



Progress in wind forecasting in the ECMWF model

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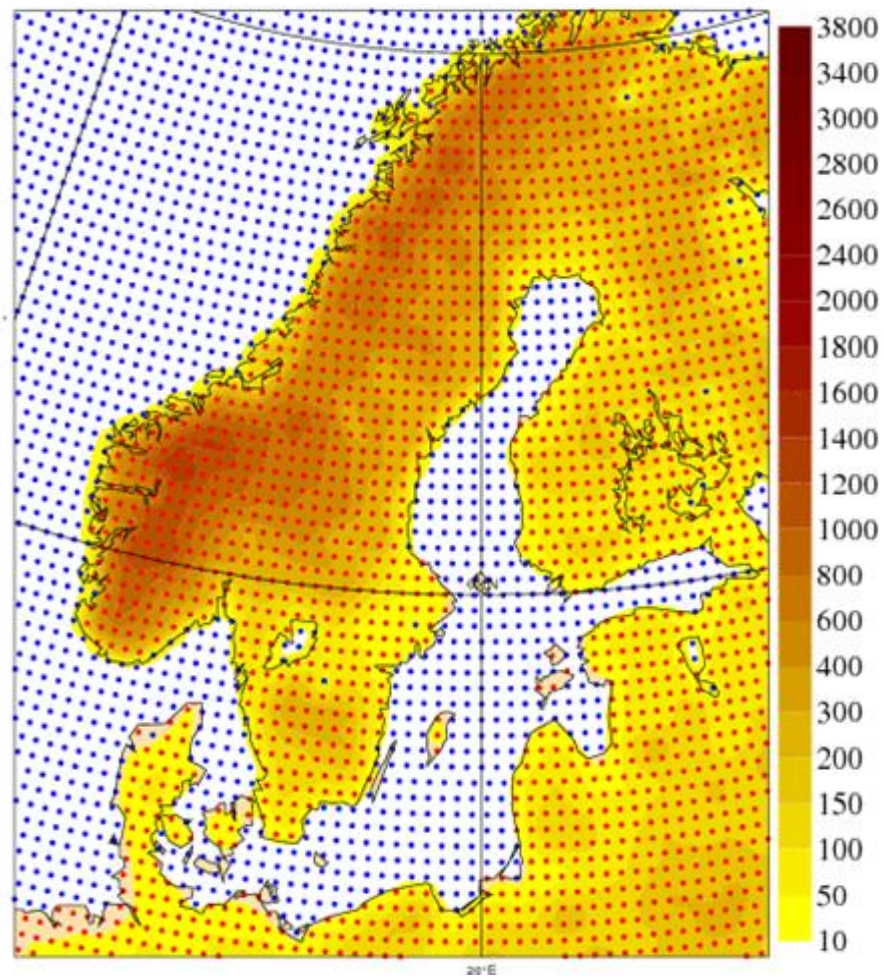
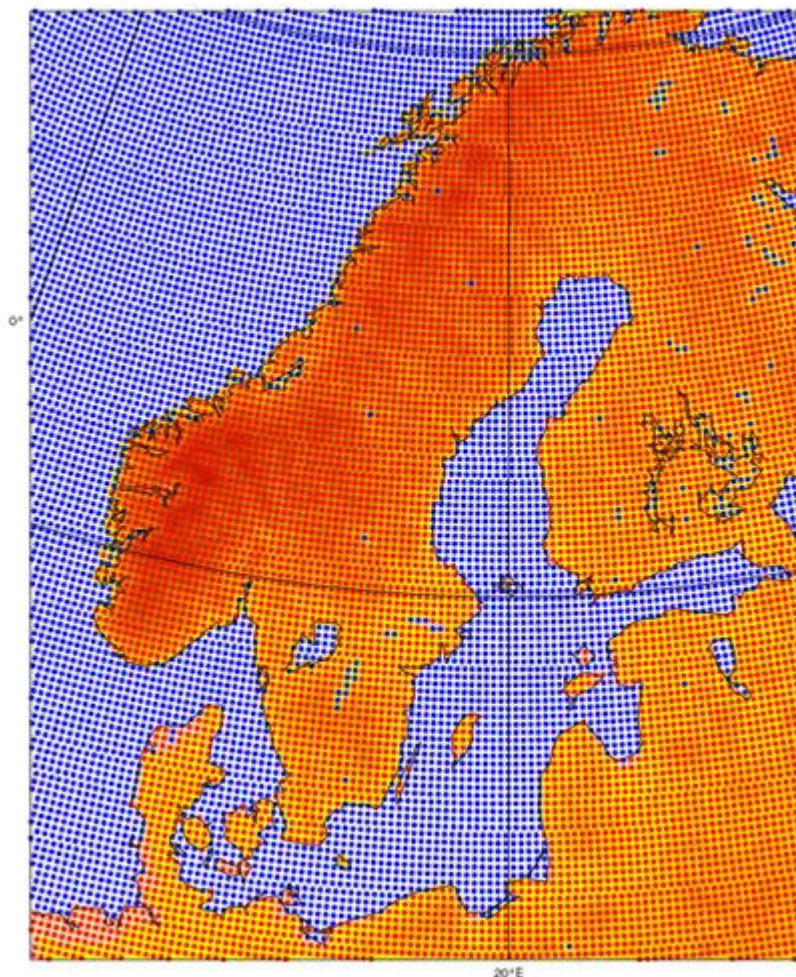
Overview

- ECMWF forecasts
- Forecast error and model improvements
- Ensemble v deterministic forecast
- Ensemble calibration
- Next model upgrade (spring 2016)
- Summary

ECMWF forecasts

High resolution forecast
T1279 (16 km)

Ensemble forecast
T639 (32 km)



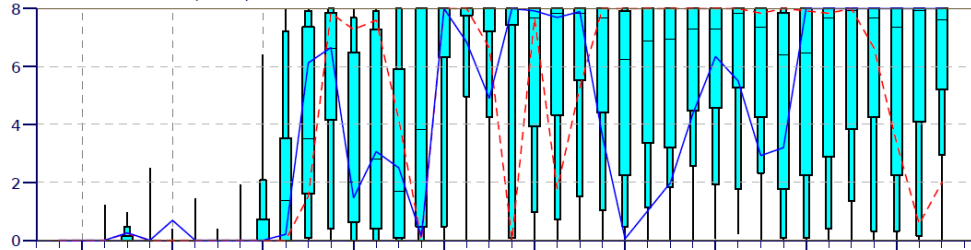
ECMWF forecast, Leuven

ENS Meteogram

Leuven, Belgium 51.01°N 4.58°E (EPS land point) 35 m

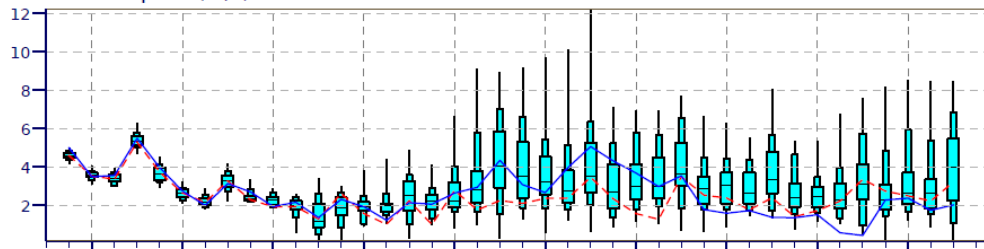
High Resolution Forecast and ENS Distribution Wednesday 30 September 2015 12 UTC

Total Cloud Cover (okta)



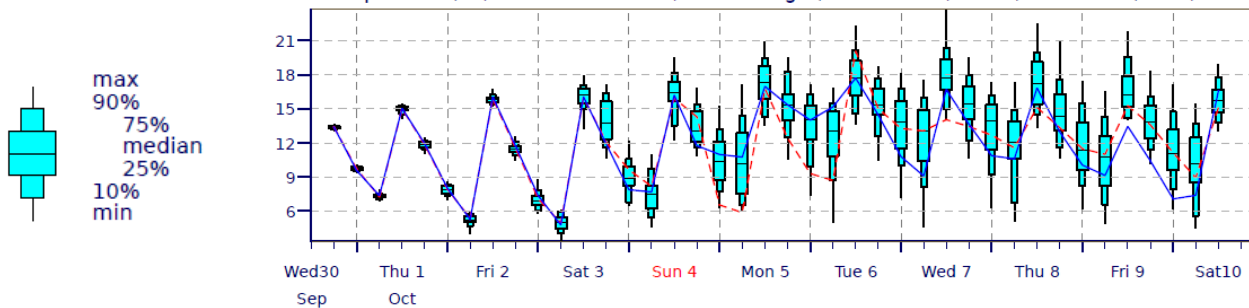
Cloud cover

10m Wind Speed (m/s)



Wind speed

2m Temperature(°C) reduced to 35 m (station height) from 15 m (T1279) and 11 m (T639)

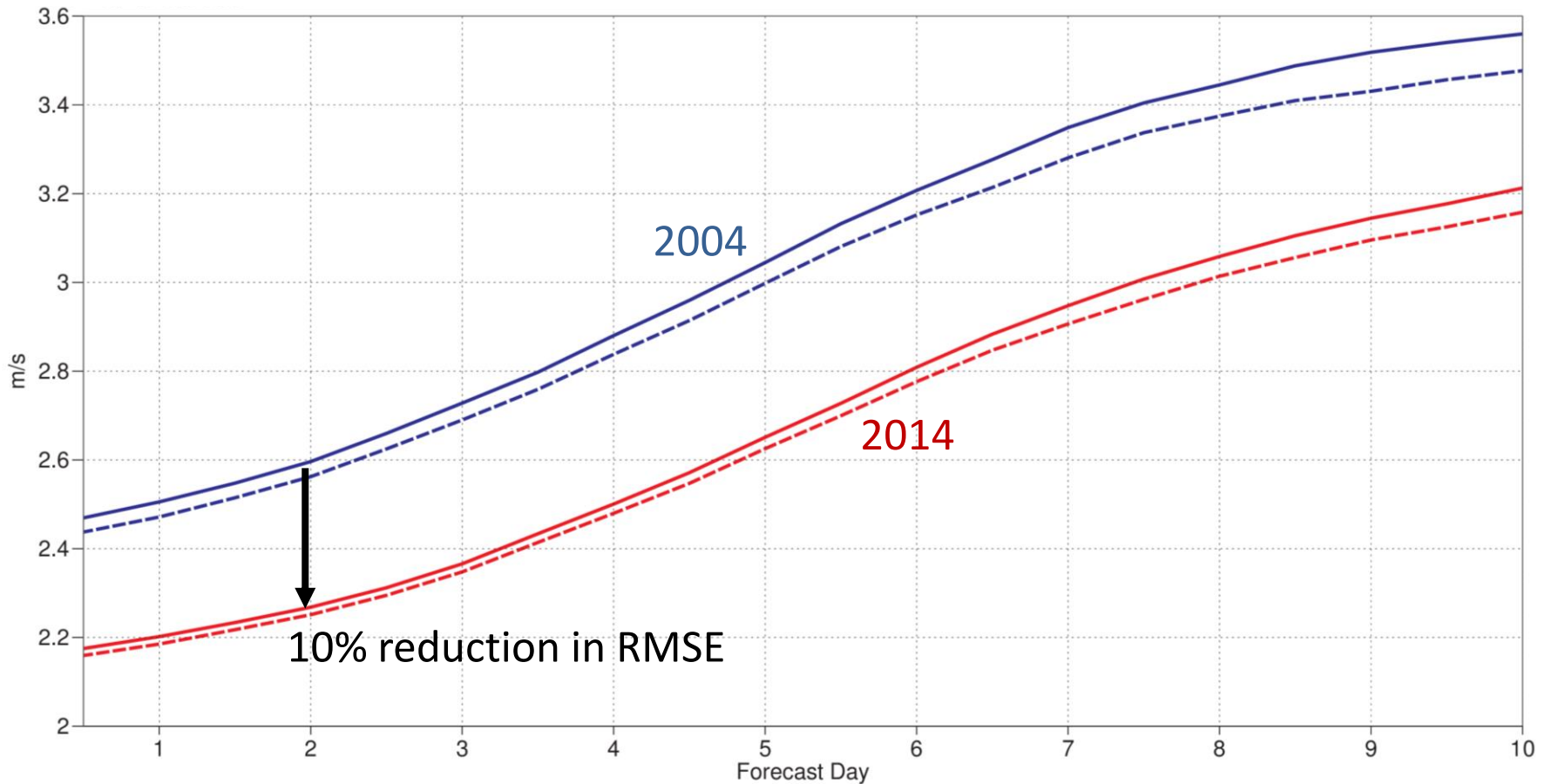


Temperature

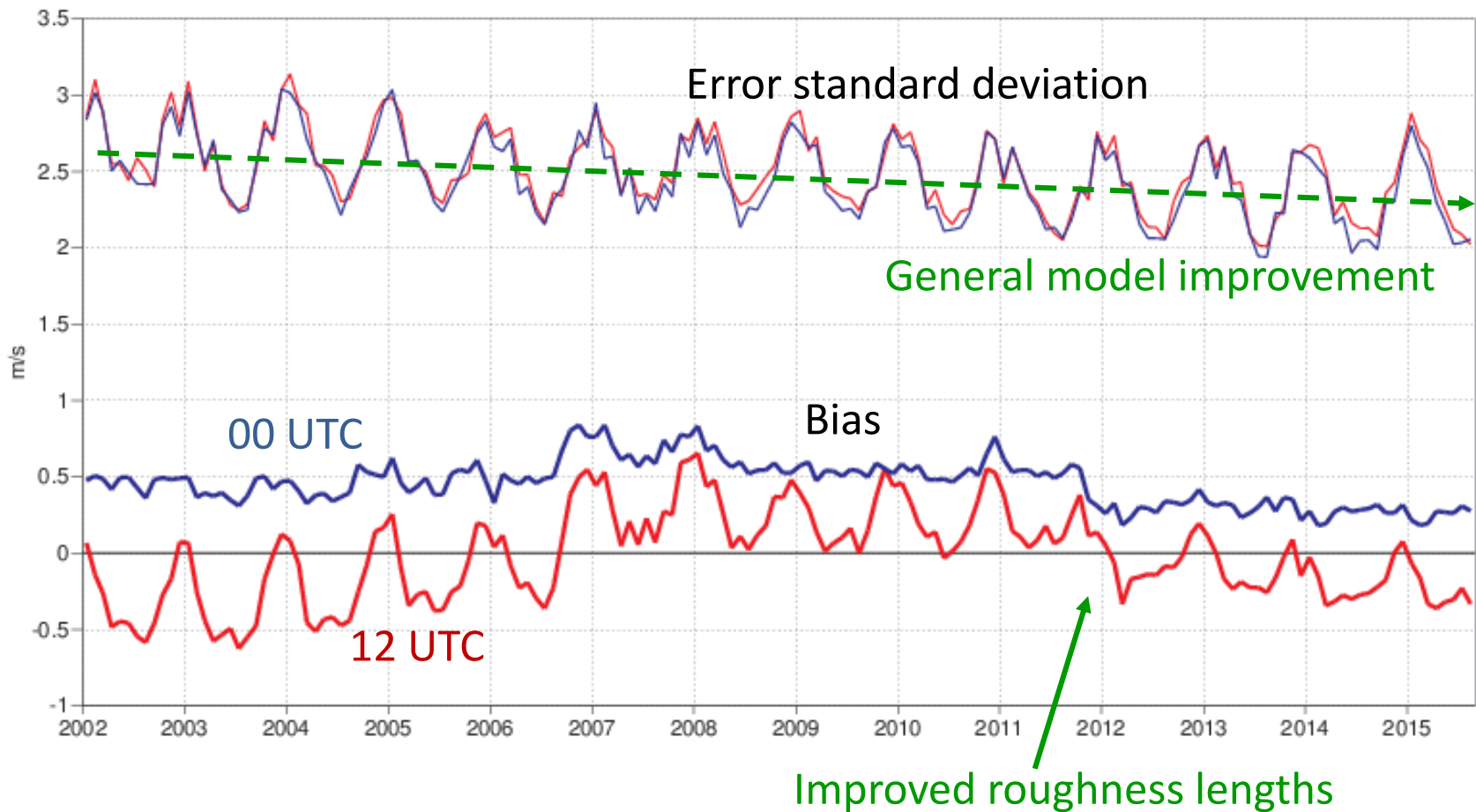
Forecast performance

Point forecast errors in Europe

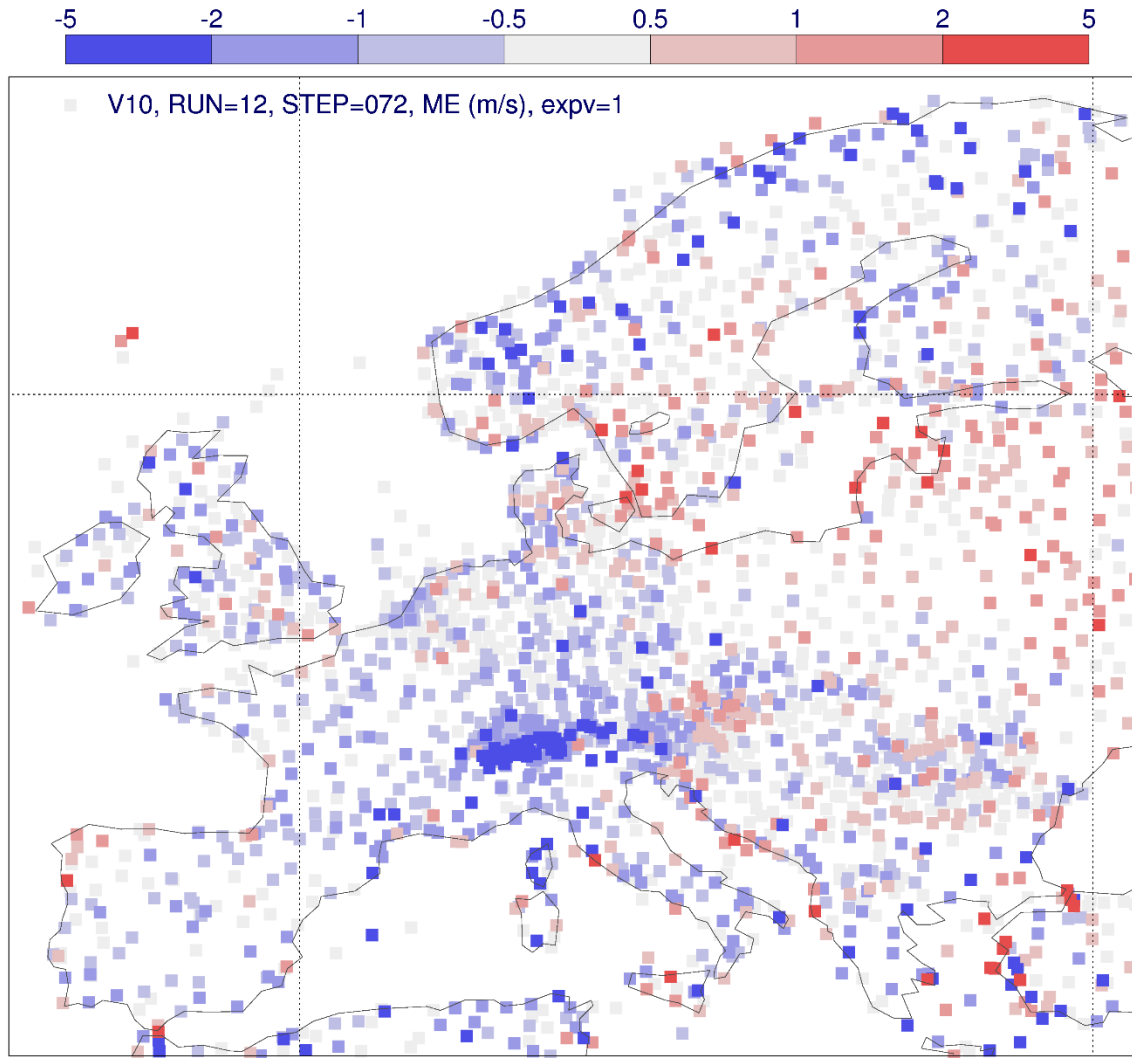
10-m wind: verification against SYNOP



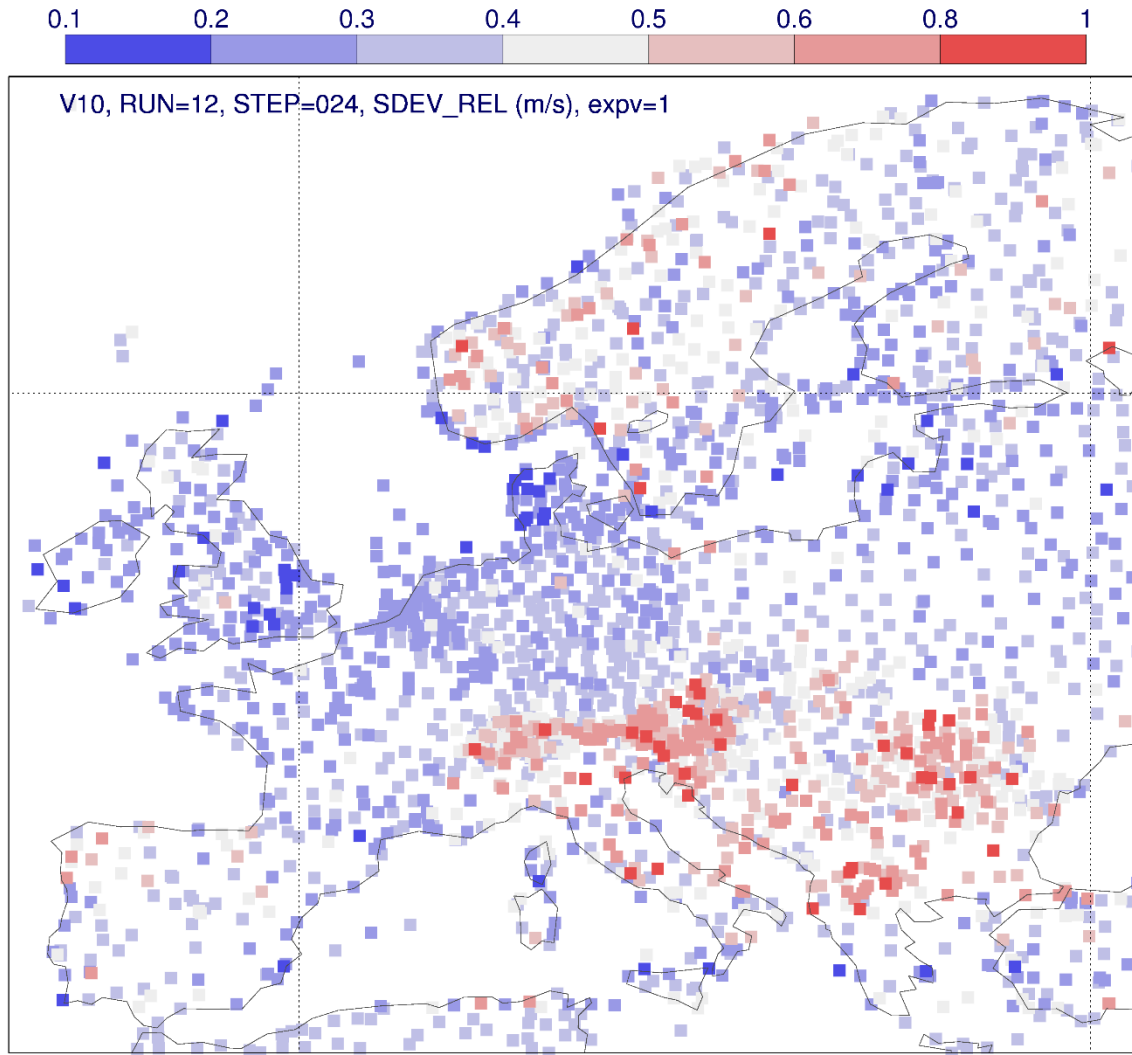
Point forecast errors in Europe (Day 3)



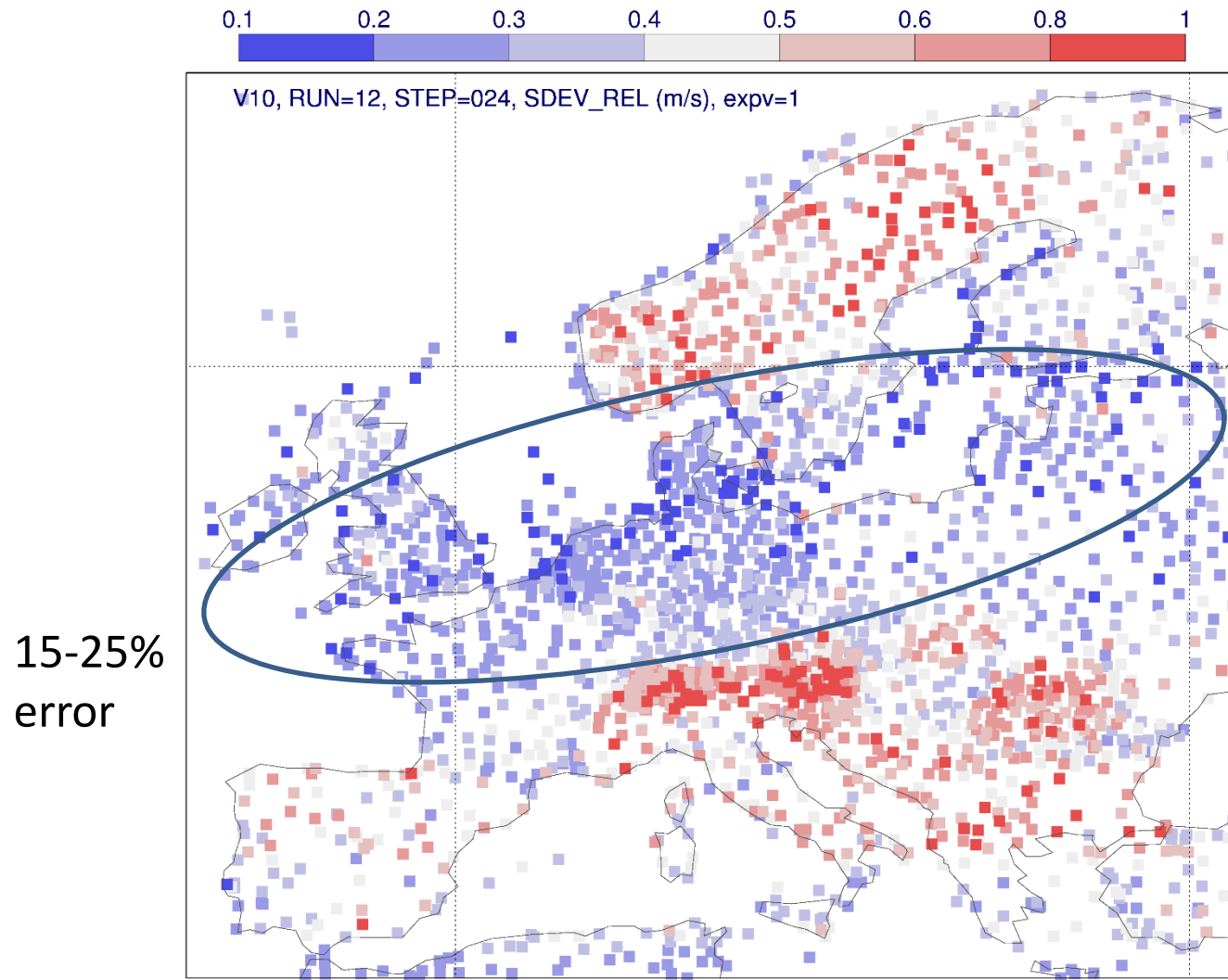
Systematic error (bias), summer



'Random' error (normalized), summer

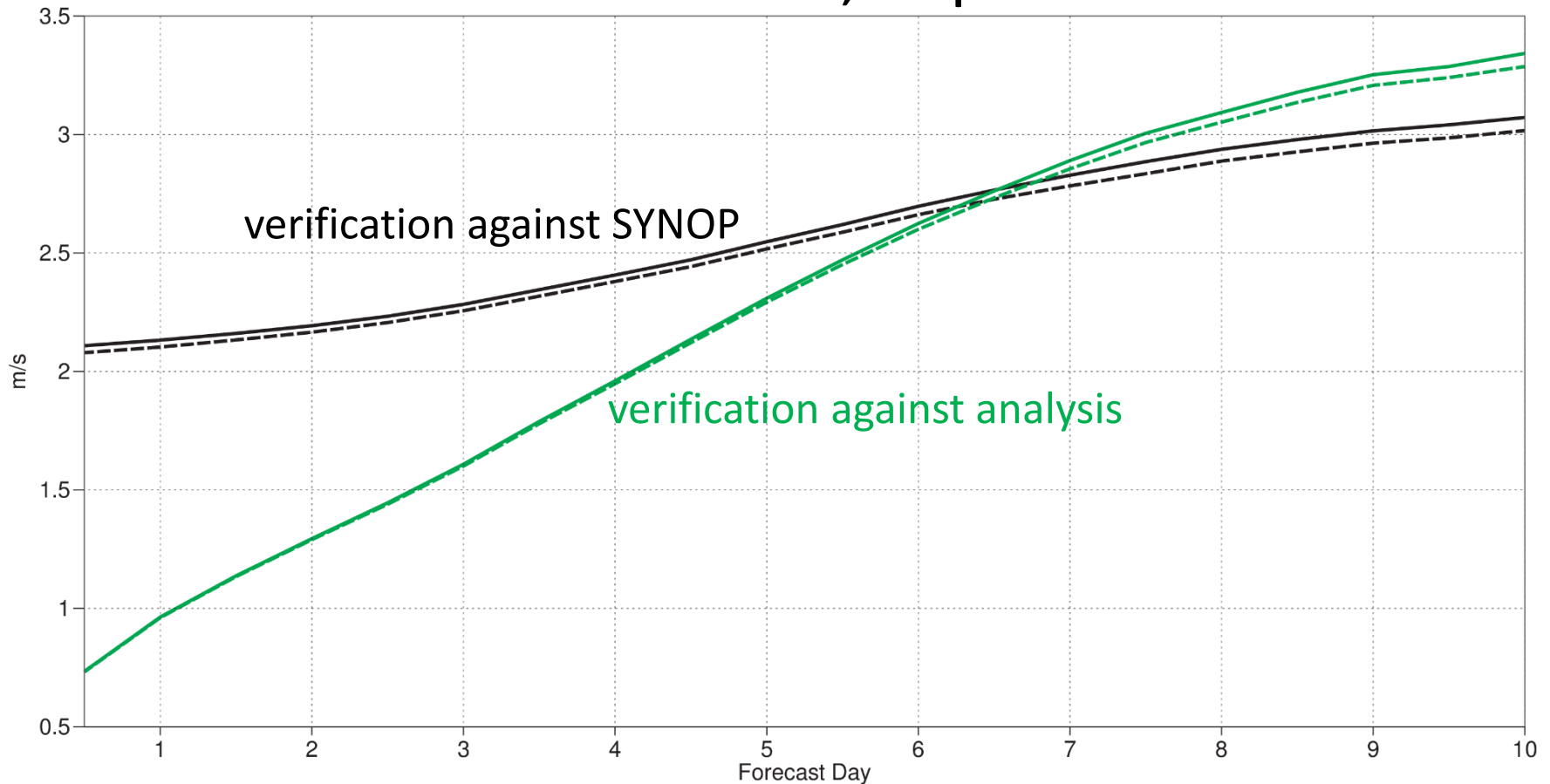


'Random' error (normalized), winter

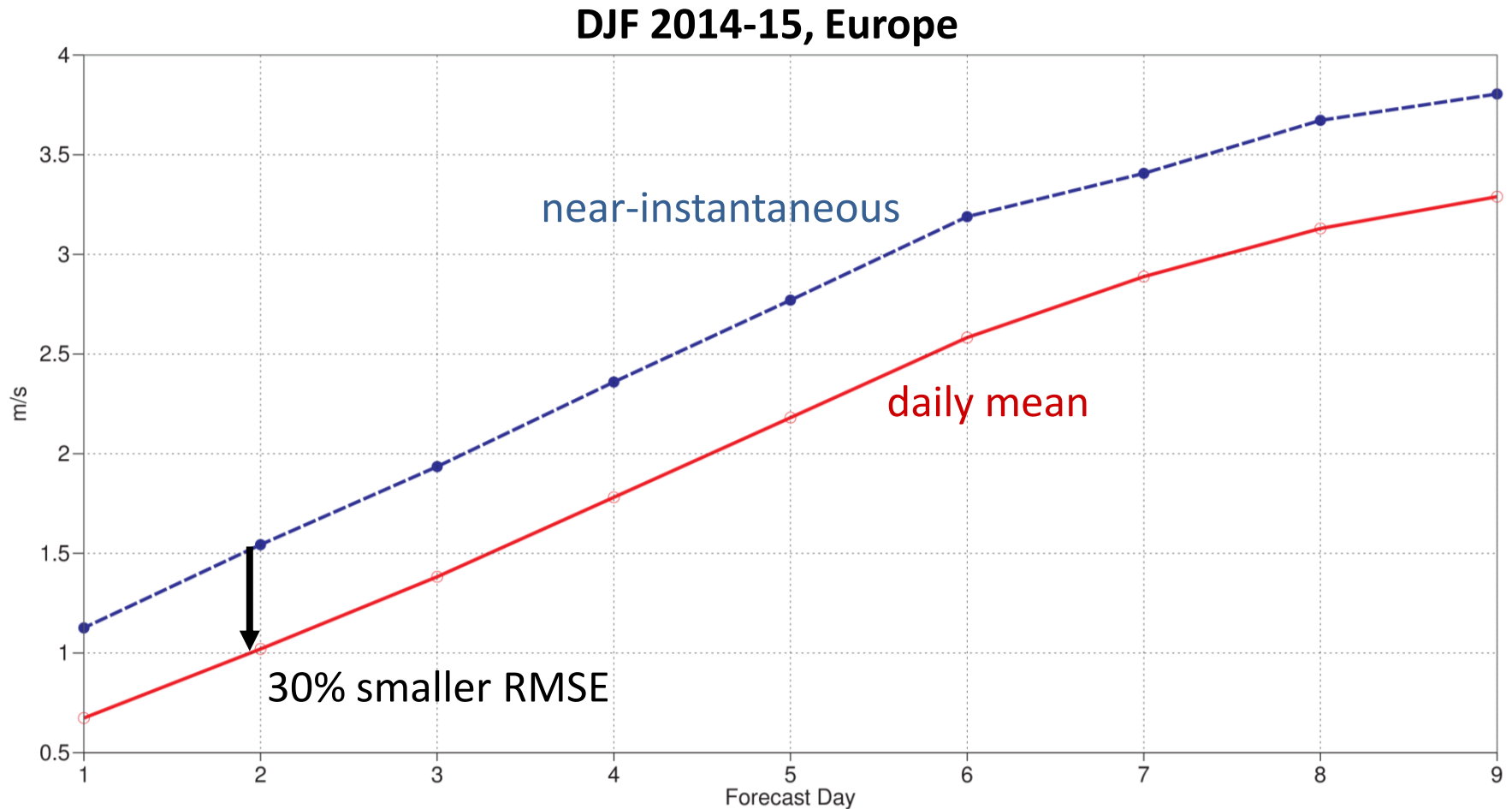


Spatial representativeness

Jan-Dec 2014, Europe



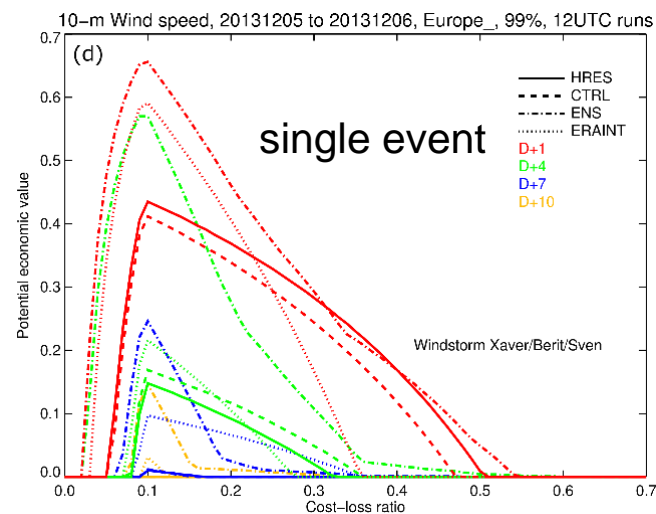
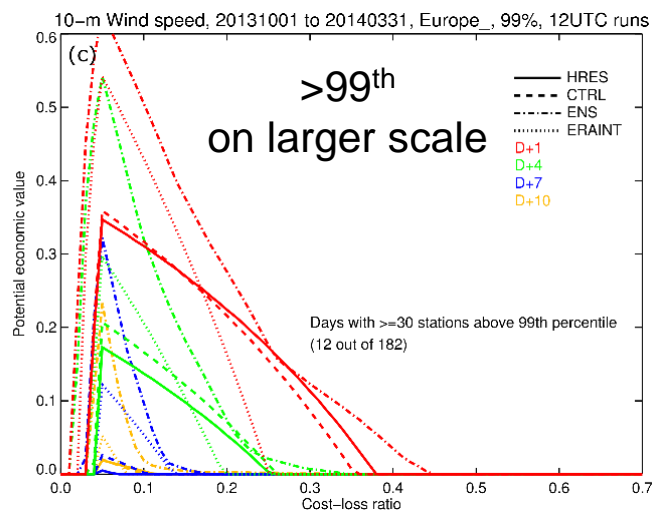
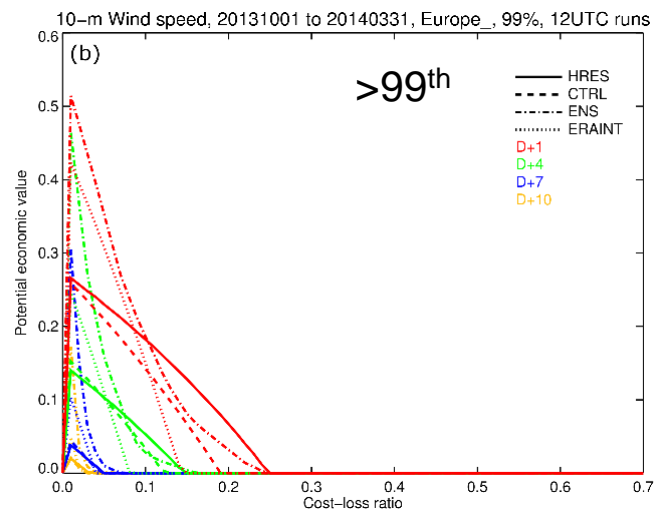
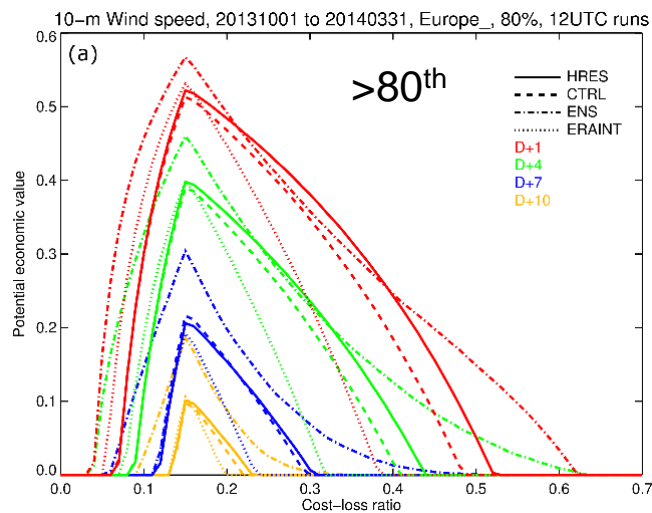
Temporal representativeness

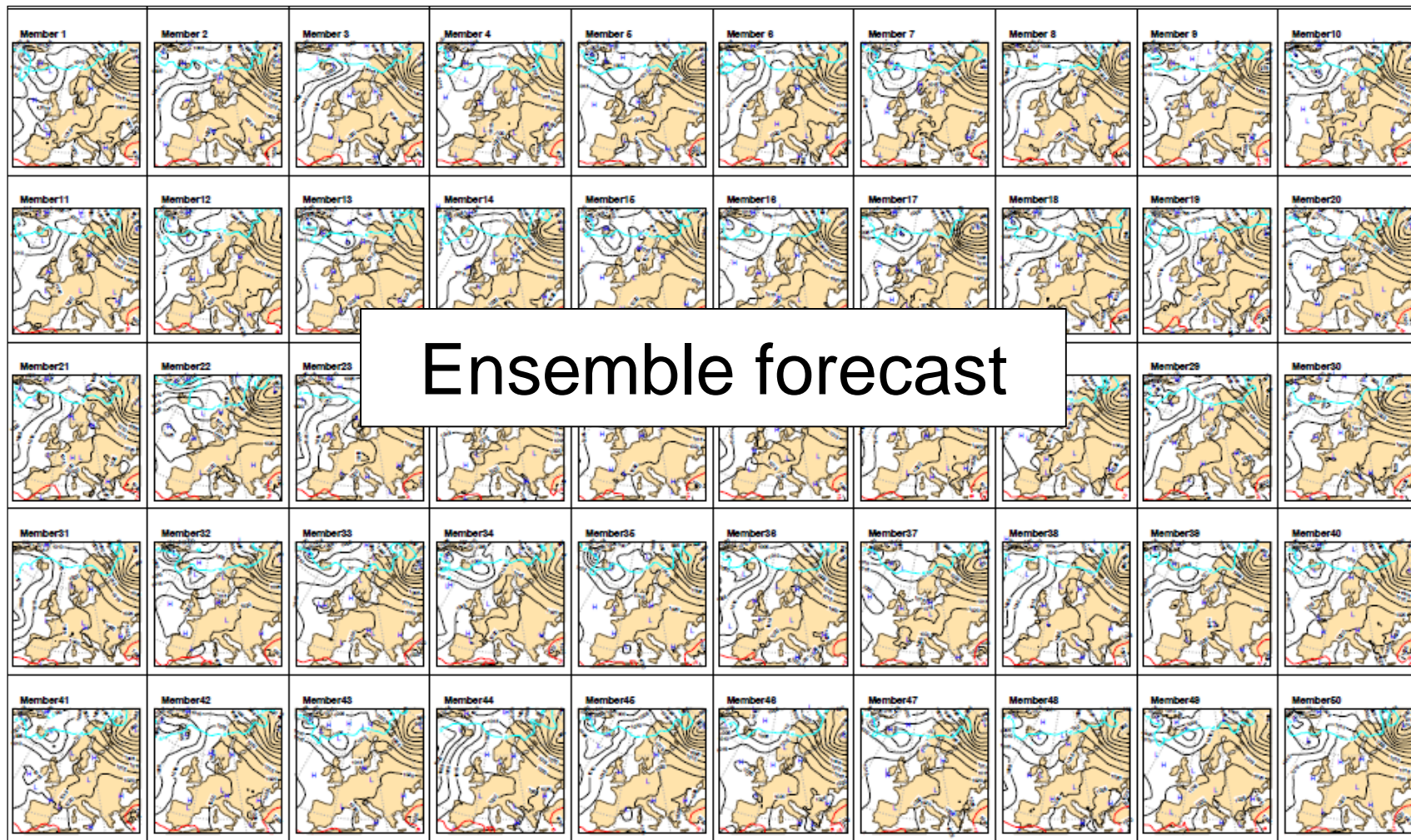


Extreme wind events

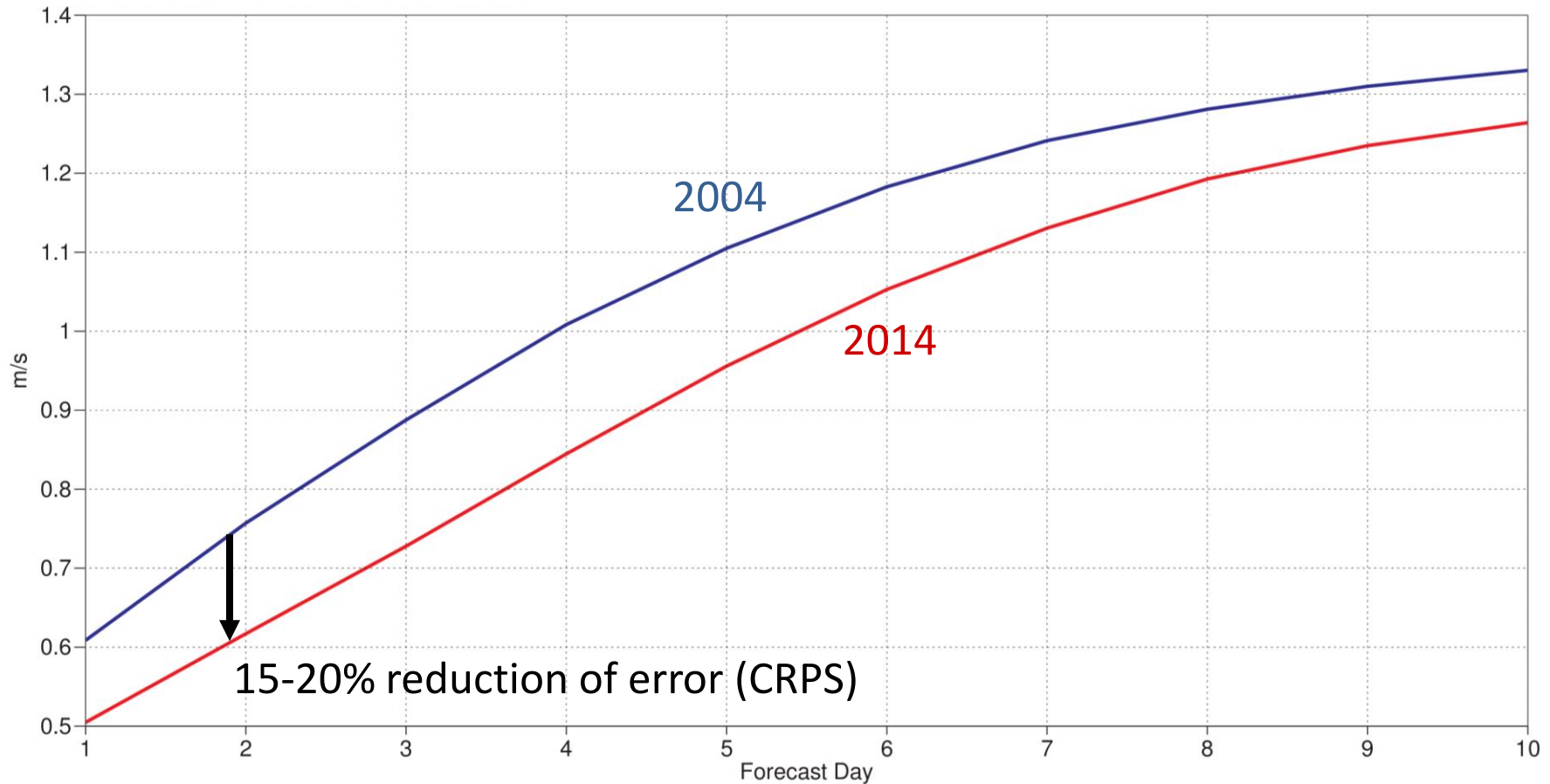


Extreme wind events

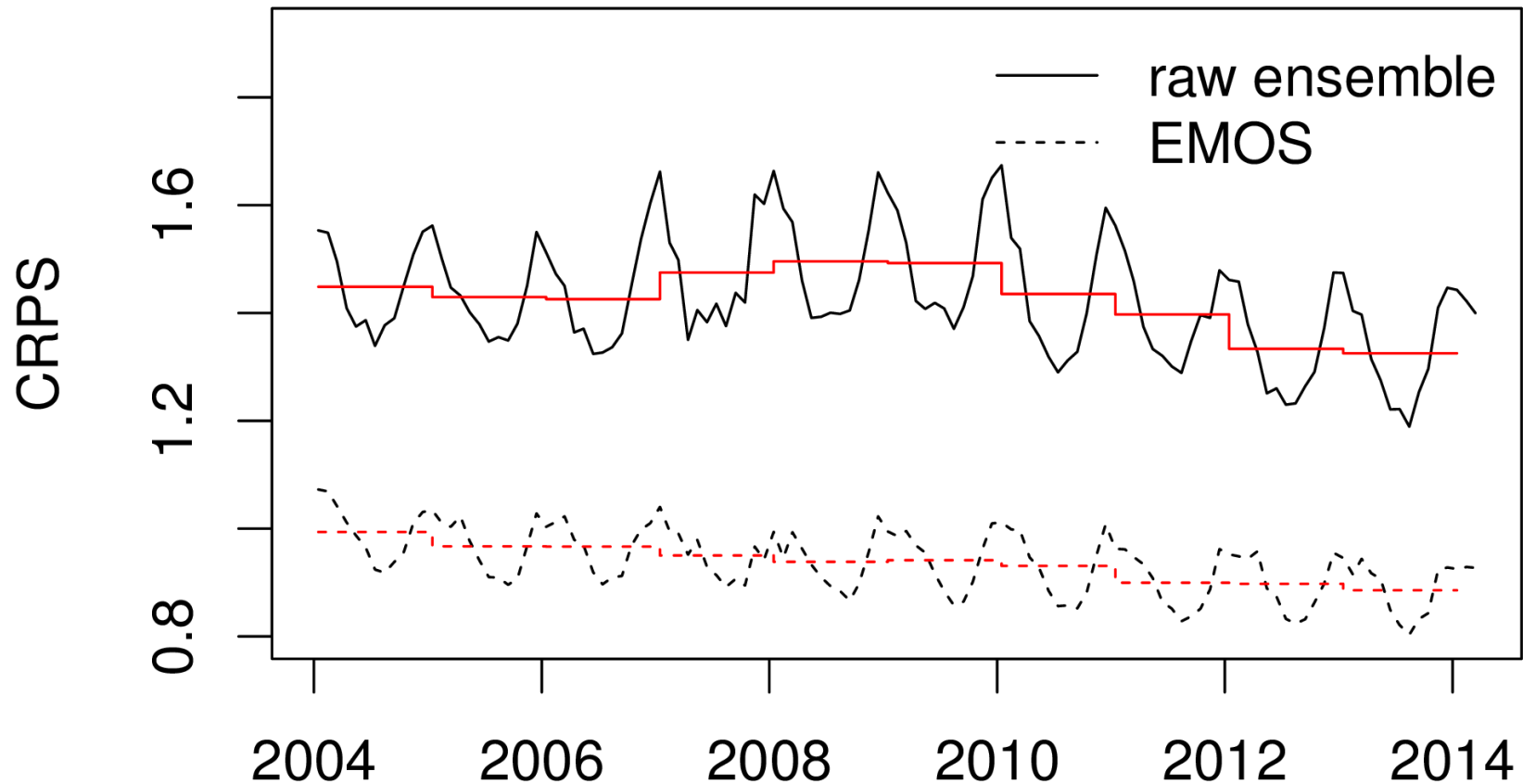




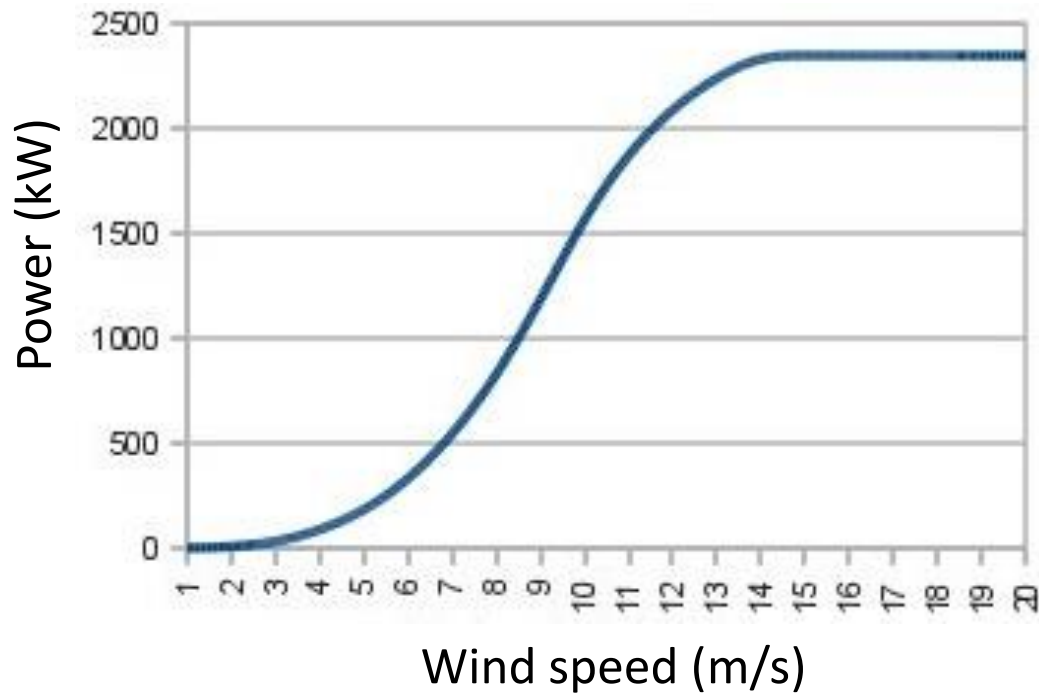
Ensemble forecast, NH extra-tropics



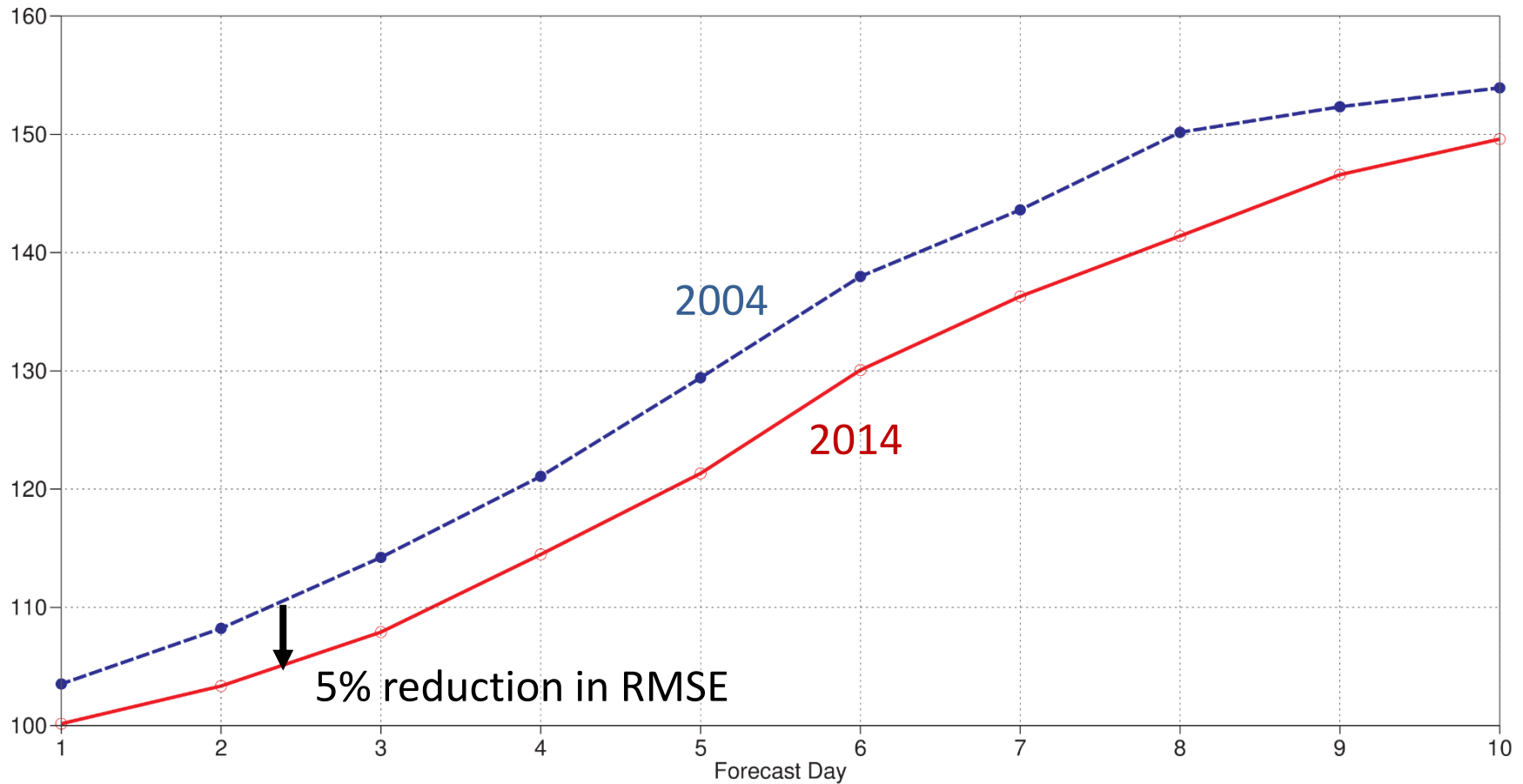
Forecast calibration



Verification based on power curve



Power-weighted verification



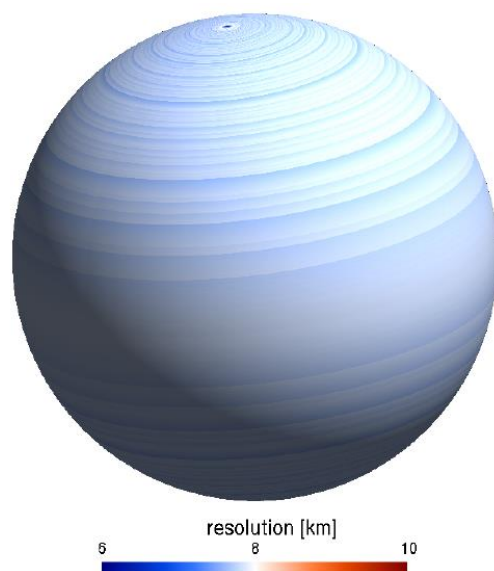
The future

Resolution upgrade in spring 2016

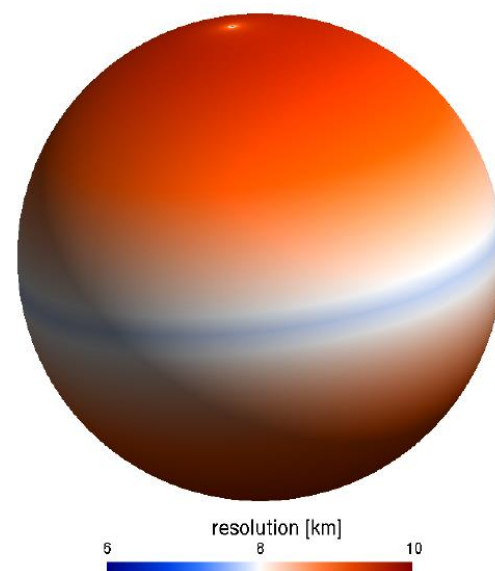
HRES: 16 km \rightarrow 8-10 km

ENS: 32 km \rightarrow 16-20 km

Ocean: 1 \rightarrow $\frac{1}{4}$ deg

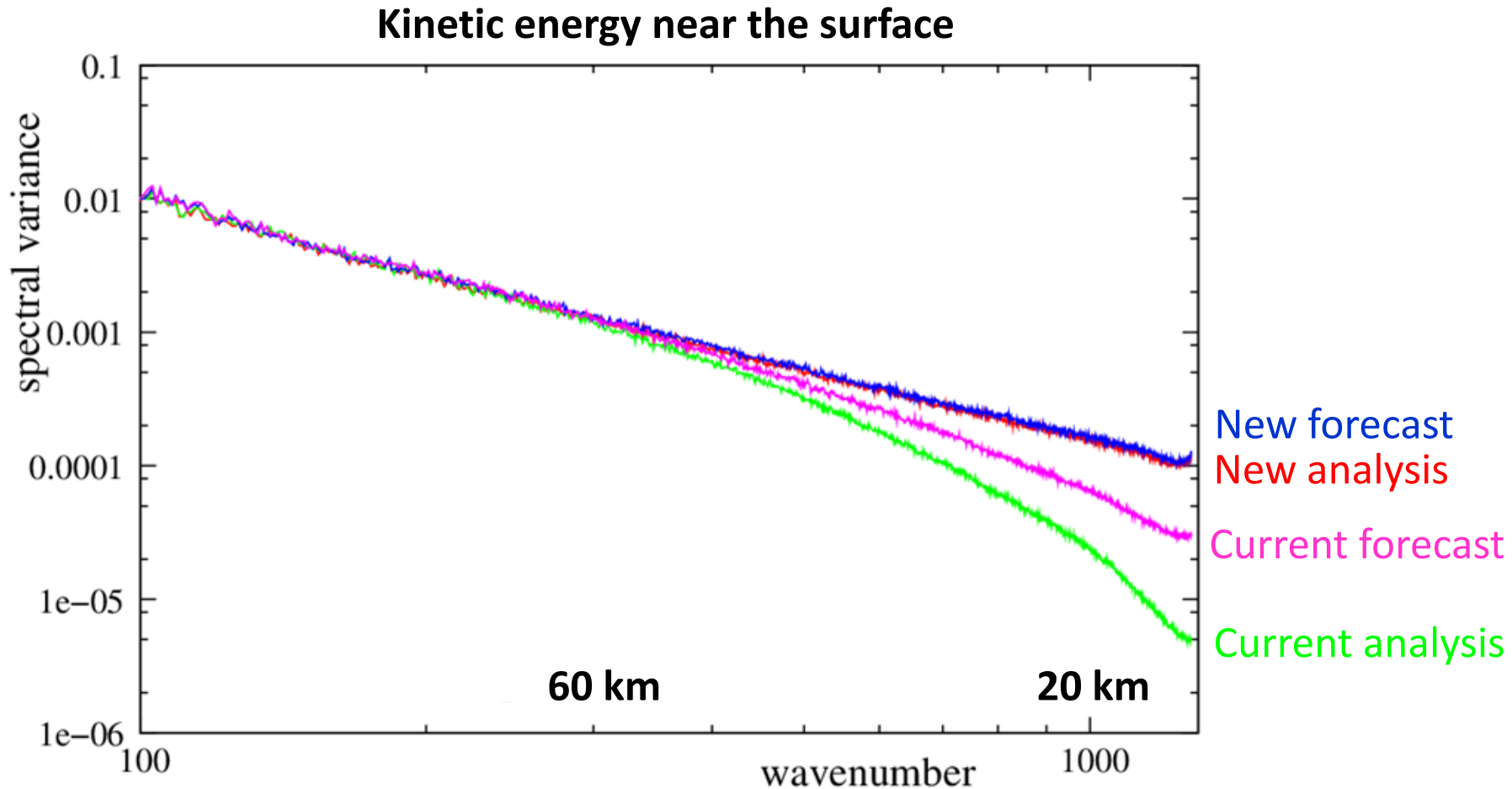


Standard Reduced Gaussian grid

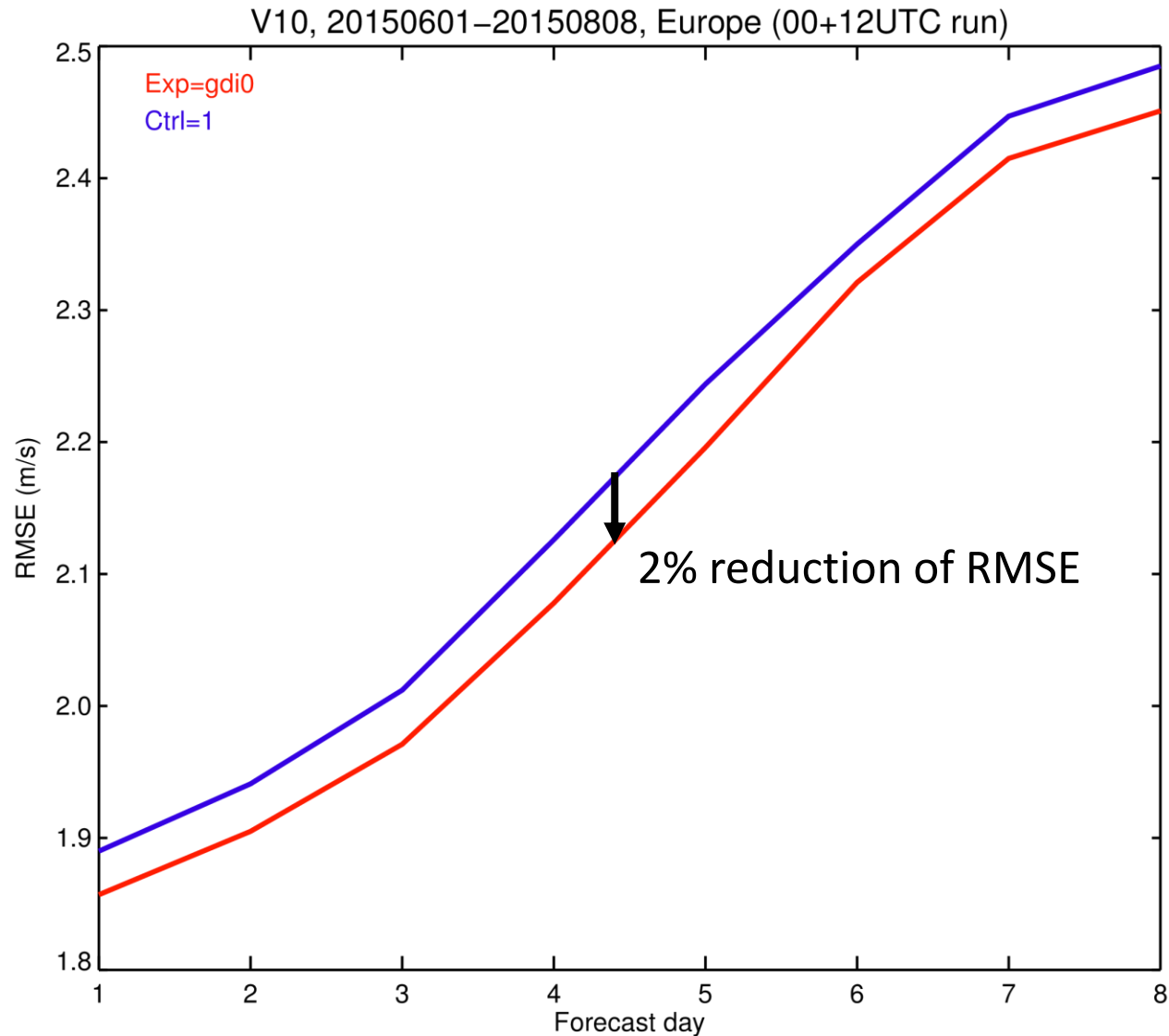


Octahedral Reduced Gaussian grid

Resolution upgrade 2016: improved spectra



Resolution upgrade 2016: improved wind speed



Future plans

- 5 km global ensemble by 2025
 - Computing requirements: 60 MW!!
- requires preparation for future HPC architectures (2018 onwards)



New ECMWF re-analysis dataset

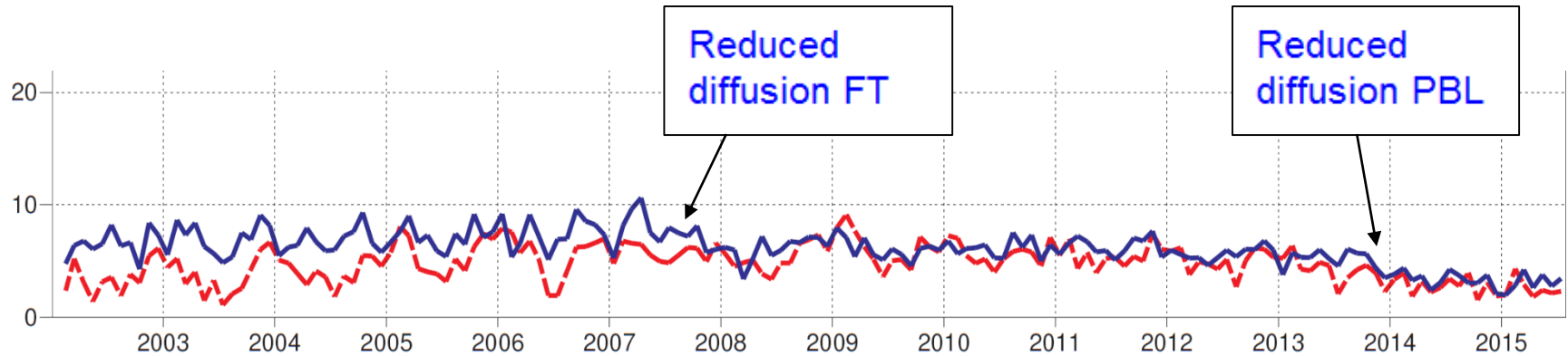
	ERA-Interim	ERA5
Start of production	August 2006 IFS Cy31r2	Before end 2015, reach NRT before end 2017 (20 days/day) IFS Cy41r2
Spatial resolution	79 km global 60 levels to 10 Pa	31 km global (T639) 137 levels to 1 Pa
Output frequency	6-hourly	1-hourly
Time period	1979 – present	1979 - present

Summary

- Forecasts slowly but continuously improving
- Representativeness problem → calibration
- Clear benefits from ensemble forecast
- Resolution upgrade 2016: 2-3% improvement
- New re-analysis: ERA5 (starting soon)

Thank you!

Wind direction error, Europe



Point forecast errors in Europe

850hPa wind speed

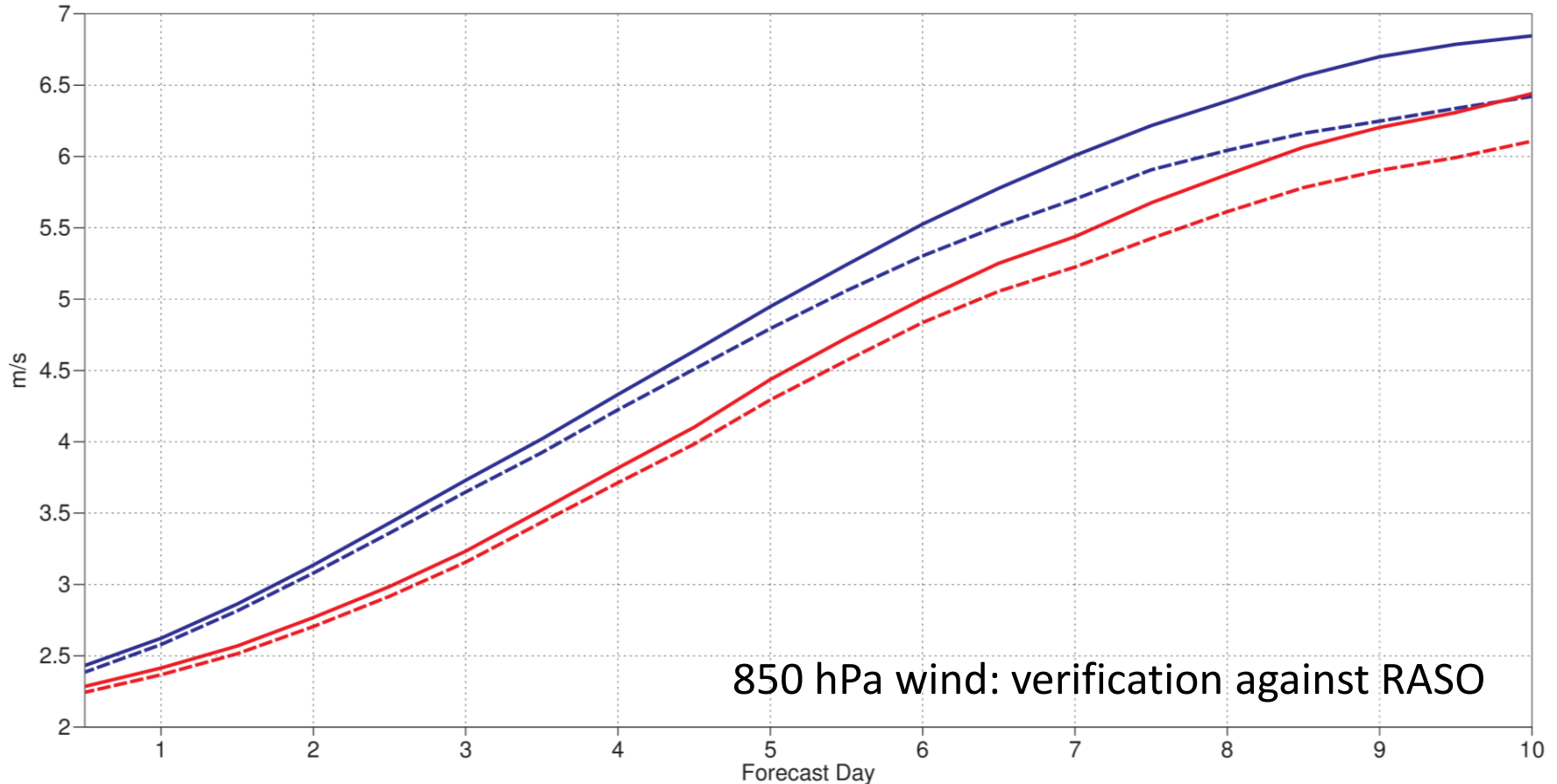
Europe N Africa (lat 25.0 to 70.0, lon -10.0 to 28.0)

Date: 20040101 00UTC to 20141231 12UTC

oper_ob od oper 0001

Mean method: standard

--- 2014 sdef
— 2014 rmsef
--- 2004 sdef
— 2004 rmsef



850 hPa wind: verification against RASO

Point forecast errors in Europe

850hPa wind speed

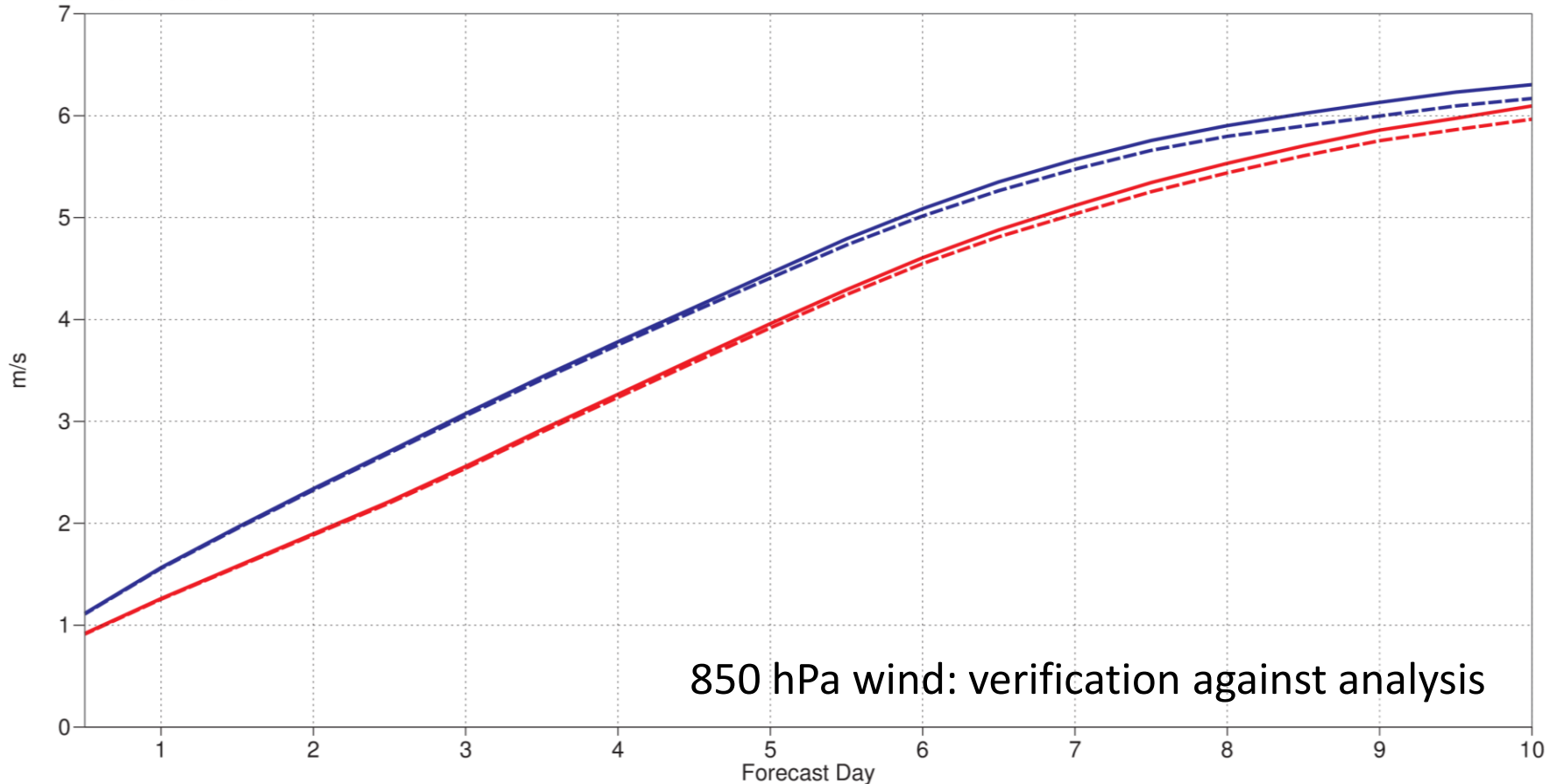
Europe (lat 35.0 to 75.0, lon -12.5 to 42.5)

Date: 20040101 00UTC to 20141231 12UTC

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Mean method: standard

--- 2014 sdef
— 2014 rmsef
--- 2004 sdef
— 2004 rmsef



850 hPa wind: verification against analysis

Point forecast errors in Europe

10m wind speed

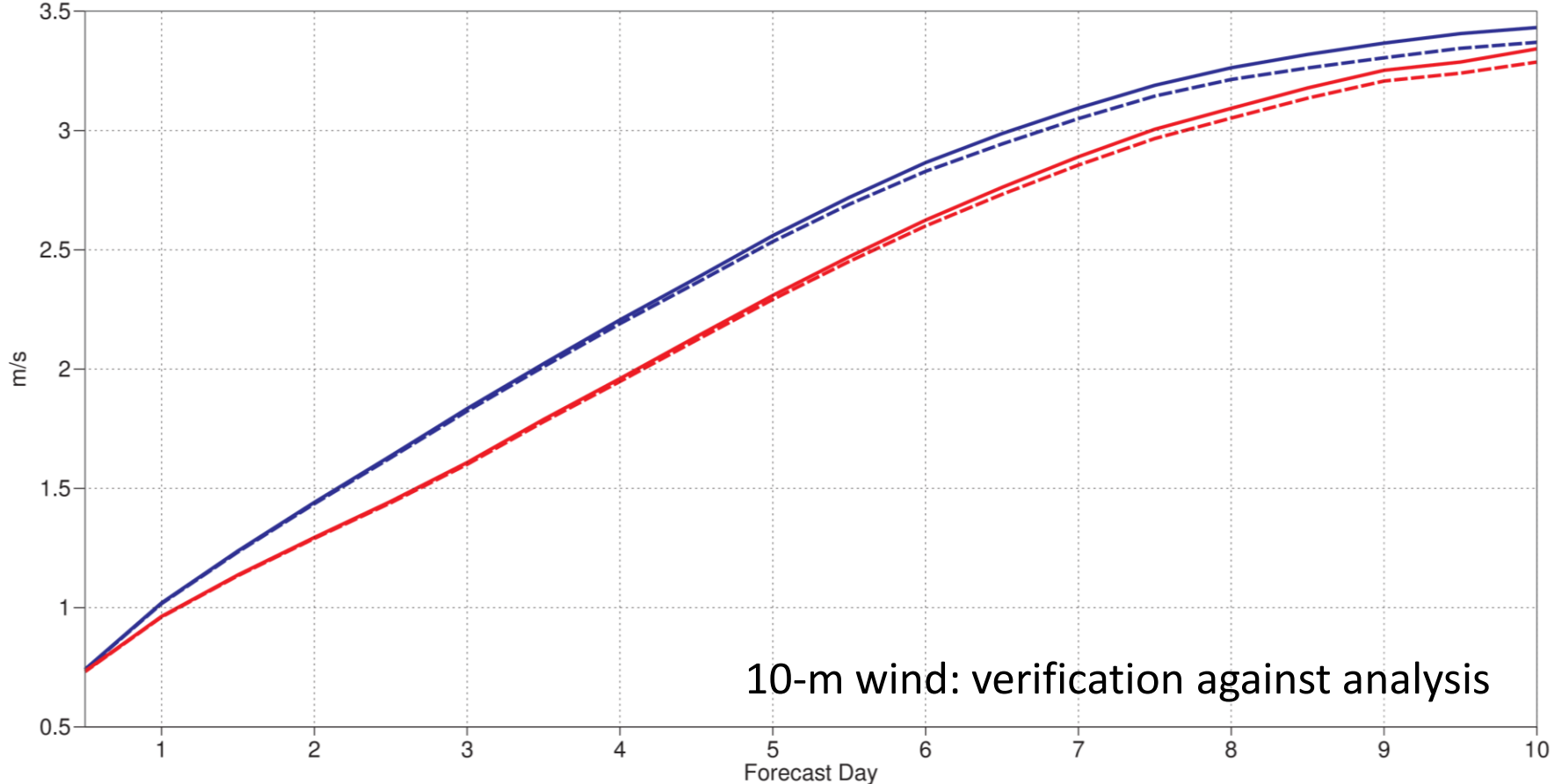
Europe (lat 35.0 to 75.0, lon -12.5 to 42.5)

Date: 20040101 00UTC to 20141231 12UTC

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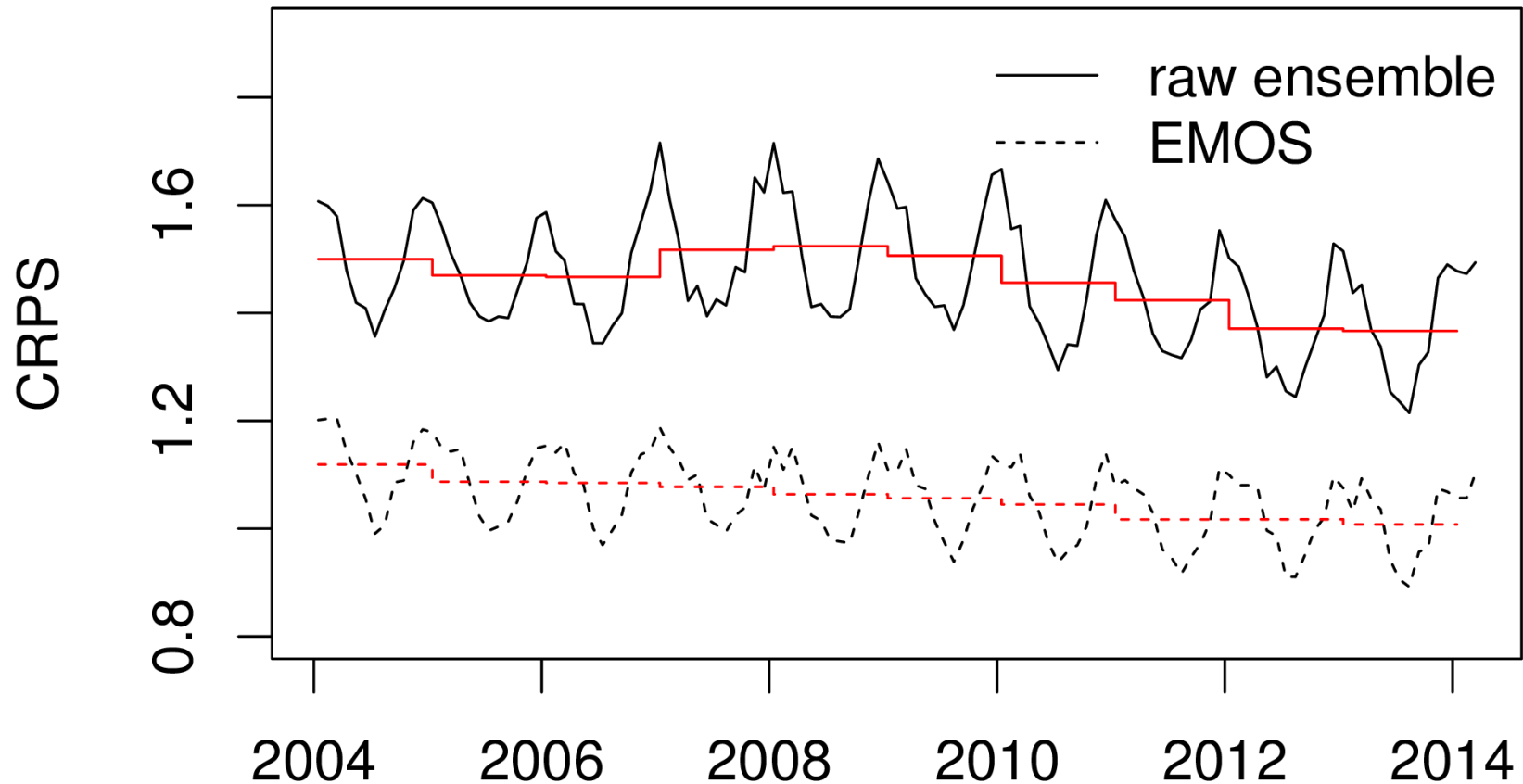
Mean method: standard

--- 2014 sdef
— 2014 rmsef
--- 2004 sdef
— 2004 rmsef



10-m wind: verification against analysis

Forecast calibration



Forecast calibration

