Verification of extreme events in NWP

Thomas Haiden & Linus Magnusson

Philippines
Nov 2013

NW Europe
Dec 2013

British Isles
Feb 2014

United States
Feb 2014

Balkans
May 2014

ECMWF 'Severe Event Catalogue'

Jun 2013	Flood	Central Europe
Aug 2013	Flood	Russia
Sep 2013	Flood	Colorado
Oct 2013	Windstorm	NW Europe
Nov 2013	Typhoon Haiyan	Philippines
Nov 2013	Extreme rainfall	Sardinia, Italy
Nov 2013	Windstorm	Scandinavia
Dec 2013	Windstorm	NW Europe
Dec 2013	Windstorm+flood	British Isles
Dec 2013	Ice storm	Canada and US
Dec 2013	Extreme snowfall	Israel
Jan 2014	Cold spell	US
Jan 2014	Extreme snowfall	Central/Southern Europe
Feb 2014	Freezing rain	Slovenia
Feb 2014	Windstorm+flood	British Isles
Feb 2014	Extreme snowfall	Eastern US
Mar 2014	Windstorm	Scandinavia
Apr 2014	Tornadoes	US Midwest
May 2014	Flood	Balkans

Verification of extreme events

- **Case studies**

  Problem: biased towards events that actually happened

  Problem: generalization of results

  Practical approach: combine with statistical evaluations

- **Statistical evaluation**

  Problem: contradiction between ‘extreme’ and ‘statistical’

  Problem: scores degenerate for rare events

  Practical approach: verify not-quite-so-extreme events and use specially designed scores

Verification of extreme events

	OBS yes	OBS no
FCST yes	a	b
FCST no	c	d

$$FB = \frac{a+b}{a+c}$$ Frequency bias

$$H = \frac{a}{a+c}$$ Hit rate

$$F = \frac{b}{b+d}$$ False alarm rate

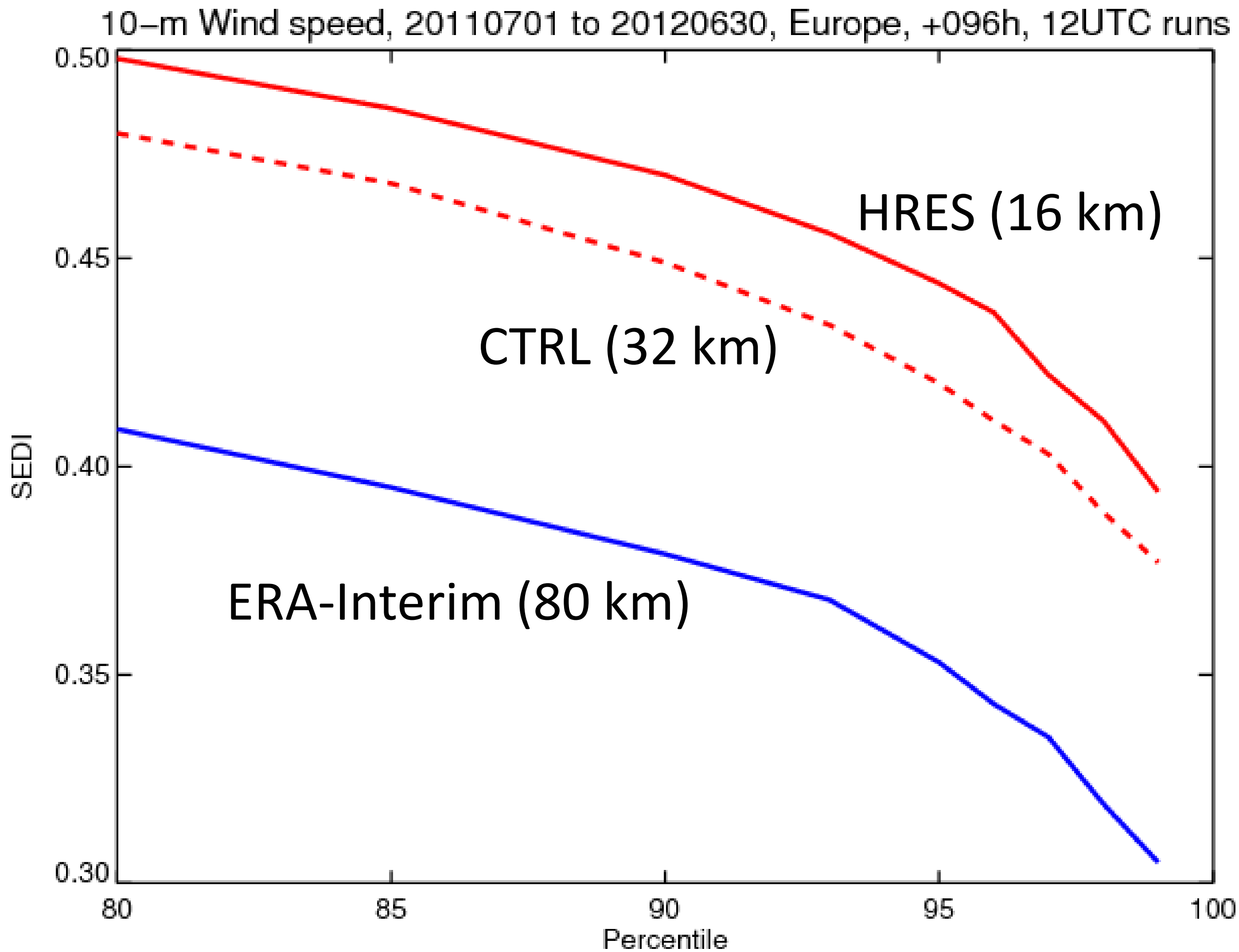
$$SEDI = \frac{\log F - \log H - \log(1-F) + \log(1-H)}{\log F + \log H + \log(1-F) + \log(1-H)}$$

Ferro and Stephenson (2011)

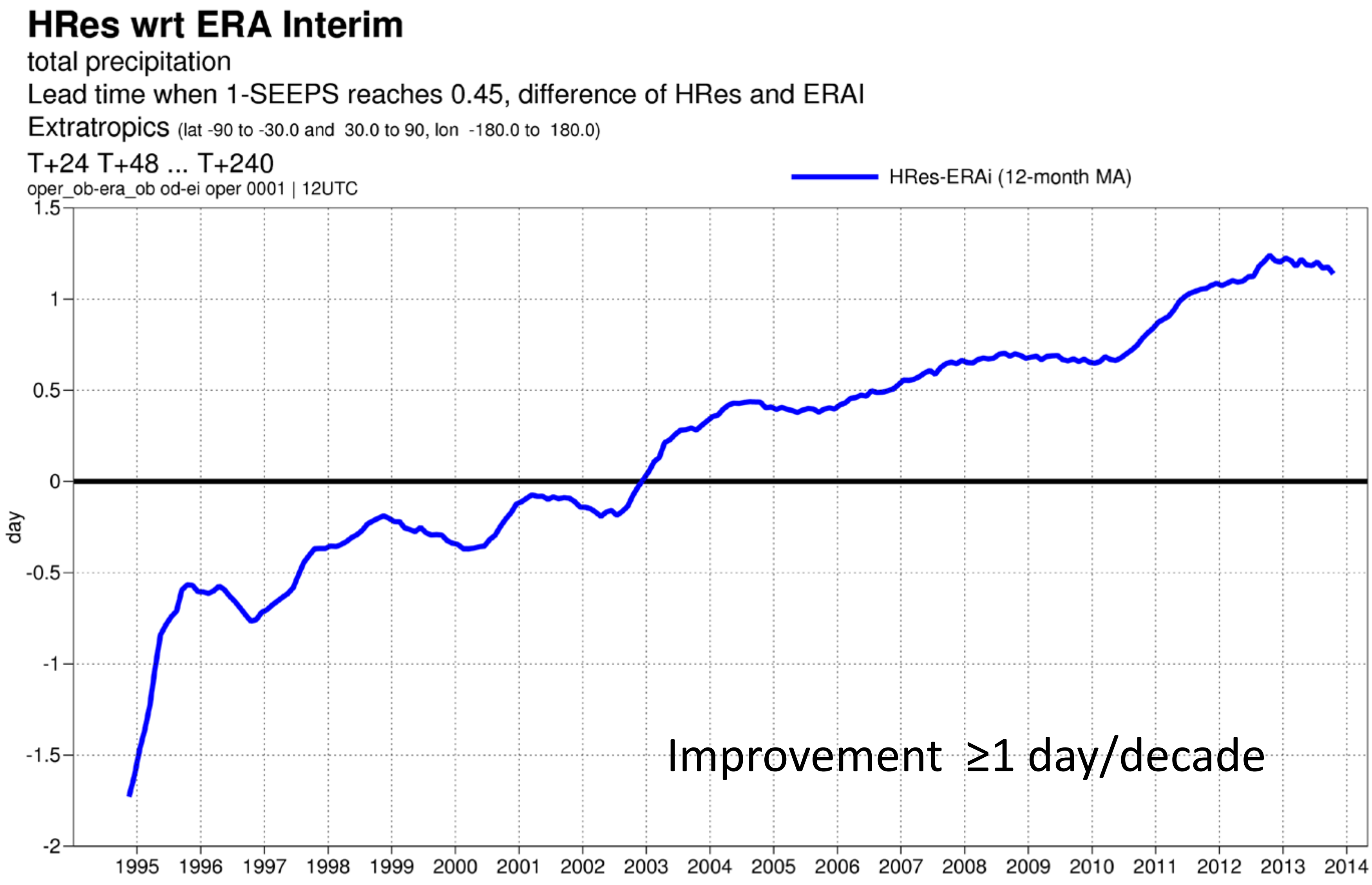
Based on calibrated forecasts (corresponding to EFI concept)

ECMWF

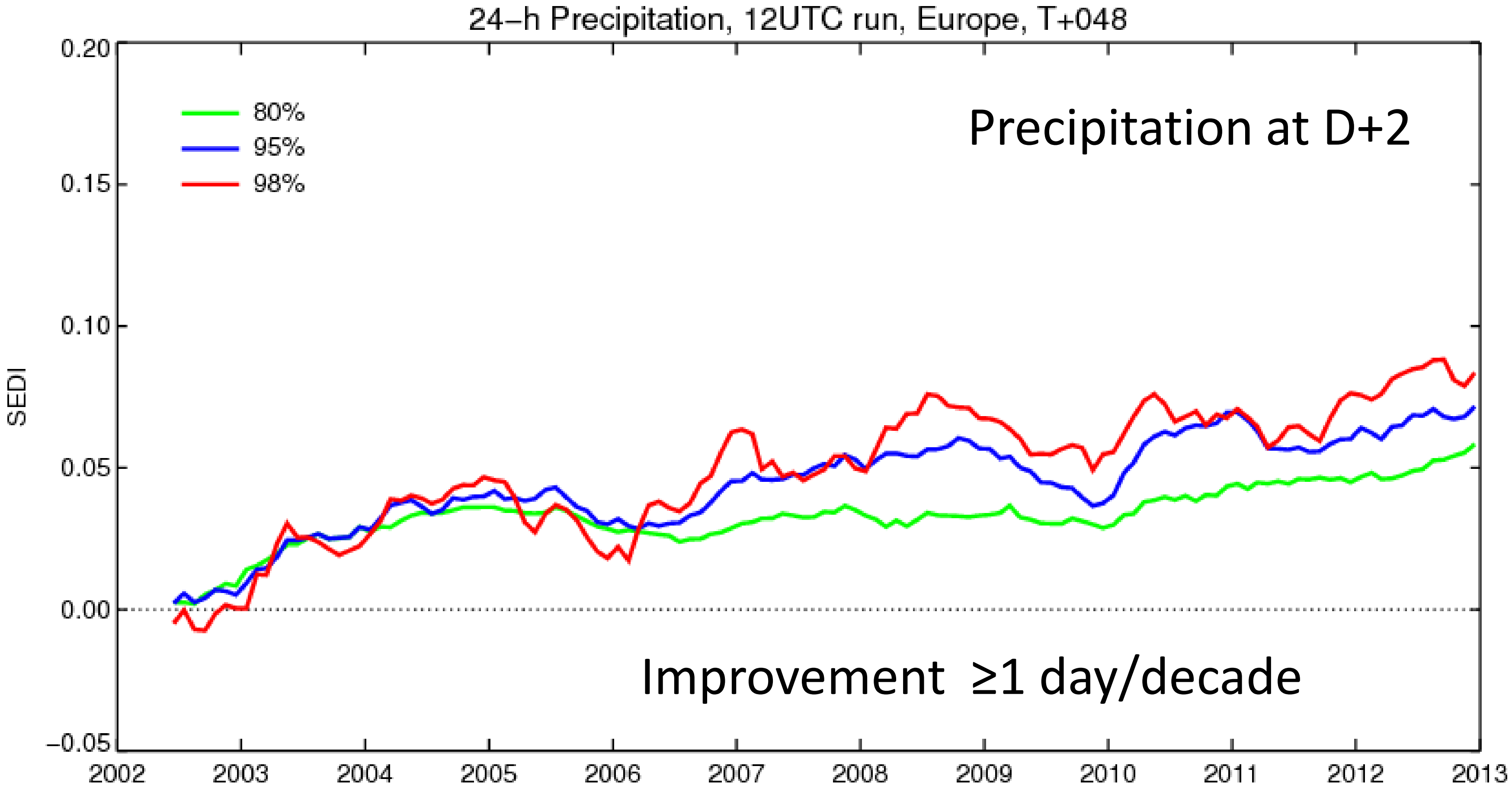
Evaluation of high wind speeds, D+4



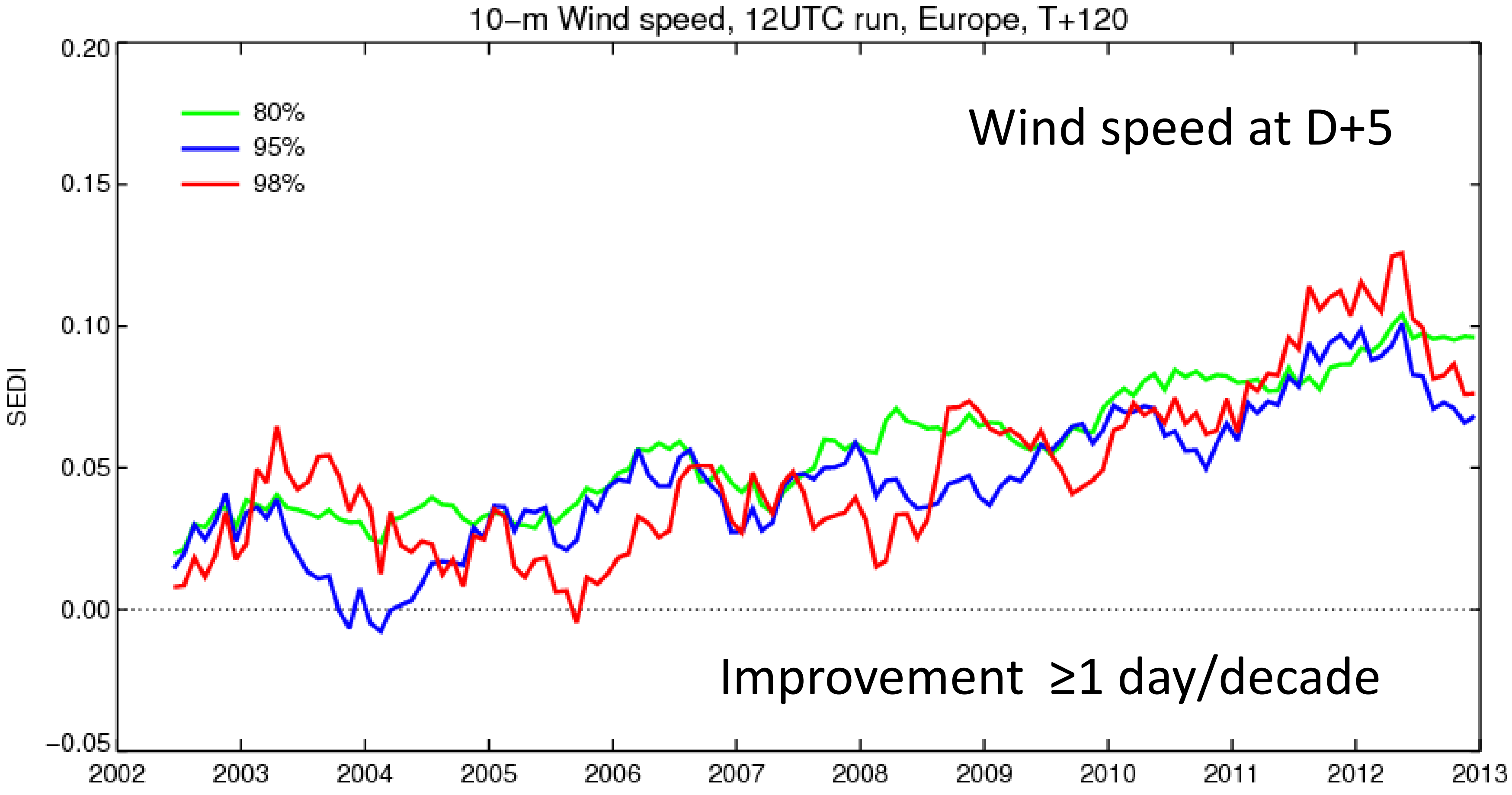
Evolution of forecast skill - precipitation



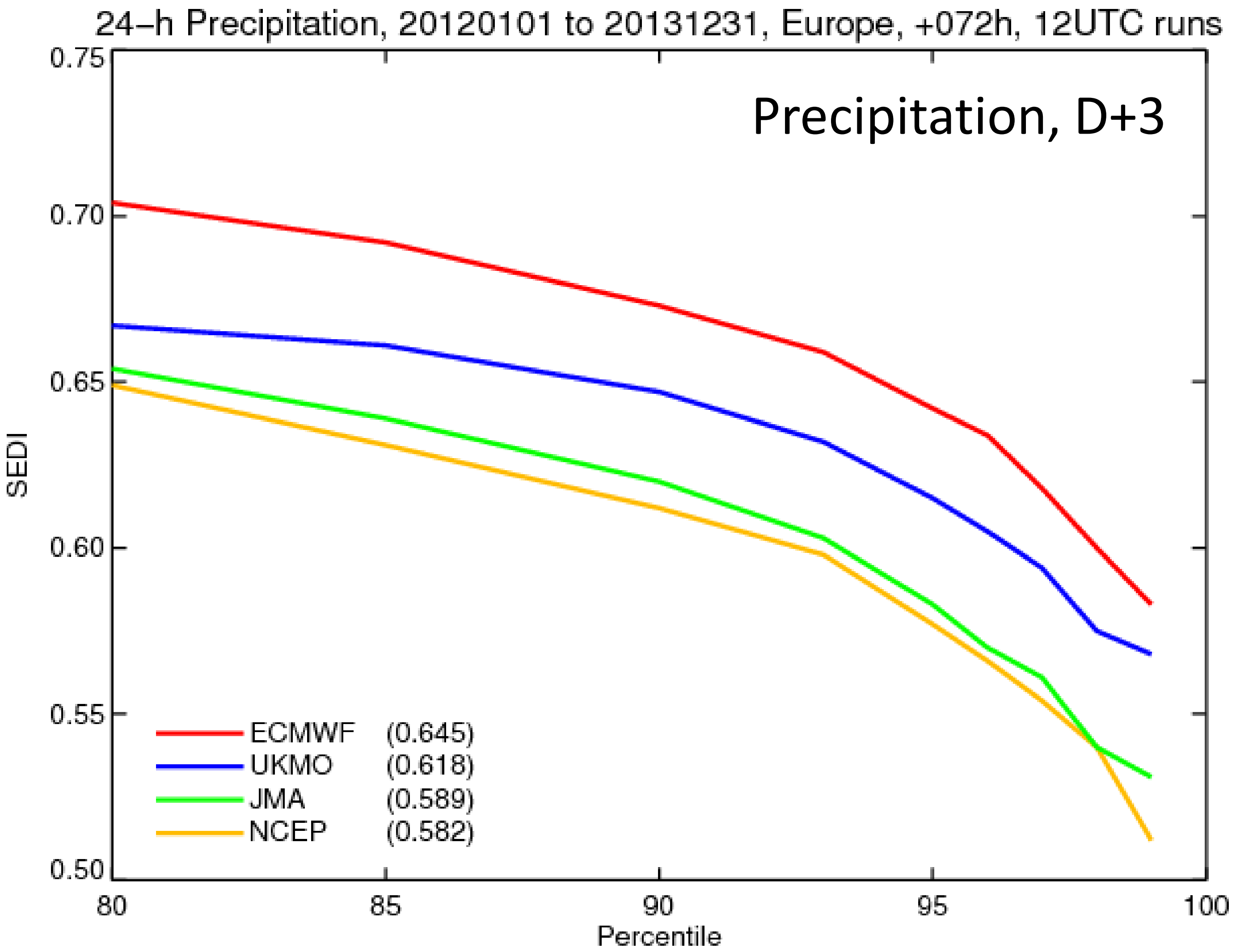
Evolution of forecast skill



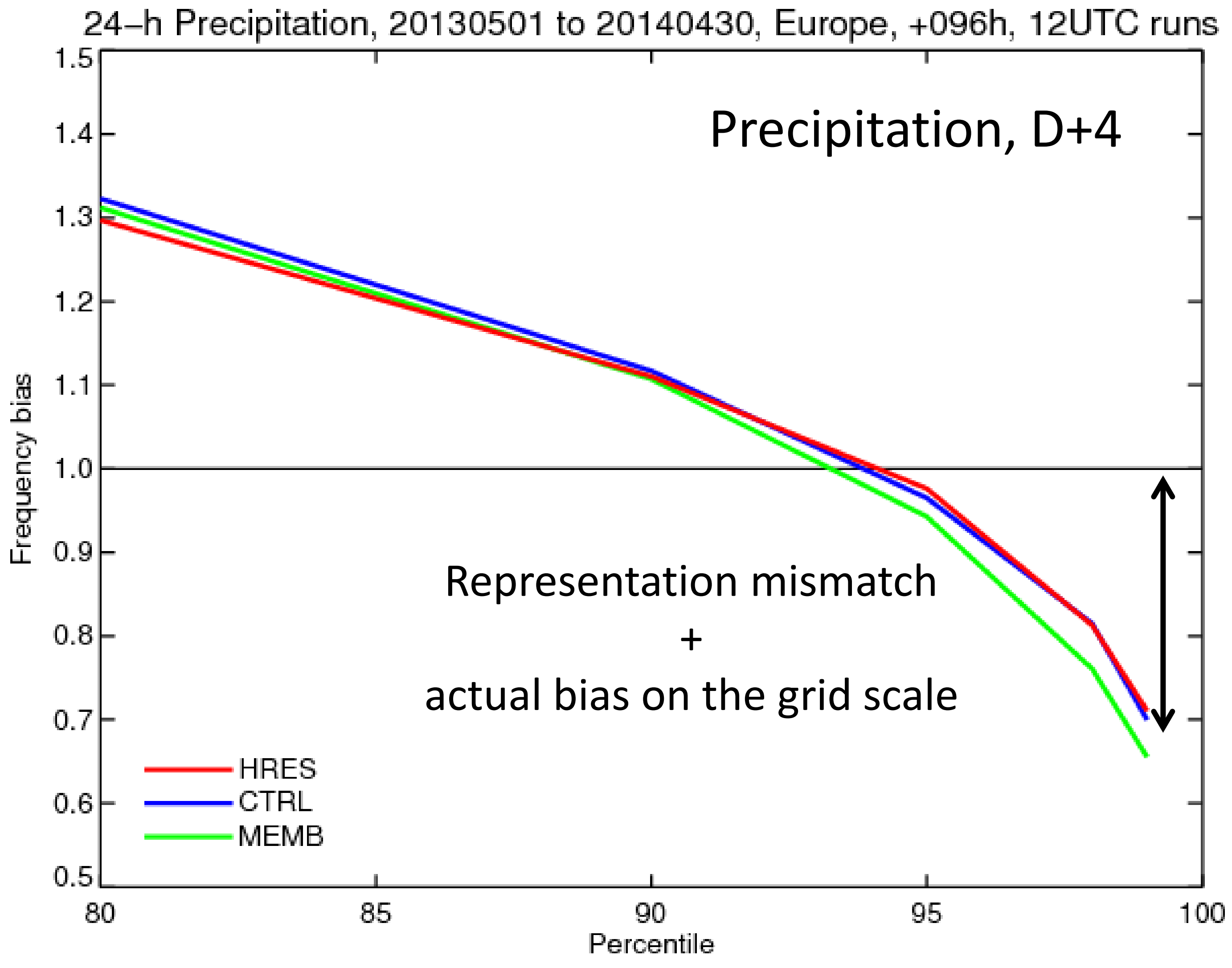
Evolution of forecast skill



Model intercomparison



Frequency bias

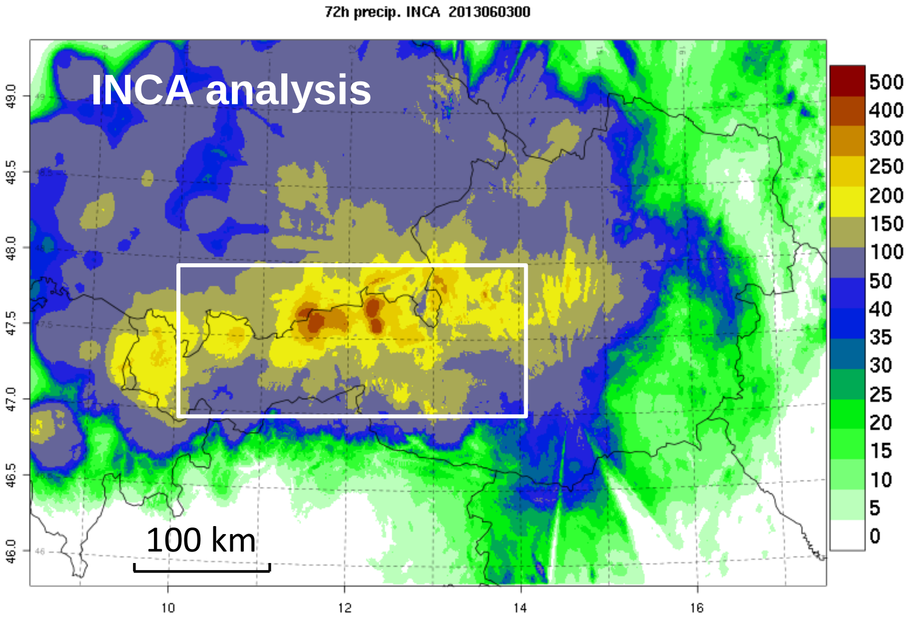


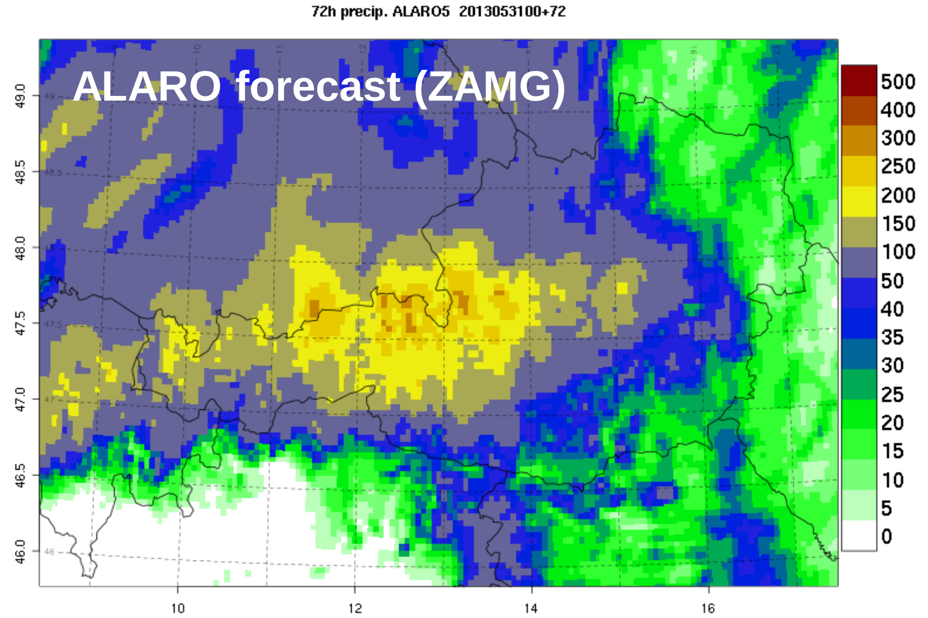
ECMWF

Central European flooding (Danube, Elbe)

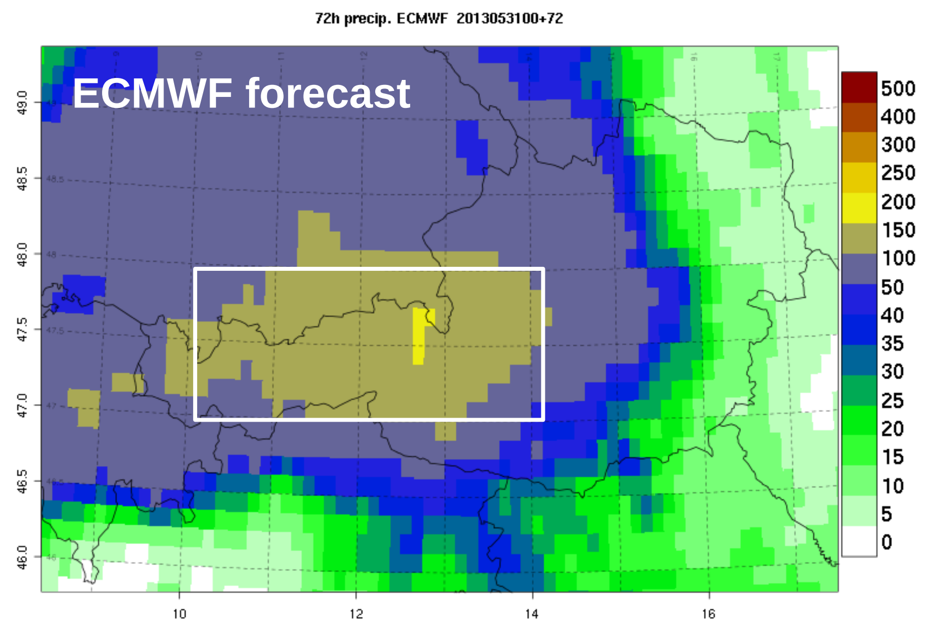
ECMWF

Precipitation from 31/05/2013 00UTC to 03/06/2013 00UTC

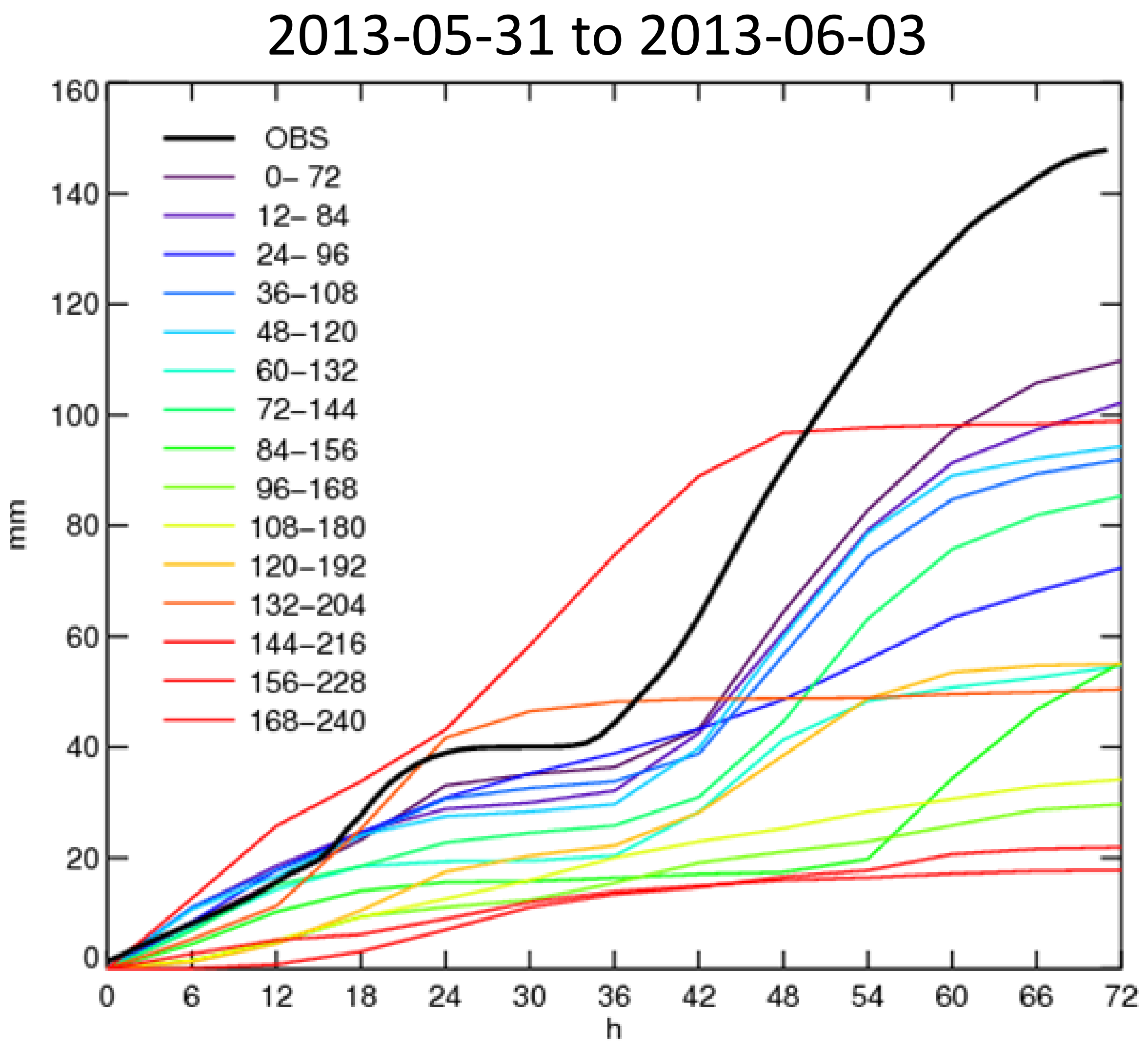




- **ALARO (5 km): very good at 100 km scale but local maxima underestimated**
- **ECMWF (16 km): correct location but underestimation of magnitude**

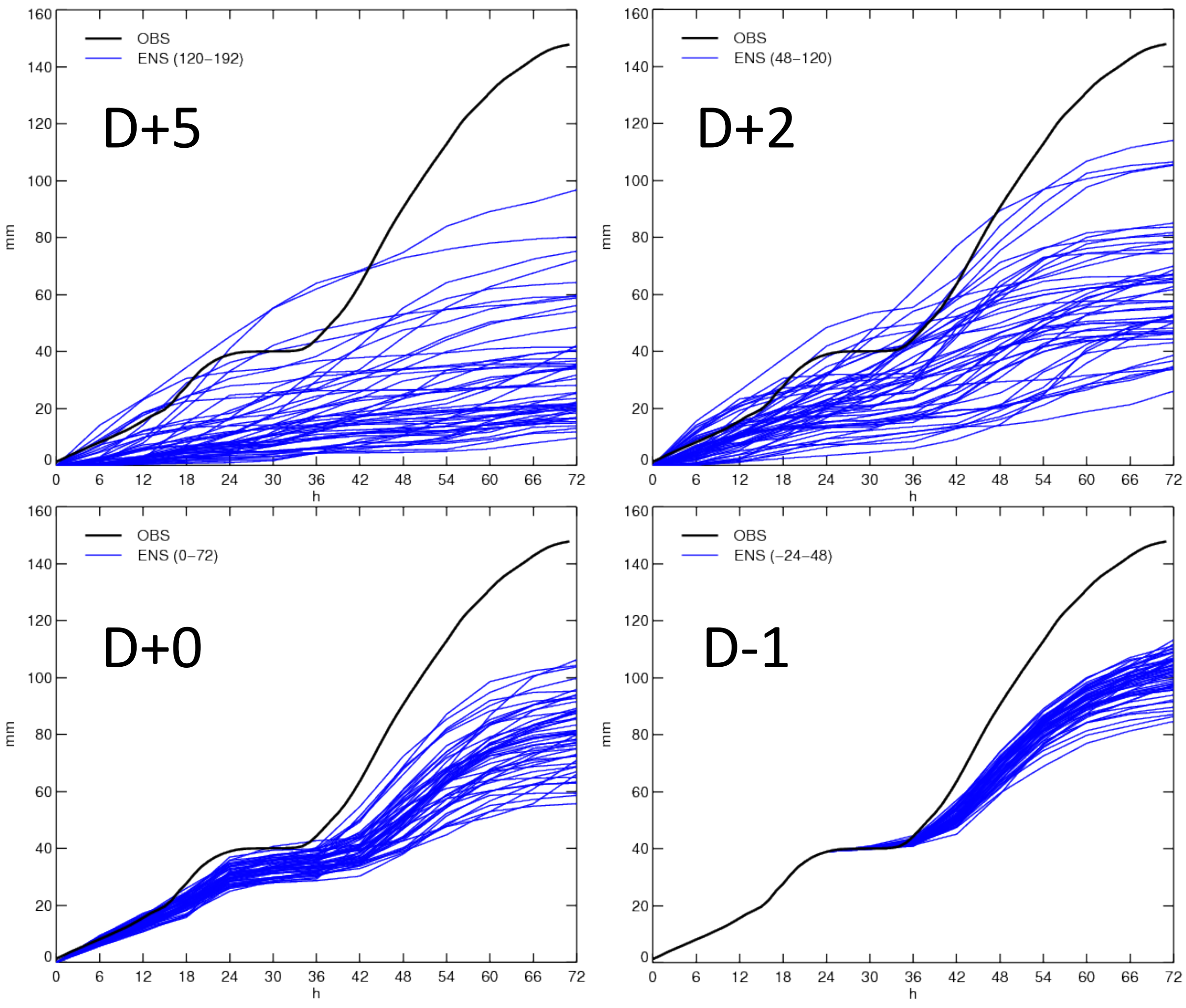


Cumulative precipitation - HRES



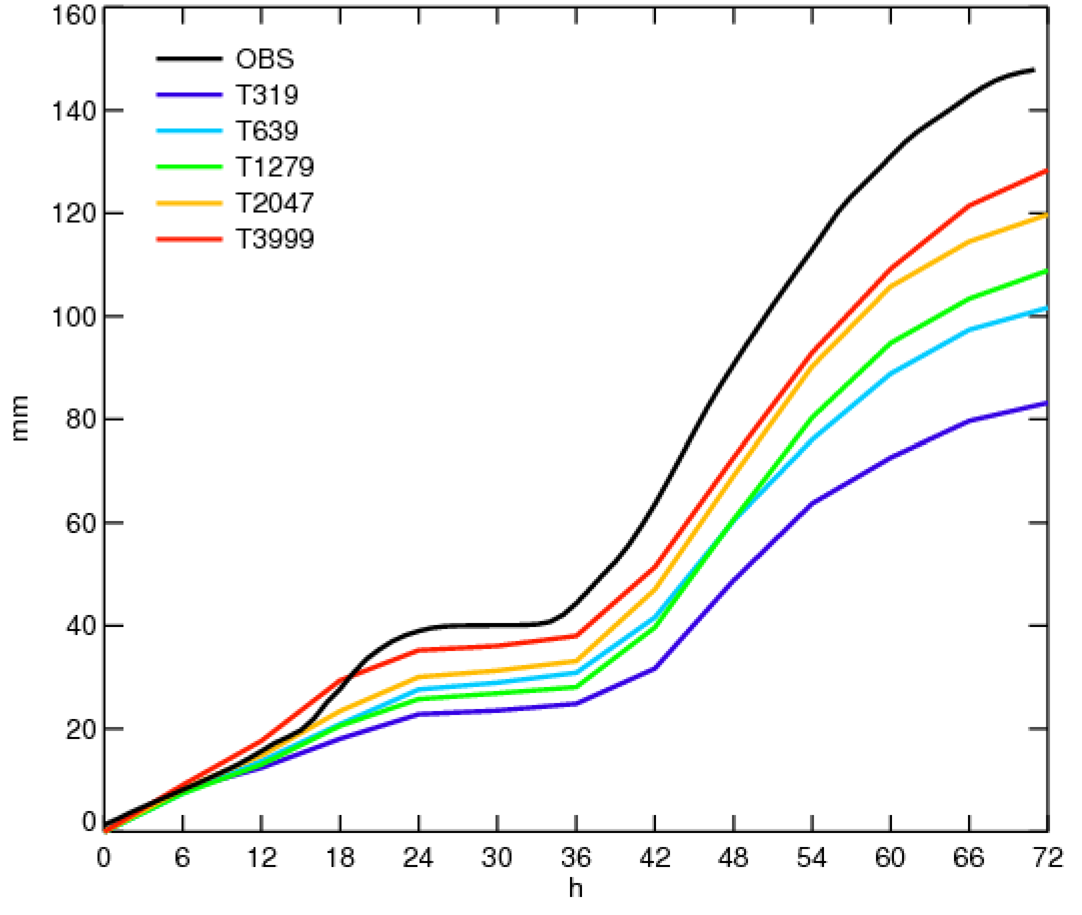
Cumulative precipitation - ENS

2013-05-31 to 2013-06-03

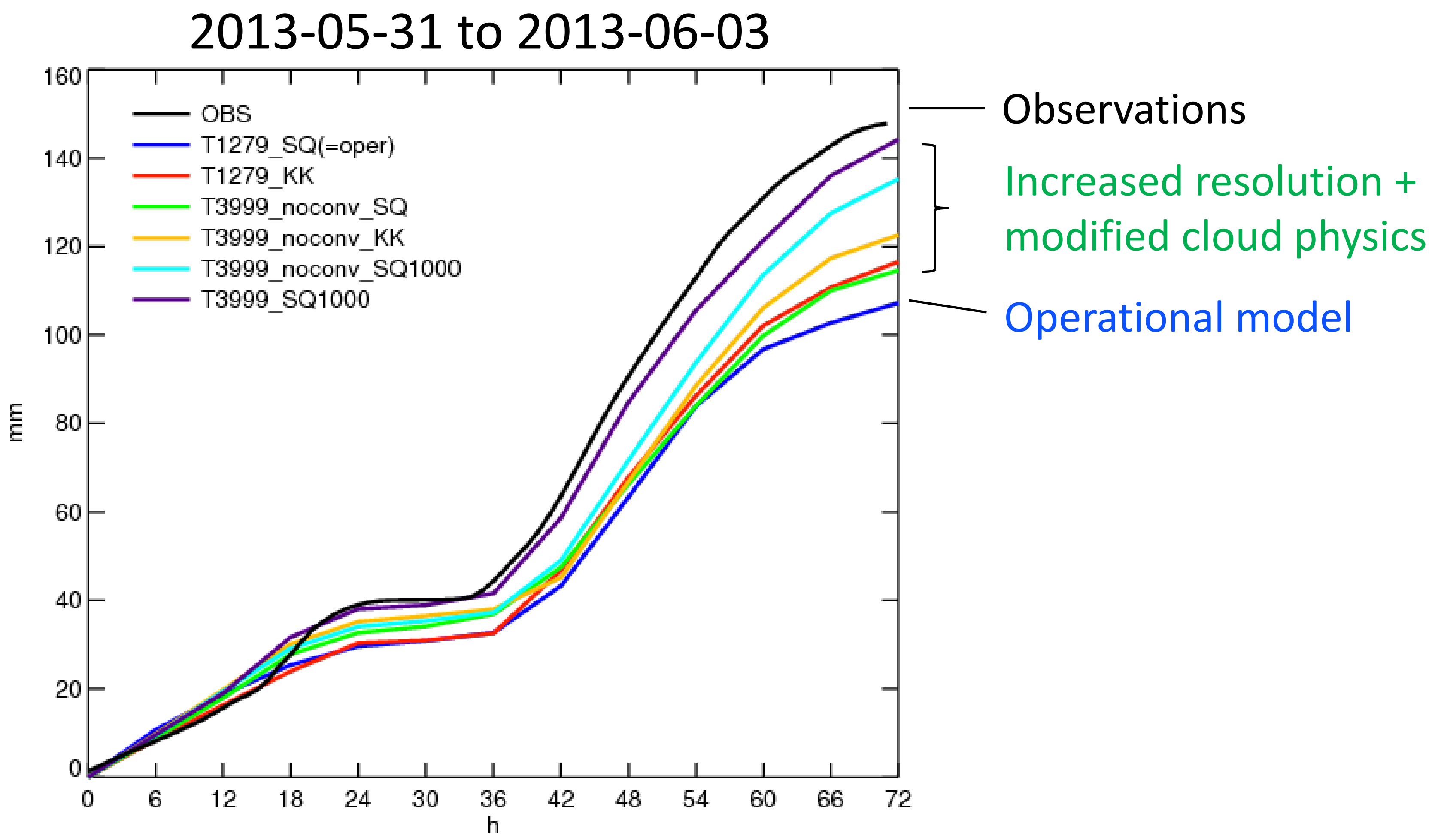


Cumulative precipitation - experiments

2013-05-31 to 2013-06-03

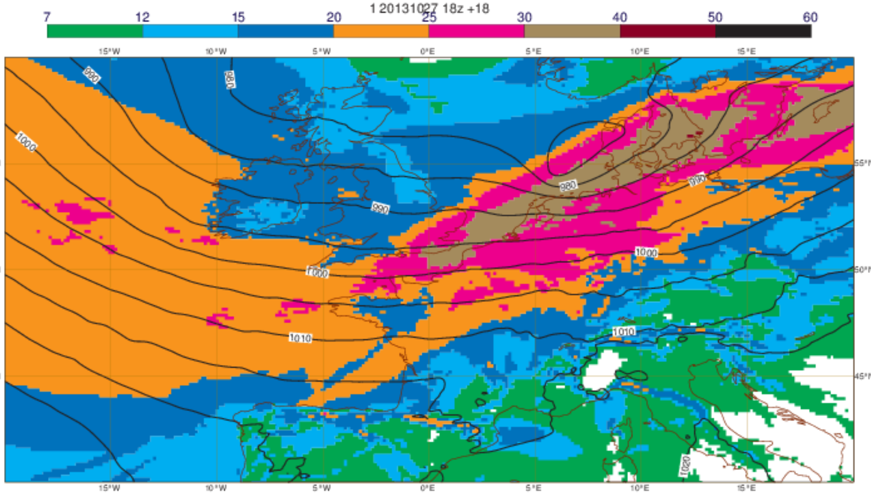


Cumulative precipitation - experiments

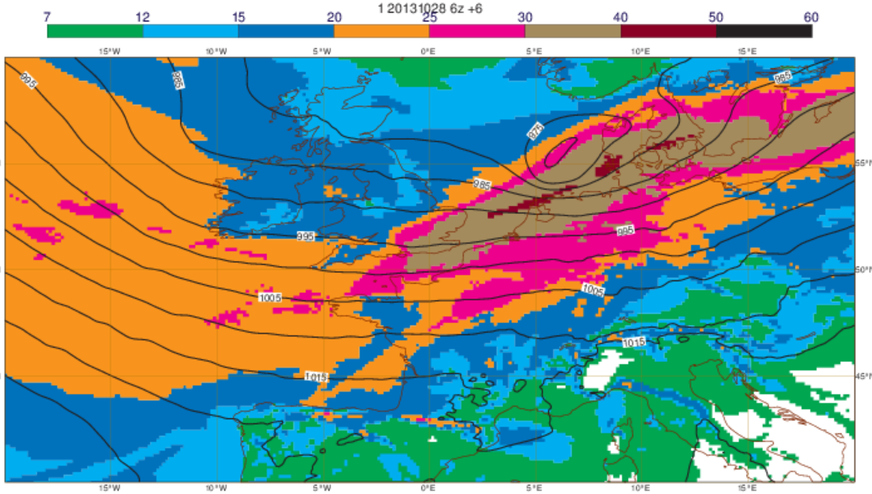


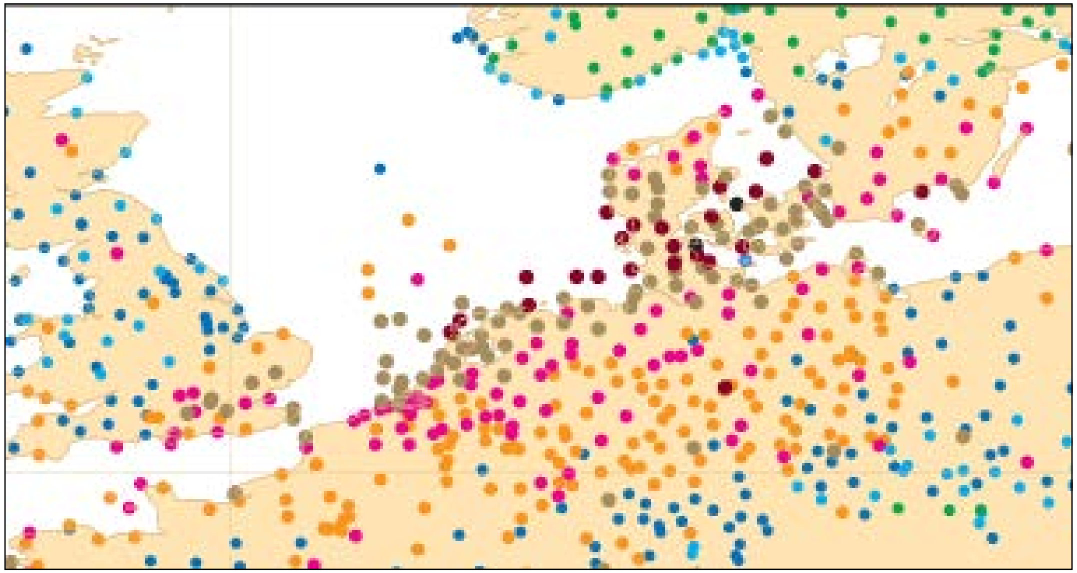
Maximum wind gusts 28 October 6-24UTC

Ini: 27 October 18 UTC



Ini: 28 October 6 UTC

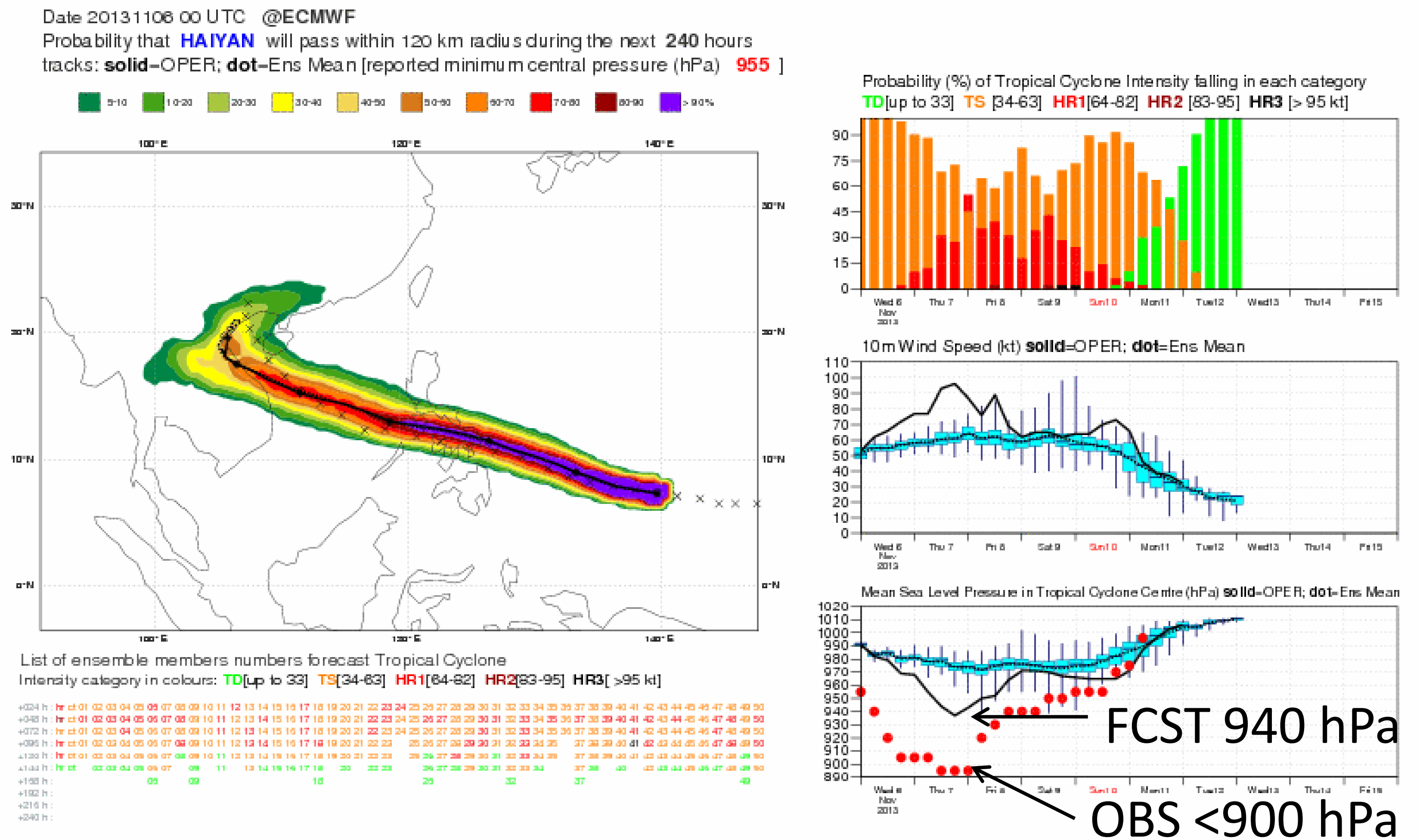




Observations

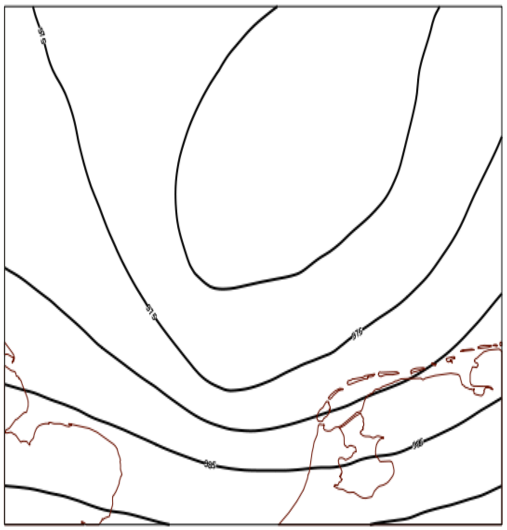
ECMWF

Haiyan, two days before landfall



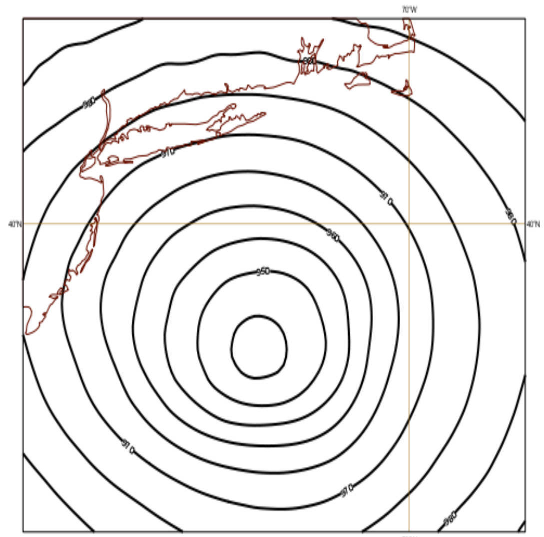
Scale of a storm

St Jude / Christian
2013-10-28



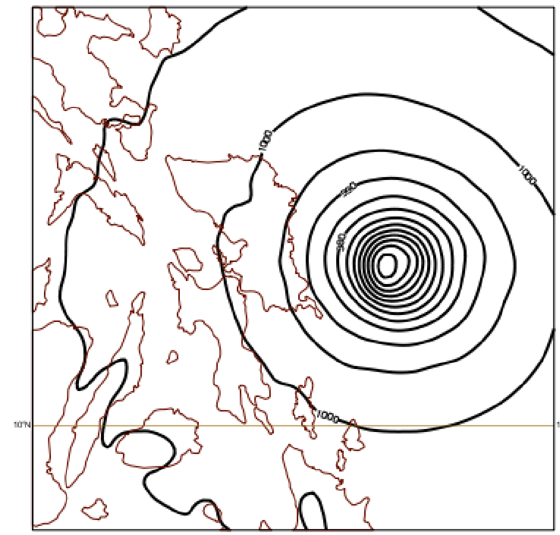
500 km

Sandy
2012-10-30



500 km

Haiyan
2013-11-08



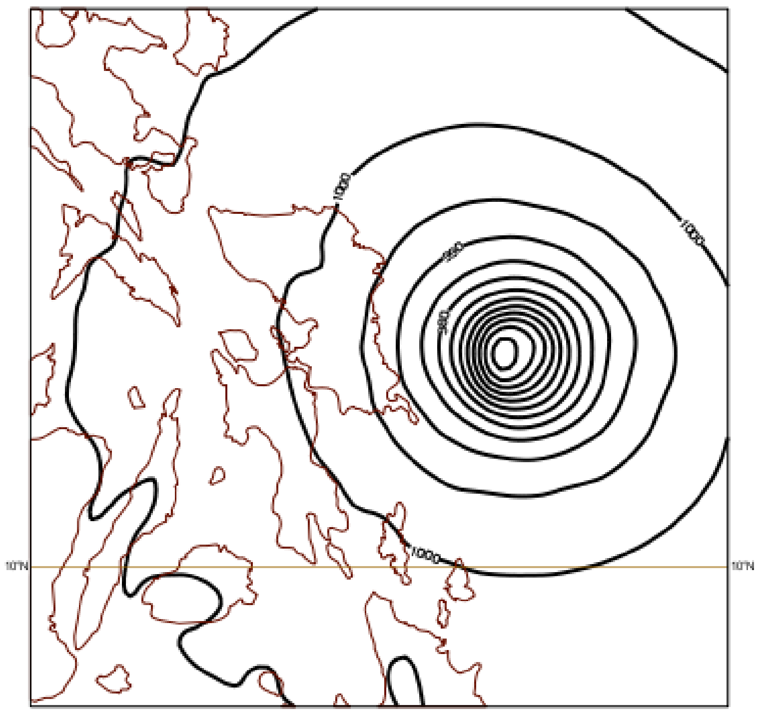
500 km

ECMWF

Effect of resolution

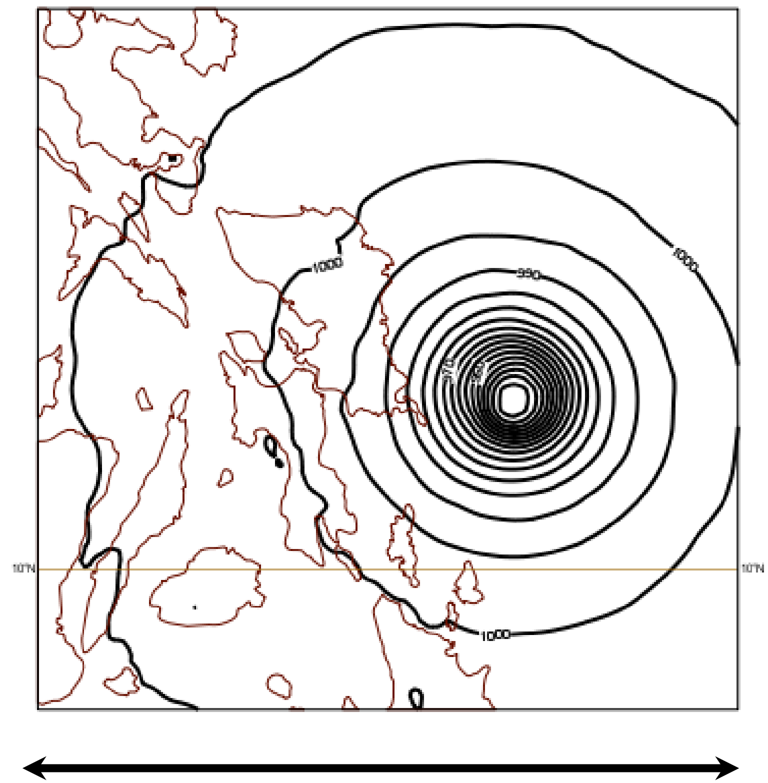
T1279 – min 943 hPa

2013-11-06 00:00:00 0z +48, Min pres: 943 (Obs: 895 hPa)



T2047 – min 922 hPa

2013-11-06 00:00:00 0z +48, Min pres: 922 (Obs: 895 hPa)

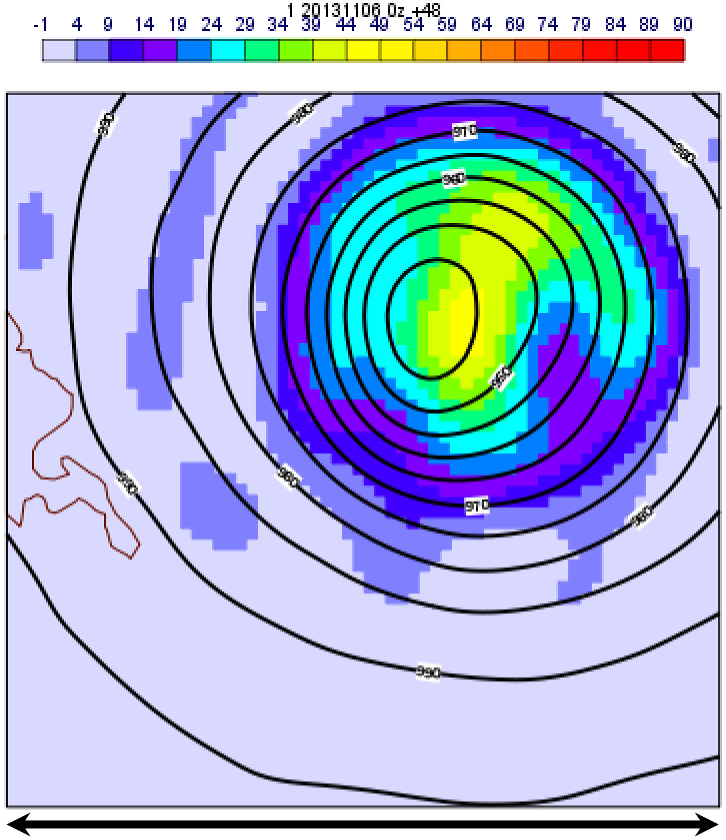


5°≈500 km

ECMWF

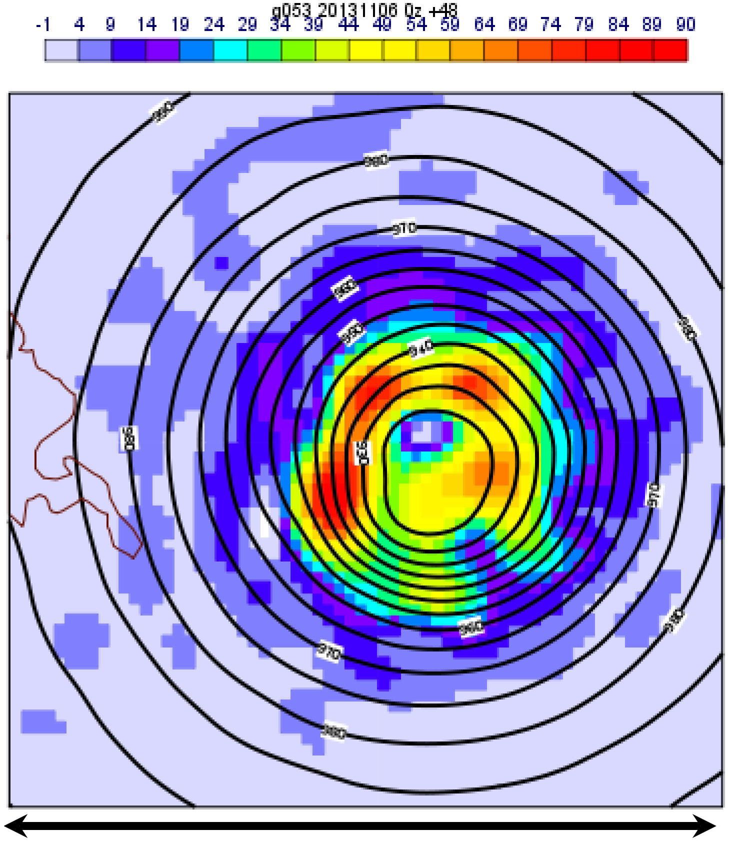
850 hPa vorticity and MSL pressure

T1279 (Δx=16 km)



300 km

T2047 (Δx=10 km)



300 km

ECMWF

Conclusions

- **Location and timing of events usually well predicted**
- **Reduced intensity errors at higher model resolution**
- **Skill evolution for 98th percentile similar to overall skill evolution**
- **Case studies: provide physical and modelling insights**
- **Statistical evaluations: provide context, trends, quantify model improvements**