

Shaping future approaches to evaluating high-impact weather forecasts

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ECMWF strategy 2016 – 2025

- Forecast targets by 2025
 - Ensemble predictions of **high impact weather up to two weeks ahead**
 - Seamless approach, aiming towards predictions of **large scale patterns and regime transitions up to four weeks ahead** and global-scale anomalies up to a year ahead
- How do we achieve these goals?
 - High-resolution ensemble
 - Earth-system model
 - Observations
 - Scalability
 - Funding
 - People



Strategy 2016 – 2025: Verification

- Verification challenges:
 - High-impact weather
 - Small sample sizes
 - High-resolution ensemble
 - Earth-system model
 - Observations
 - Regime transitions
 - Combined HRES+CTRL+ENS



Technical Advisory Committee Subgroup:

- Recommend verification procedures for ensemble forecasts matching the **most important end users requirements for high impact weather up to two weeks ahead**;
- Recommend verification procedures suitable to evaluate ensemble forecasts of large scale patterns and regime transitions up to four weeks ahead;



Users needs - high-impact weather up to two weeks ahead

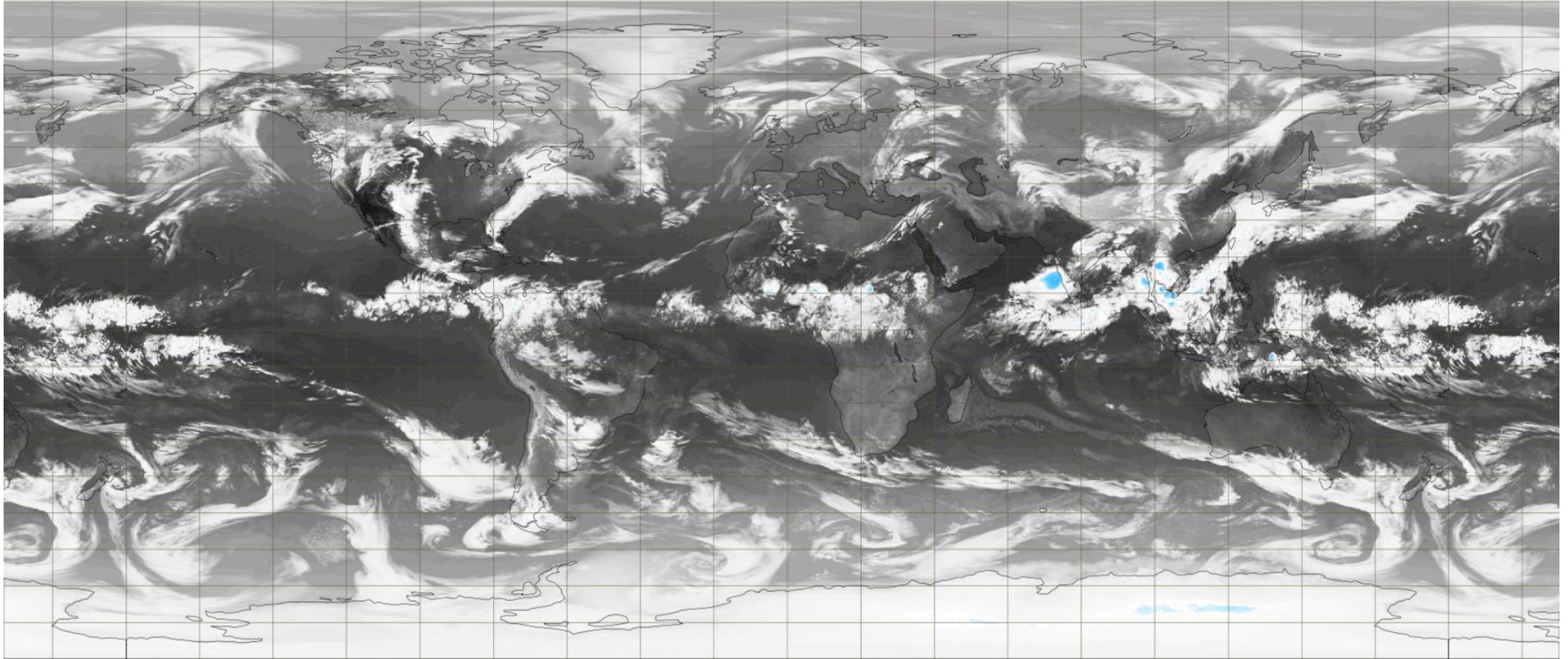
- Anomalous weather
- Persistent events – heat waves, drought
- Episodic events - short periods of heavy precip in week, stormy periods
- Onset, duration, end of large-scale blocking
- Regimes and transitions

- Precipitation, 2m temperature, 10m wind
- Combined events (precip+temp, precip+wind)
- Forest fire hazard, persistent fog, freezing rain

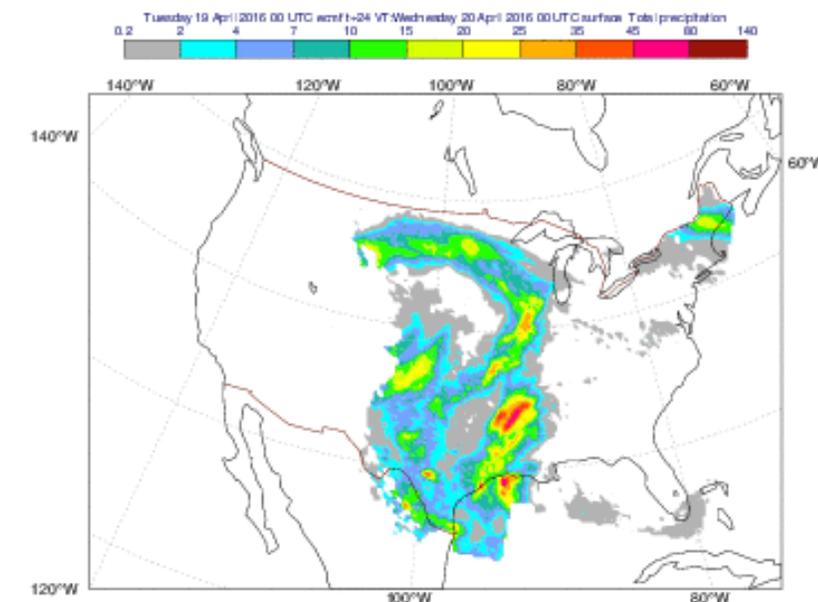
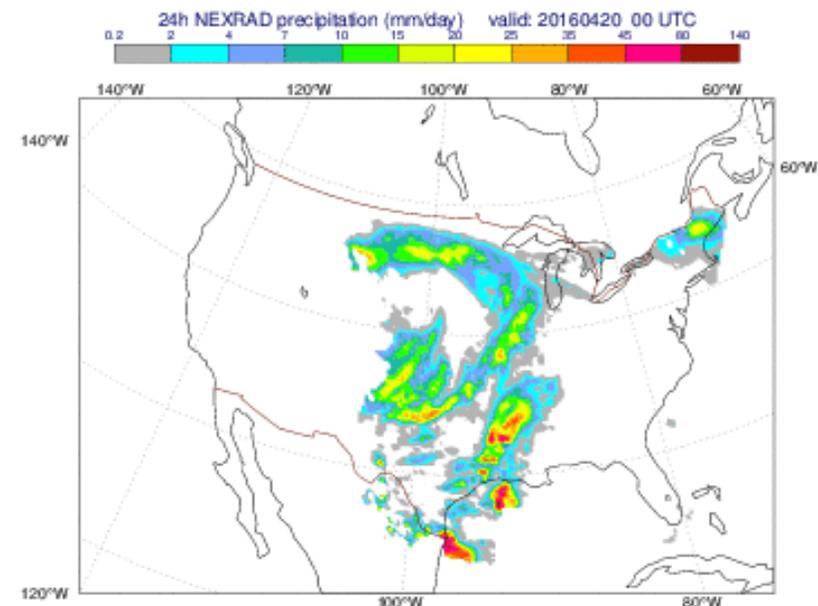
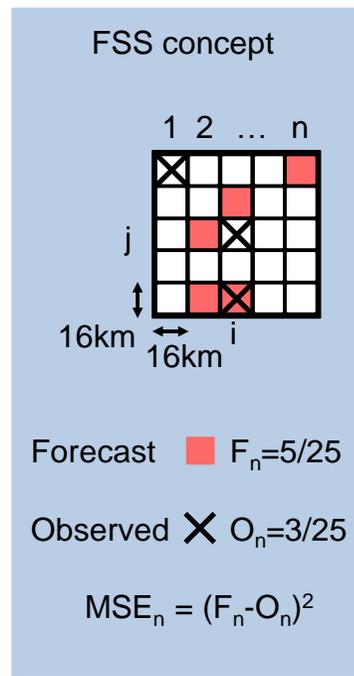
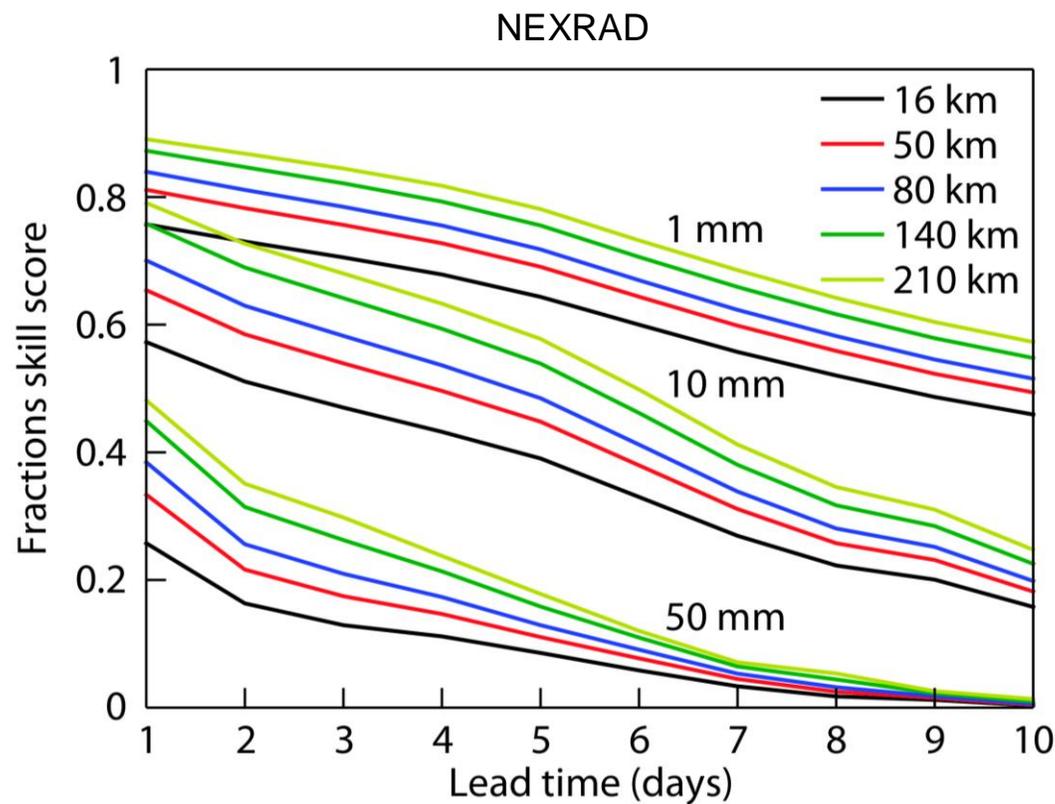
- Displacements in space and time
- Time window more important than spatial uncertainty



High-resolution

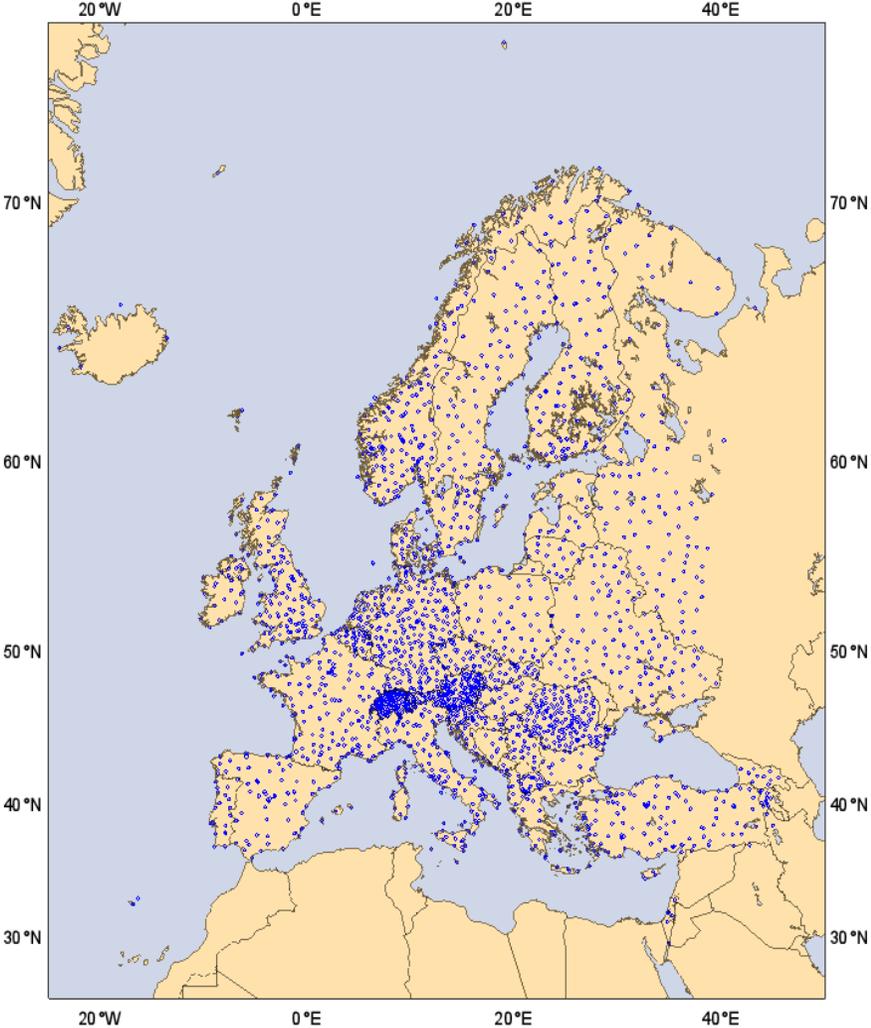


High-resolution (neighbourhood methods)

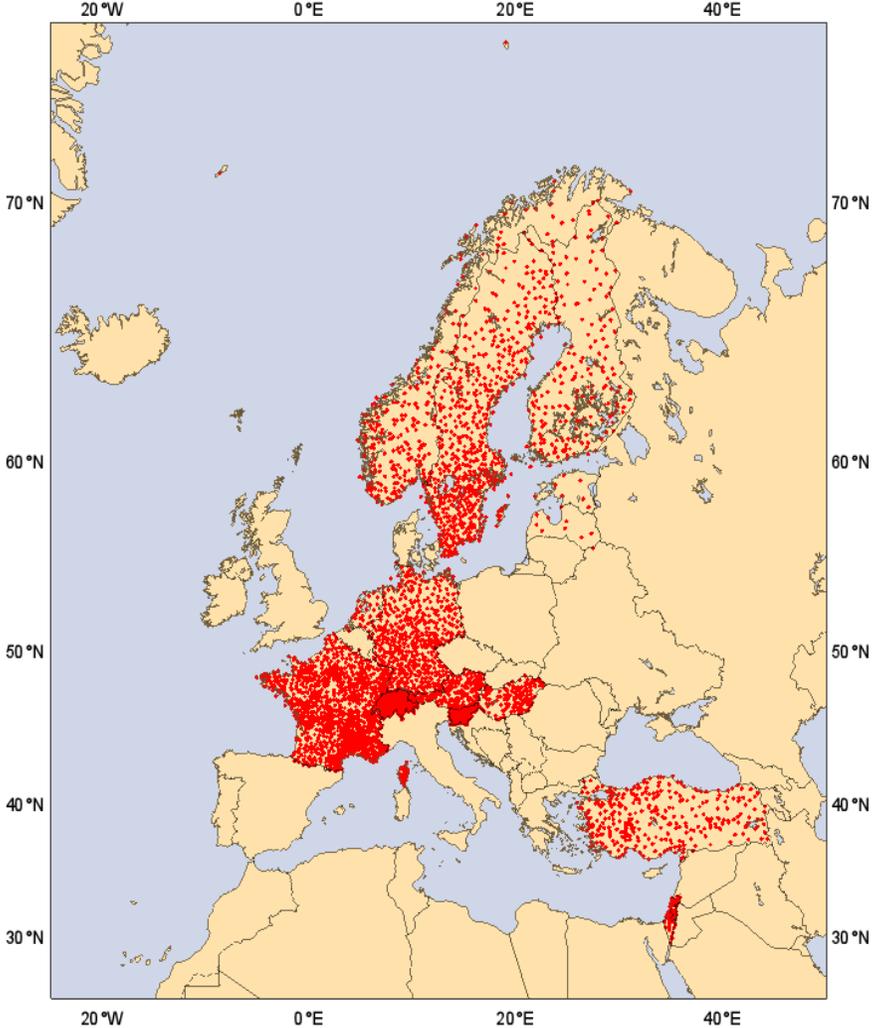


Additional surface observations for verification

SYNOP



HDOBS

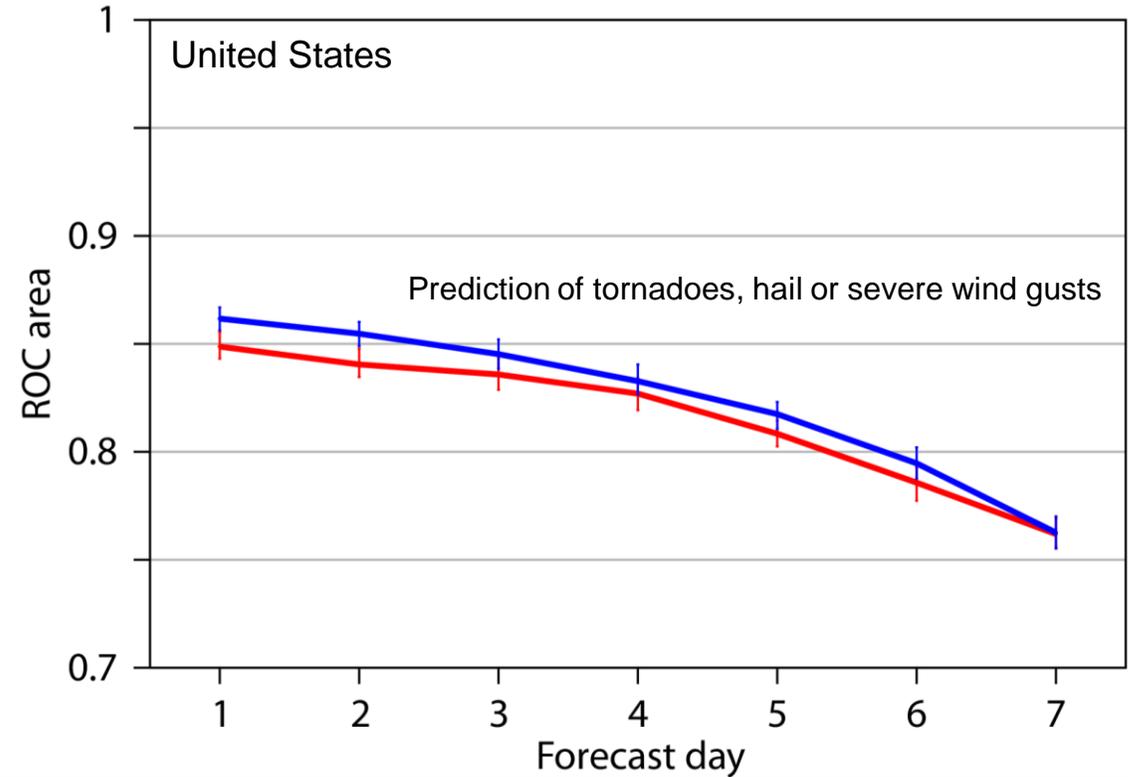
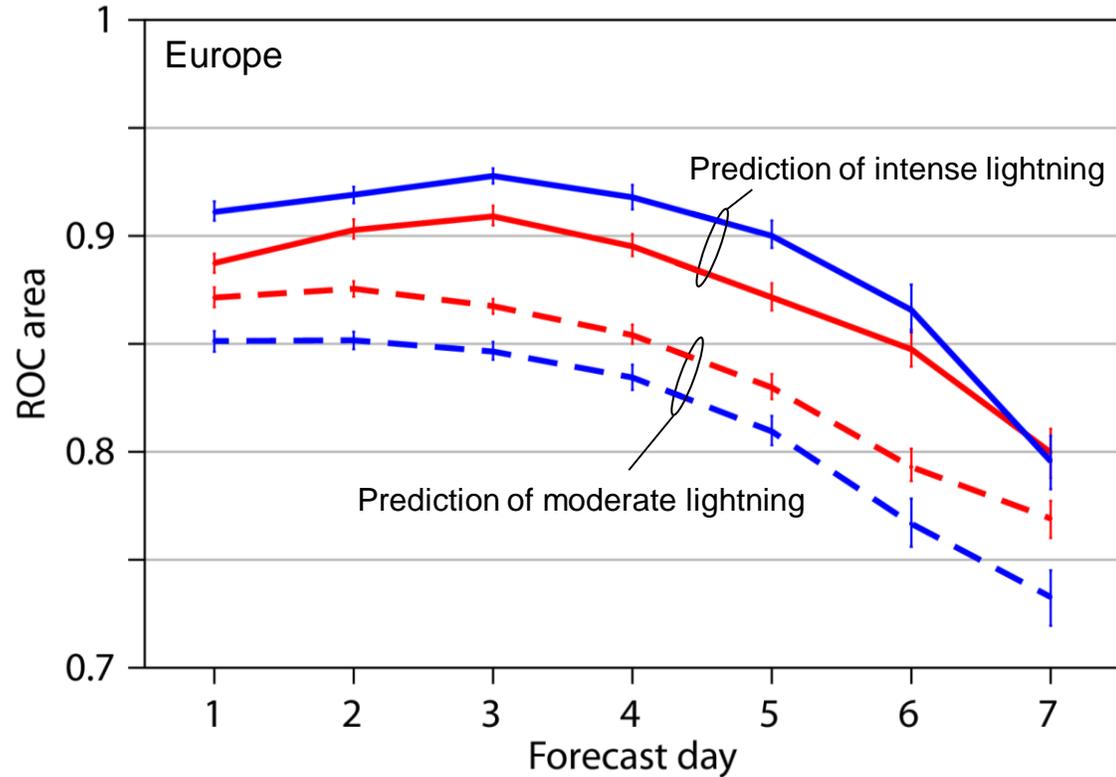


Severe convective storms - EFI for CAPE and CAPE-Shear

New observations for verification: lightning, severe weather reports

EFI { CSP — CAPE

1 April to 31 October 2014

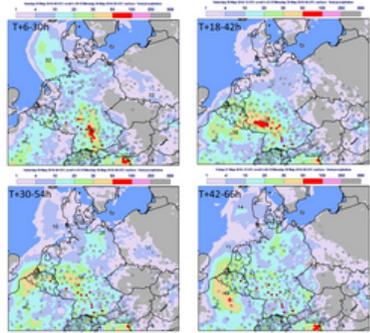


UK Met Office ATDnet lightning detection system. Intense = 0.04% highest frequency, moderate = 0.60% highest frequency.
 Reports of tornadoes, large hail (diameter ≥ 2.5 cm) and severe wind gusts (≥ 26 ms⁻¹)

Severe event catalogue

<https://software.ecmwf.int/wiki/display/FCST/Severe+Event+Catalogue>

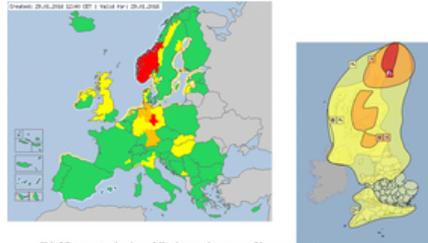
Featured



201605 - Convection - Europe

During the last days of May, western and central parts of Europe from France to Poland and Hungary was hit by events of severe convection and heavy rainfall. A man was killed in southern Poland hit by lightning. In Paris, a birthday party in Parc Monceau was struck, injuring 11 people, eight of them children on Saturday afternoon, 28 May. Several are in a life-threatening condition. Three people were seriously hurt at a youth football match in Germany. Heavy rain caused some localized flooding as well. On 29 May to 30 May torrential rain hit south-western Germany and killed four people. Flash floods affected many businesses and homes. The worst affected region is the town of Braunsbach where floodwaters swept away two bridges as well. Dozens of homes there are at risk of collapse and must be evacuated. This investigation will focus on the event in Germany.

[Read more . . .](#)

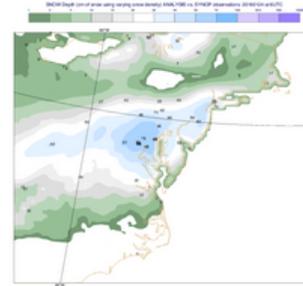


Chief forecaster's: A rapidly deepening area of low pressure is expected to track close to northern Scotland during Friday. There is now high confidence that Shetland will experience the strongest winds, with gusts quite widely above 90mph and perhaps over 100mph in places. The strongest winds will have peaked by late afternoon, though a yellow warning of wind and snow is valid for Friday night and into Saturday.

201601 - Windstorm - Thor

On 29 January a severe windstorm swept from northern British Isles to Norway. It was named as Gertrude and in Norway as Tor. The storm managed to break the all-time wind speed measurement record setting a new value of 48.9 m/s at Krakenes lighthouse north of Bergen on the coast.

[Read more . . .](#)



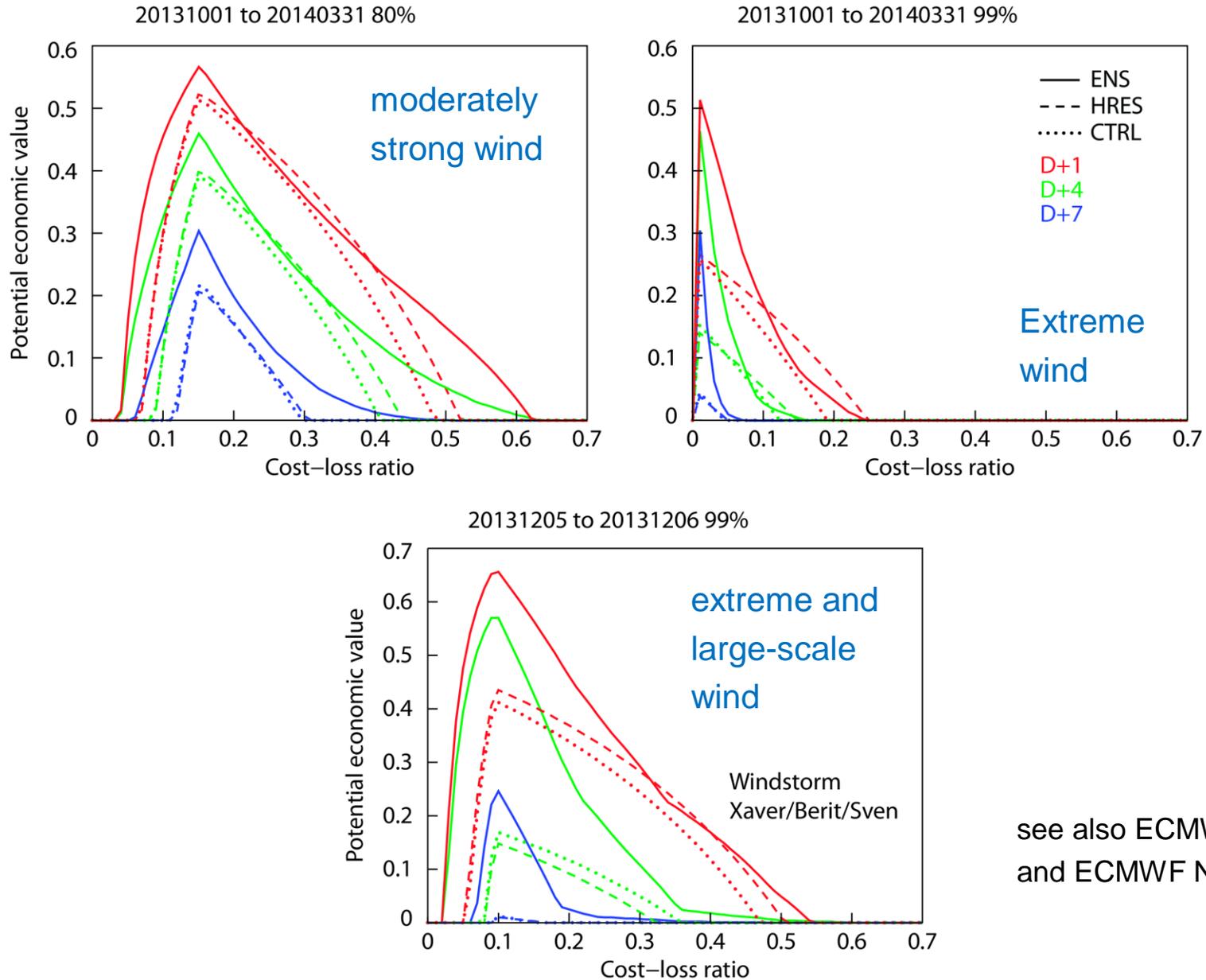
201601 - Snowstorm - US east coast

On 22-24 January a severe blizzard hit the U.S east-coast and broke records in accumulated snowfall in several places. The amount was only mm from the record in Central Park (NYC) and broke the record on JFK. For Washington DC (Dulles) it ranks as the 2nd worst snowstorm. After the cyclone New Jersey was hit by coastal flooding.

[Read more . . .](#)

- 201503 - Tropical Cyclone - Pam
- 201503 - Windstorm - N.W Europe
- 201504 - Heatwave - Arctic
- 201505 - Convection - N.W Europe
- 201505 - Heatwave - Spain, Portugal
- 201506 - Heatwave - Pakistan
- 201507 - Heatwave - Western Europe
- 201507 - Rainfall - NW Europe
- 201508 - Tropical cyclone - Soudelor
- 201509 - Rainfall - Norway
- 201509 - Rainfall - Southern Europe
- 201510 - Rainfall - Southern France
- 201510 - Tropical Cyclone - Patricia
- 201510 - Convection - Israel
- 201511 - Snowfall - Denmark
- 201511 - Windstorm - Gorm / Nils II / Clodagh (Ireland, UK,
- 201512 - Rainfall - British Isles - Part 1
- 201512 - Rainfall - British Isles - Part 2
- 201601 - Snowstorm - US east coast
- 201601 - Cold spell - China
- 201601 - Windstorm - Thor
- 201603 - Windstorm - Katie
- 201604 - Rainfall - US
- 201605 - Heatwave - India
- 201605 - Tropical cyclone - ROANU
- 201605 - Convection - Europe

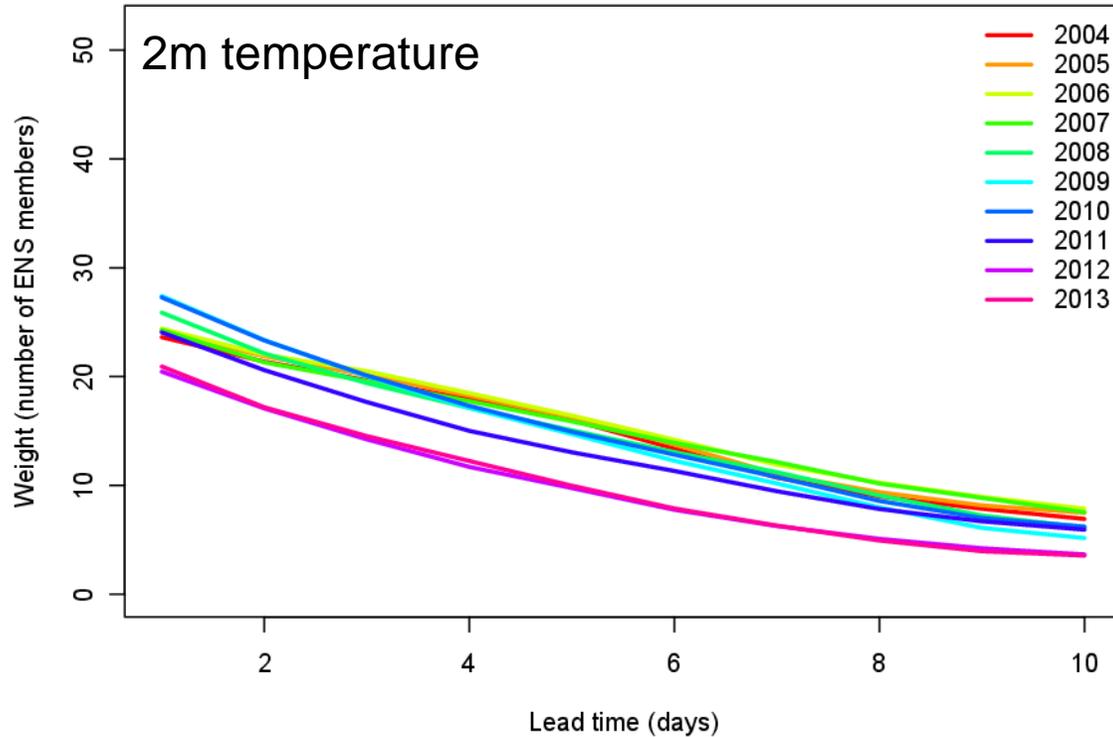
Value of forecasts for decision making



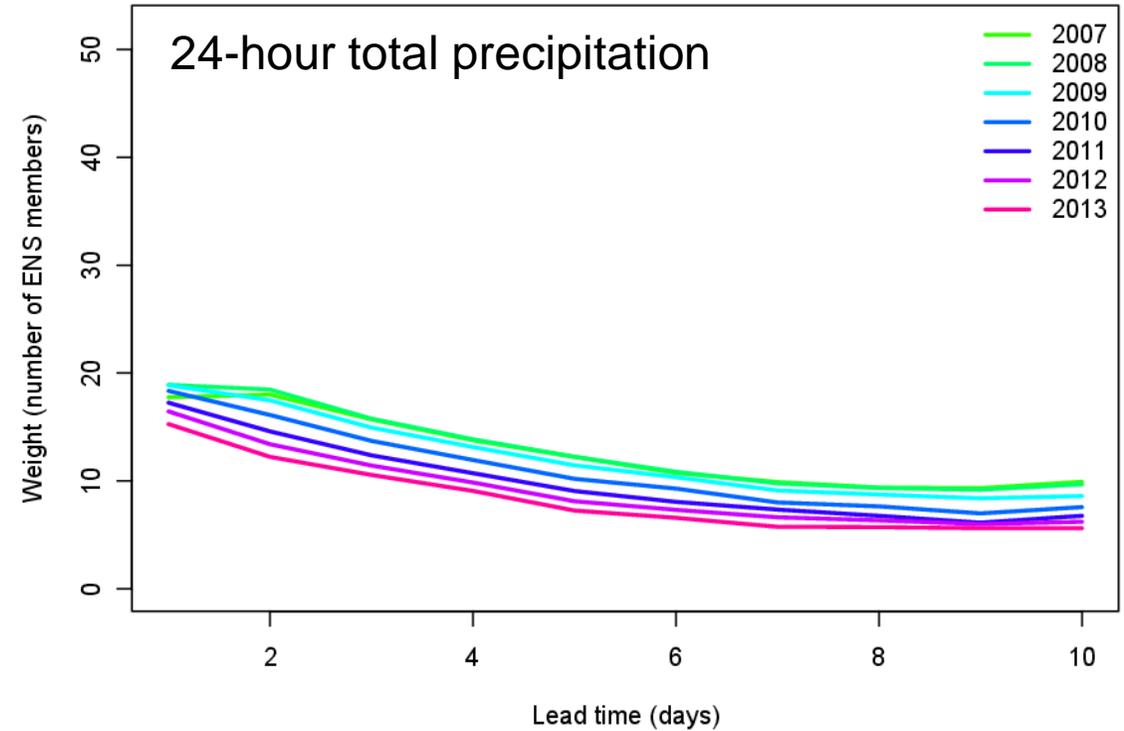
see also ECMWF Newsletter No. 139 (2014)
and ECMWF Newsletter No. 141 (2014)

Combination HRES+CTRL+ENS

Mean weight of HRES



Mean weight of HRES



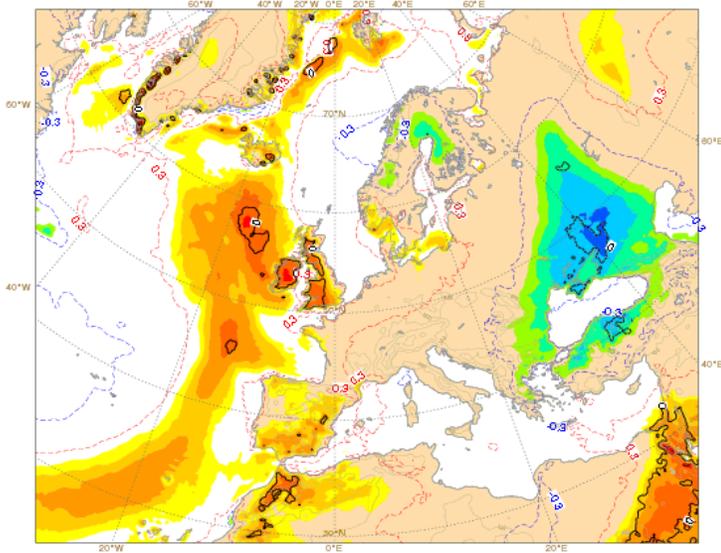
ECMWF Newsletter 142, Winter 2014-15

From Stephan Hemri, HITS

Seamless – appropriate processing in space and time-scale

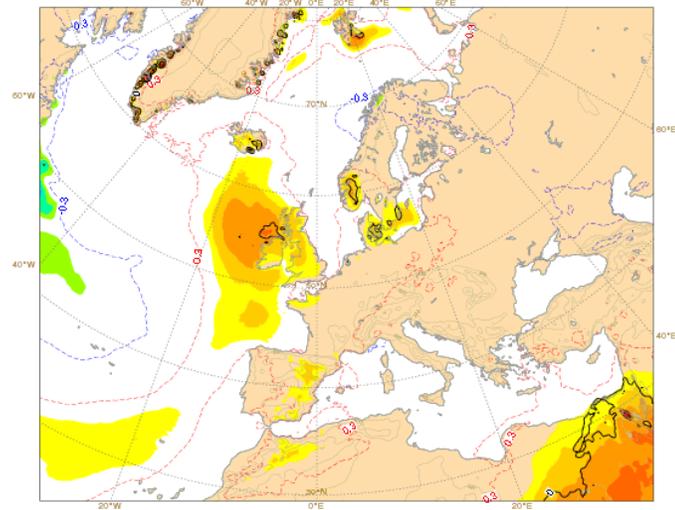
EFI 2m temperature (Sunday forecast for Wednesday)

Sun 05 Jun 2016 00UTC @ECMWF t+72-96h VT: Wed 08 Jun 2016 00UTC - Thu 09 Jun 2016 00UTC
Extreme forecast index and Shift of Tails (black contours 0,1,2,5,8) for 2m mean temperature



EFI 2m temperature (last Tuesday's forecast for Monday-Wednesday)

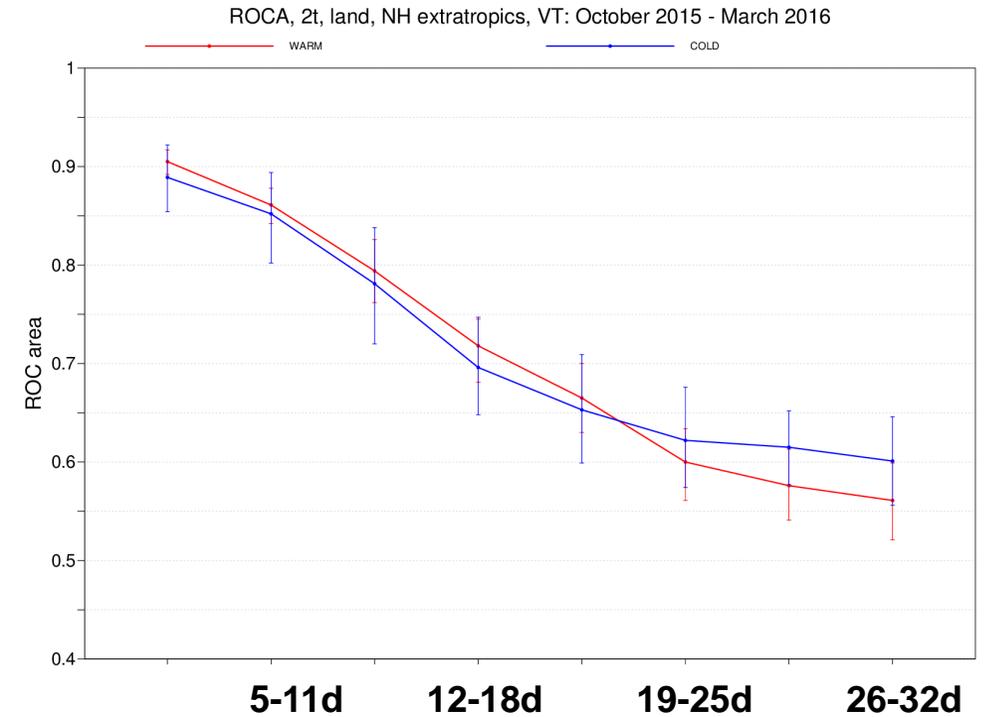
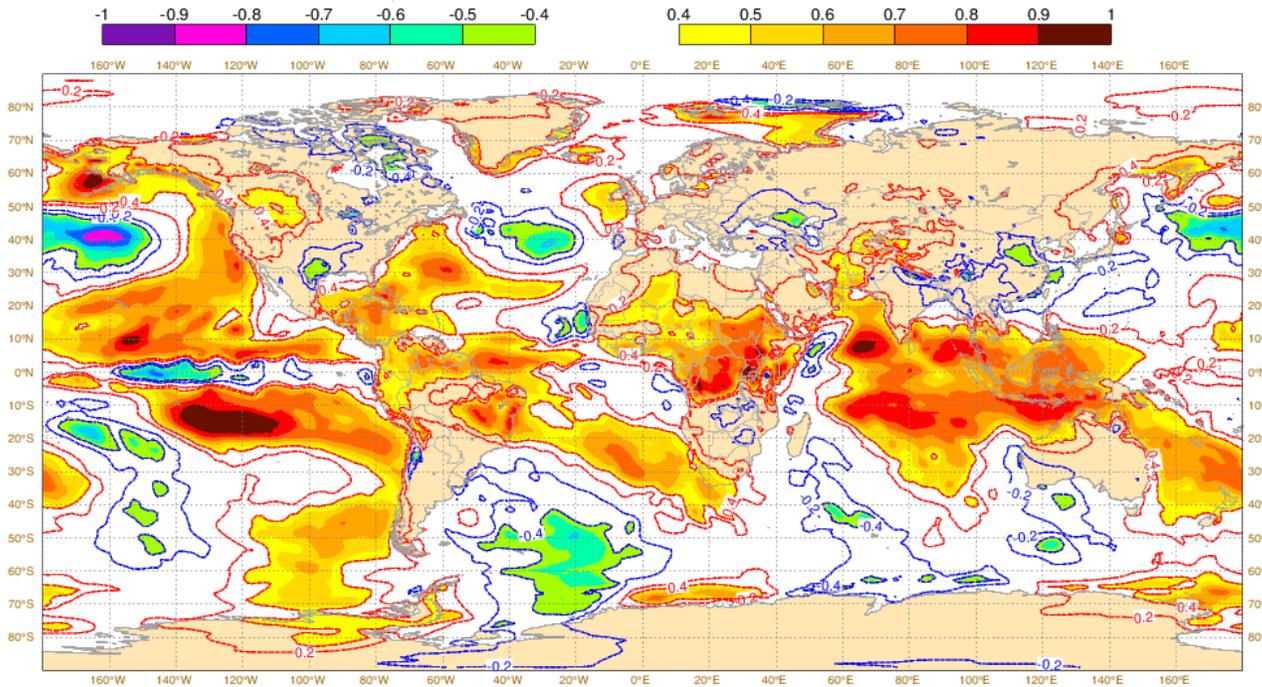
Tue 31 May 2016 00UTC @ECMWF t+144-216h VT: Mon 06 Jun 2016 00UTC - Thu 09 Jun 2016 00UTC
Extreme forecast index and Shift of Tails (black contours 0,1,2,5,8) for 2m mean temperature



Seamless – appropriate processing in space and time-scale

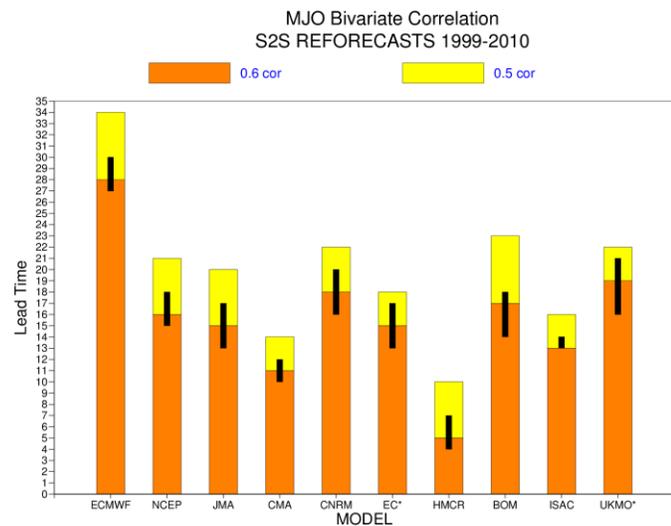
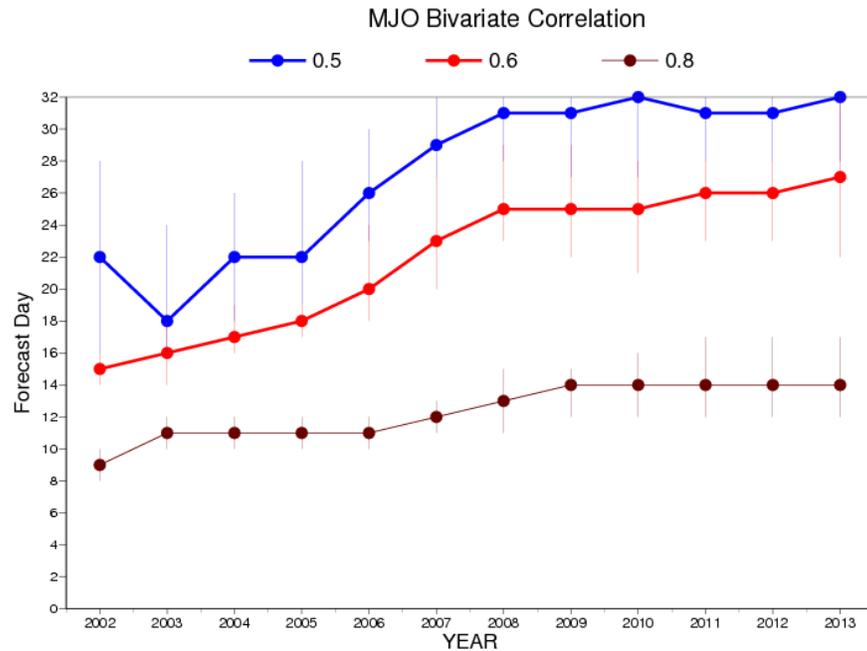
EFI 2m temperature (12-18 days)

Thu 26 May 2016 00UTC @ECMWF VT: Mon 06 Jun 2016 00UTC - Mon 13 Jun 2016 00UTC 264-432h
Extreme forecast index for: 2m mean temperature

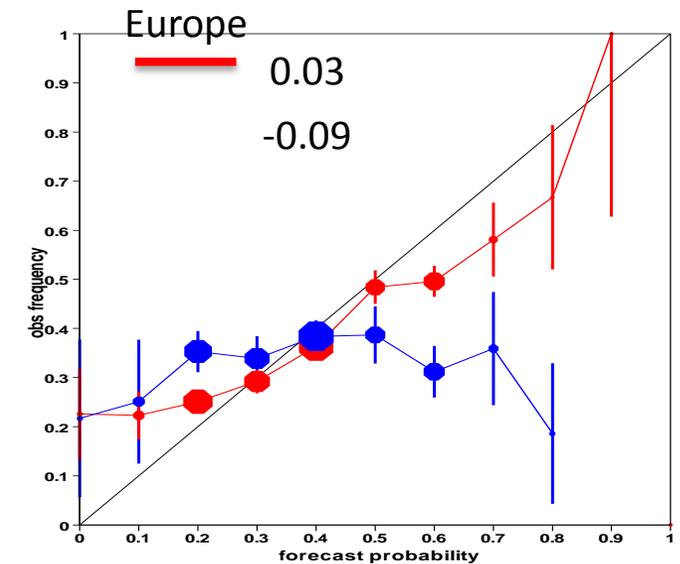
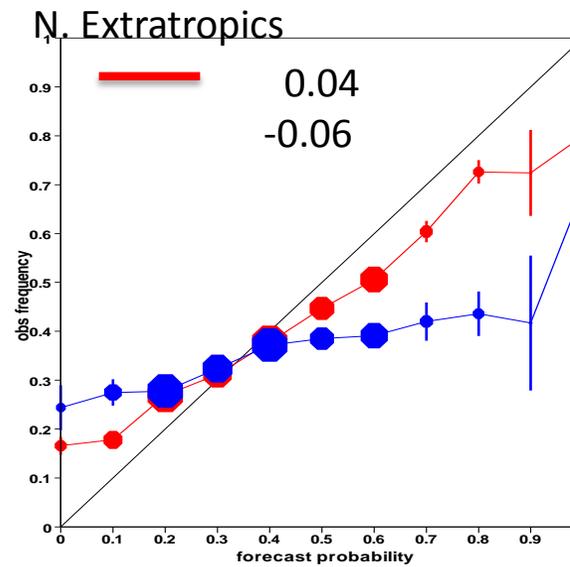


(from Ivan Tsonevsky)

Extended-range sources of predictability - MJO



Reliability Diagram
Probability of 2-m temperature in the upper tercile
Day 19–25



MJO in IC

NO MJO in IC

Regimes and conditional verification

Which Flow patterns lead to a more/less accurate forecast?

Flow dependent verification over Euro-Atlantic sector:

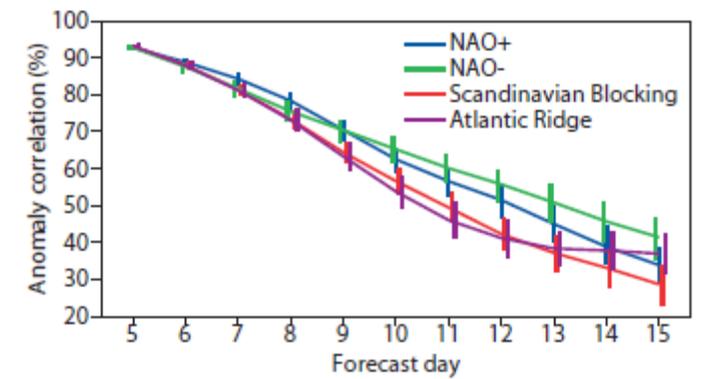
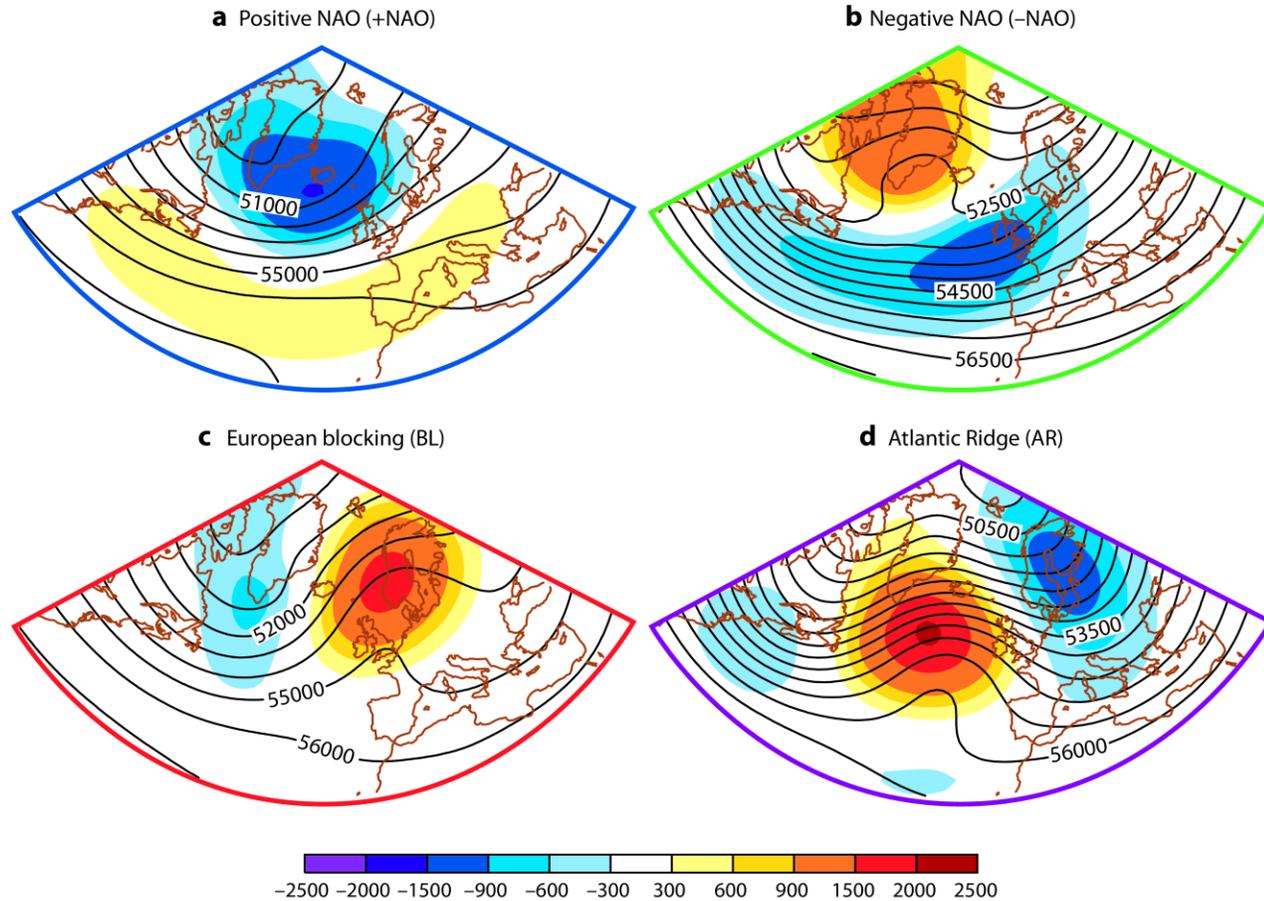


Figure 2 Anomaly correlation of the ensemble for the four forecast categories as a function of forecast range for Europe for five cold seasons (October–March 2007/08 to October–March 2011/12). The bars, based on 1,000 subsamples generated with the bootstrap method, indicate the 95% confidence intervals.

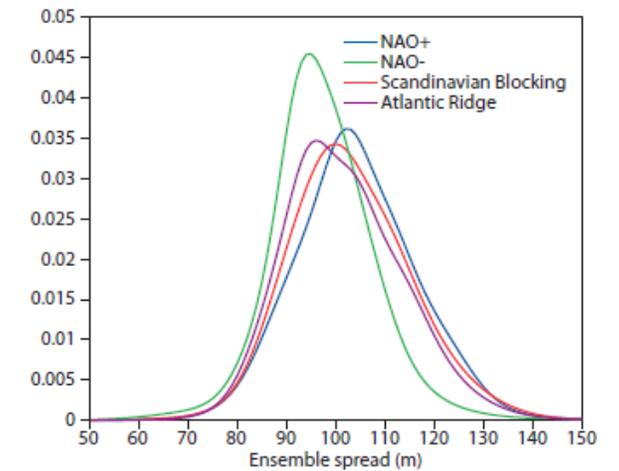


Figure 5 Ensemble spread distribution at day 10 for forecasts initiated in NAO+, NAO-, Scandinavian Blocking and Atlantic Ridge regimes. The NAO- spread distribution is significantly ($p < 0.001$) different from the other spread distributions according to the Kolmogorov Smirnov test.

Summary

- Strategy for next 10 years
 - Ensemble predictions of **high impact weather up to two weeks ahead**
 - Seamless approach, aiming towards predictions of **large scale patterns and regime transitions up to four weeks ahead** and global-scale anomalies up to a year ahead
- Verification challenges
 - High-impact weather
 - Small sample sizes
 - High-resolution ensemble
 - Earth-system model
 - Observations
 - Regime transitions
 - Combined HRES+CTRL+ENS
 - Sources of predictability: conditional verification
 - Seamless: spatial/temporal processing to extract the signal

Evaluation of forecast performance

- New model cycles
- Diagnostic study of model behaviour
- Comparison with reference systems
- Comparison with other centres
- Evaluation for severe weather
- See ECMWF web site for latest results

www.ecmwf.int/en/forecasts/quality-our-forecasts

- Severe event catalogue
- Known forecasting issues

TECHNICAL MEMORANDUM

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Evaluation of ECMWF forecasts, including 2014-2015 upgrades

T. Haiden, M. Janousek, P. Bauer,
J. Bidlot, M. Dahoui, L. Ferranti, F. Prates,
D.S. Richardson and F. Vitart

Research and Forecast Department

November 2015

This paper has not been published and should be regarded as an Internal Report from ECMWF.
Permission to quote from it should be obtained from the ECMWF.



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