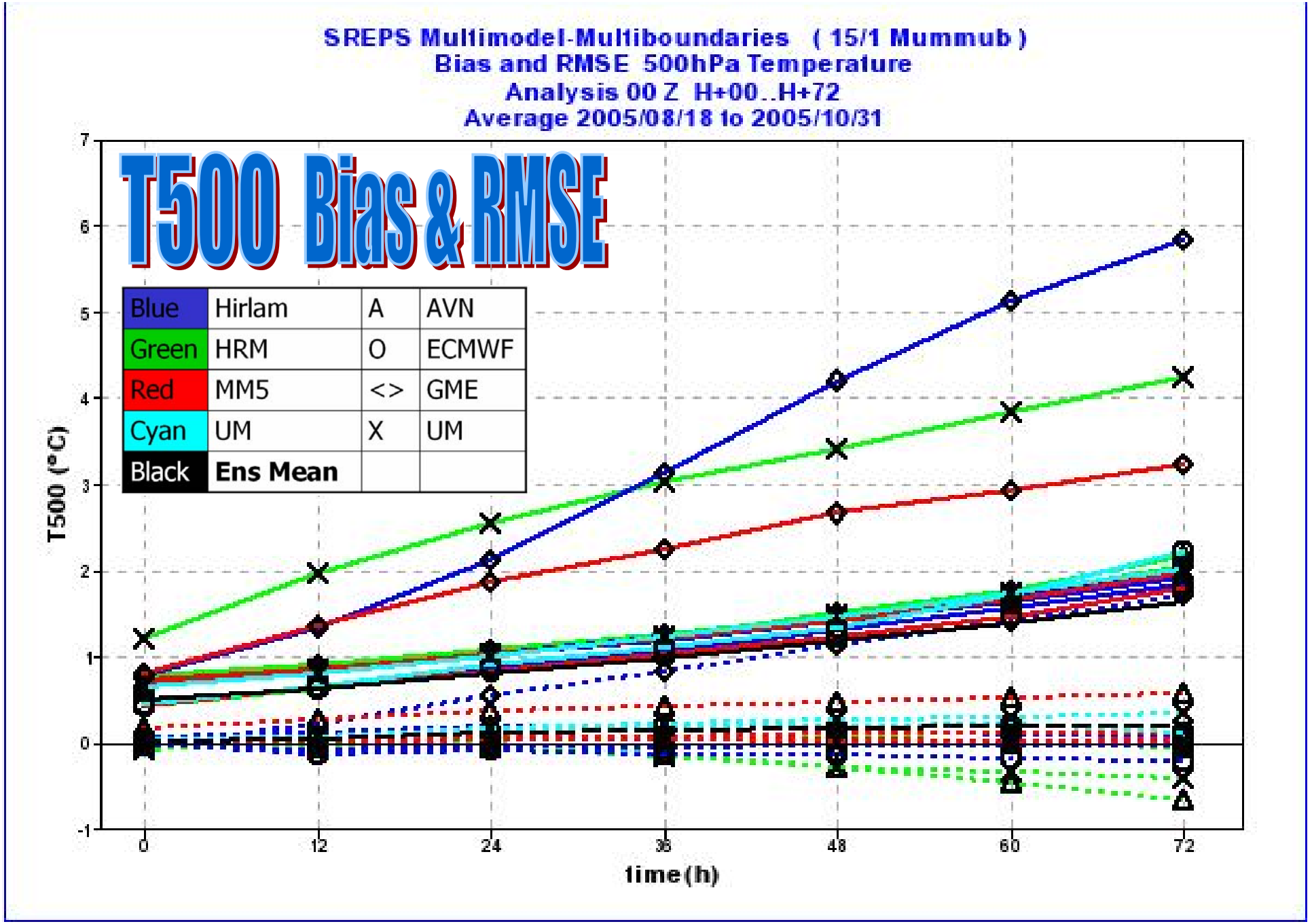
Outline

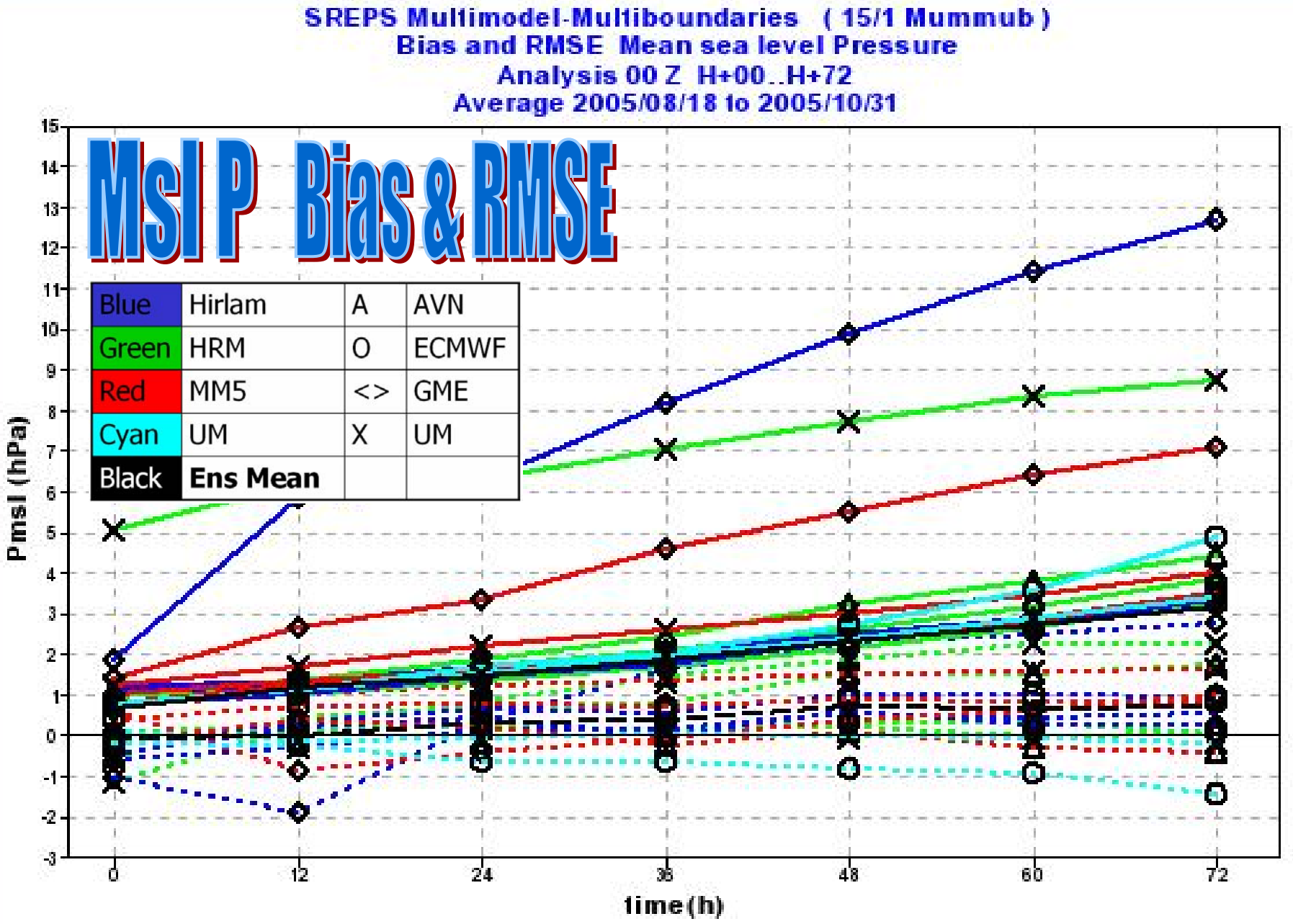
- Motivation
- Features
- Post-processing & outputs
- **Validation**
- Conclusions

Validation

- **ECMWF** operational analysis as reference.
  - & ECMWF 24h det fc for Acc. Prec.
- Verification software
  - ~ ECMWF **Metview** + Local developments
- Deterministic scores
  - Bias & RMSE for each member & Ens Mean
- Probabilistic ensemble scores
  - Rank histograms
  - Spread-skill diagrams
  - ROC
  - Reliability diagrams
- **~80** days of exercise (Aug18 to Oct31 2005).

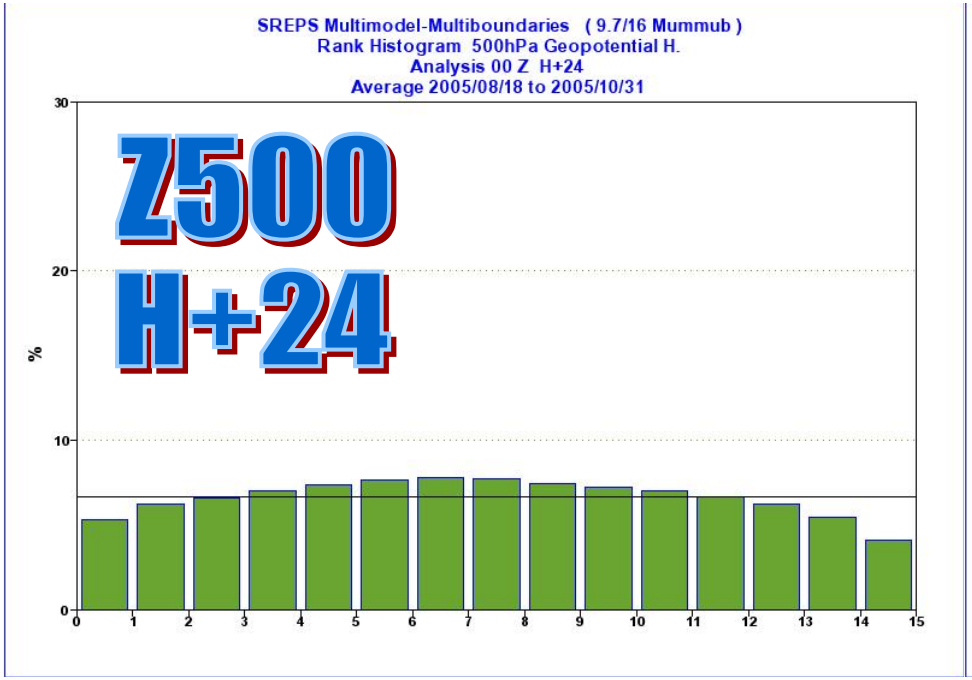

SREPS Multimodel-Multiboundaries (15/1 Mummub)
Bias and RMSE 500hPa Geopotential H.
Analysis 00 Z H+00..H+72
Average 2005/08/18 to 2005/10/31
Z500 Bias & RMSE
Blue Hirlam A AVN
Green HRM O ECMWF
Red MM5 <> GME
Cyan UM X UM
Black Ens Mean
Z500 (Dm)
time (h)
0
12
24
36
48
60
72

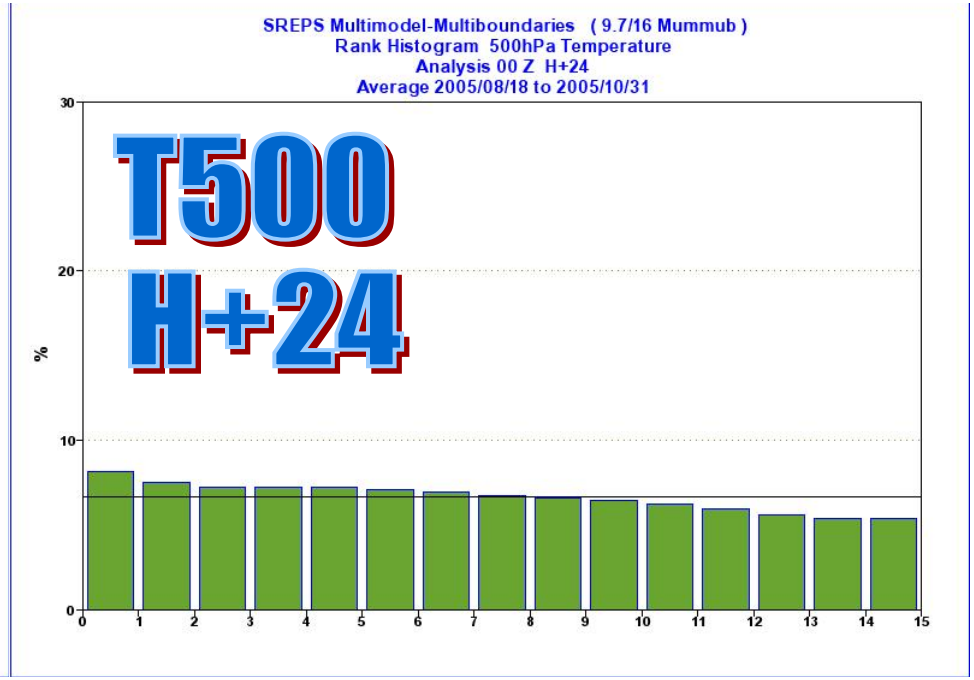

SREPS Multimodel-Multiboundaries (15/1 Mummub)
Bias and RMSE 500hPa Temperature
Analysis 00 Z H+00..H+72
Average 2005/08/18 to 2005/10/31
T500 Bias & RMSE
Blue Hirlam A AVN
Green HRM O ECMWF
Red MM5 <> GME
Cyan UM X UM
Black Ens Mean
T500 (°C)
time (h)
7
6
5
4
3
2
1
0
-1
0
12
24
36
48
60
72

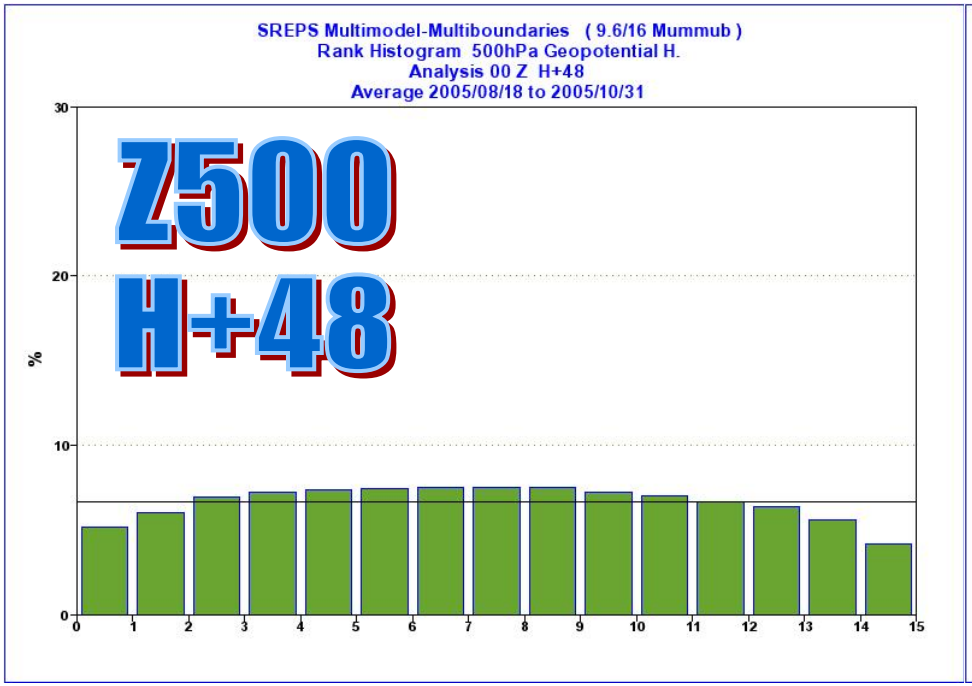

SREPS Multimodel-Multiboundaries (15/1 Mummub)
Bias and RMSE Mean sea level Pressure
Analysis 00 Z H+00..H+72
Average 2005/08/18 to 2005/10/31
MsI P Bias & RMSE
Blue Hirlam A AVN
Green HRM O ECMWF
Red MM5 <> GME
Cyan UM X UM
Black Ens Mean
Pmsl (hPa)
time (h)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
0
12
24
36
48
60
72

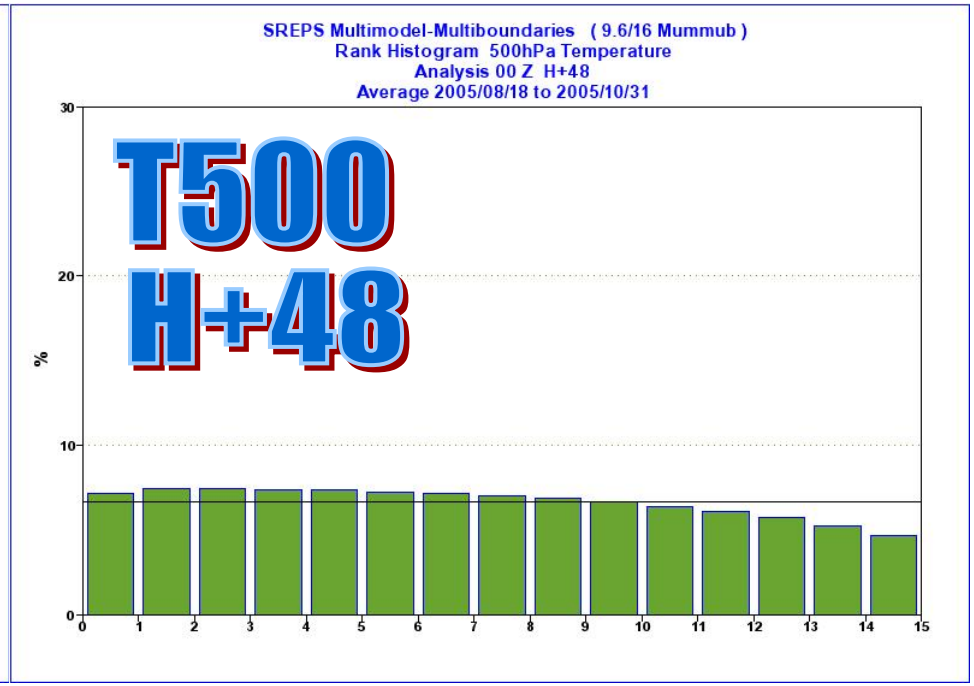
Rank histograms

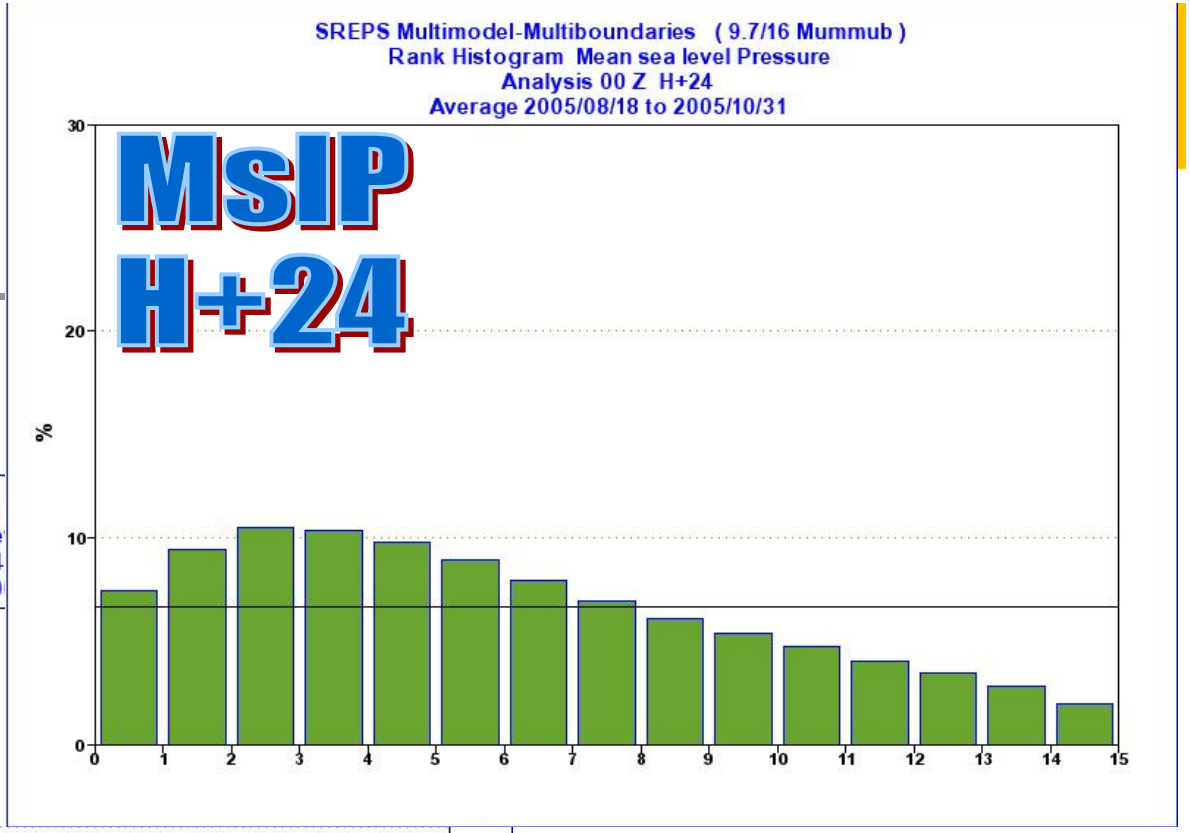
- Ensemble members ranked from smallest to greatest value.
- Percent of cases which verifying analysis falls in an interval.
- First interval, below smallest member.
- Last one, above greatest member.
- Z500, T500, Msl Pressure
  - H+24, H+48

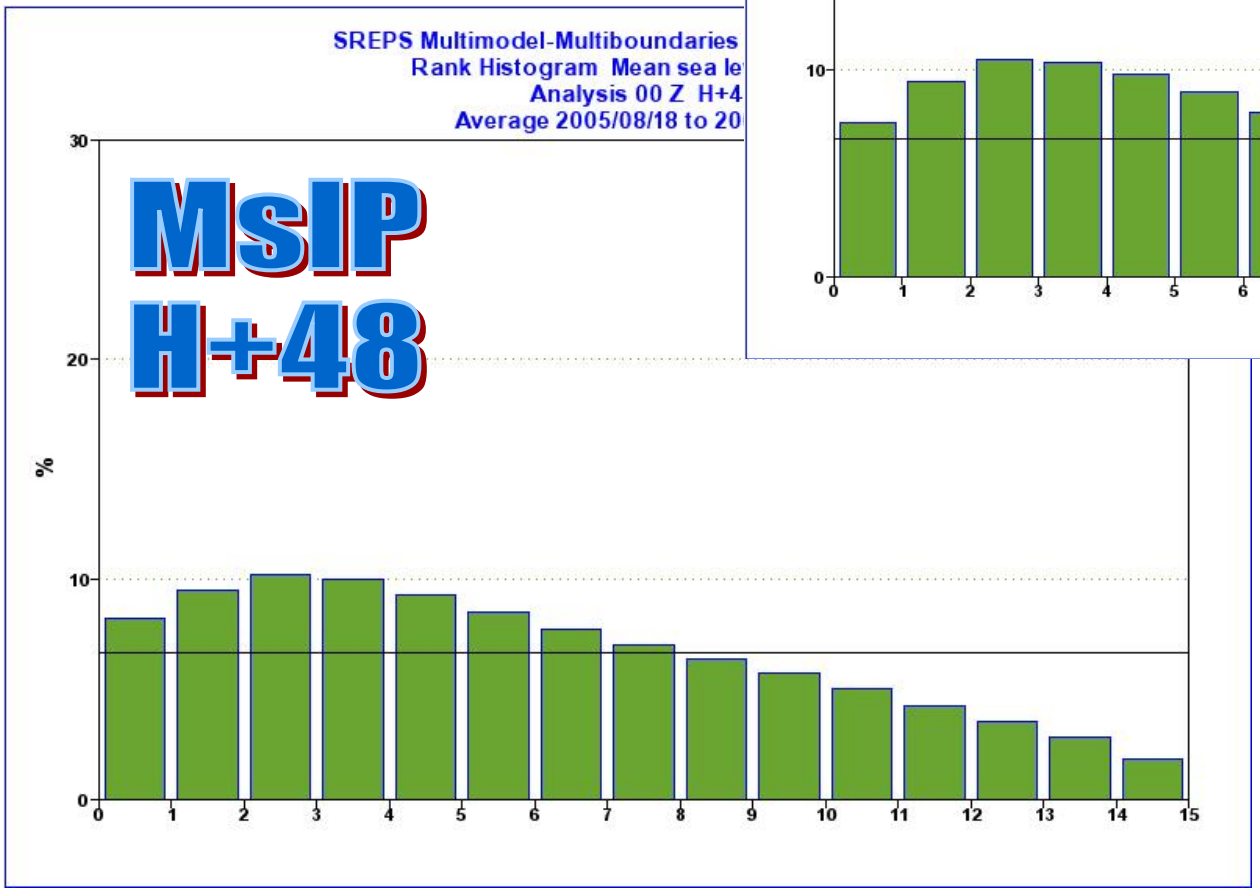

SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
Rank Histogram 500hPa Geopotential H.
Analysis 00 Z H+24
Average 2005/08/18 to 2005/10/31
Z500
H+24
%


SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
Rank Histogram 500hPa Temperature
Analysis 00 Z H+24
Average 2005/08/18 to 2005/10/31
T500
H+24
%


SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
Rank Histogram 500hPa Geopotential H.
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
Z500
H+48
%

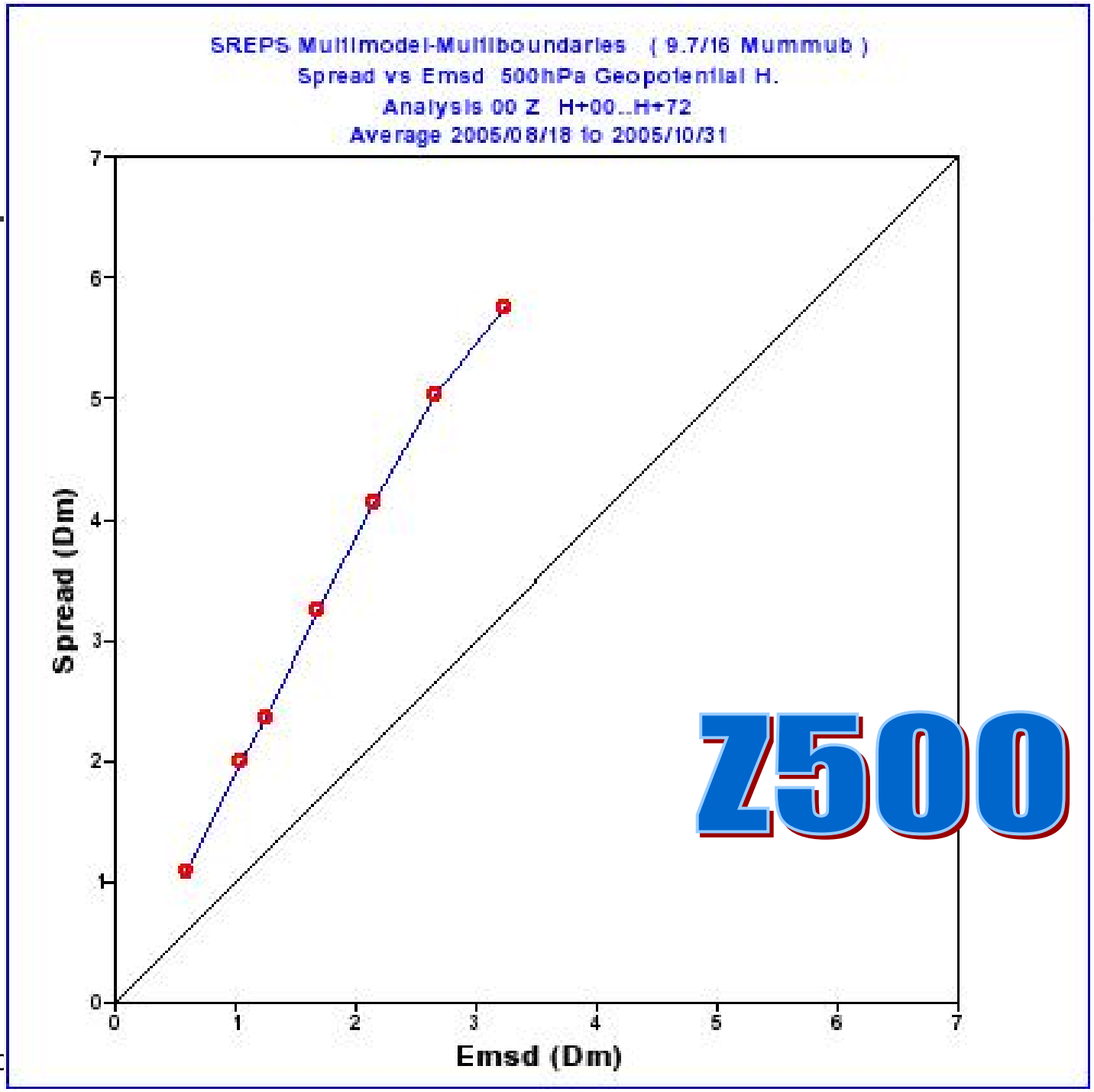

SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
Rank Histogram 500hPa Temperature
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
T500
H+48
%

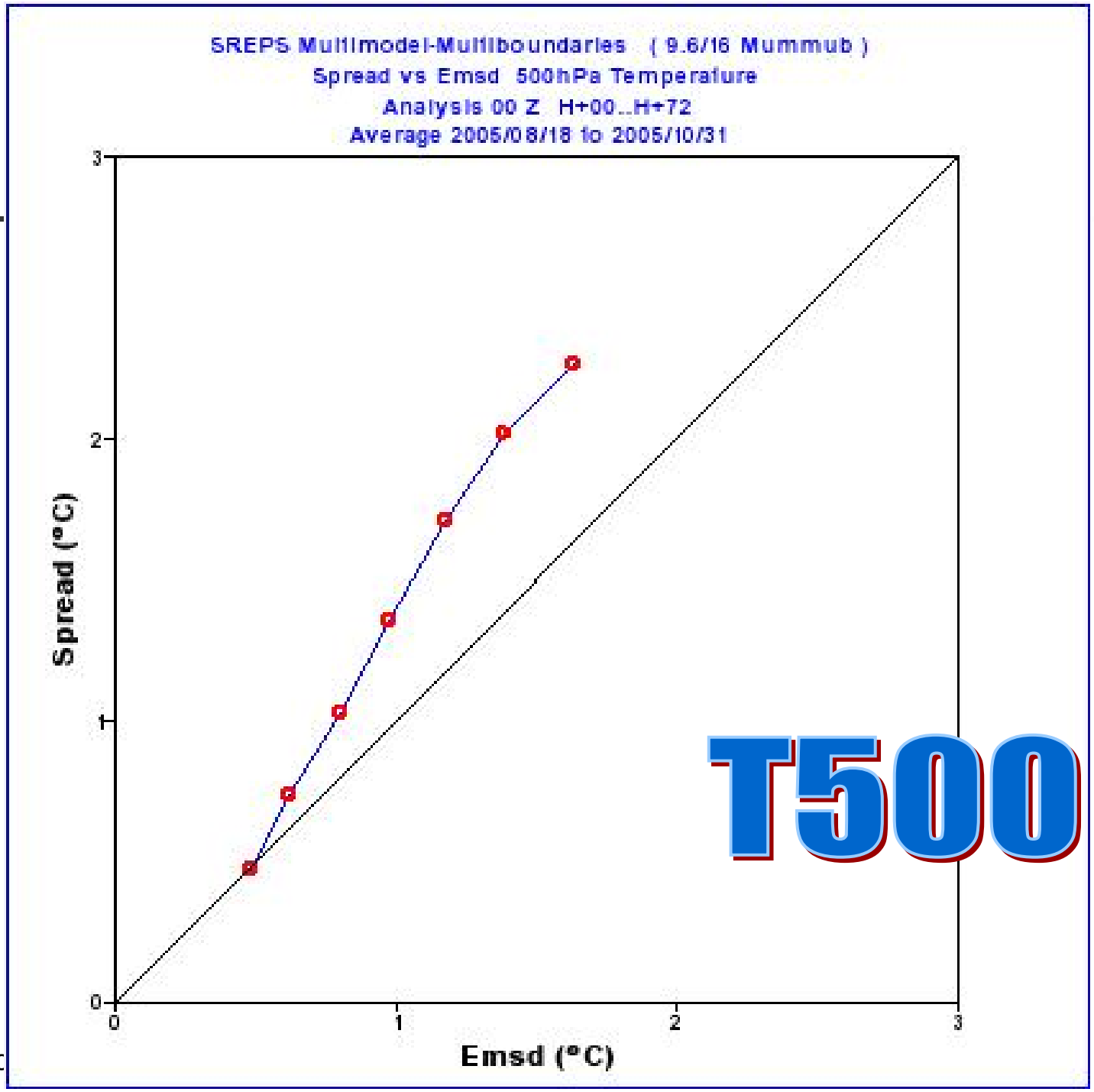

SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
Rank Histogram Mean sea level Pressure
Analysis 00 Z H+24
Average 2005/08/18 to 2005/10/31
MsIP
H+24
%
0
10
20
30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

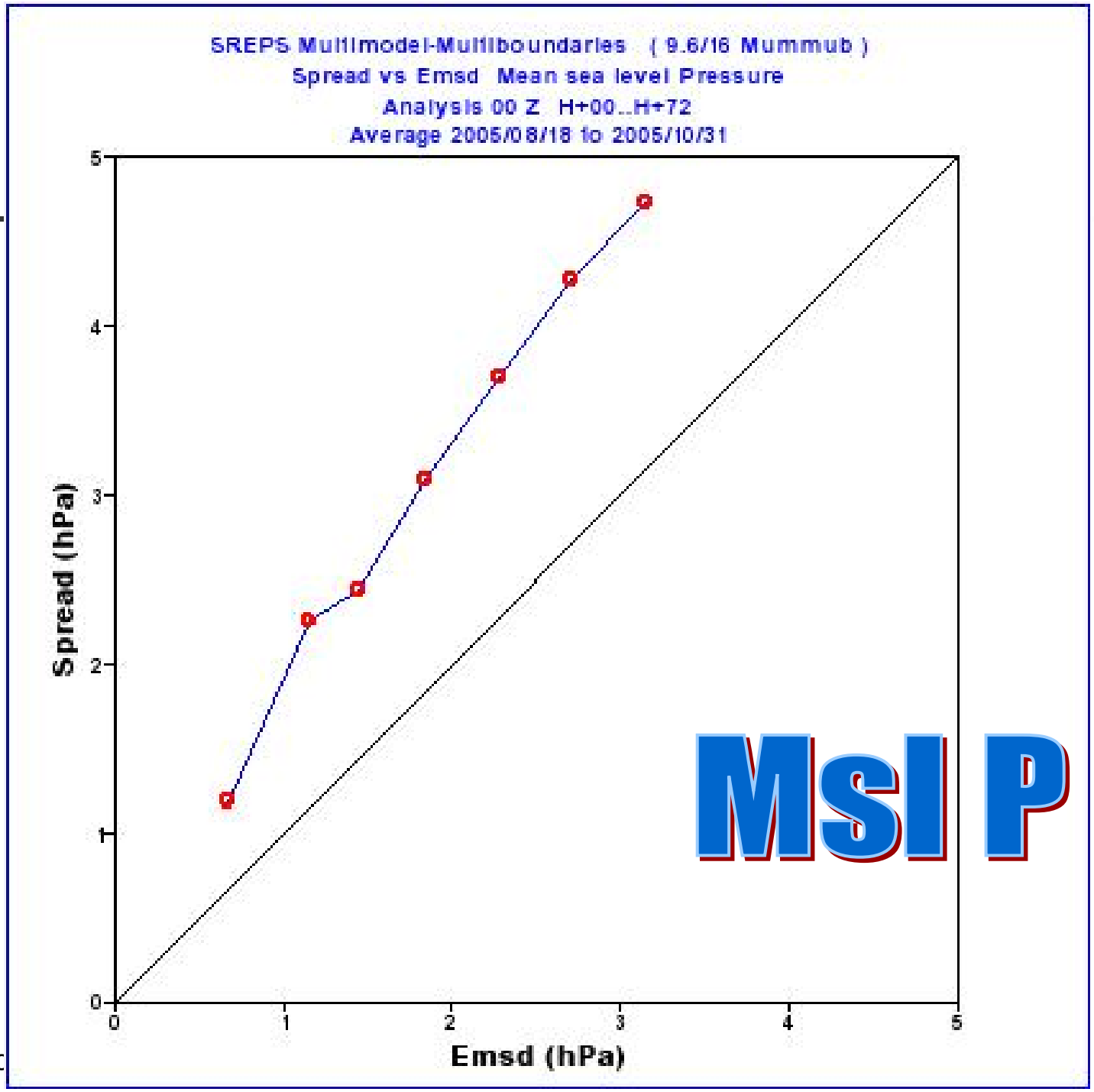

SREPS Multimodel-Multiboundaries
Rank Histogram Mean sea le
Analysis 00 Z H+4
Average 2005/08/18 to 20
MsIP
H+48
%
0
10
20
30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Spread-skill diagrams: Spread vs Ensemble Mean Error

- Z500
  - H+00 to H+72
- T500
  - H+00 to H+72
- Msl Pressure
  - H+00 to H+72

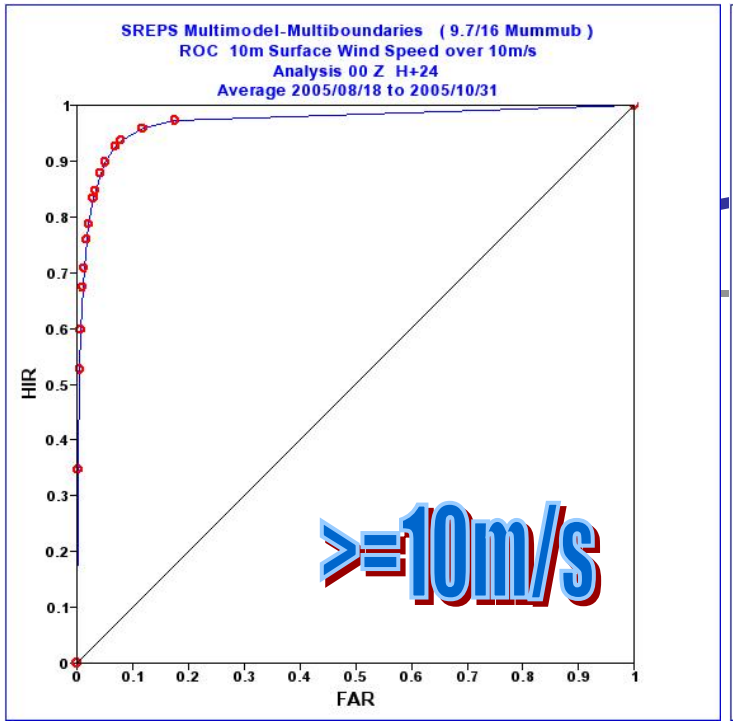

SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
Spread vs Emsd 500hPa Geopotential H.
Analysis 00 Z H+00..H+72
Average 2005/08/18 to 2005/10/31
Spread (Dm)
Emsd (Dm)
0
1
2
3
4
5
6
7
Z500

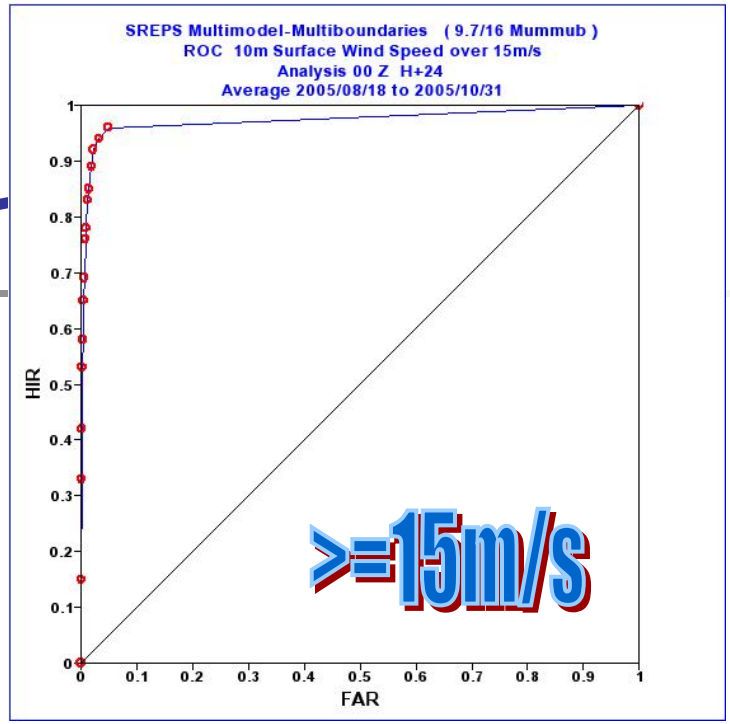

SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
Spread vs Emsd 500hPa Temperature
Analysis 00 Z H+00..H+72
Average 2005/08/18 to 2005/10/31
Spread (°C)
Emsd (°C)
0
1
2
3
T500

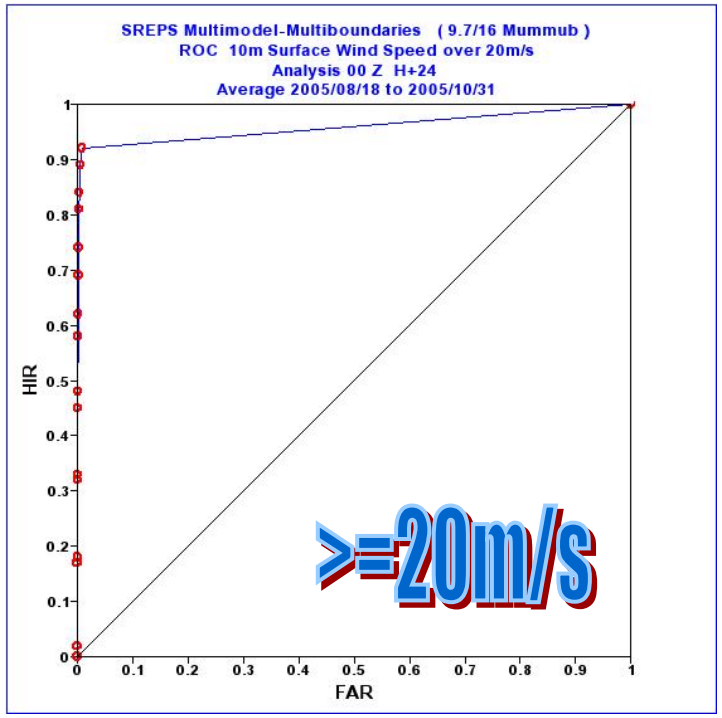

SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
Spread vs Emsd Mean sea level Pressure
Analysis 00 Z H+00..H+72
Average 2005/08/18 to 2005/10/31
Spread (hPa)
Emsd (hPa)
0
1
2
3
4
5
MsI P

ROC Curves

- 10m Wind Speed
  - Thresholds: 10m/s, 15m/s
  - H+24, H+48
- 24h Accumulated Precipitation
  - Thresholds: 1mm, 5mm, 10mm, 20mm
  - H+24, H+48

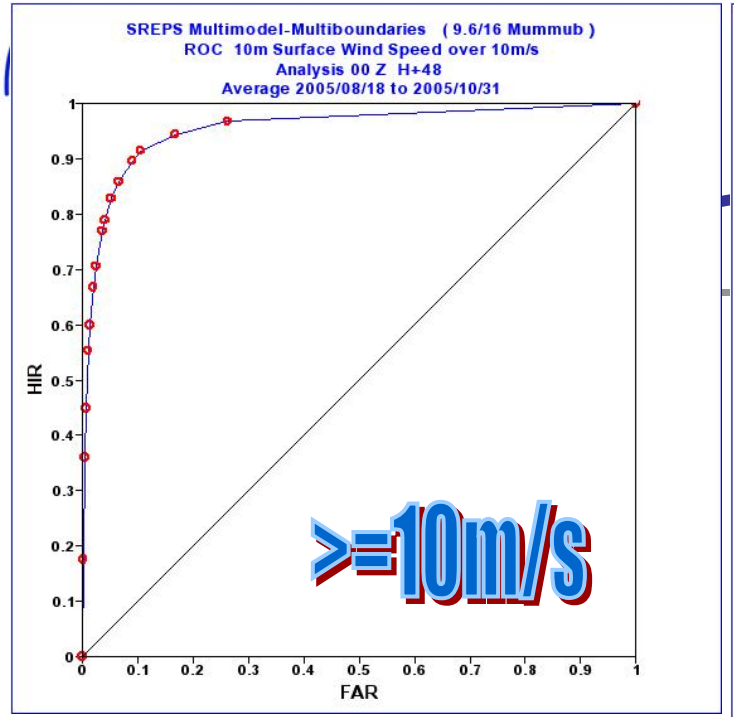

SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
ROC 10m Surface Wind Speed over 10m/s
Analysis 00 Z H+24
Average 2005/08/18 to 2005/10/31
HIR
FAR
>=10m/s

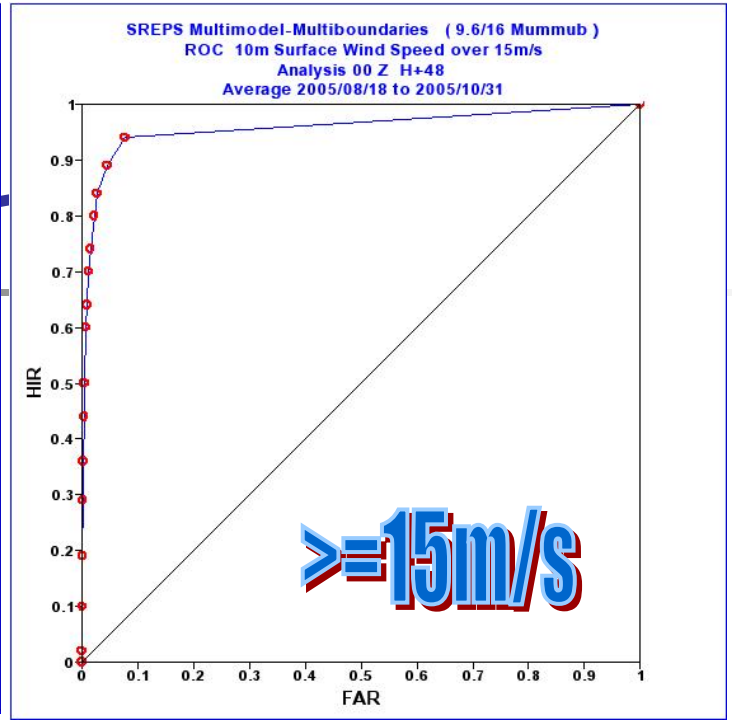

SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
ROC 10m Surface Wind Speed over 15m/s
Analysis 00 Z H+24
Average 2005/08/18 to 2005/10/31
HIR
FAR
>=15m/s

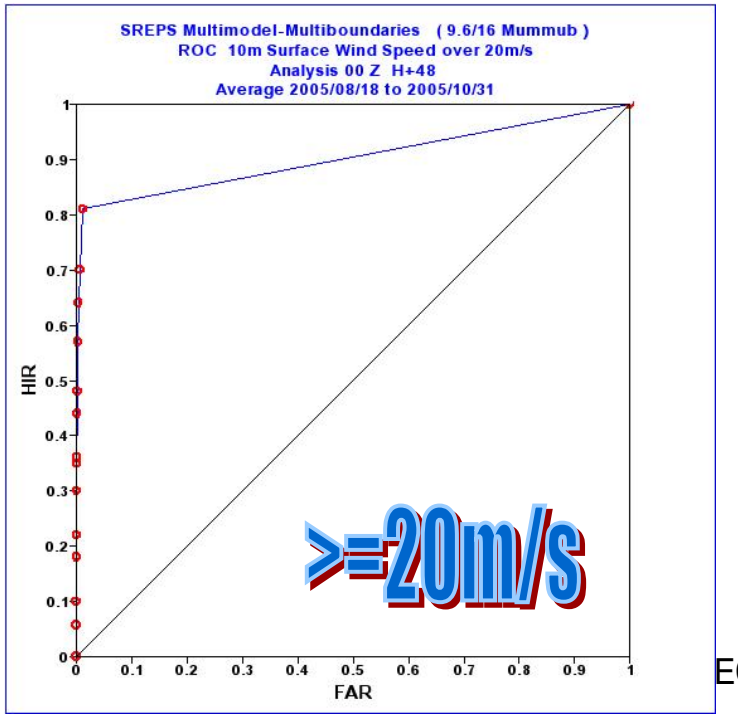

SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
ROC 10m Surface Wind Speed over 20m/s
Analysis 00 Z H+24
Average 2005/08/18 to 2005/10/31
HIR
FAR
>=20m/s

10mWind

H+24

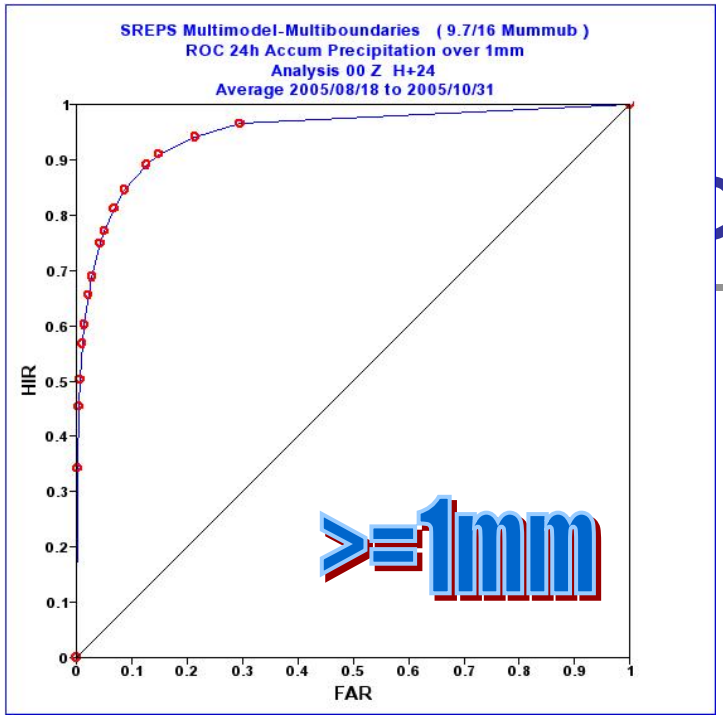

SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
ROC 10m Surface Wind Speed over 10m/s
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
HIR
FAR
>=10m/s

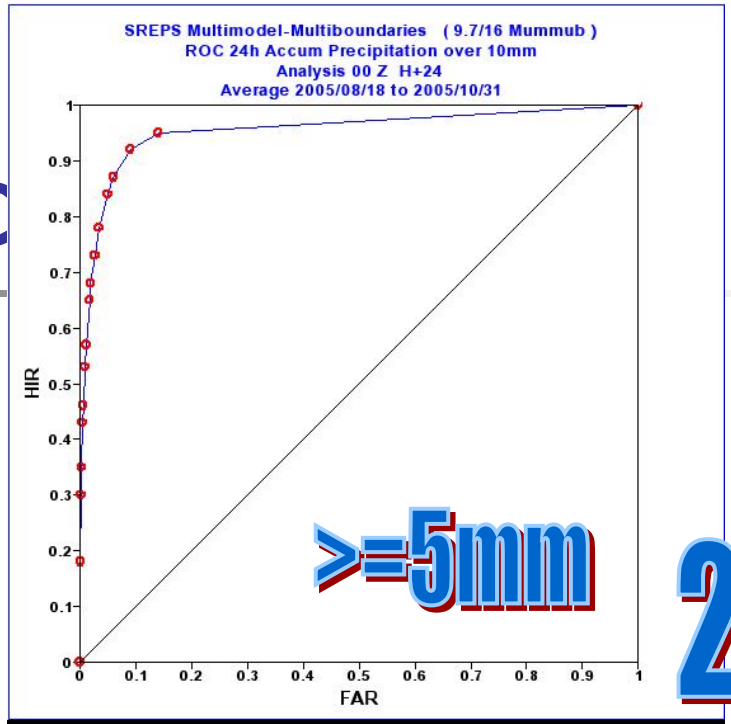

SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
ROC 10m Surface Wind Speed over 15m/s
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
HIR
FAR
>=15m/s

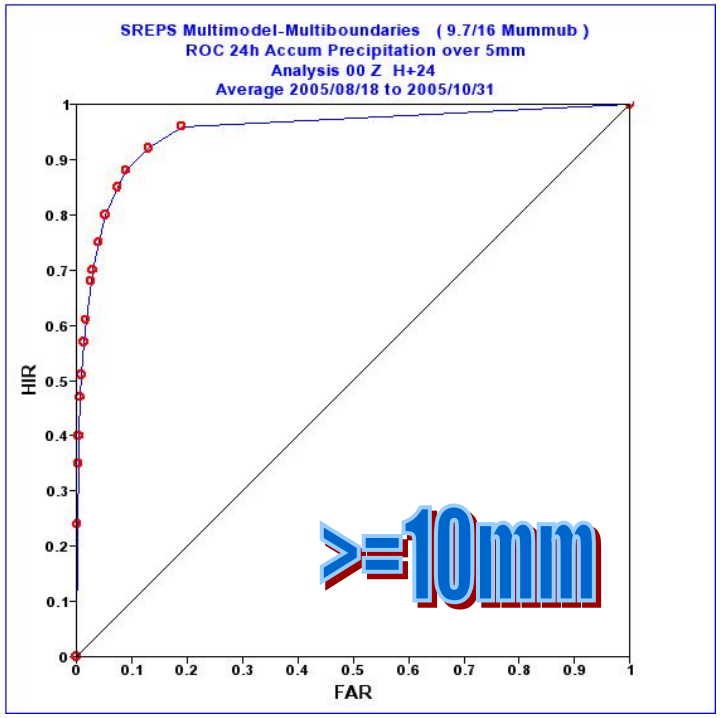

SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
ROC 10m Surface Wind Speed over 20m/s
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
HIR
FAR
>=20m/s

10mWind

H+48

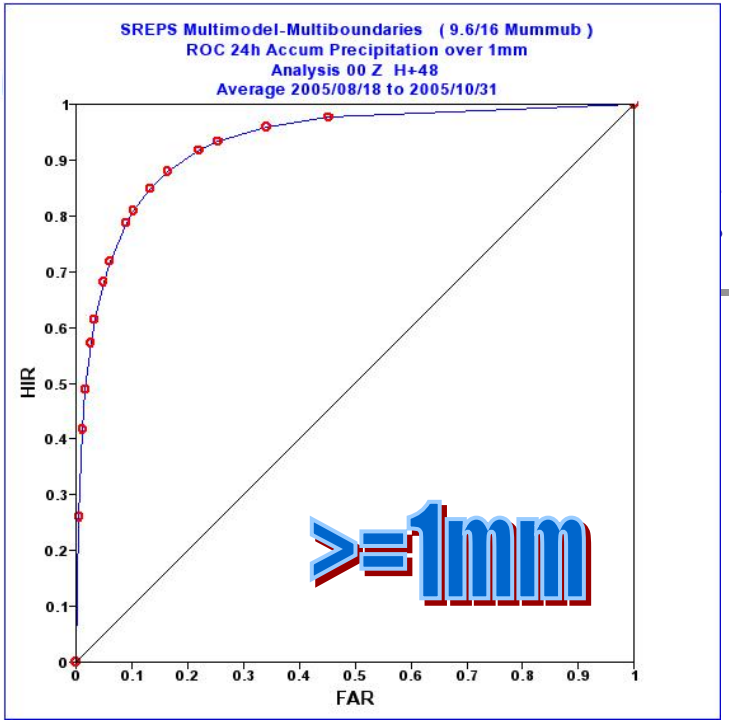


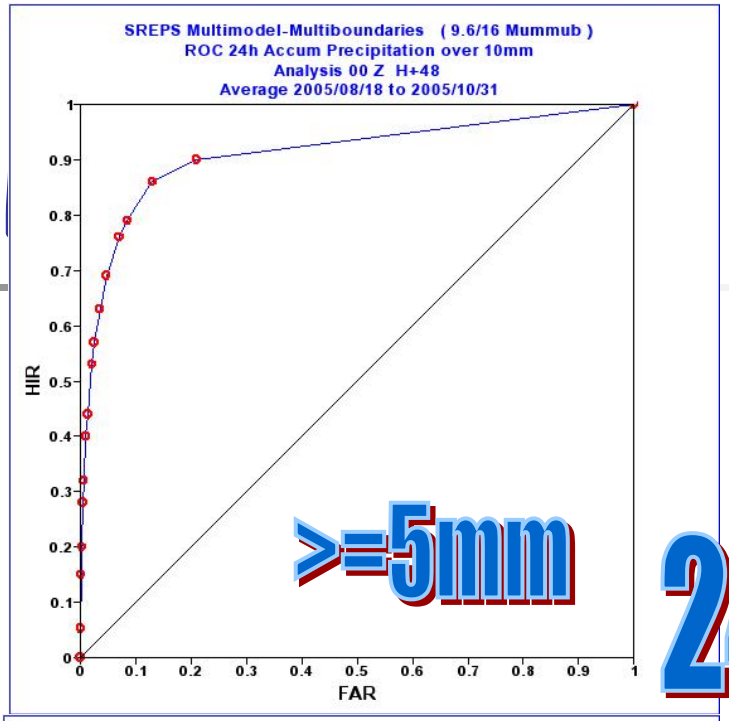


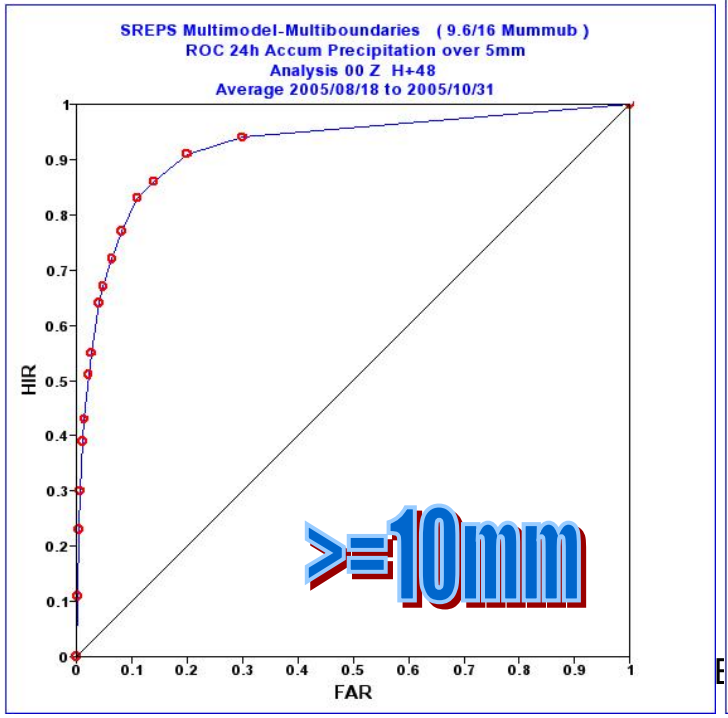


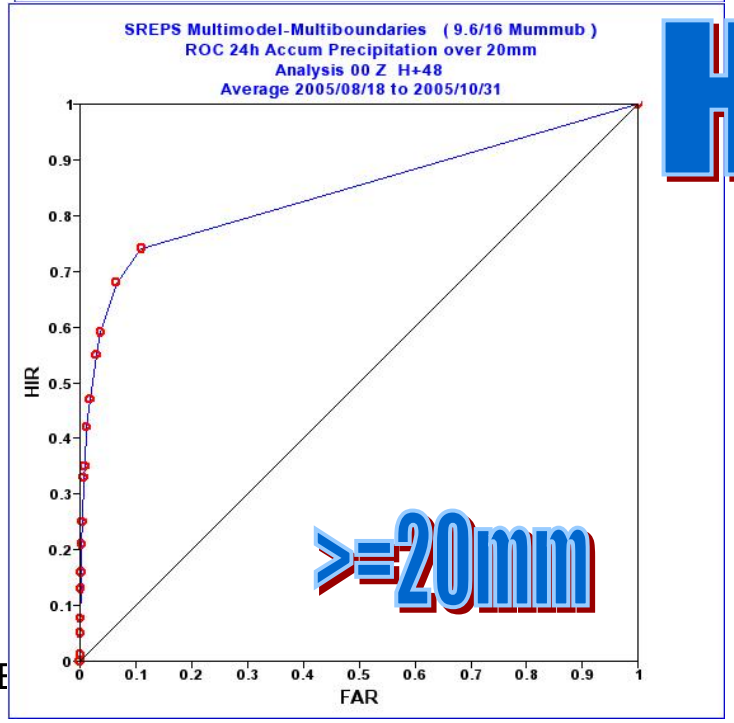
>=20mm

24hAccP
H+24


SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
ROC 24h Accum Precipitation over 1mm
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
HIR
FAR
>=1mm


SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
ROC 24h Accum Precipitation over 10mm
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
HIR
FAR
>=5mm

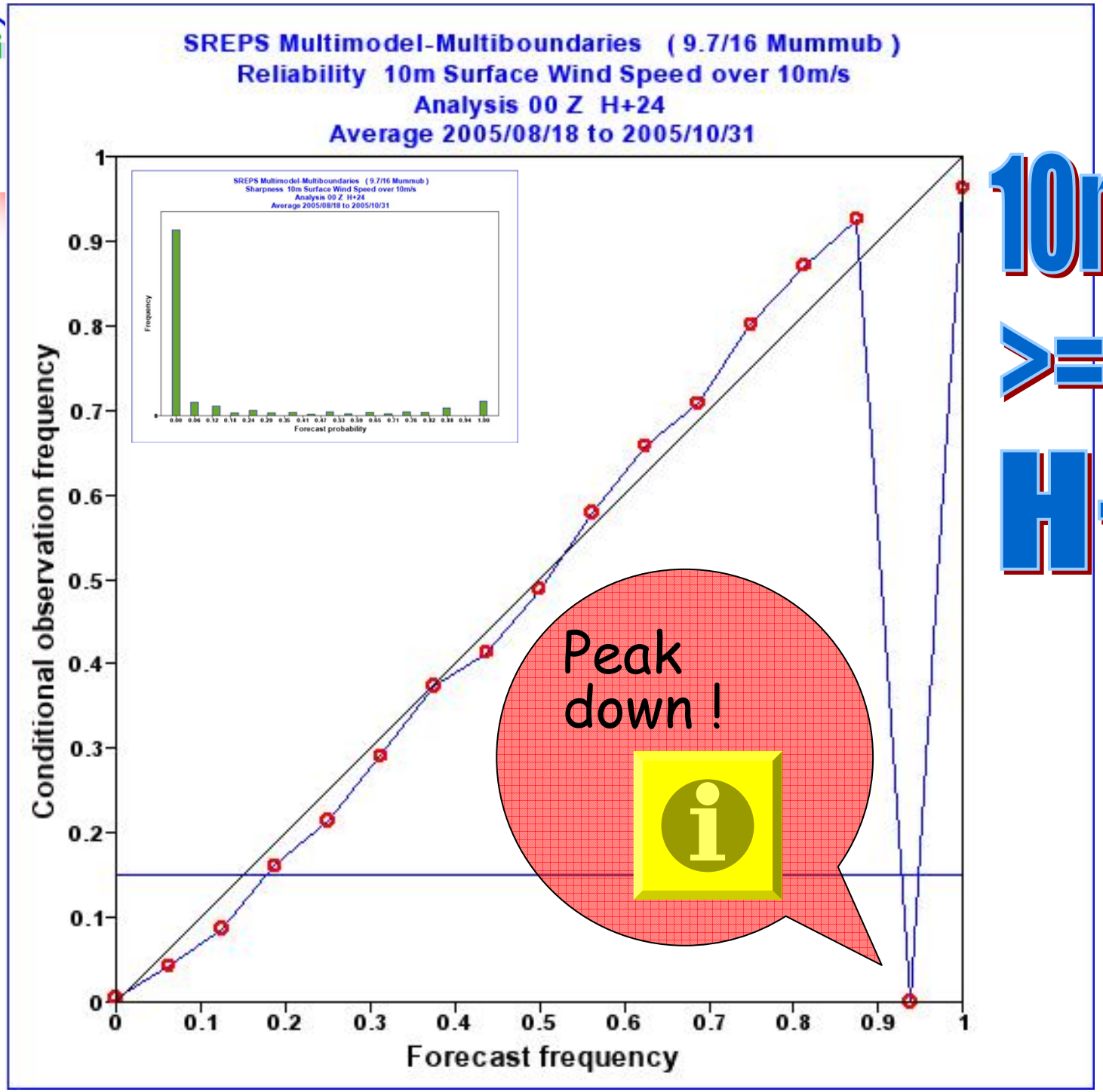

SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
ROC 24h Accum Precipitation over 5mm
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
HIR
FAR
>=10mm


SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
ROC 24h Accum Precipitation over 20mm
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
HIR
FAR
>=20mm

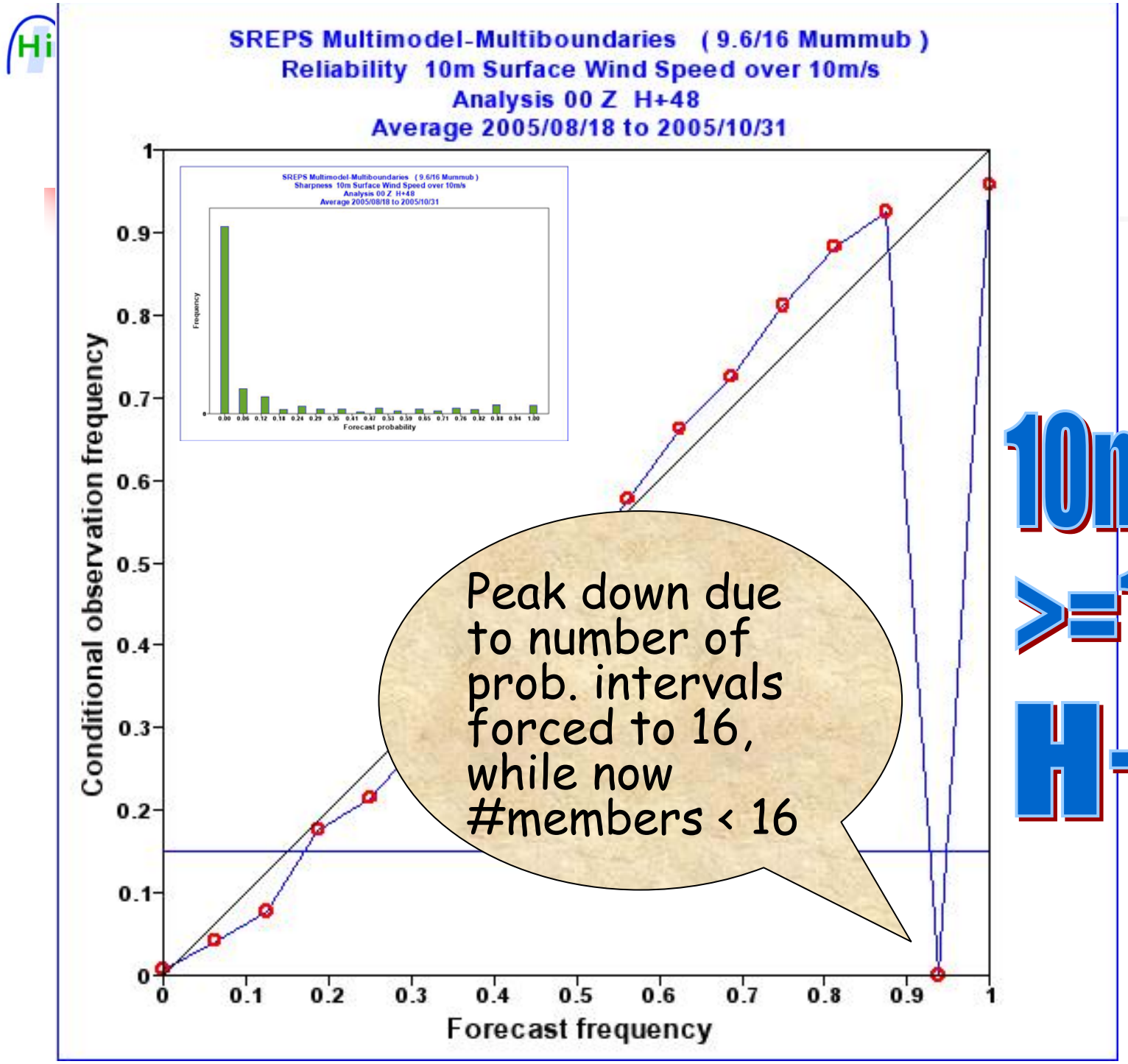
24hAccP
H+48

Reliability Diagrams

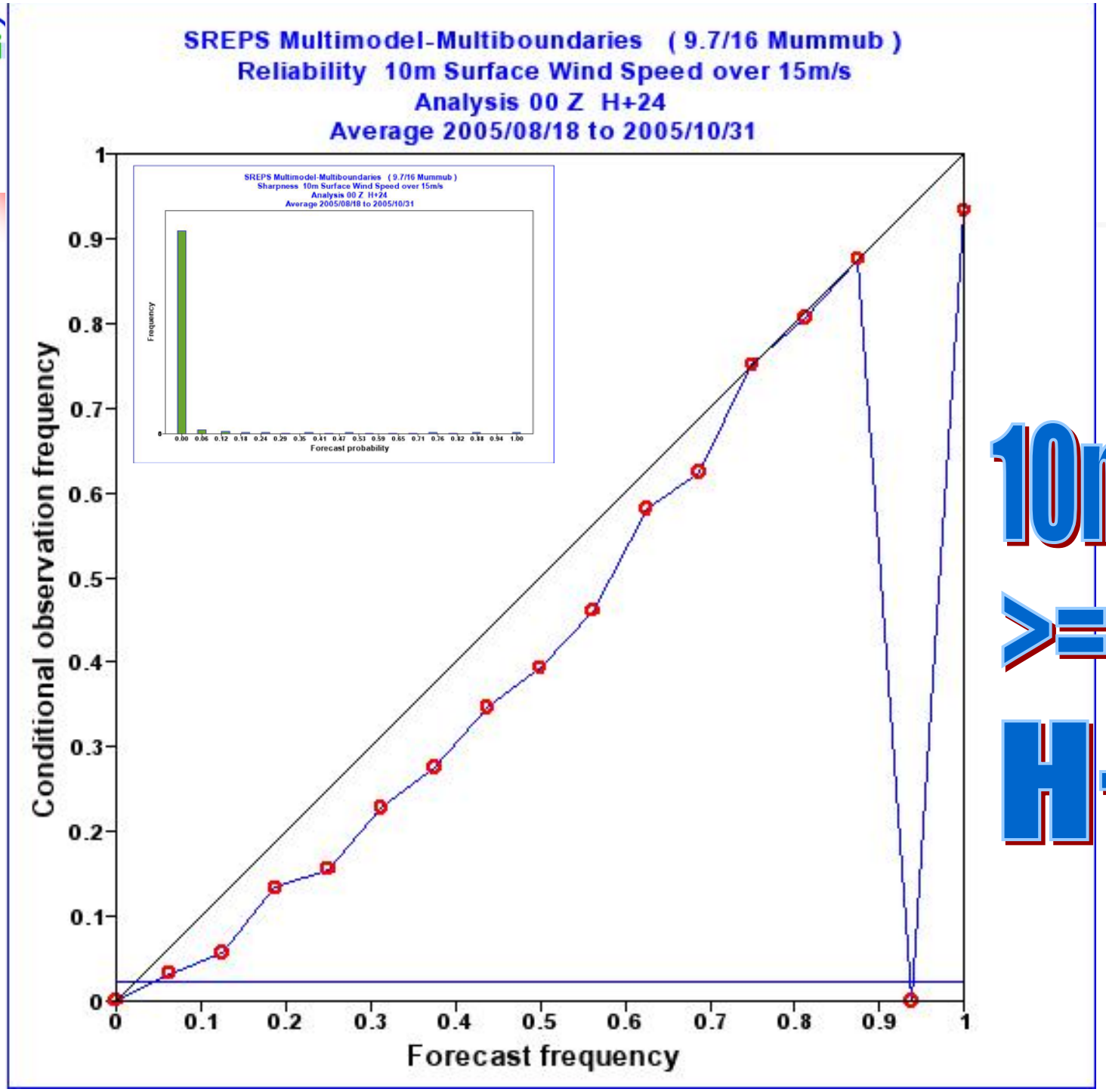
- 10m Wind Speed
  - Thresholds: 10m/s, 15m/s
  - H+24, H+48
- 24h Accumulated Precipitation
  - Thresholds: 1mm, 5mm, 10mm, 20mm
  - H+24, H+48



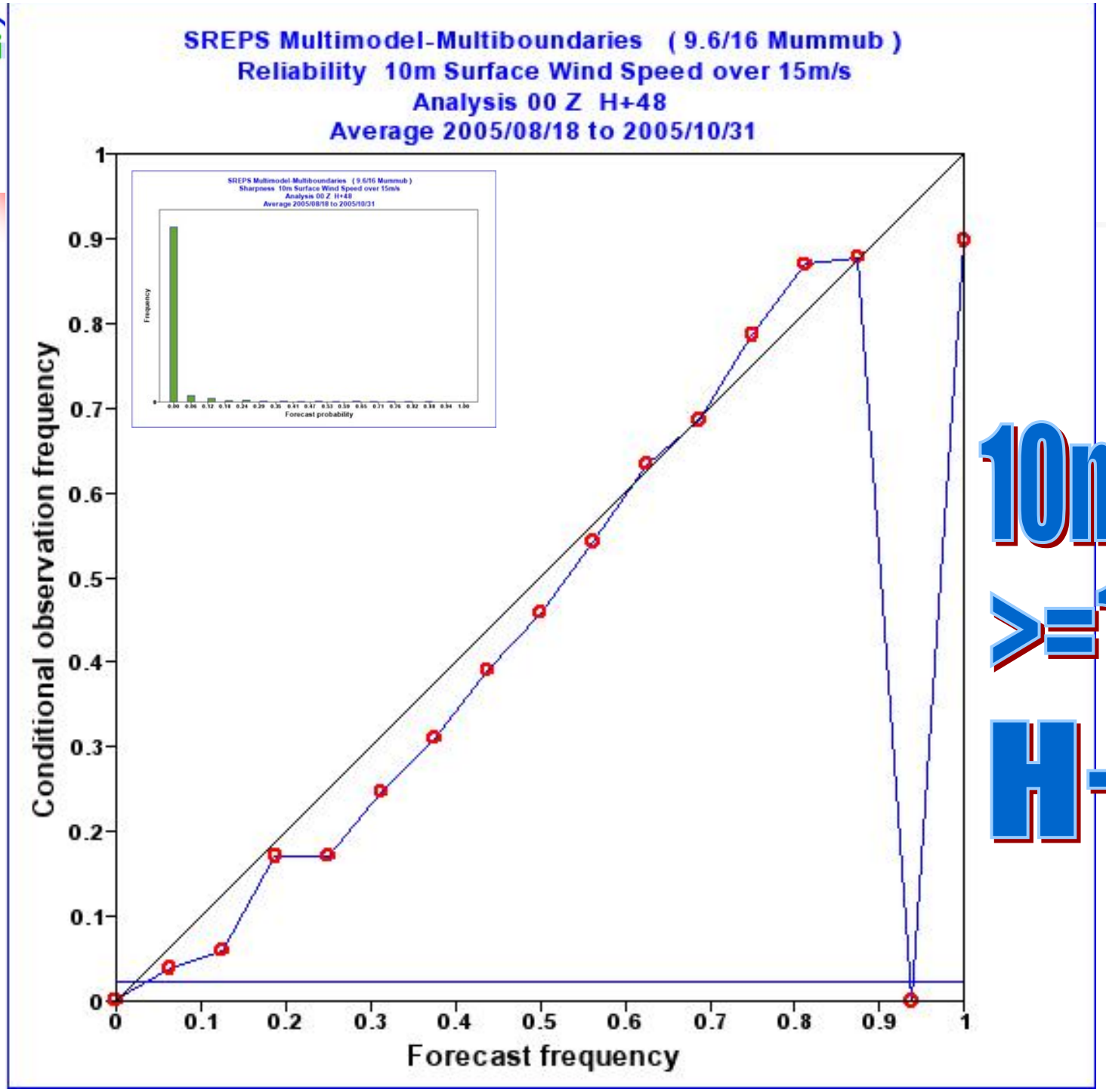
10mWind >=10m/s H+24



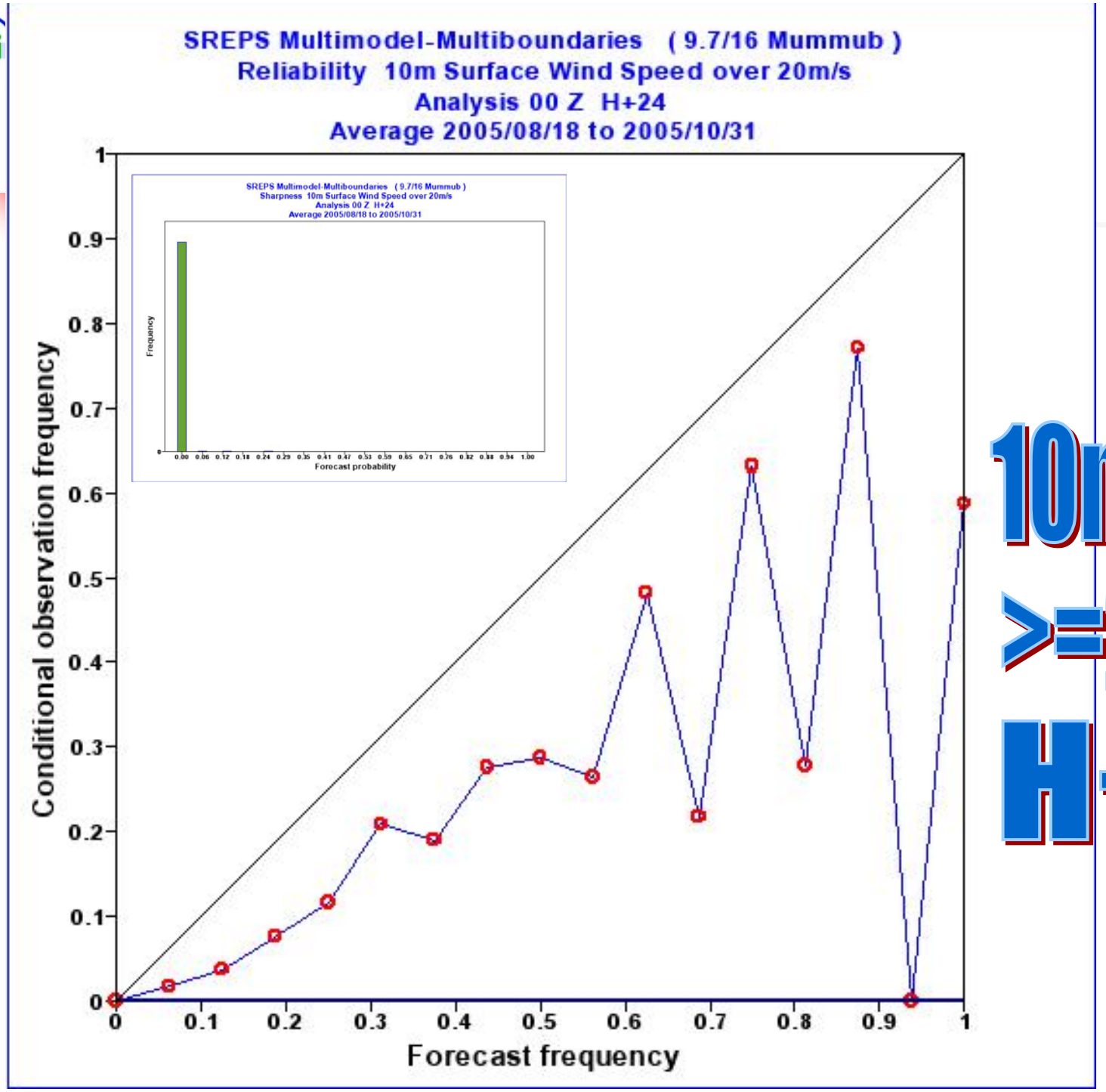
10mWind >=10m/s H+48



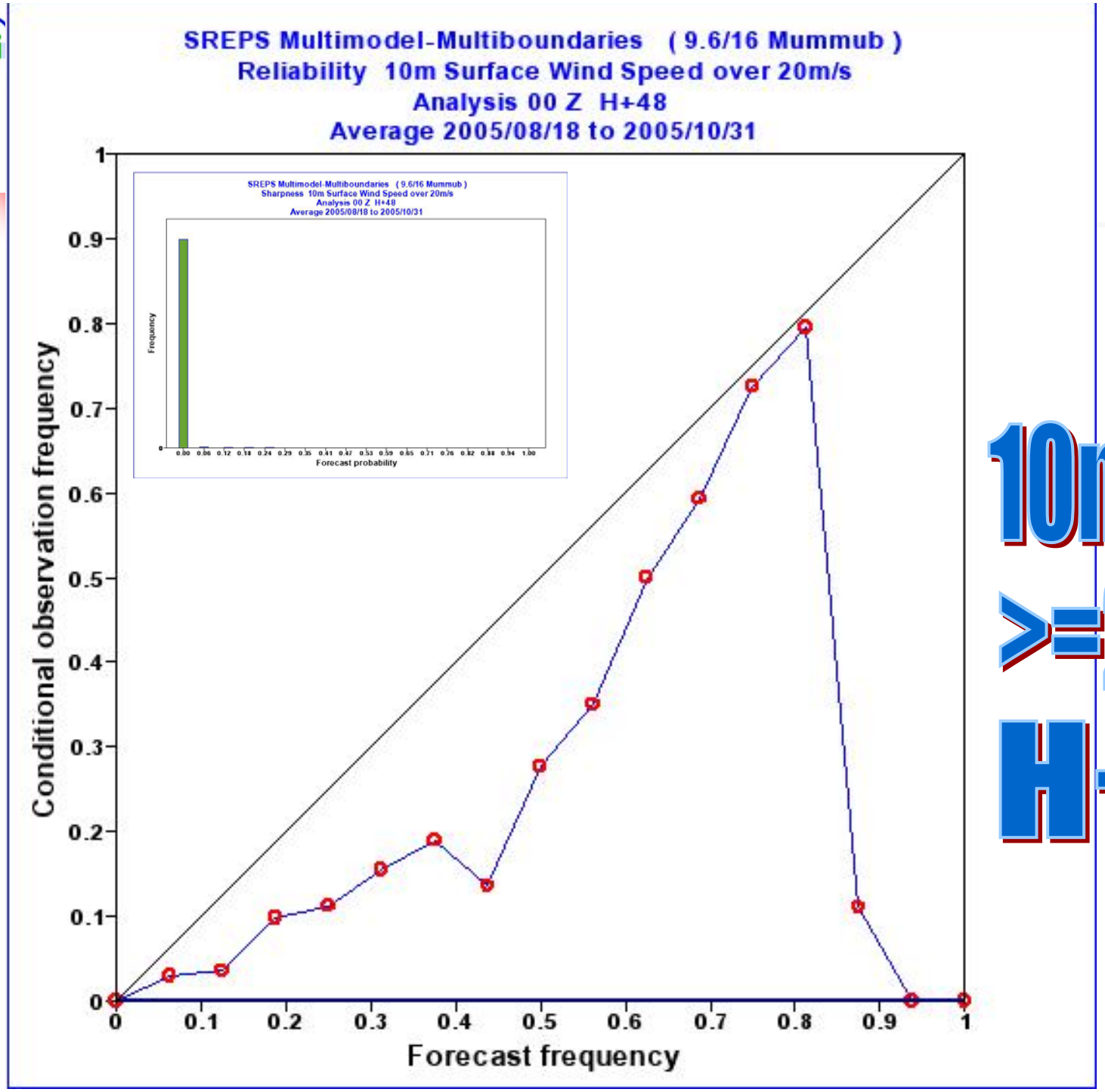
10mWind
>=15m/s
H+24



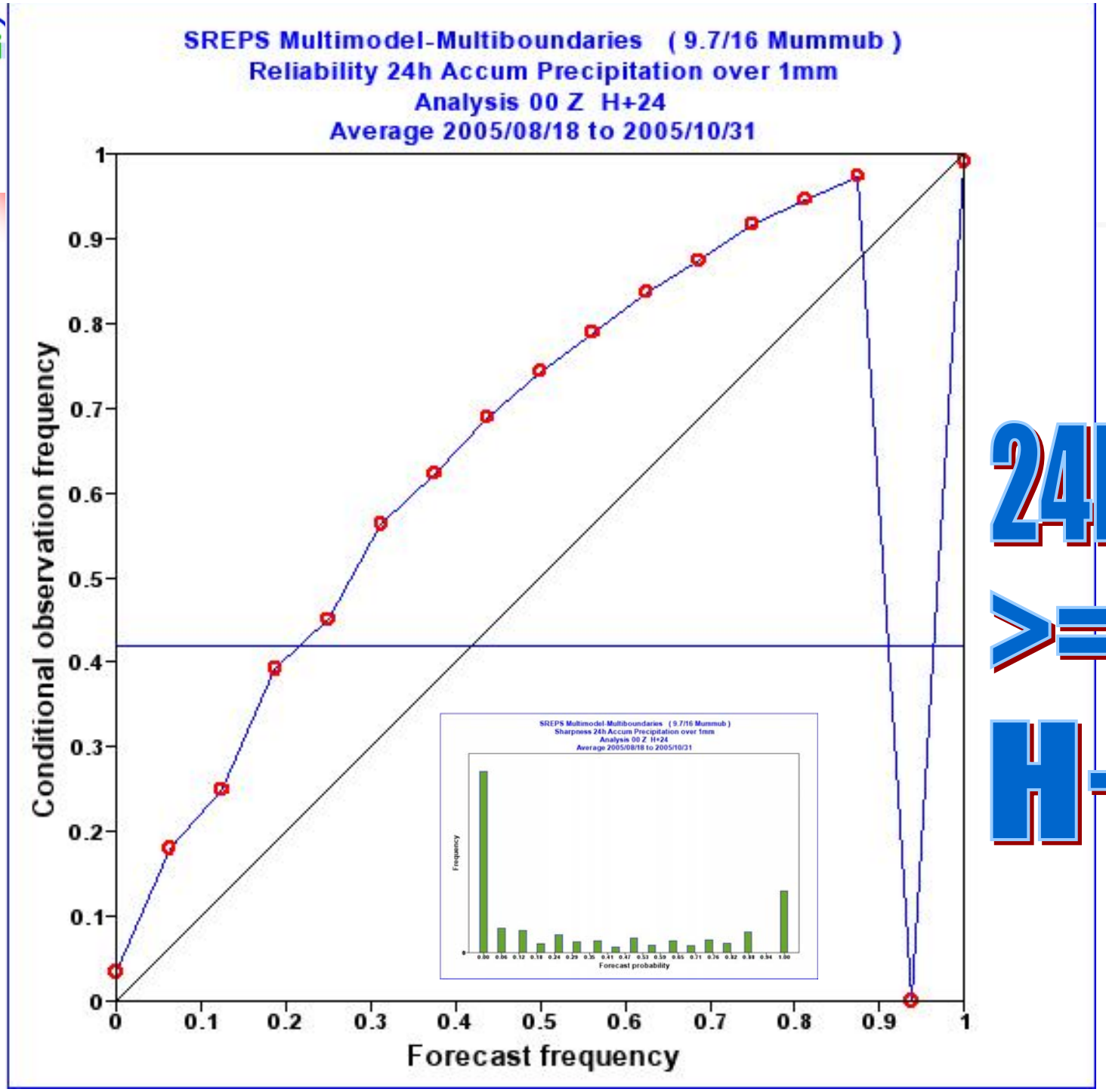
10mWind
>=15m/s
H+48



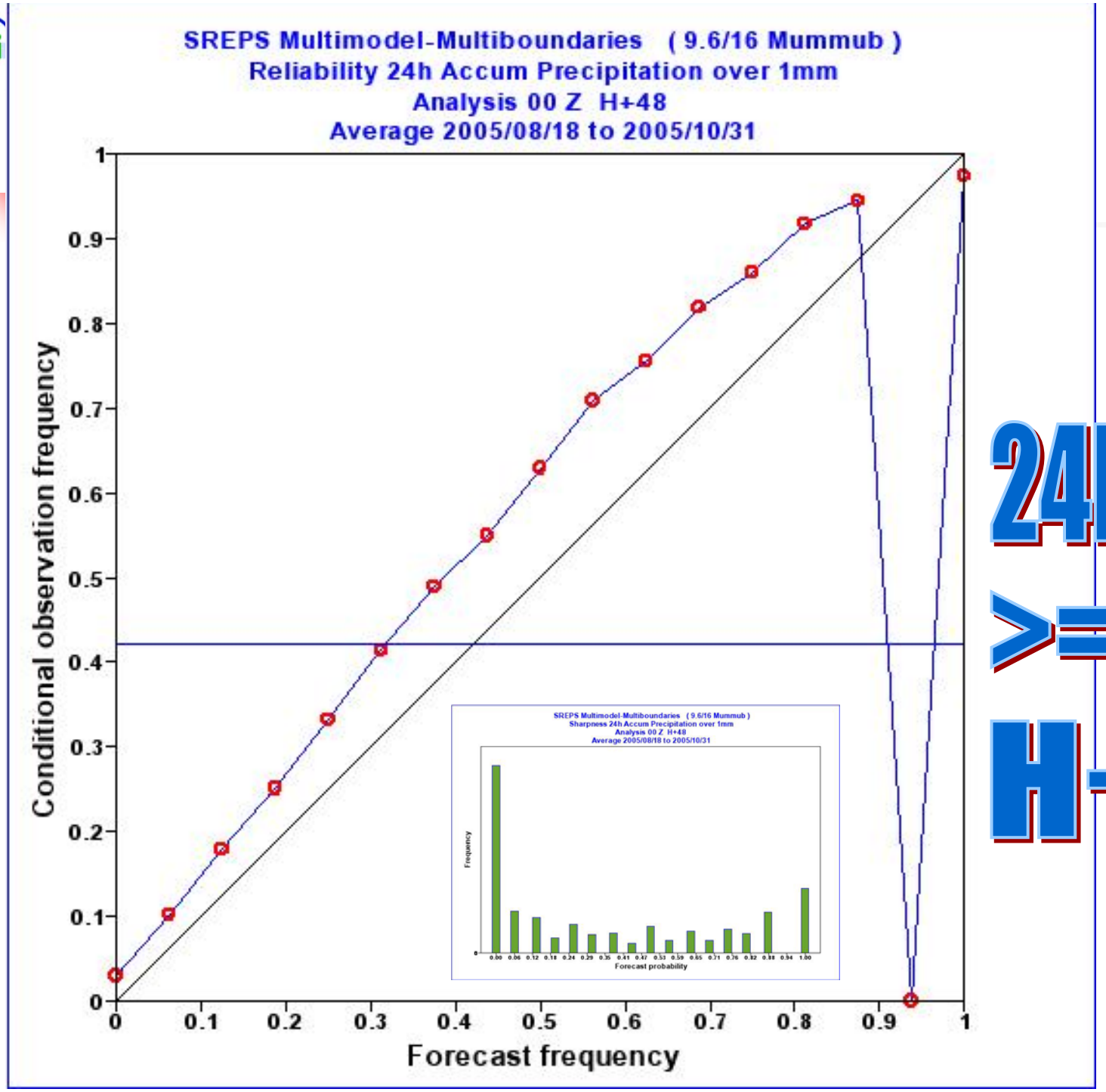
10mWind
>=20m/s
H+24



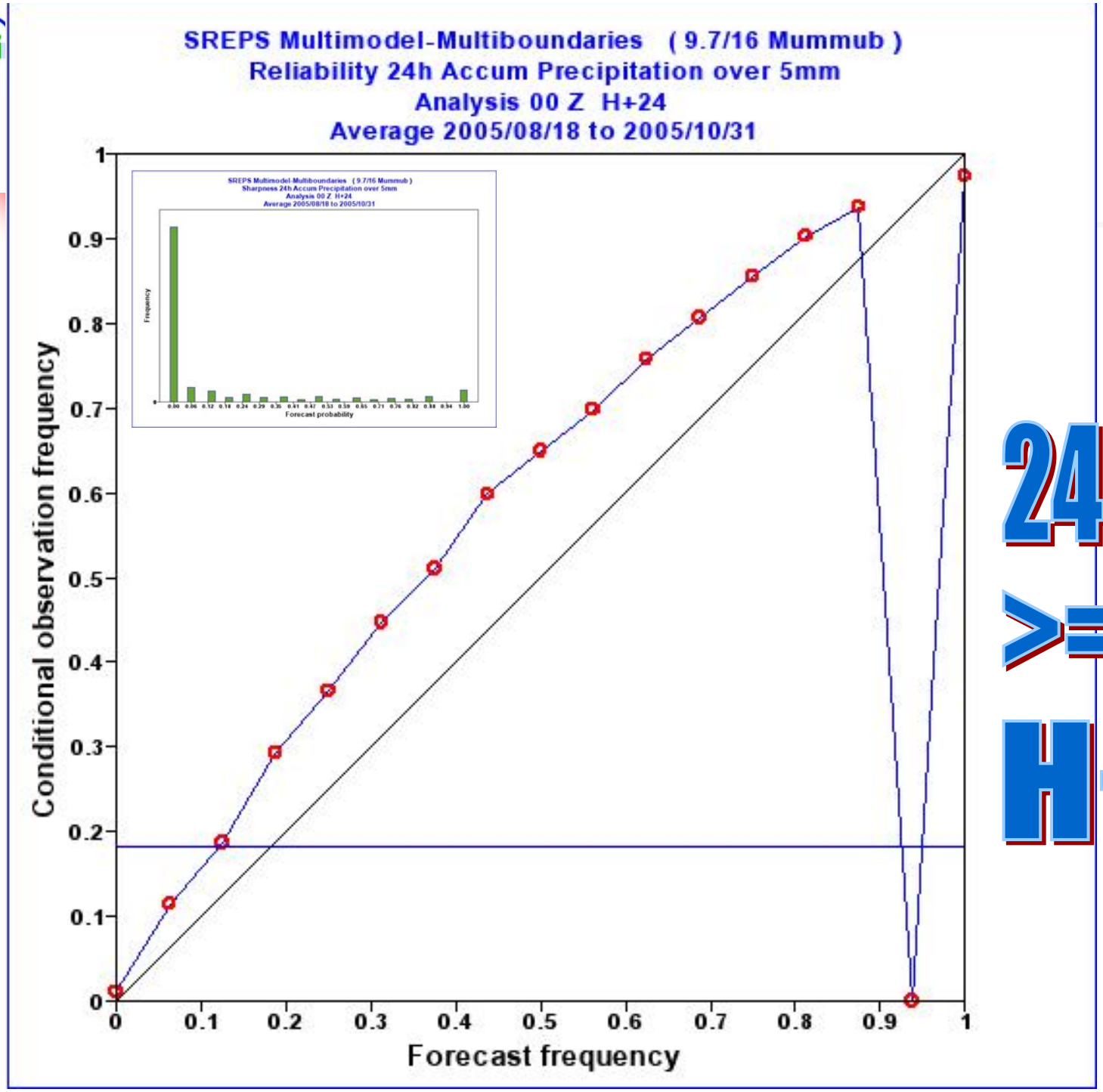
10mWind
>=20m/s
H+48



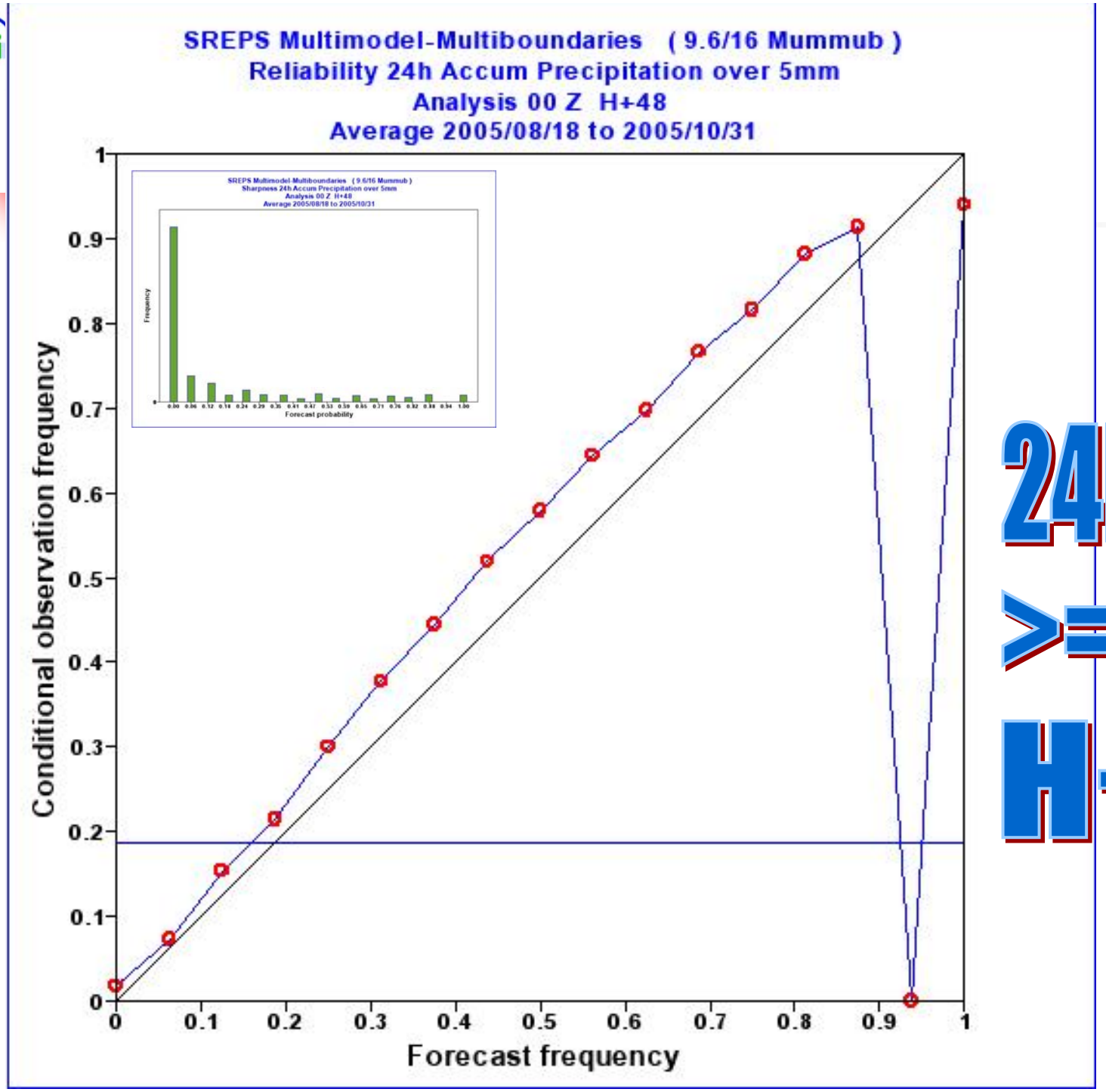
24hAccP
>=1mm
H+24



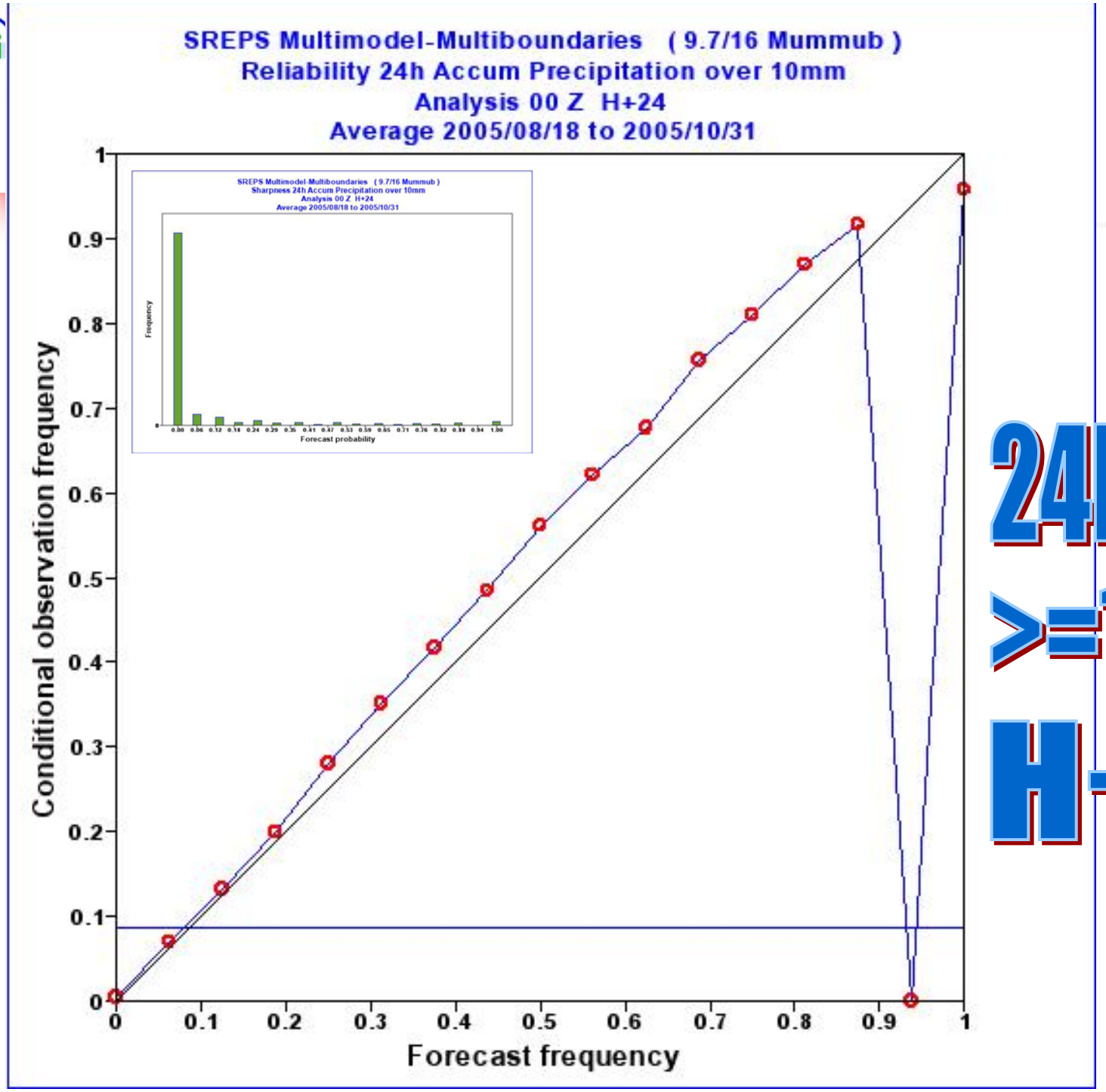
24hAccP
>=1mm
H+48



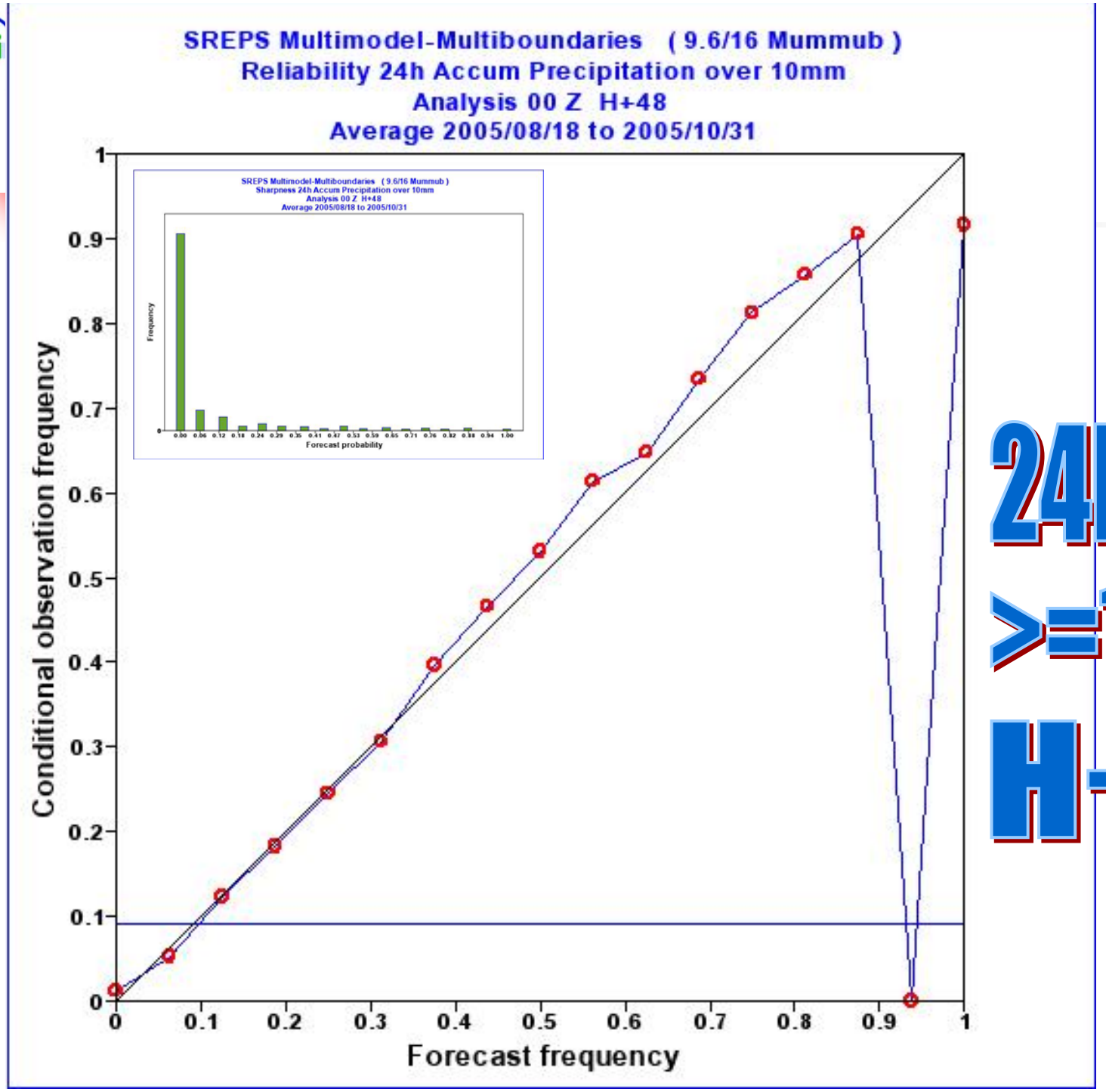
24hAccP
>=5mm
H+24



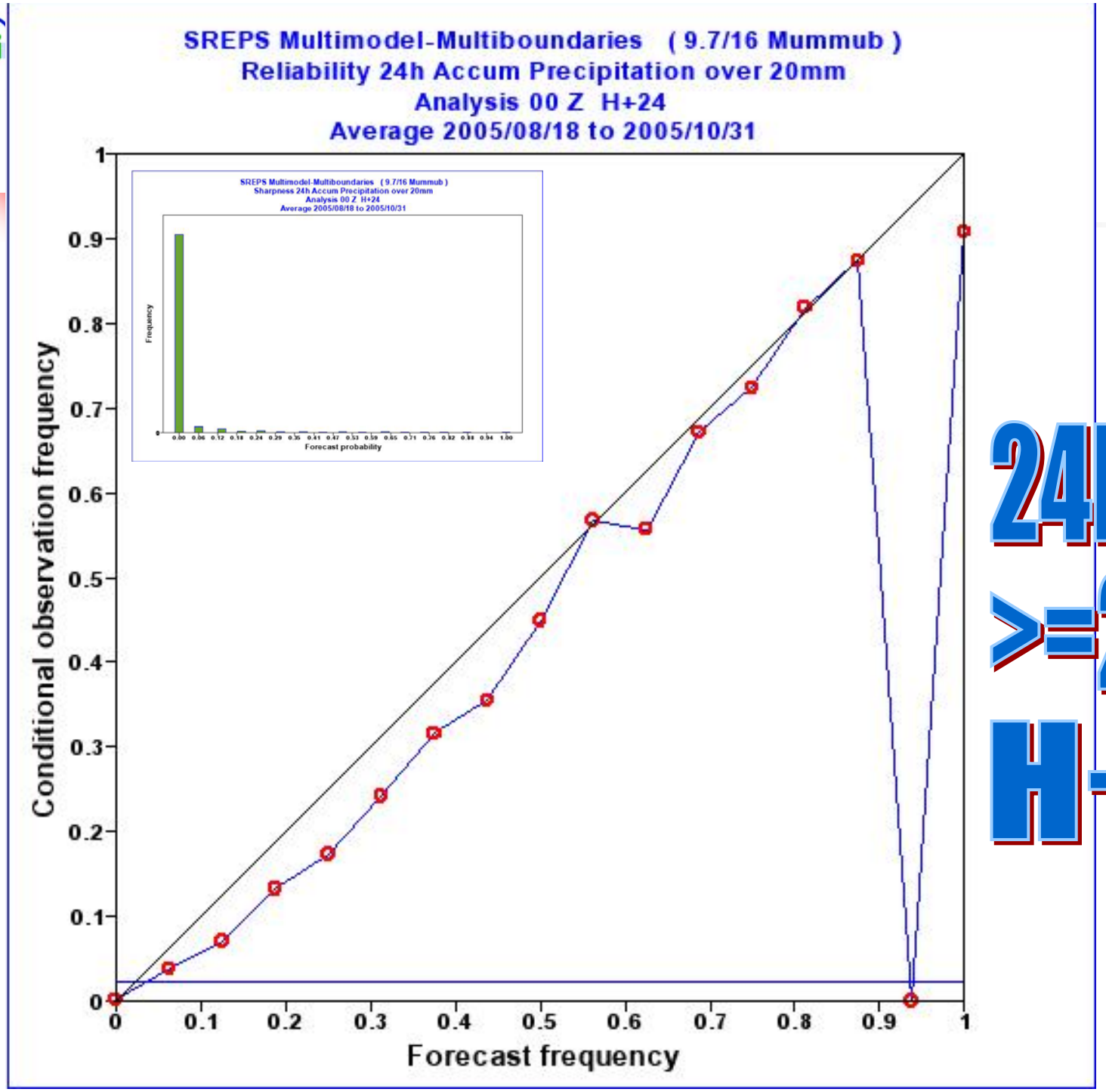
24hAccP
>=5mm
H+48



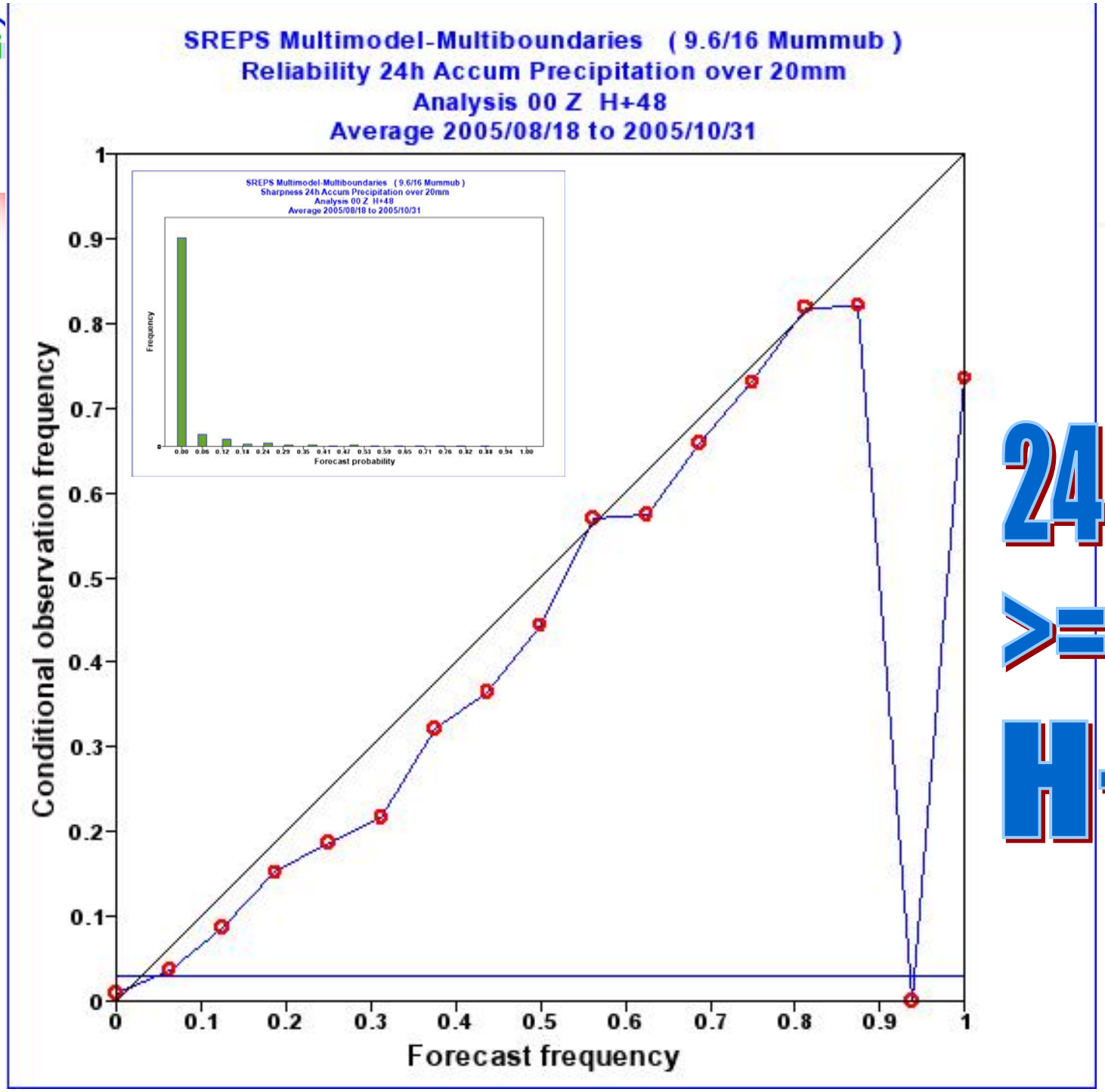
24hAccP
>=10mm
H+24



24hAccP
>=10mm
H+48



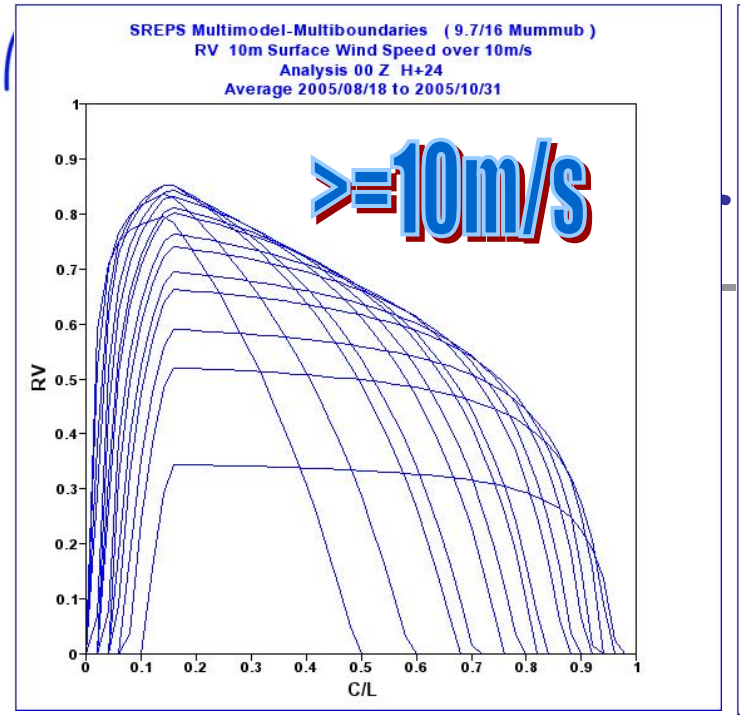
24hAccP
>=20mm
H+24

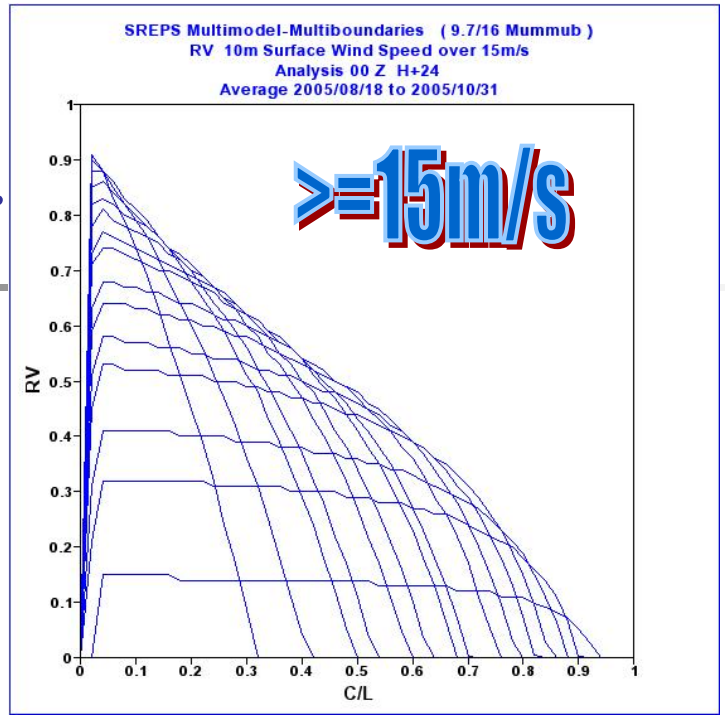


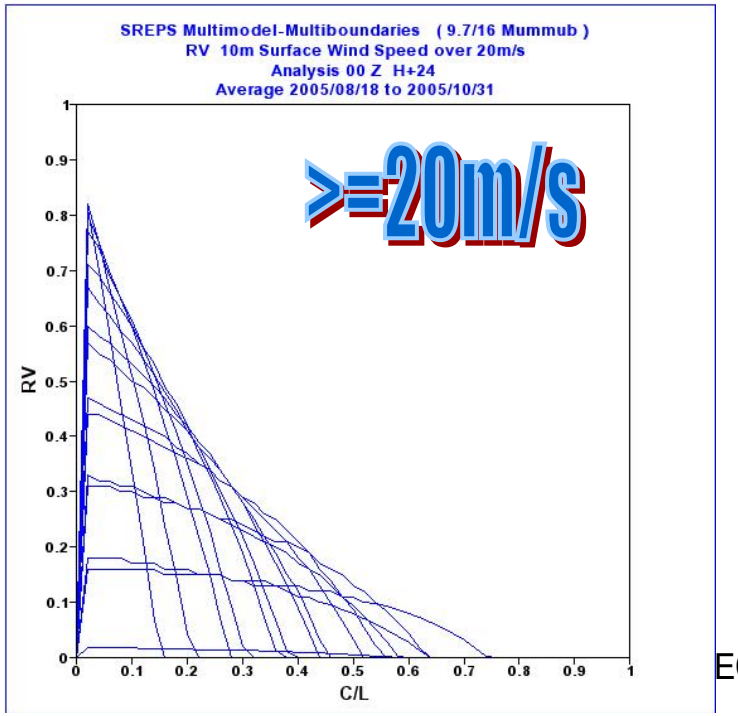
24hAccP >=20mm H+48

RV Curves

- 10m Wind Speed
  - Thresholds: 10m/s, 15m/s
  - H+24, H+48
- 24h Accumulated Precipitation
  - Thresholds: 1mm, 5mm, 10mm, 20mm
  - H+24, H+48

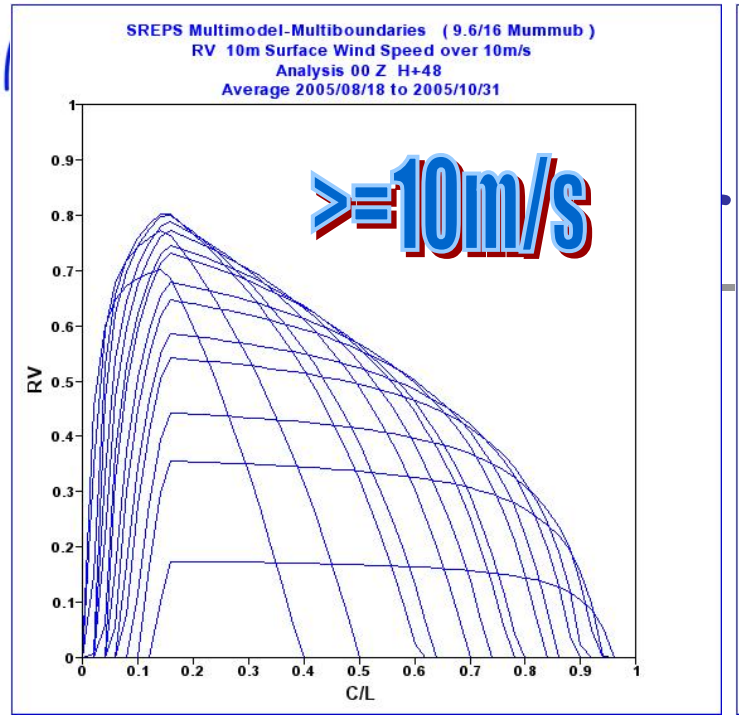

SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
RV 10m Surface Wind Speed over 10m/s
Analysis 00 Z H+24
Average 2005/08/18 to 2005/10/31
>=10m/s
RV
C/L

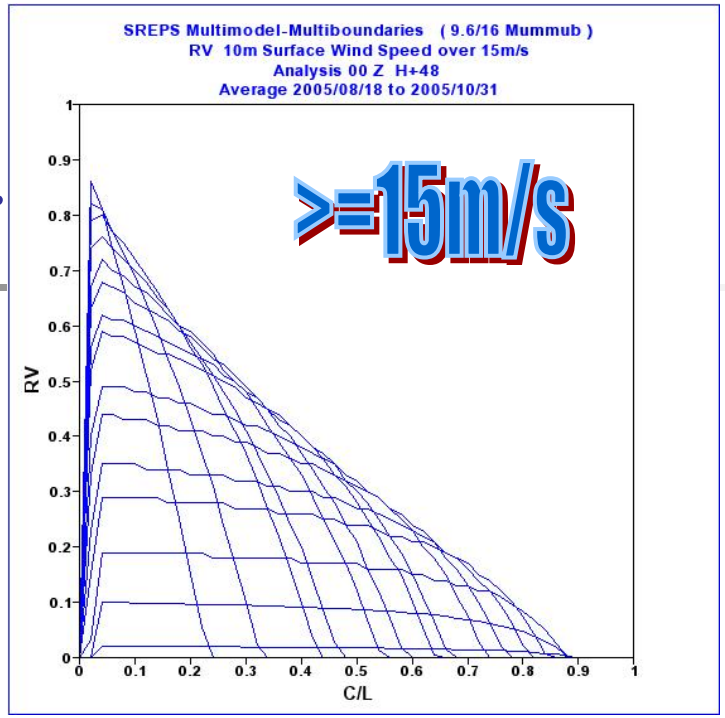

SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
RV 10m Surface Wind Speed over 15m/s
Analysis 00 Z H+24
Average 2005/08/18 to 2005/10/31
>=15m/s
RV
C/L

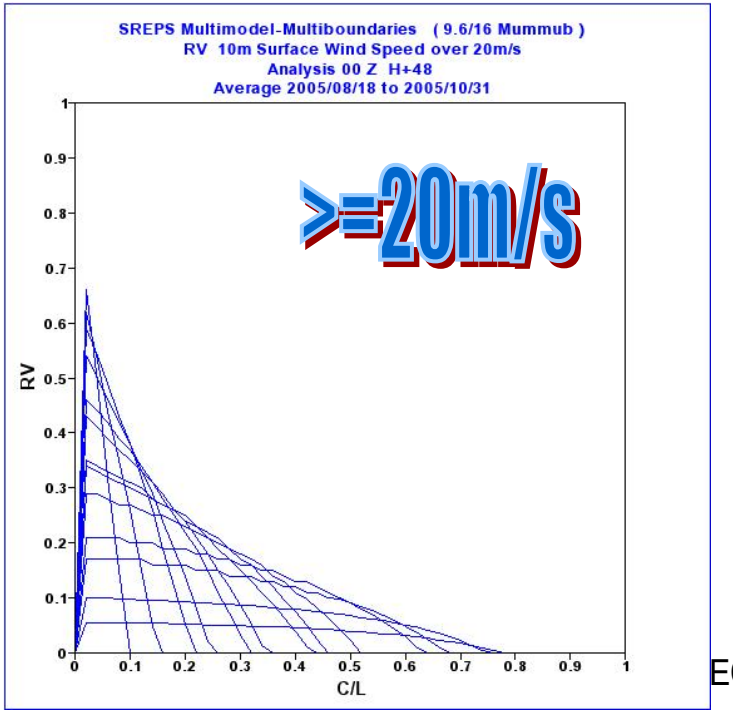

SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
RV 10m Surface Wind Speed over 20m/s
Analysis 00 Z H+24
Average 2005/08/18 to 2005/10/31
>=20m/s
RV
C/L

10mWind

H+24

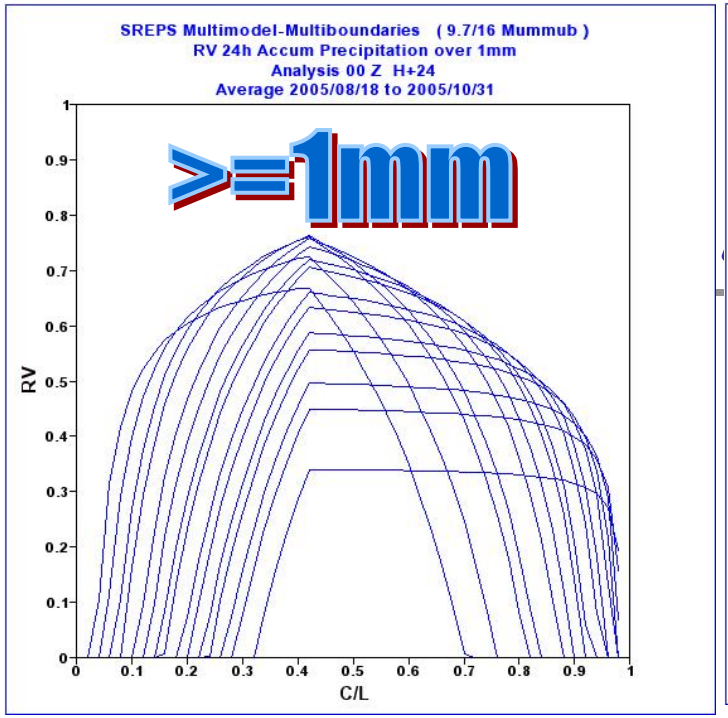

SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
RV 10m Surface Wind Speed over 10m/s
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
>=10m/s
RV
C/L

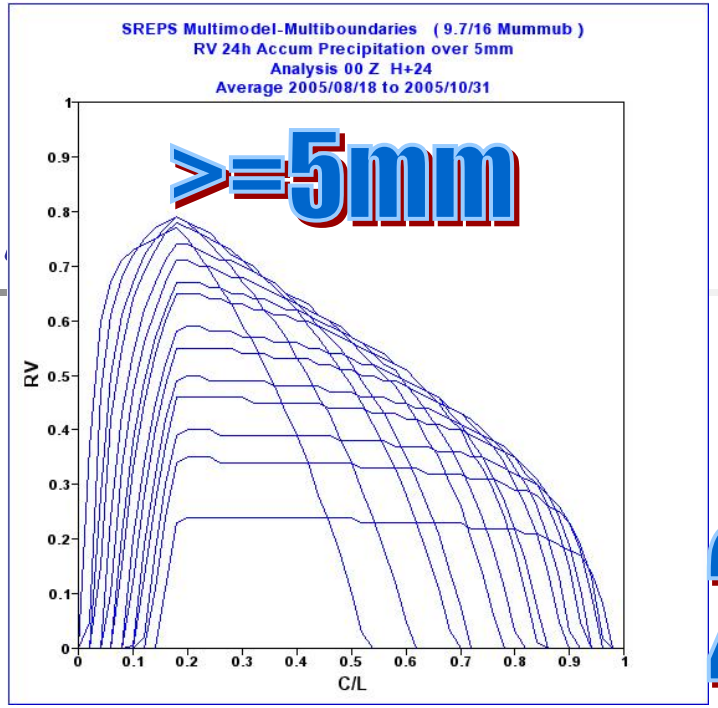

SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
RV 10m Surface Wind Speed over 15m/s
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
>=15m/s
RV
C/L

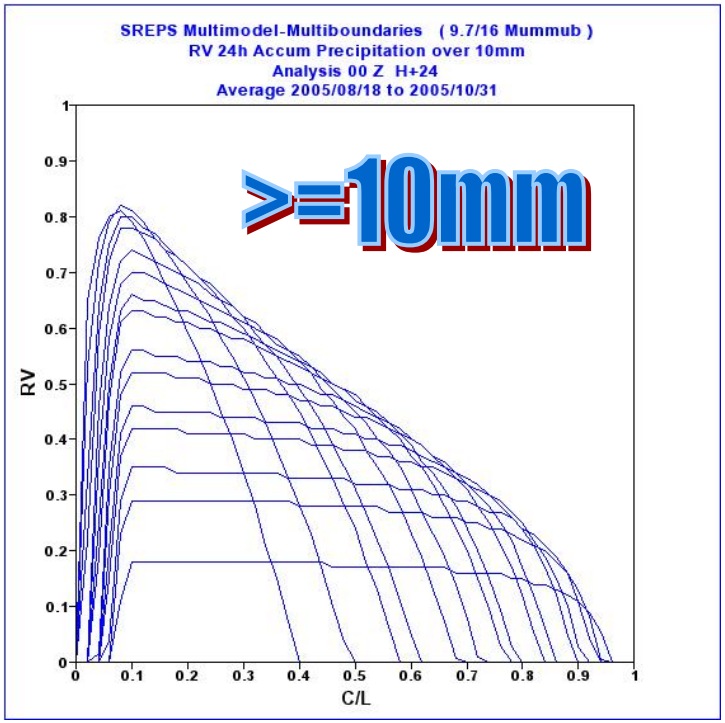

SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
RV 10m Surface Wind Speed over 20m/s
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
>=20m/s
RV
C/L

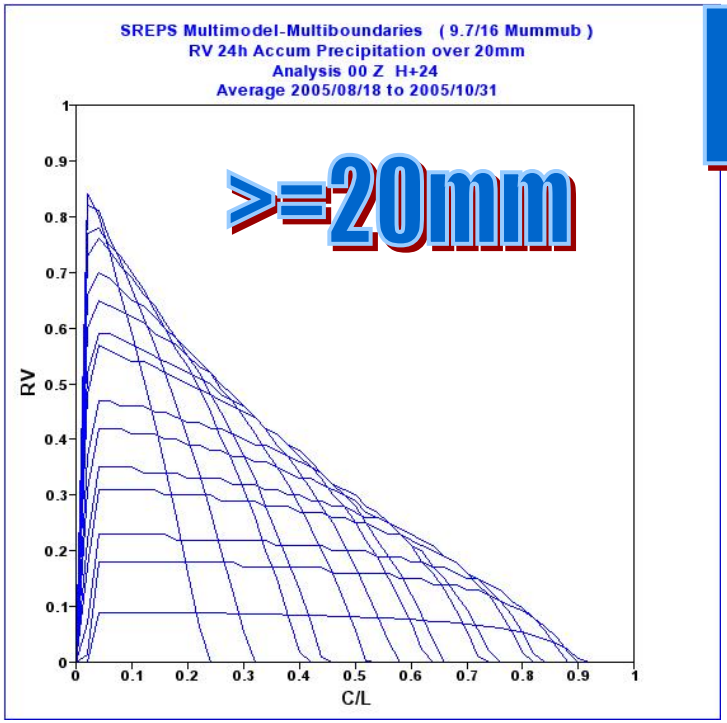
10mWind

H+48


SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
RV 24h Accum Precipitation over 1mm
Analysis 00 Z H+24
Average 2005/08/18 to 2005/10/31
>=1mm
RV
C/L

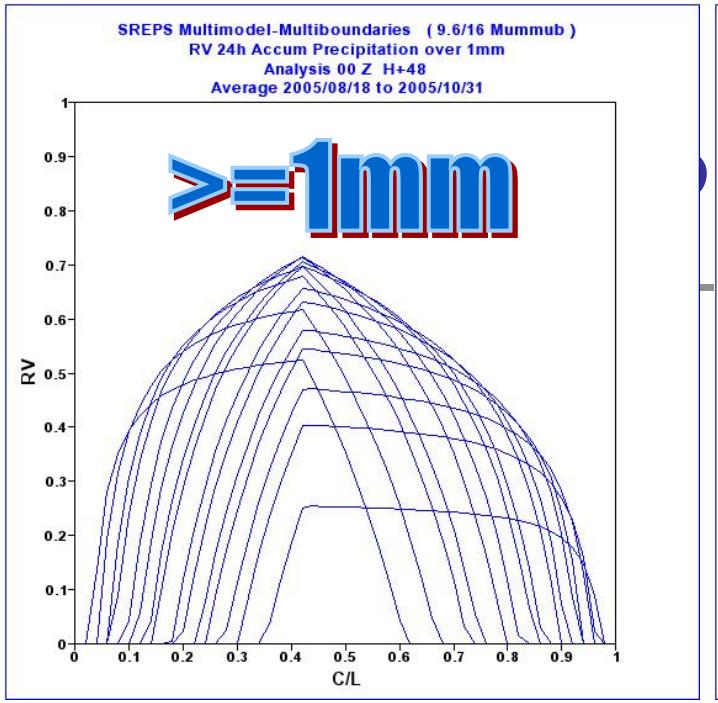

SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
RV 24h Accum Precipitation over 5mm
Analysis 00 Z H+24
Average 2005/08/18 to 2005/10/31
>=5mm
RV
C/L

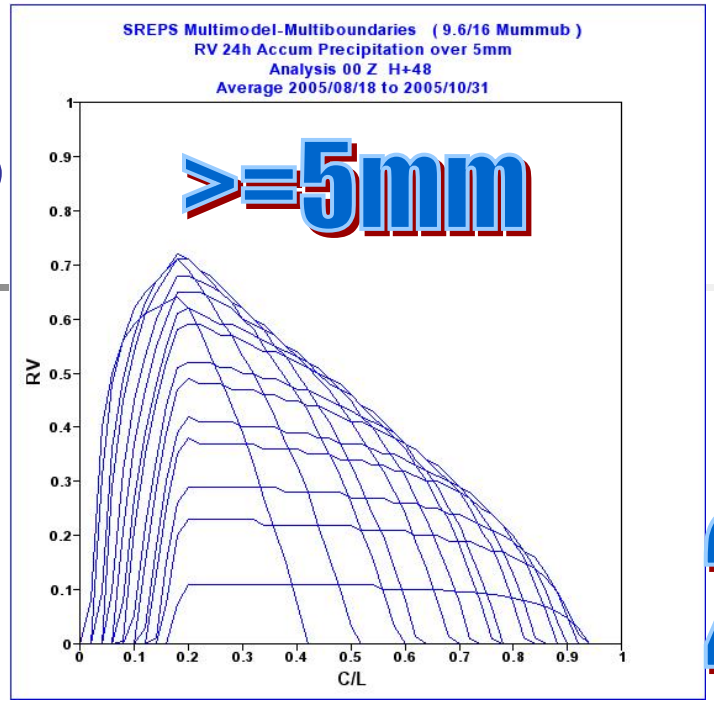

SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
RV 24h Accum Precipitation over 10mm
Analysis 00 Z H+24
Average 2005/08/18 to 2005/10/31
>=10mm
RV
C/L

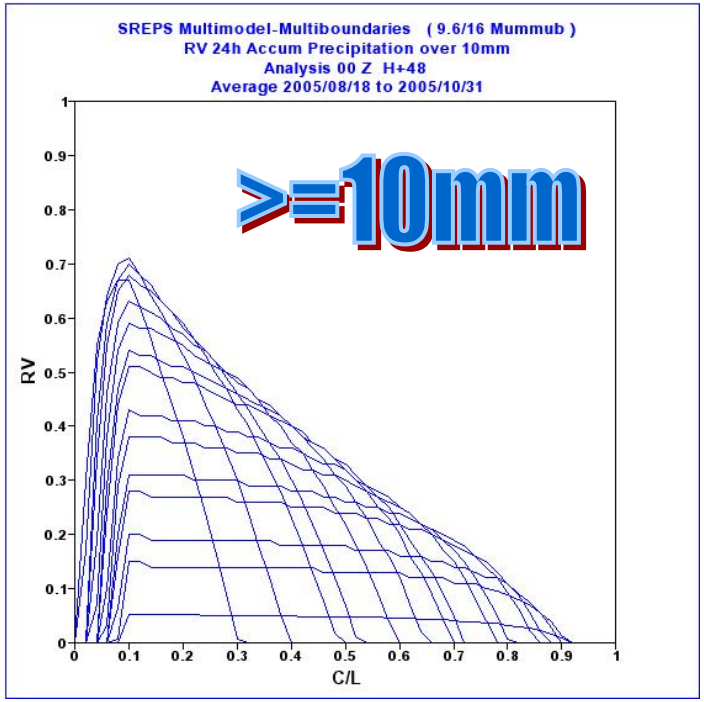

SREPS Multimodel-Multiboundaries (9.7/16 Mummub)
RV 24h Accum Precipitation over 20mm
Analysis 00 Z H+24
Average 2005/08/18 to 2005/10/31
>=20mm
RV
C/L

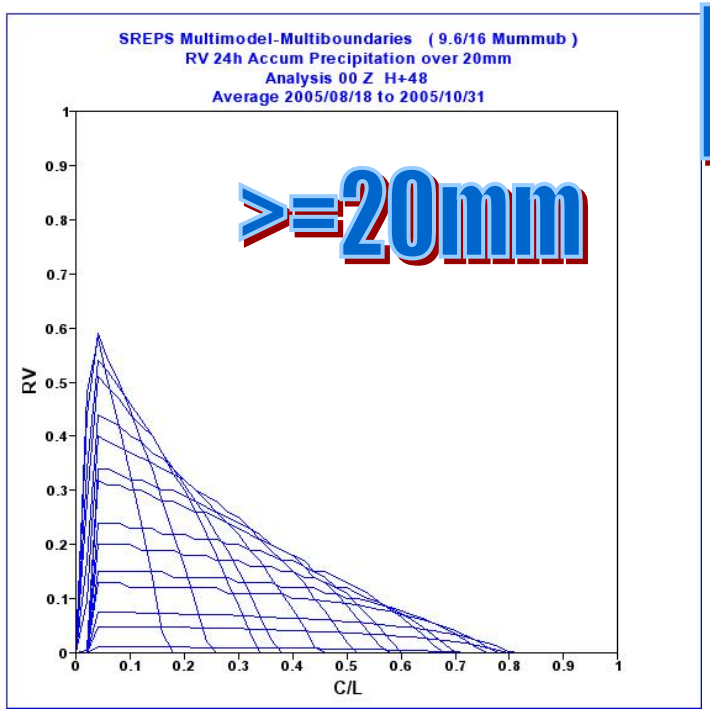
24hAccP

H+24


SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
RV 24h Accum Precipitation over 1mm
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
>=1mm
RV
C/L


SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
RV 24h Accum Precipitation over 5mm
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
>=5mm
RV
C/L


SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
RV 24h Accum Precipitation over 10mm
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
>=10mm
RV
C/L


SREPS Multimodel-Multiboundaries (9.6/16 Mummub)
RV 24h Accum Precipitation over 20mm
Analysis 00 Z H+48
Average 2005/08/18 to 2005/10/31
>=20mm
RV
C/L

24hAccP

H+48

Outline

- Motivation
- Features
- Post-processing & outputs
- Validation
- **Conclusions**

Relevant aspects for Multimodel

- Advantages:
  - Better representation of model errors (SAMEX and DEMETER)
  - Consistent set of perturbations of initial state and boundaries
  - Better results (SAMEX, DEMETER, Arribas et al. MWR Jul2005)
- Disadvantages:
  - Difficult to implement operationally (four different models should be maintained operationally)
  - Expensive in terms of human resources
  - No control experiment in the ensemble

Conclusions

- An EPS is expected to help in Short Range Forecasts
- INM bets on a Multimodel-Multiboundaries system, difficult & expensive to implement operationally
- The system is under construction
- Preliminary results look promising
- First verification exercise shows model biases ~ spurious spread

Future

- Near
  - **16** members full-operational
  - **Bias** removal
  - **Calibration**: Bayesian Model Averaging
  - Verification against **observations**
  - **Comparison** with other ensembles
- Beyond
  - **Time-lagged** 64 members 4runs/day
  - More Post processing software (targeting clustering)

Team

García-Moya, J.A.	Head, Pre-processing, Hirlam
Callado, A.	UM
Santos, C.	Post-processing, Verification, Hirlam
Santos, D.	MM5
Simarro, J.	HRM, Pre-processing

Thanks to…

- MetOffice
  - Ken Mylne, Jorge Bornemann
- DWD
  - Detlev Majewski, Michael Gertz
- ECMWF
  - Metview Team, Paco Doblas

Questions

- ?...
  - j.garciamoya@inm.es
  - csantos@inm.es

Outline

- Motivation
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- Conclusions
- **Extras**

INM

- INM is the Spanish Meteorological Institute.
- Headquarters are located in Madrid.
- About 1500 people working for INM.
- Mostly an operational institute, research is about 10%.

Current Computer

- Cray X1e

- Accepted June 2005
  - 8 M€
  - 2.3 Tf; 15 nodes x 8MSPs/node
  - Deterministic Forecast + SREPS.

Peak-down explanation

- Peak down due to number of prob. intervals forced to 16, when #members < 16

	16	15	14	13	12	11	10	9
0	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1	0,063	0,067	0,071	0,077	0,083	0,091	0,100	0,111
2	0,125	0,133	0,143	0,154	0,167	0,182	0,200	0,222
3	0,188	0,200	0,214	0,231	0,250	0,273	0,300	0,333
4	0,250	0,267	0,286	0,308	0,333	0,364	0,400	0,444
5	0,313	0,333	0,357	0,385	0,417	0,455	0,500	0,556
6	0,375	0,400	0,429	0,462	0,500	0,545	0,600	0,667
7	0,438	0,467	0,500	0,538	0,583	0,636	0,700	0,778
8	0,500	0,533	0,571	0,615	0,667	0,727	0,800	0,889
9	0,563	0,600	0,643	0,692	0,750	0,818	0,900	1,000
10	0,625	0,667	0,714	0,769	0,833	0,909	1,000	
11	0,688	0,733	0,786	0,846	0,917	1,000		
12	0,750	0,800	0,857	0,923	1,000			
13	0,813	0,867	0,929	1,000				
14	0,875	0,933	1,000					
15	0,938	1,000						
16	1,000							

Questions

- ?...
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  - csantos@inm.es