On the use of high-resolution network observations to verify precipitation forecasts.

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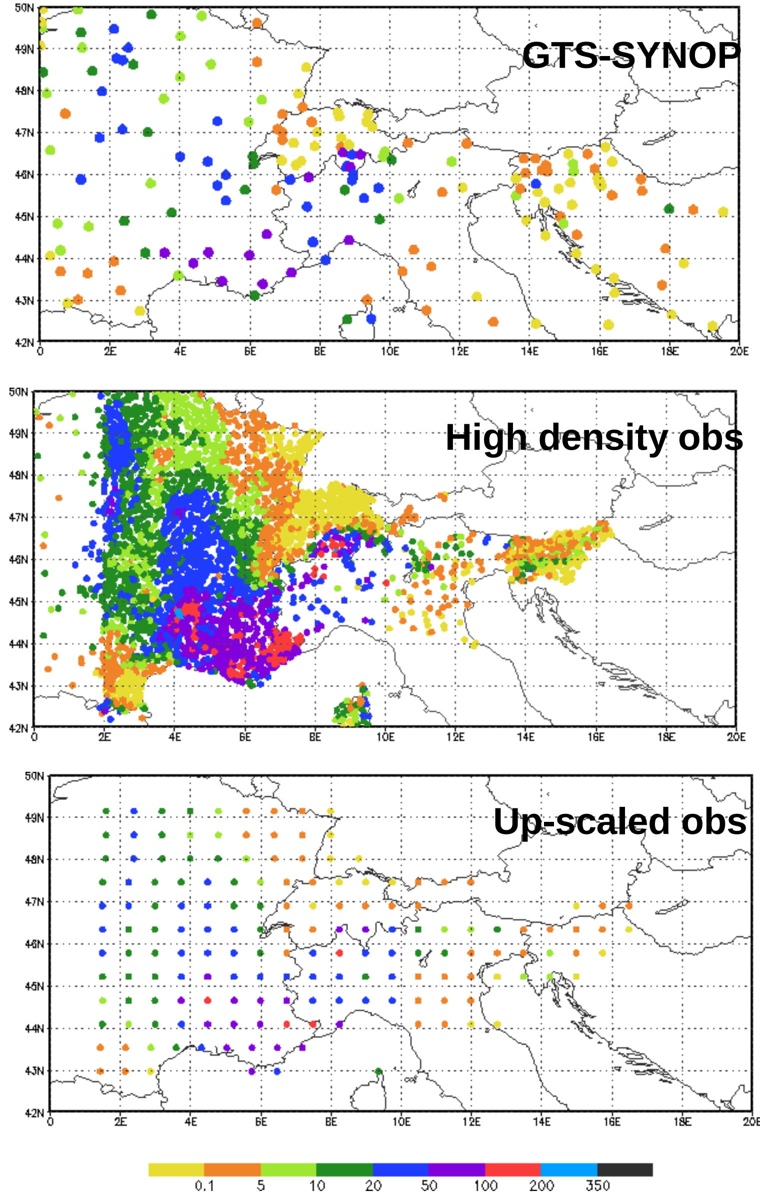
Thanks to Jaime Garcia Fernandez, ECMWF Member States and Co-operating States

Outline

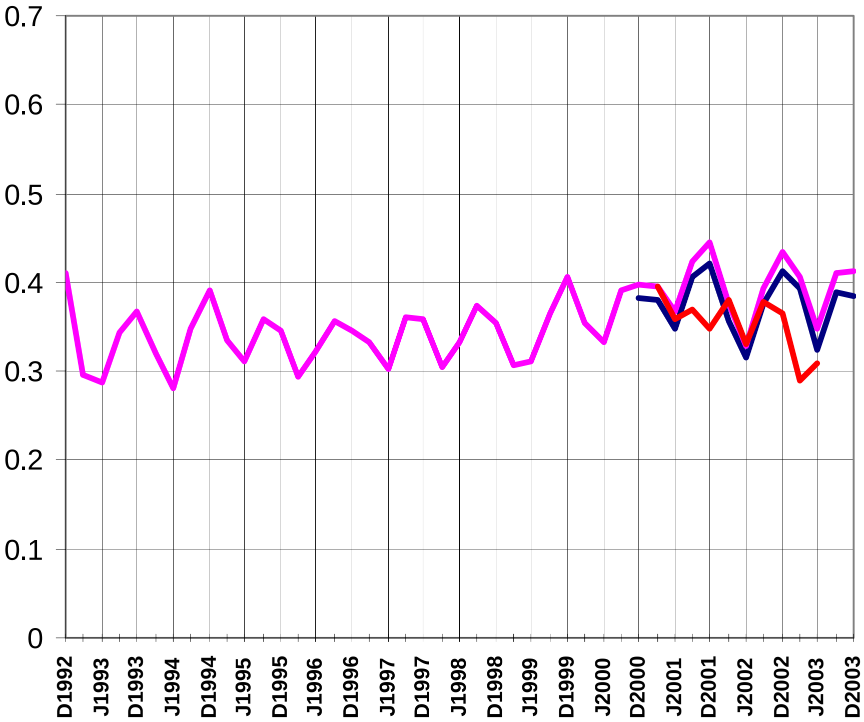
1. Why high_resolution precipitation networks?
2. Deterministic verifications: Europe and North America
3. Extreme events (Deterministic verifications)
4. Probabilistic verifications: Spain
5. Conclusions

The Up-scaling technique

- **There are many methods available to up-scale observations to the model resolution**
- **We have used a simple averaging procedure of all the observations contained in a model gridbox**
- **Alps: SYNOP coverage, high-density observations and up-scaled observed values for Sept. 20, 1999**



ECMWF



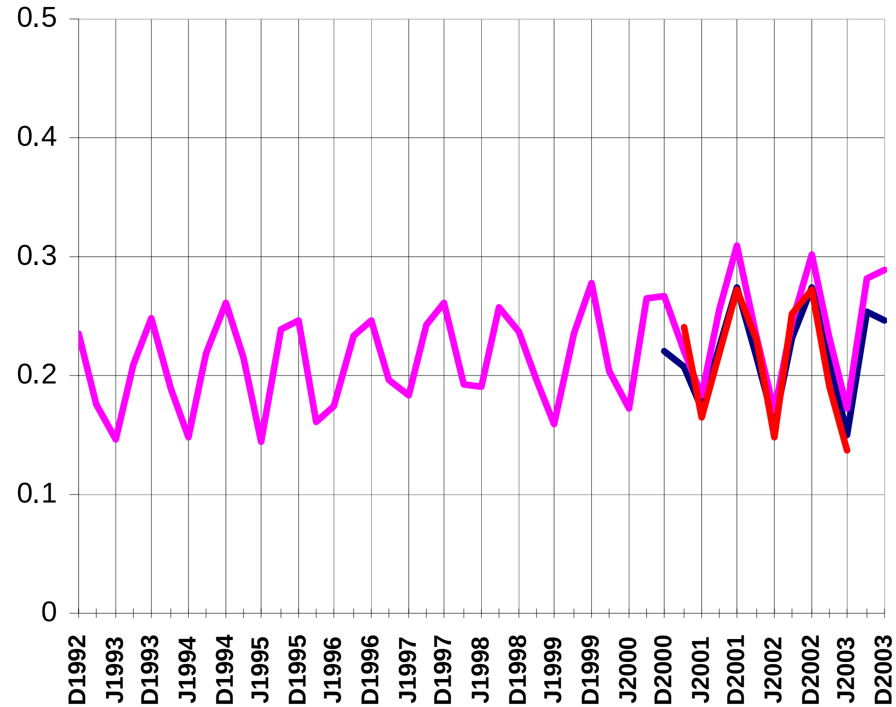
ETS – threshold > 1mm/24h

HR verified against GTS SYNOPS
LR verified against GTS SYNOPS
HR verified against up-scaled obs.

Verification area: Europe

35N 75N –30W 32E
24h accumulation period

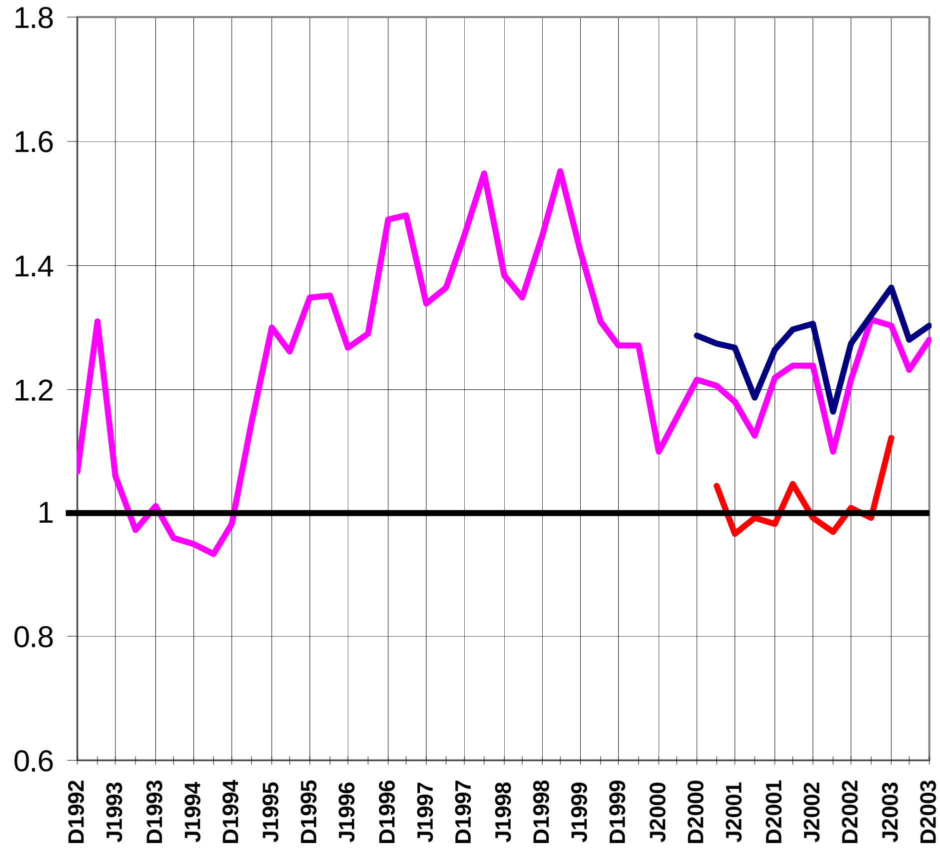
ETS – threshold > 10mm/24h



$$ETS = \frac{hits - hits_{random}}{hits + false \cdot alarms + misses - hits_{random}}$$

$$hits_{random} = \frac{(hits + misses)(hits + false \cdot alarms)}{total}$$

Verification area: Europe



FBI – threshold > 1mm/24h

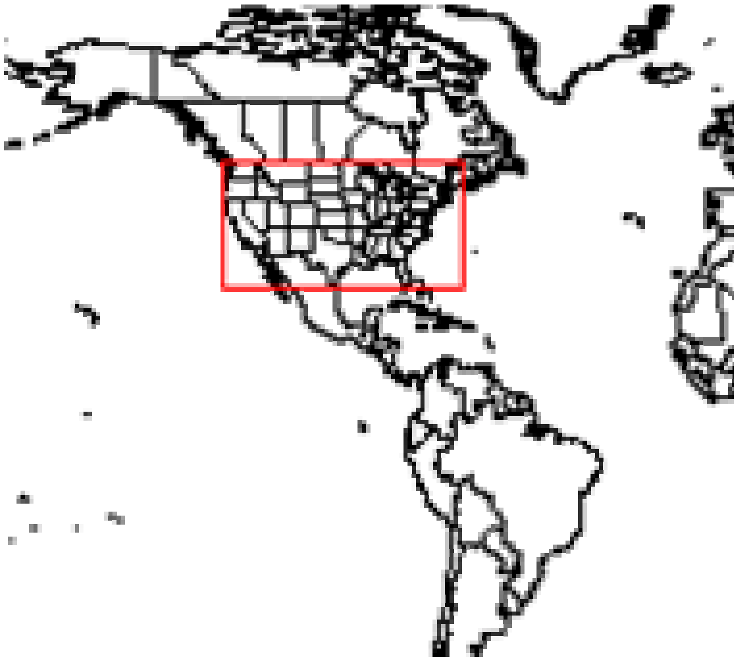
$$\text{FBI} = \frac{\text{No. of forecast occurrences}}{\text{No. of actual occurrences}}$$

HR verified against GTS SYNOPS

LR verified against GTS SYNOPS

HR verified against up-scaled obs.

USA – STAGEIV precipitation analysis

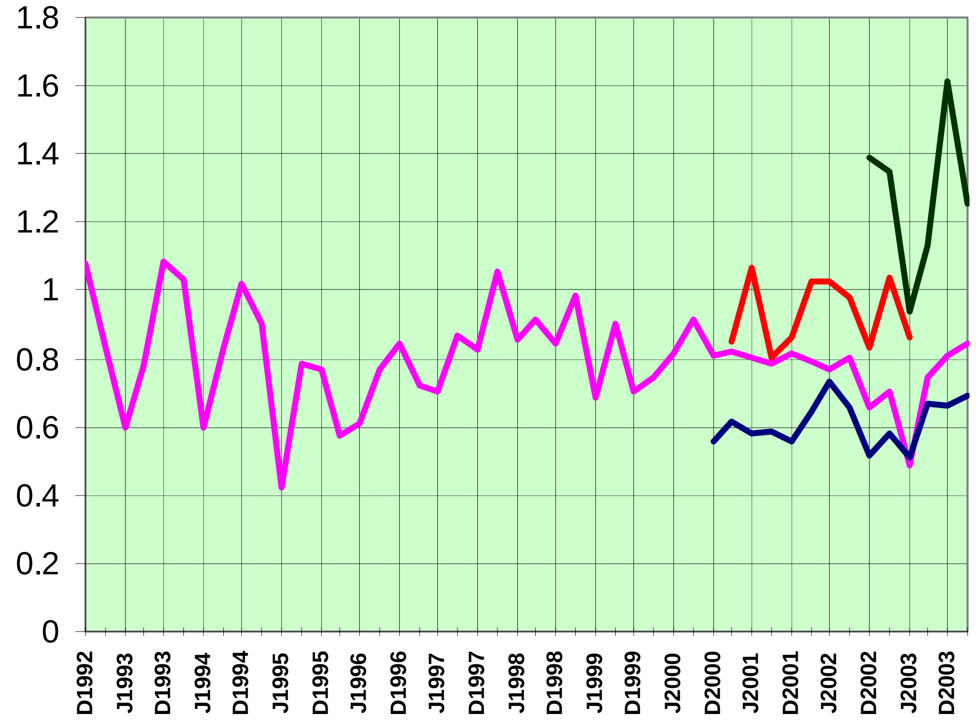


- Gauges and radar data (quality controlled)
- 4Km grid for the USA
- Precipitation accumulated over 1h, 6h or 24h
- Files in GRIB
- Timeliness:the four 6-hourly analyses covering the previous 12Z-12Z are generally received by 15Z (for the automated runs) and 21Z (the manually QC'd runs).

Verification area: Europe and North America

FBI – threshold > 20mm/24h

$$FBI = \frac{\text{No. of forecast occurrences}}{\text{No. of actual occurrences}}$$



<u>Europe</u>

HR verified against GTS SYNOPS

LR verified against GTS SYNOPS

HR verified against up-scaled obs.

D – DJF

J -- JJA

<u>North America</u>

HR verified against up-scaled obs

Verification area: Europe and North America

ETS – threshold > 20mm/24h

<u>Europe</u>

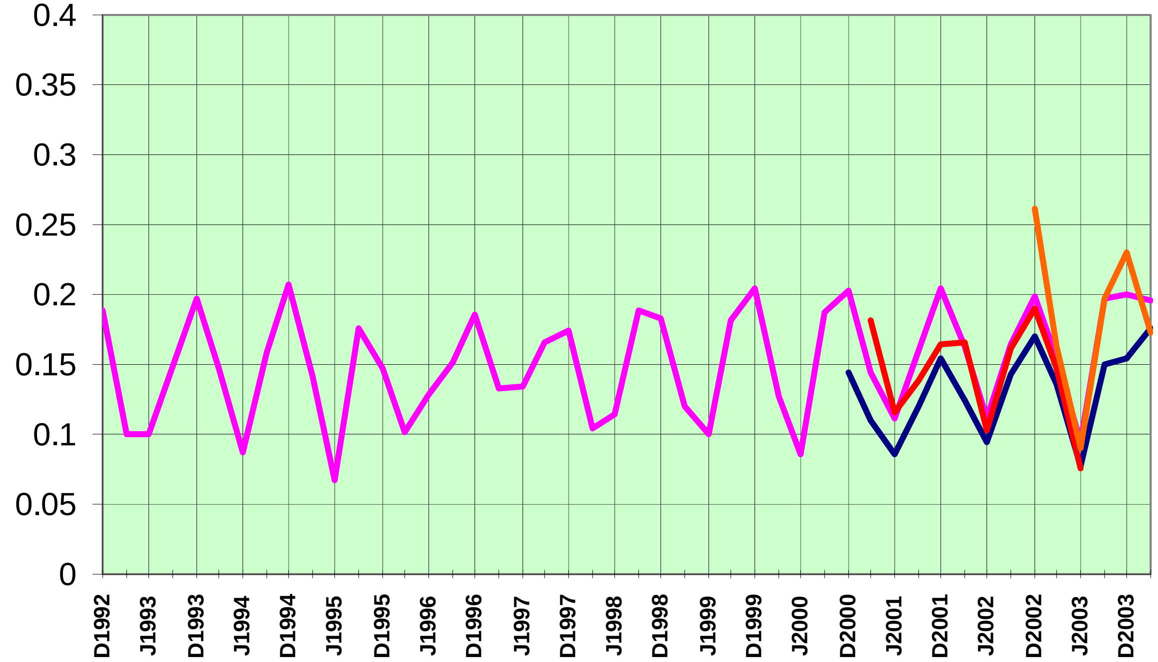
HR verified against GTS SYNOPS

LR verified against GTS SYNOPS

HR verified against up-scaled obs.

<u>North America</u>

HR verified against up-scaled obs



D – DJF

J -- JJA

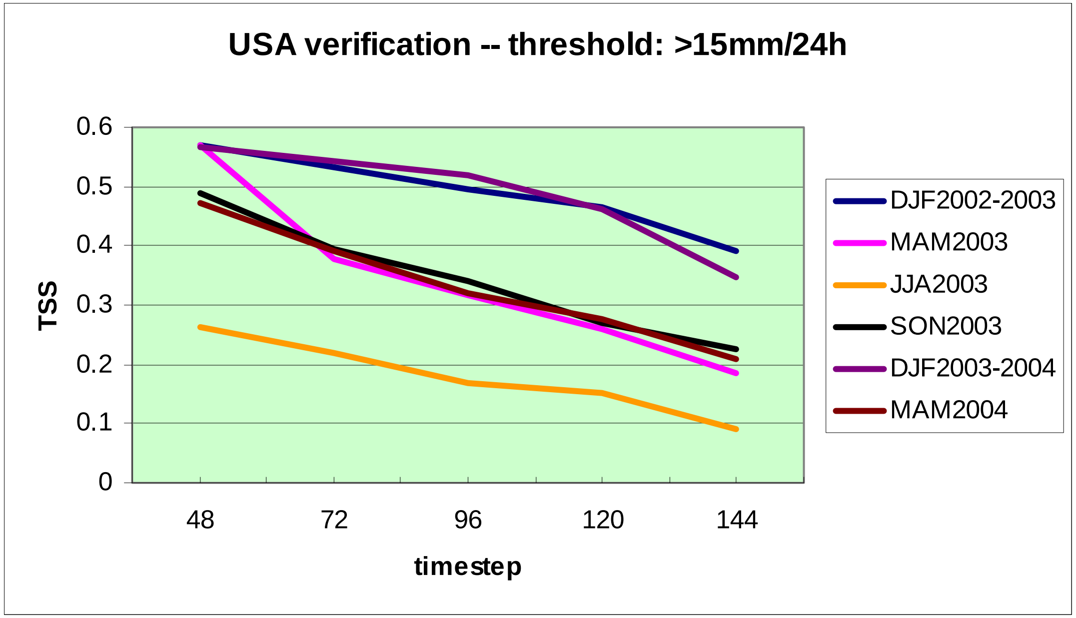
$$ETS = \frac{hits - hits_{random}}{hits + false \cdot alarms + misses - hits_{random}}$$

$$hits_{random} = \frac{(hits + misses)(hits + false \cdot alarms)}{total}$$

ECMWF

Verification area: North America

TSS – threshold > 15mm/24h



1. Score decreases as forecast range lengthens
2. Scores are divided into three groups:
   - Winter
   - Spring and Autumn
   - summer

$$TSS = \frac{hits}{hits + misses} \cdot - \cdot \frac{false \cdot alarms}{false \cdot alarms + correct \cdot negative}$$

Forecast model:
40km resolution

EXTREME EVENTS
Verification area: UK

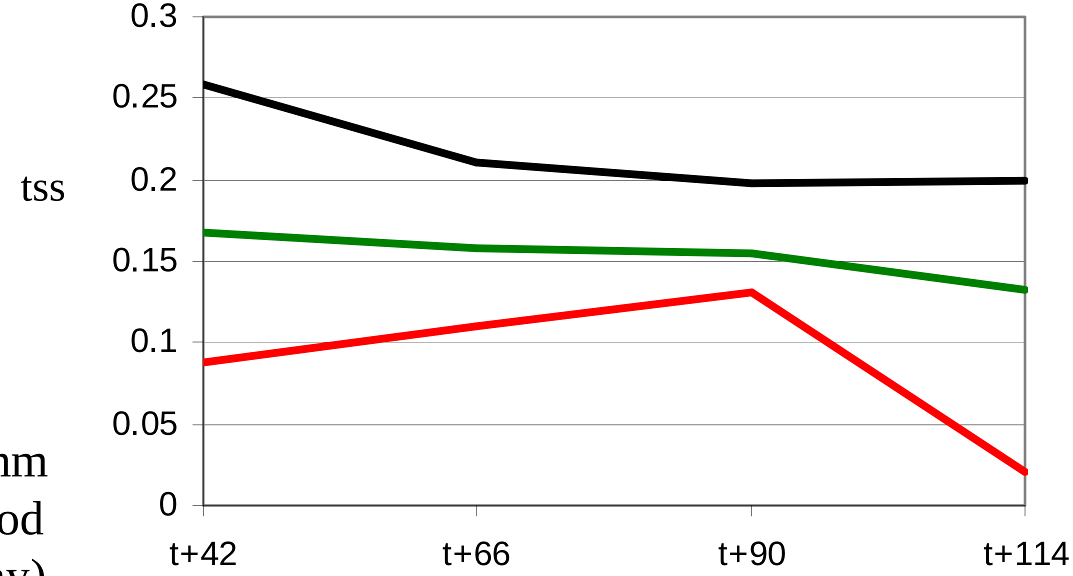
$$TSS = \frac{hits}{hits + misses} - \frac{false \cdot alarms}{false \cdot alarms + correct \cdot negative}$$

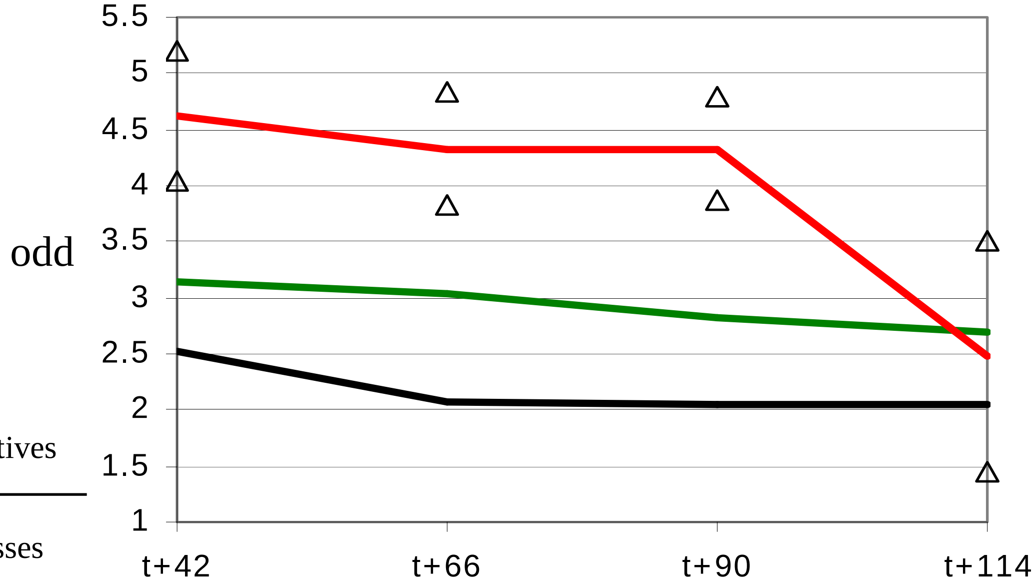
Sample of extreme events:

102 events from Oct. 2001 to Feb. 2004.

Rain persisting for > 2h to give 15mm within a three hour period, or a period of intense rainfall (around 25mm/day)

(courtesy of K. Mylne and T. Legg UK Metoffice)





Thresholds:

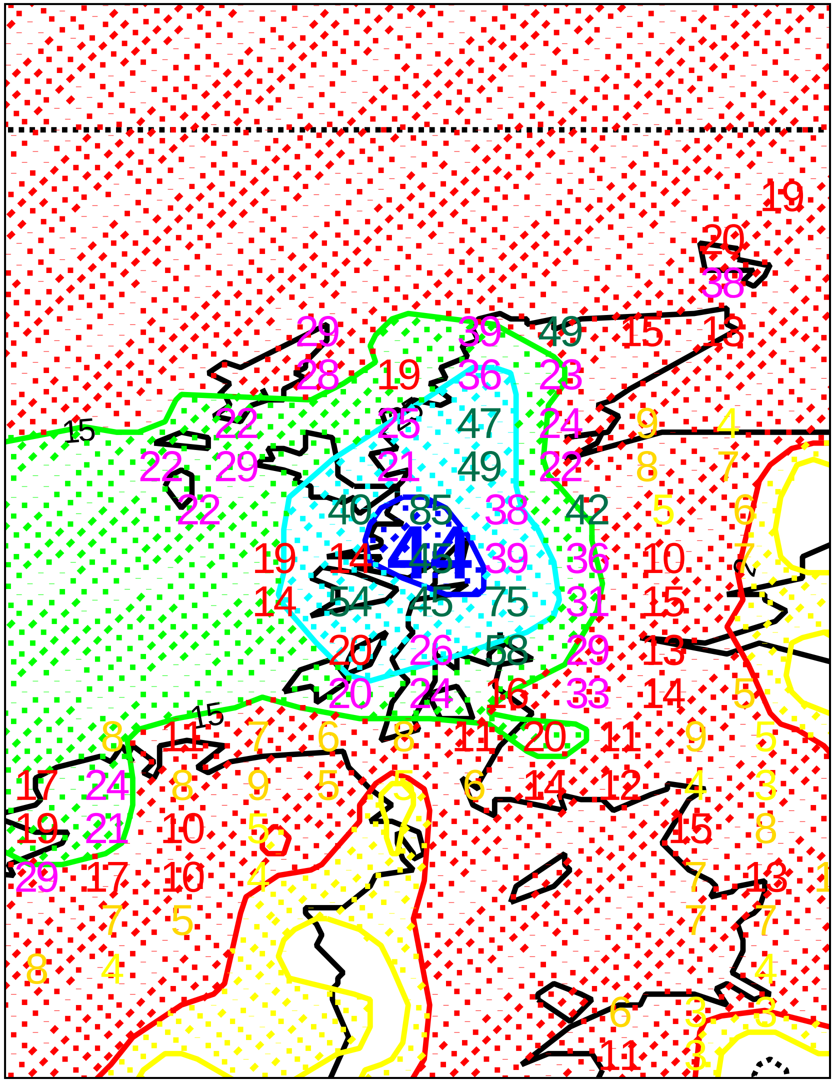
15mm/24h

25mm/24h

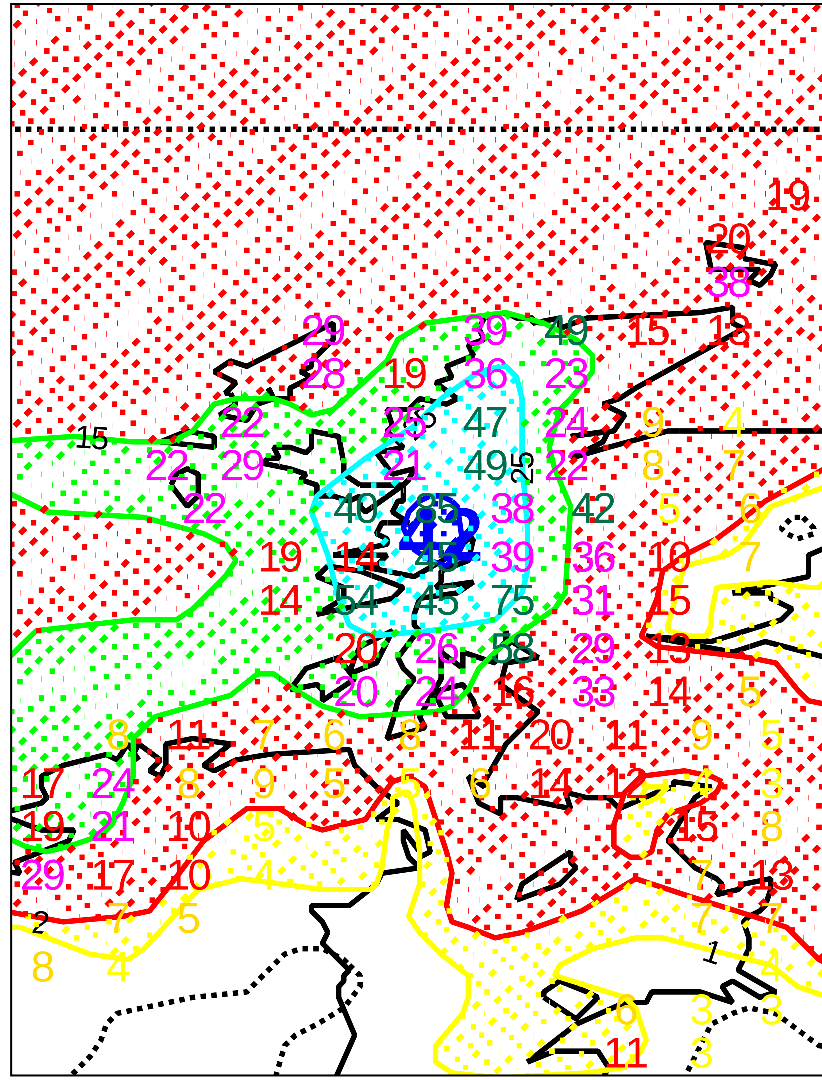
40mm/24h

$$ODD = \frac{\text{Hits*correct negatives}}{\text{False alarms*misses}}$$

Base date 20020302 12UTC
Range t+90

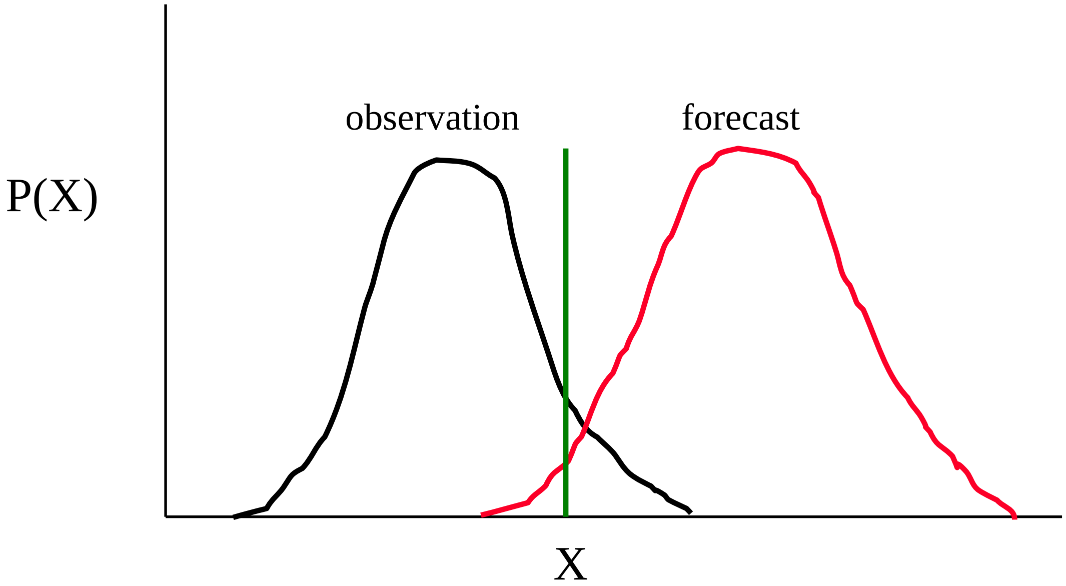


Base date 20020303 12UTC
Range t+66



1 - 2 mm | 2 - 15 mm | 15 - 25 mm | 25 - 40 mm | 40 - 44.496 mm

FUZZY VERIFICATION



Attempt to take into consideration the uncertainties in the observations and in the forecasts

(Beth Ebert, oral presentation at workshop Making verification more meaningful, NCAR, 29 July-1 August 2002)

Assumptions:

The given forecast can be represented by a probability distribution function (PDF)

The observations can also be represented by a PDF

$$BS = \frac{1}{n}\sum_{j=1}^{n}(p_j - x_j)^2$$

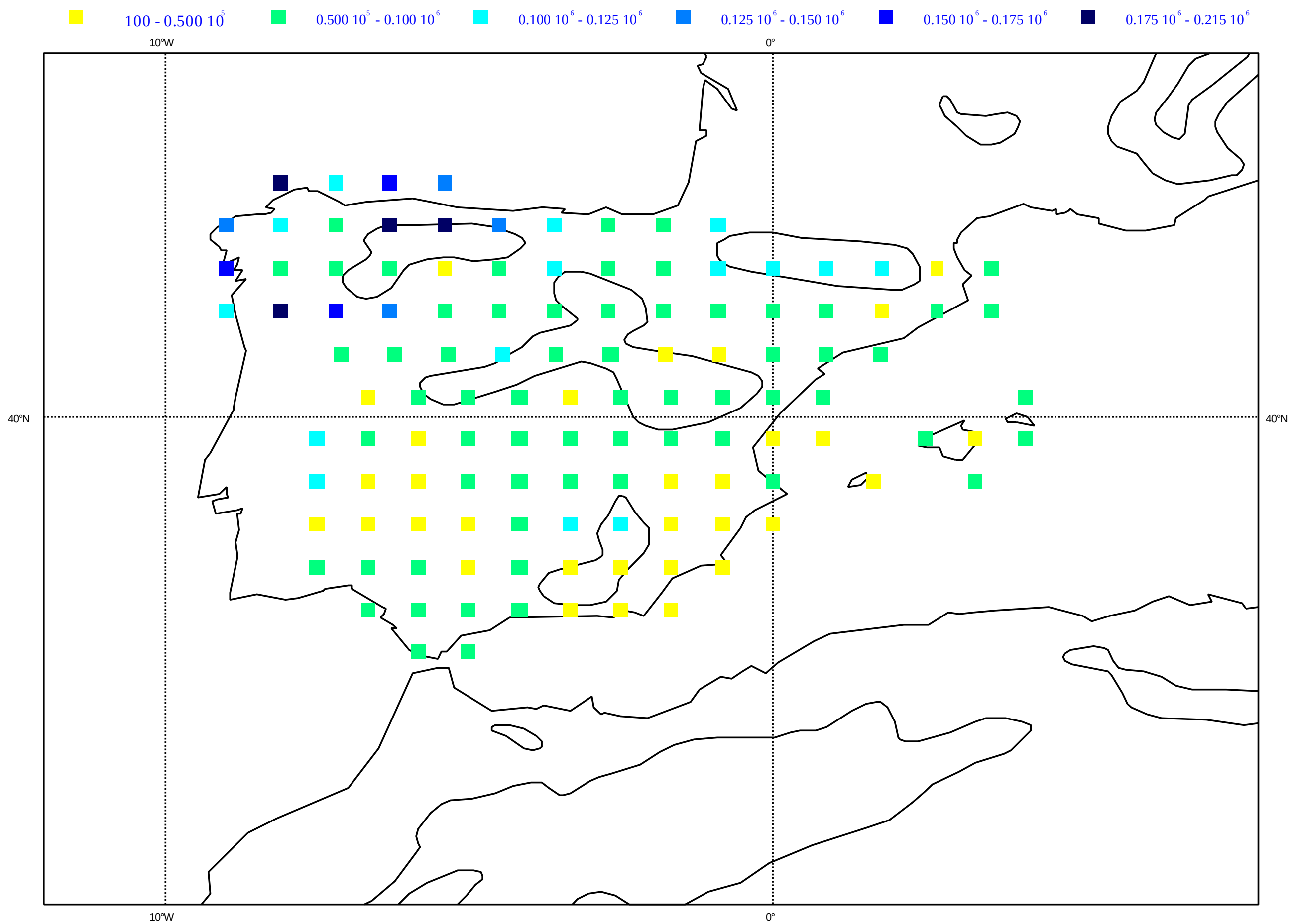
Fuzzy verification

Area: Spain

SON 2002

< 0.1

> 0.15



BS values for each grid point.

Forecast verified against up-scaled values.

The observation probability is either 0 or 1 (traditional method)

Forecast range t+42

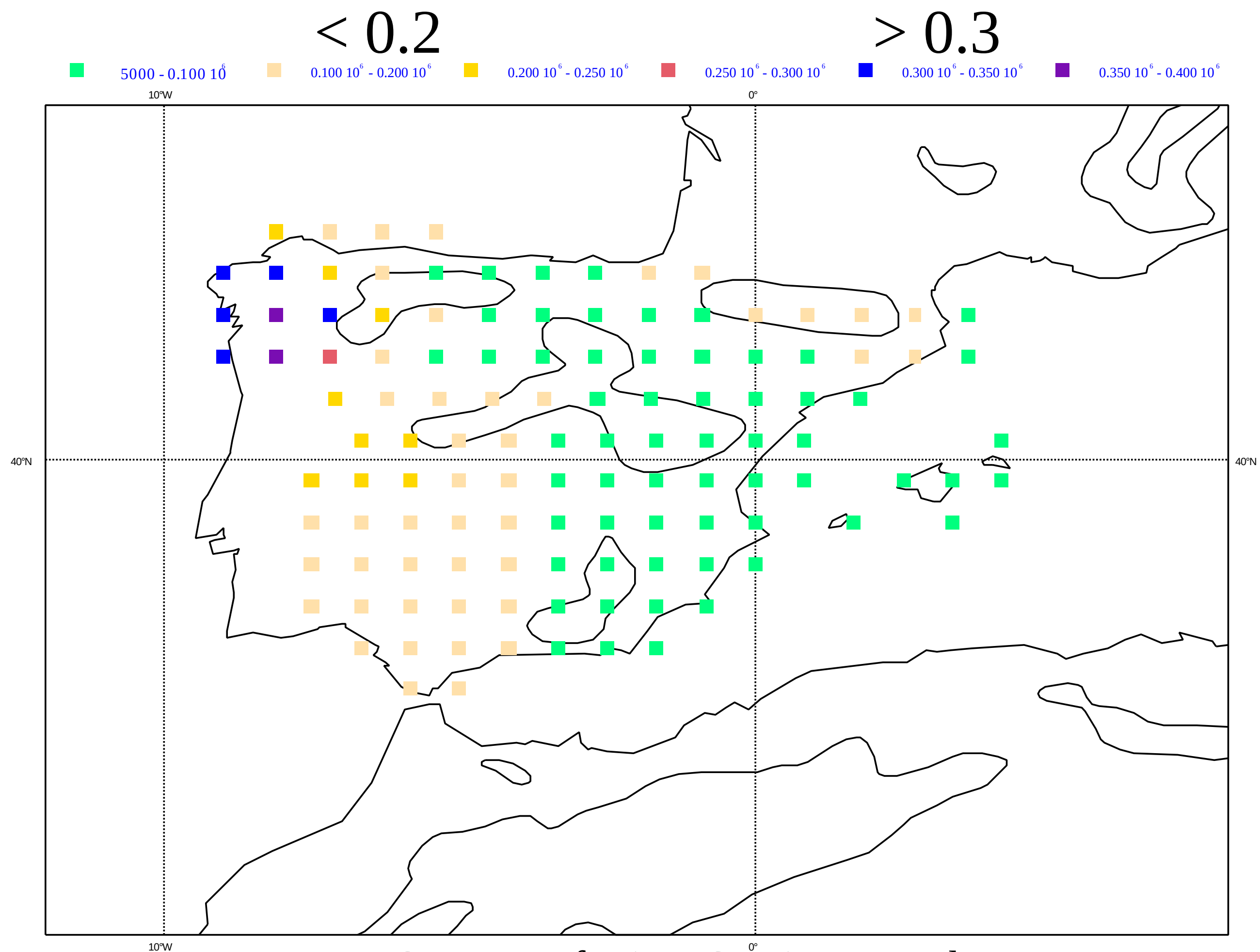
Courtesy of Jaime Garcia Fernandez

Fuzzy verification

Area: Spain

SON 2002

BS values for each grid point.
Forecast verified against an observed PDF.
The observation probability is between 0 and 1 (fuzzy verification)

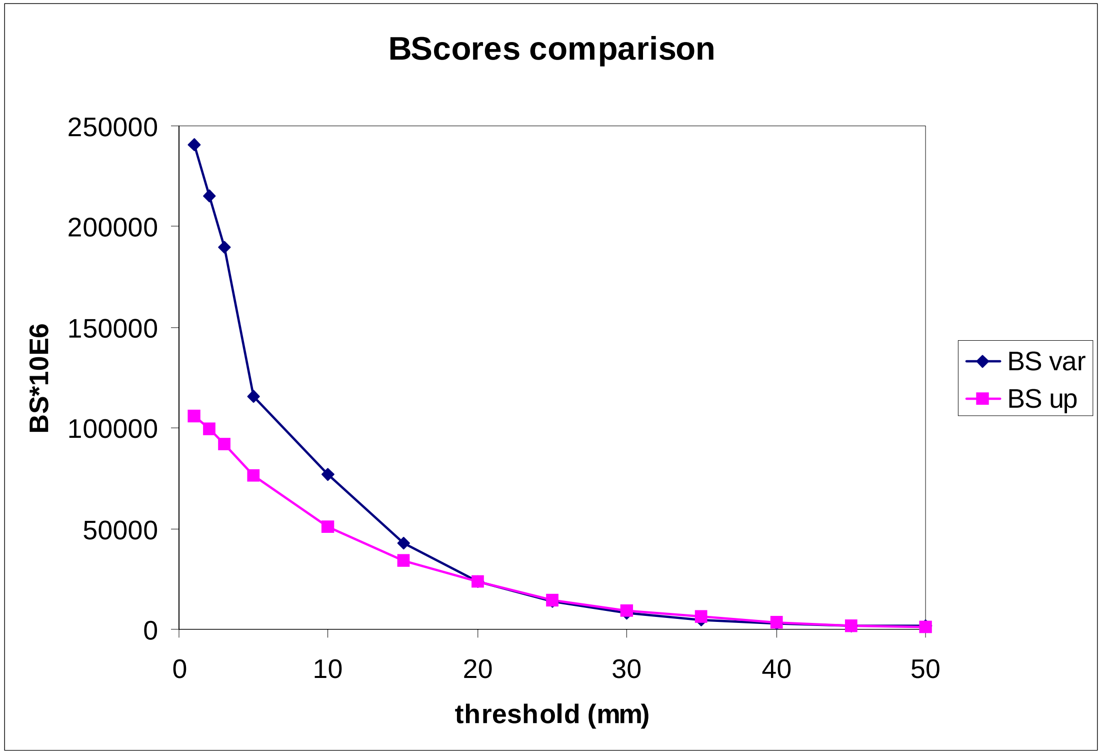


Courtesy of Jaime Garcia Fernandez

Forecast range t+42

Fuzzy verification
Area: Spain
SON 2002

BS averaged over the whole Spanish territory for SON 2002



Observed PDF
Up-scaled values

Forecast range t+42

Courtesy of Jaime Garcia Fernandez

Conclusions

- High density network data allow fairer verification of NWP models. Efforts should be made to have these data available to the scientific community.
- Users' needs are essential when verifying weather forecasts: extreme events in the UK have been shown as example.
- High density network data have been used for Fuzzy verification: each observed and forecast value is described by a probability density function. Preliminary work has been shown for the ECMWF Ensemble Prediction System, more needs to be done to extend the results to different forecast ranges and seasons.