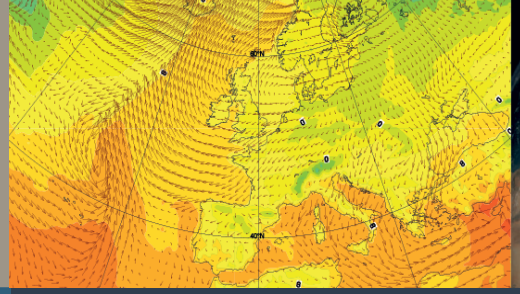




ALADIN General Assembly – HIRLAM Council
DECEMBER 2016

ECMWF REPORT

ECMWF EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

Advancing weather science

1 Earth system modelling

2 Earth system assimilation and predictability

Delivering global predictions

3 The integrated ensemble system

4 The quality of our forecasts

Sustaining high-performance computing

5 Scalability

6 High-performance computing

Supporting ECMWF

7 Funding and people

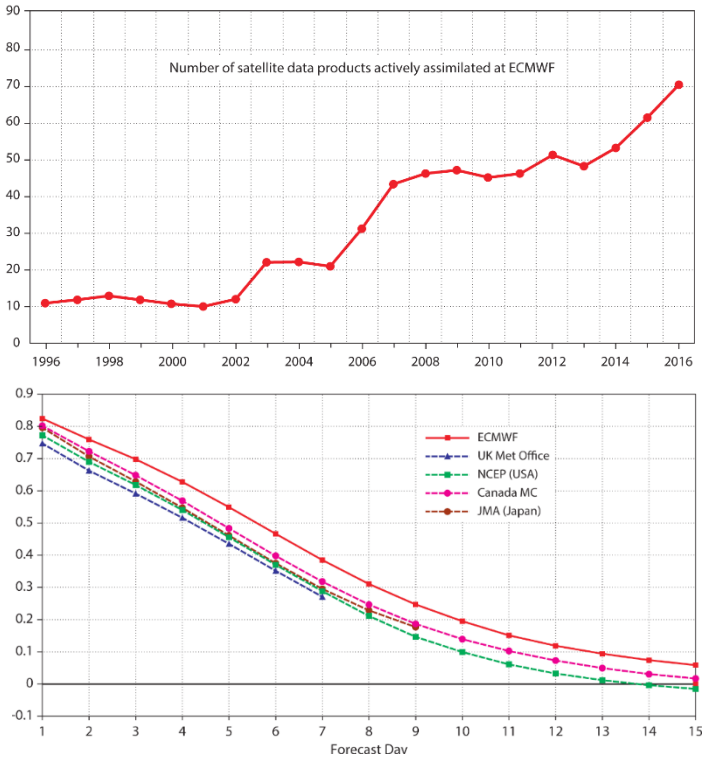
8 ECMWF's accommodation

Serving Member and Co-operating States

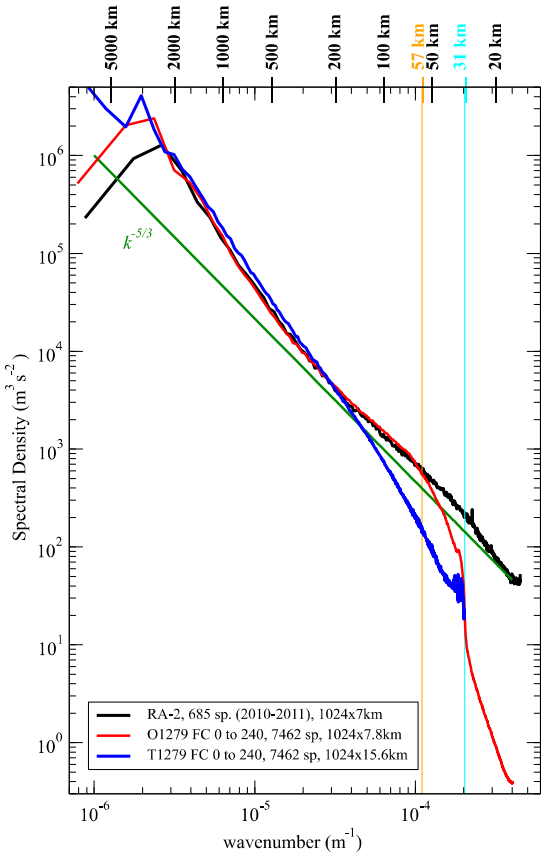
9 Making deliverables and expertise available

10 Delivering environmental information

ECMWF use of satellite data



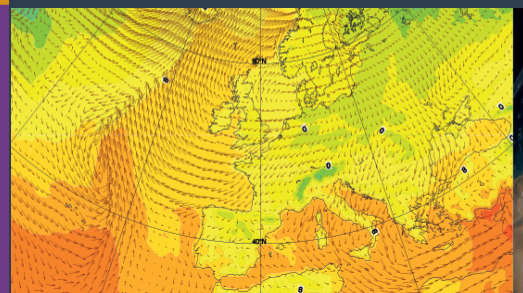
Ensemble skill over the past twelve months



Wind Speed Spectrum of $T_{CO}1279$ (Operational IFS)

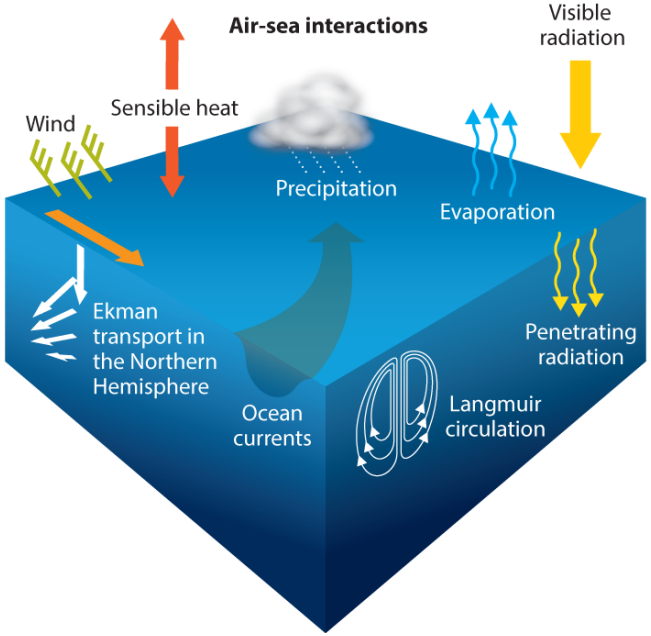
- High resolution prediction = 9km
- Ensemble prediction = 18km
- Early stages of coupled modelling ocean-atmosphere
- Satellite observations from over 70 instruments
- Medium-range prediction skill up to 8-9 days
- Large pattern predictions up to two weeks
- Over 300 forecasters trained in using our products per year
- Collaboration across the world and 100 days of workshops and seminars held at ECMWF
- 2 x Cray XC40 and 1 GPU cluster

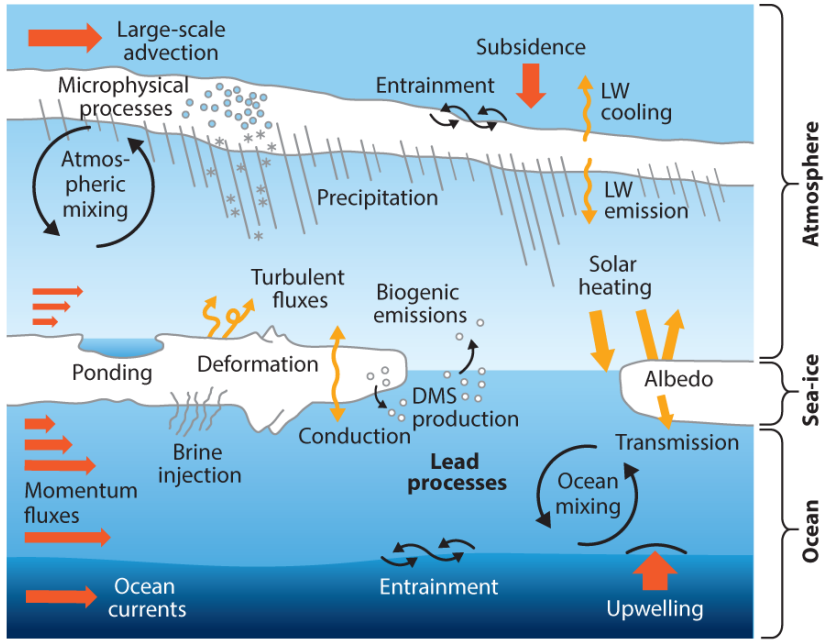
1. ADVANCING WEATHER SCIENCE



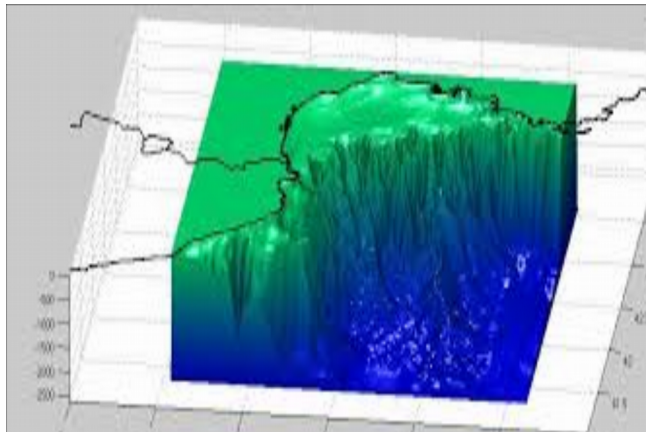


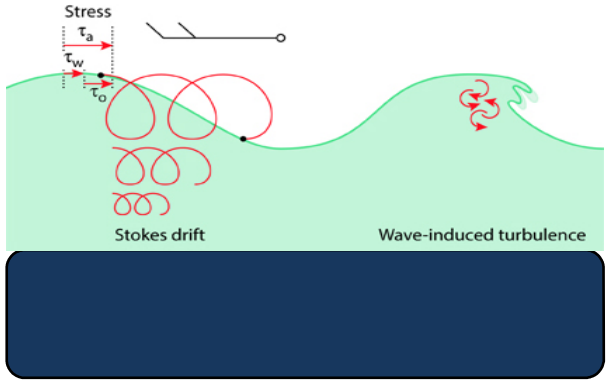
Oceans: from climate to weather





Ocean, waves, sea-ice at ECMWF





NEMO3.4

NEMO3.4 (Nucleus for European Modelling of the Ocean)

Madec et al. (2008)

Mogensen et al. (2012)

ORCA1_Z42: 1.0° x 1.0°ORCA025_Z75 : 0.25° x 0.25°

EC-WAM

ECMWF Wave Model

Janssen, (2004)

Janssen et al. (2013)

ENS-WAM : 0.25° x 0.25°

HRES-WAM: 0.125° x 0.125°

LIM2

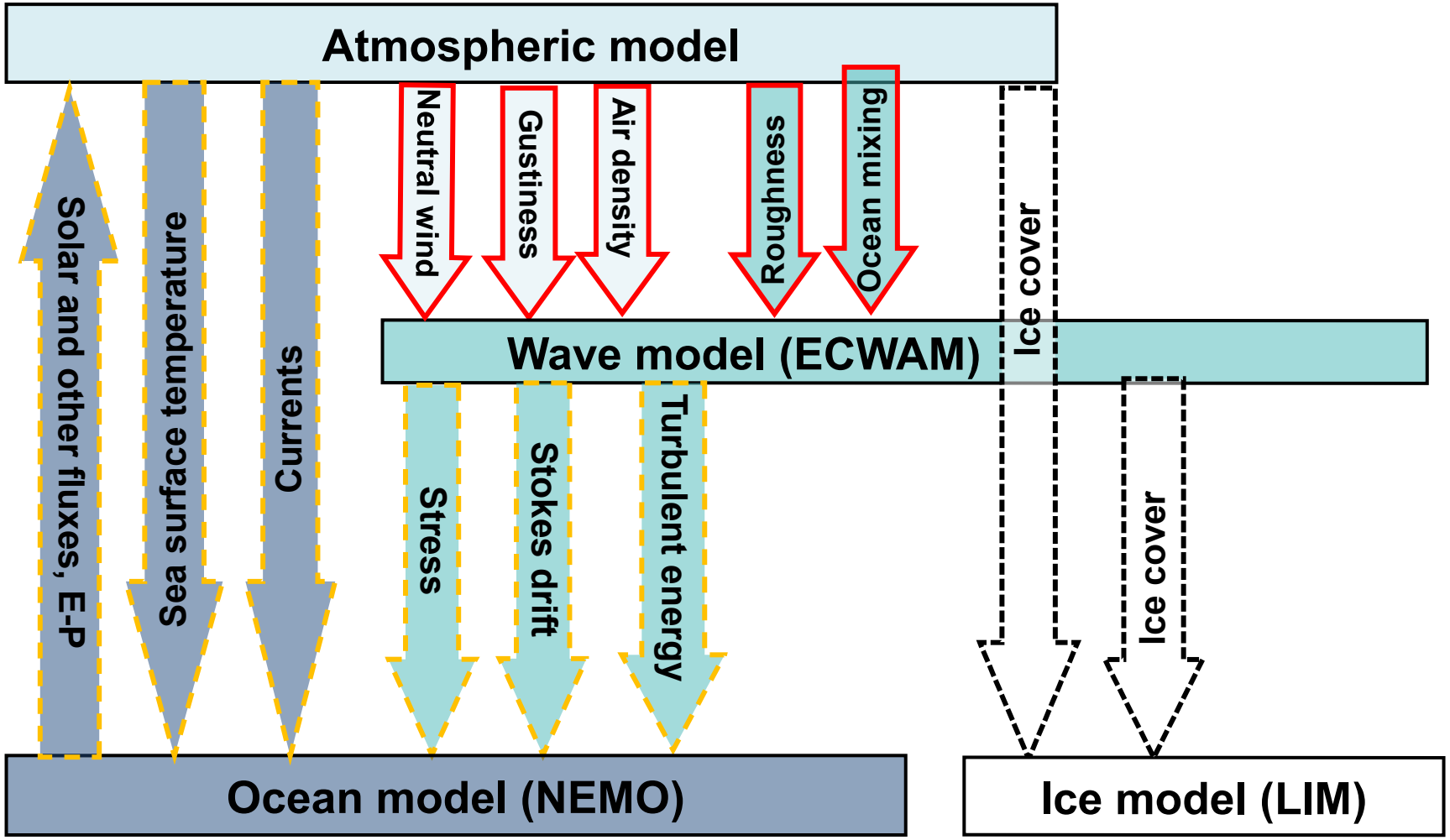
The Louvain-la-Neuve Sea Ice Model

Fichefet and Morales Maqueda (1997)

Bouillon et al. (2009)

Vancoppenolle et al. (2009)ORCA025_Z75 : 0.25° x 0.25°

Retracing the pathway of operational advances



Timeline

2016

Legend for the coupling

All Forecasts

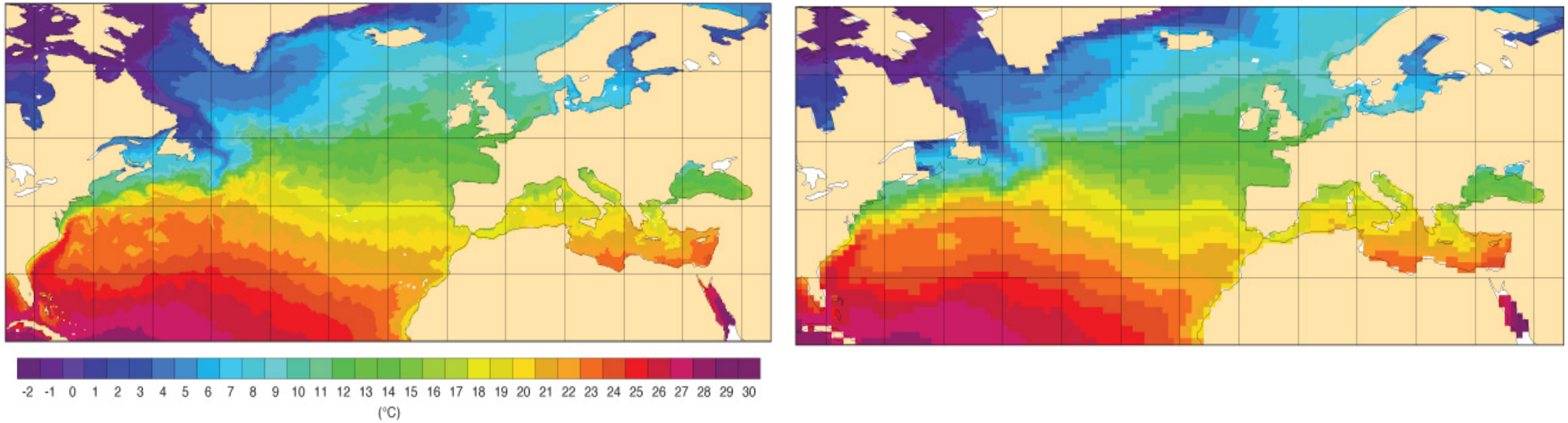
Ensemble

New cycle

Ingredients of the 43r1 upgrade: water-component

RESOLUTION Enhancement

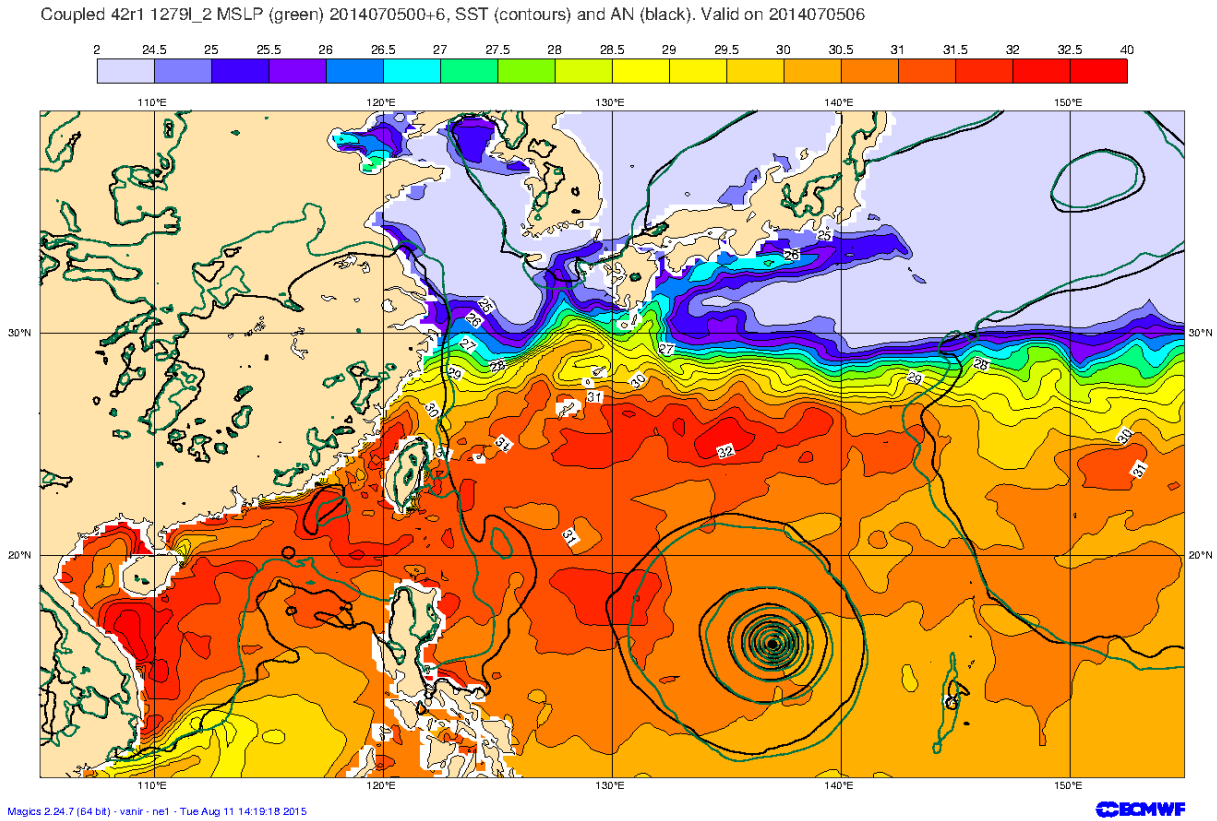
4 times more in horizontal scale and 50% more in vertical in the Ensemble Forecast System



Ocean coupling with High Impact Weather

ATMOSPHERE-OCEAN COUPLING EVIDENCE

A case study on Neoguri Typhoon (5-7 July 2014) The air-sea interactions are particularly evident in the case of tropical cyclones

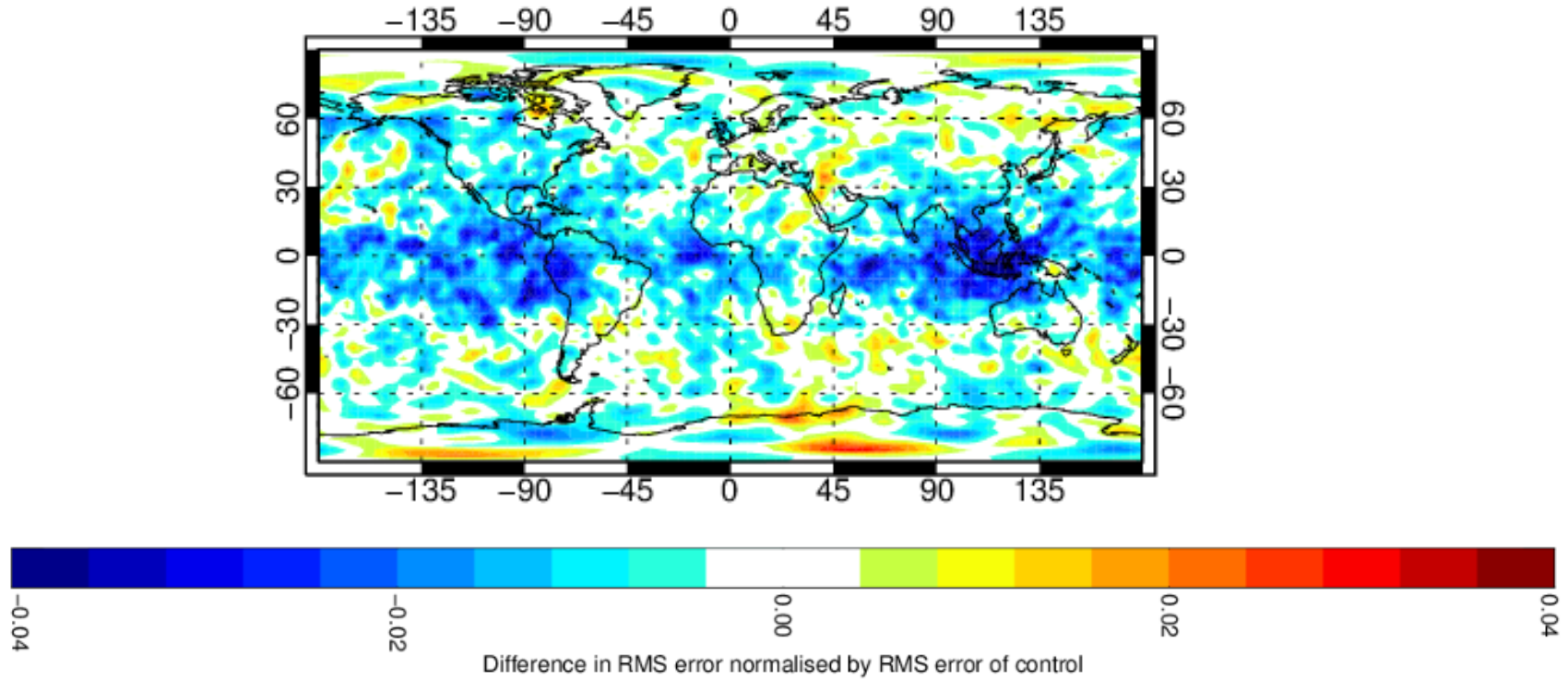


Towards a coupled system used across all ECMWF Forecasting Systems

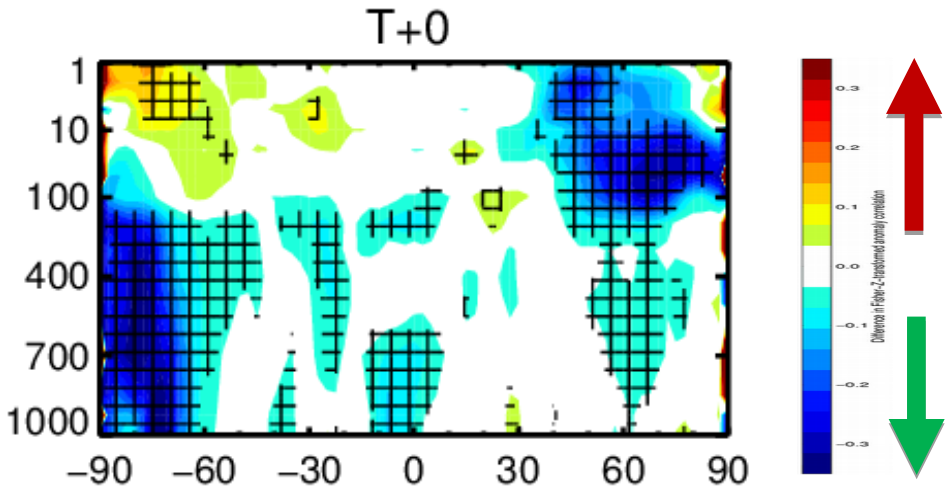
BENEFIT OF COUPLING FOR MEDIUM-RANGE

Wind forecasts improvements throughout the atmosphere @DAY7

(impact onto the Hadley cell) T+168; 200hPa

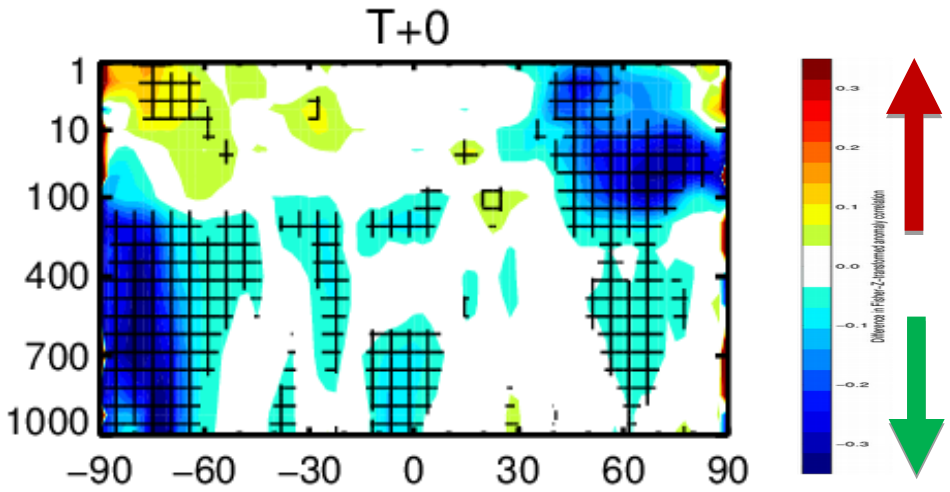


From coupled modelling to data assimilation: CERA-20C



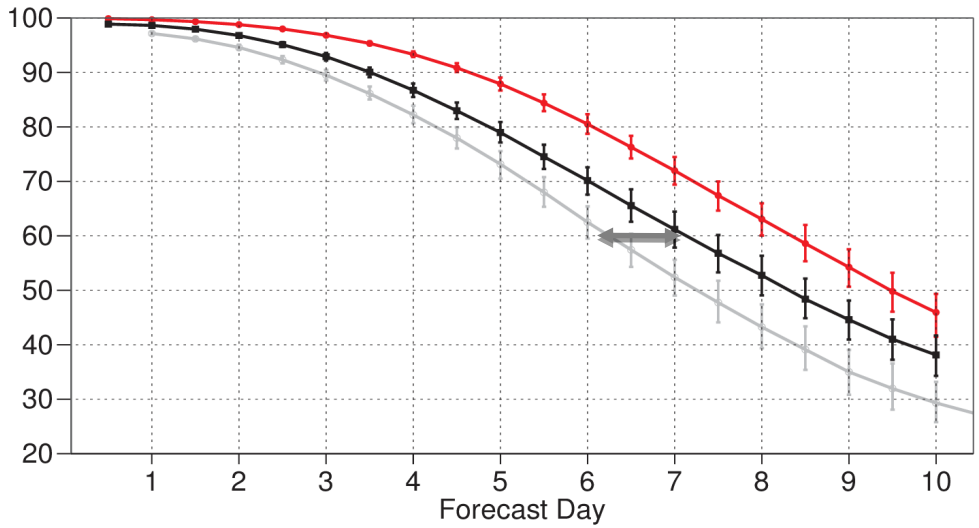
Clear benefits for the analysis if coupled data assimilation

From coupled modelling to data assimilation: CERA-20C



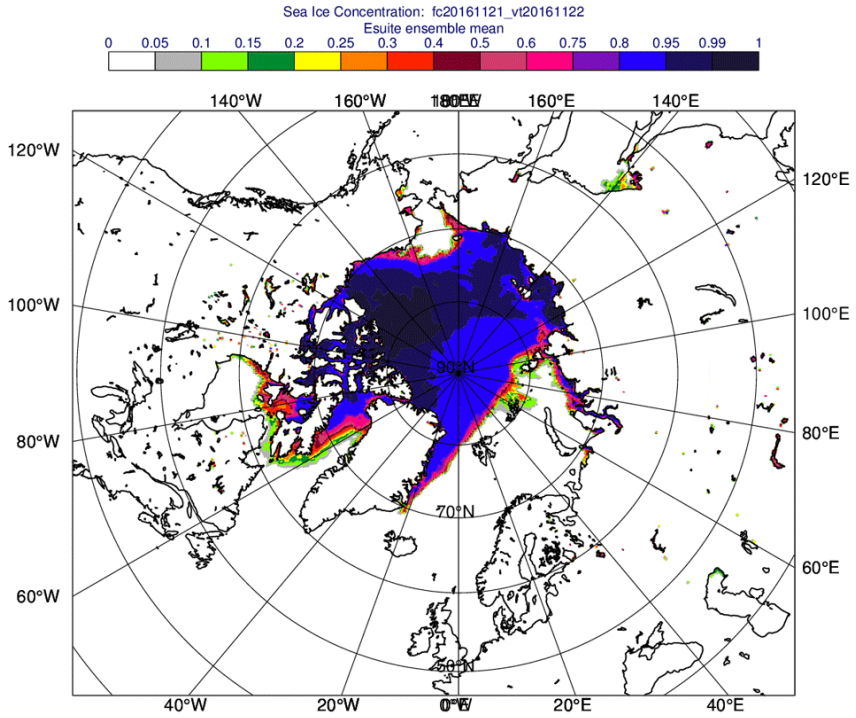
Clear benefits for the analysis if coupled data assimilation

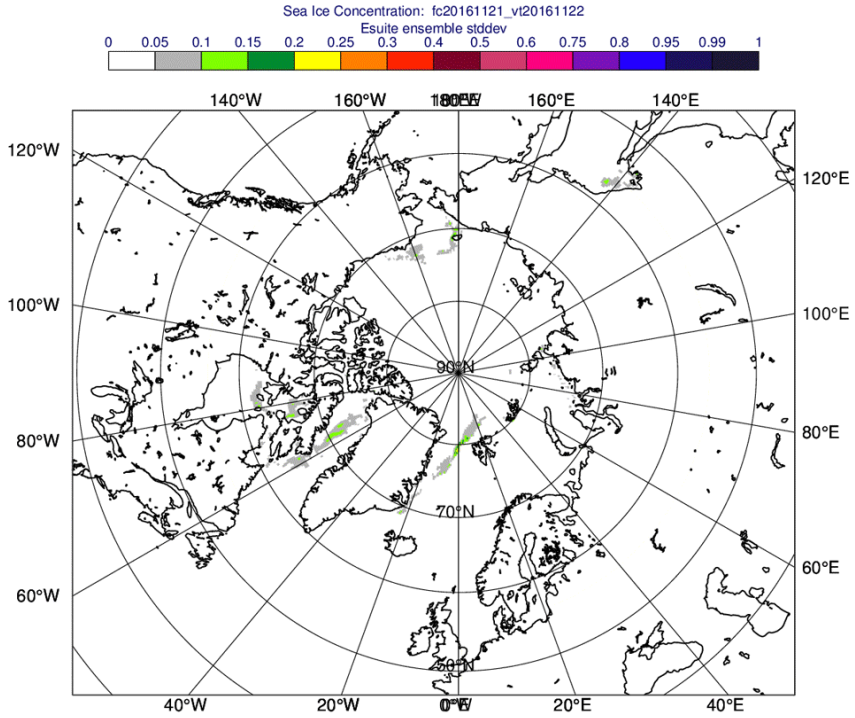
Anomaly correlation for geopotential height at 500hPa in the Northern hemisphere, with respect to ERA-Interim analysis



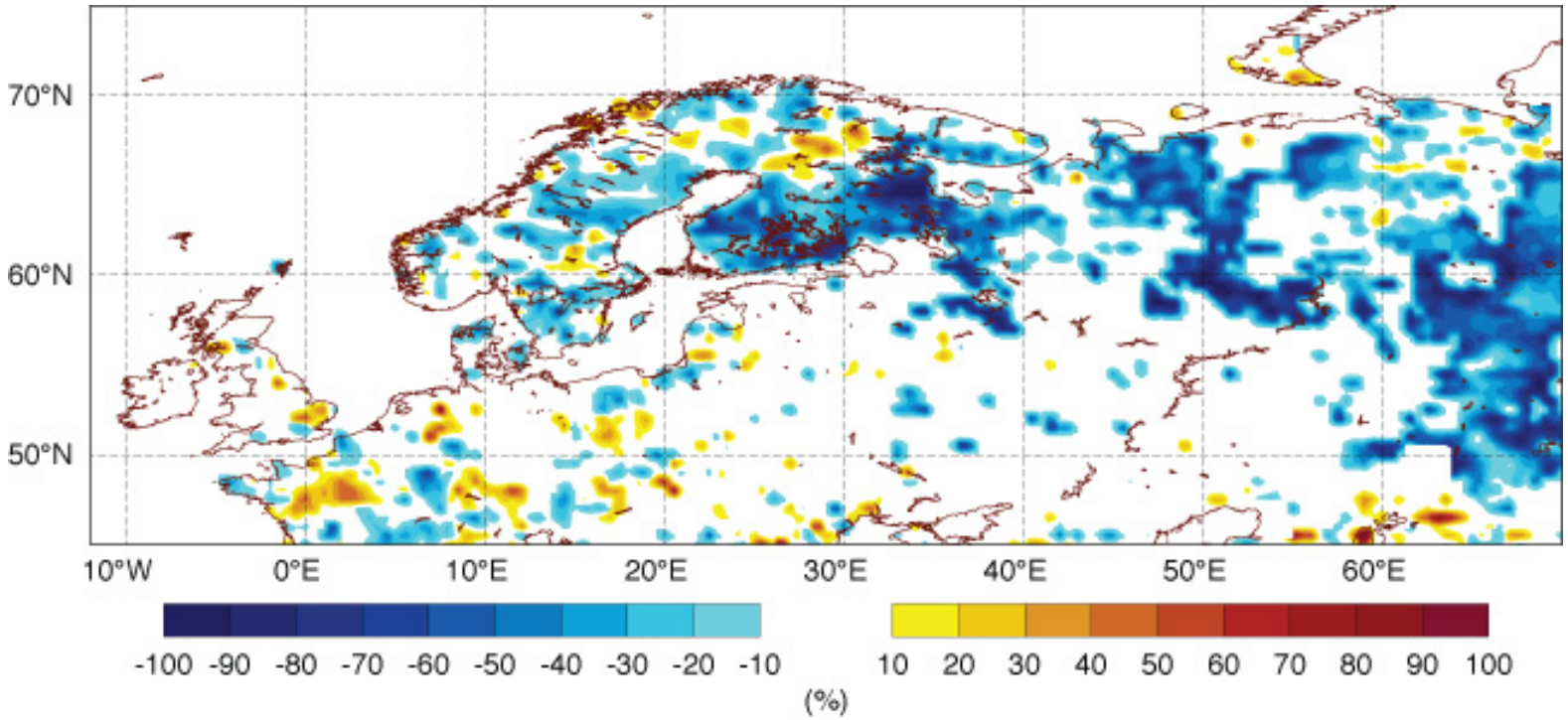
And forecast skill improved by ~0.7 day

Ingredients of the 43r1 upgrade: sea-ice-component

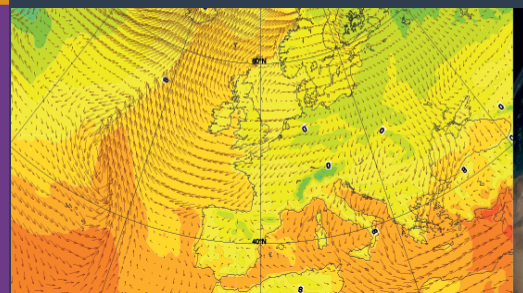




43r1: other benefits…e.g. in cloud cover



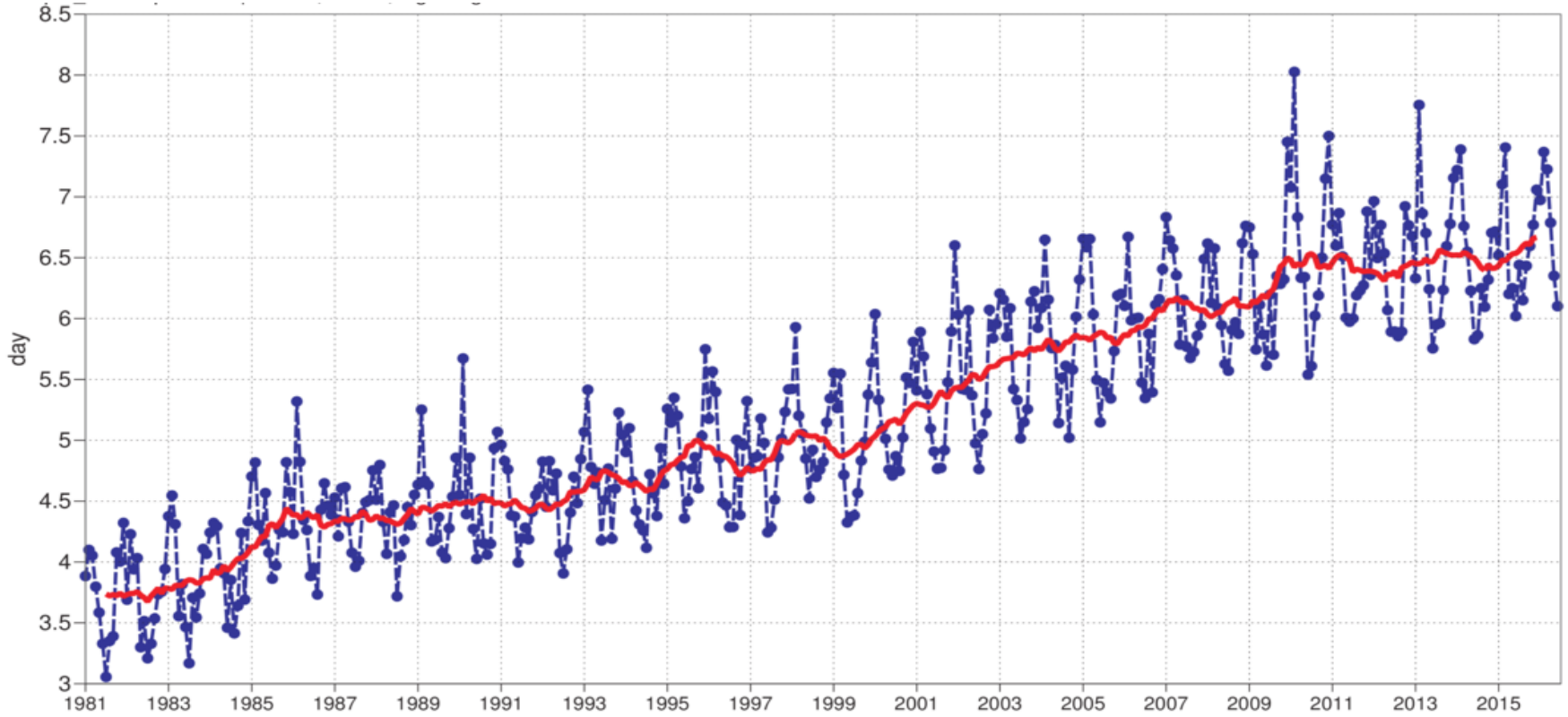
2. DELIVERING GLOBAL PREDICTIONS



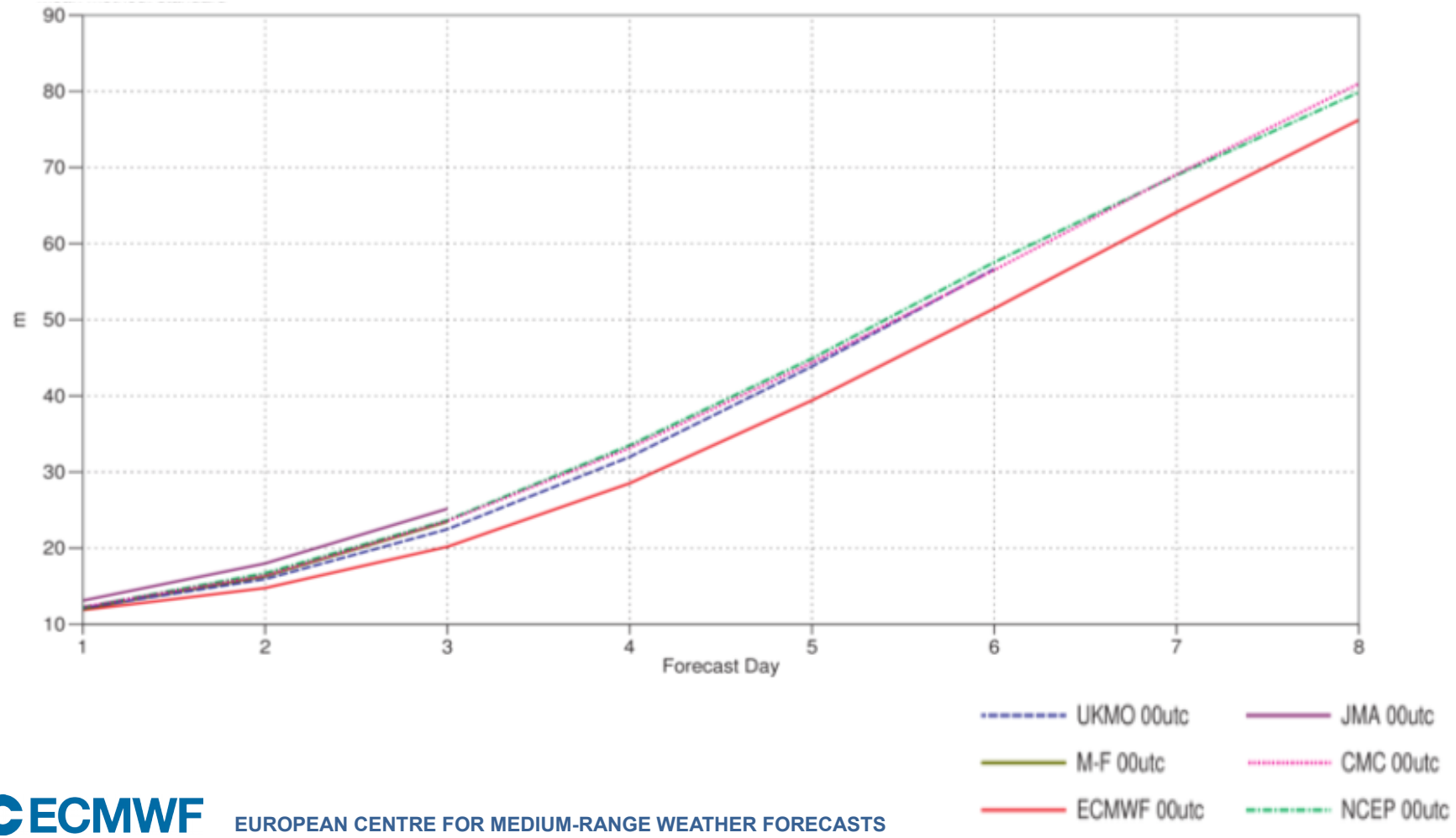


Headline scores and WMO verification

HRES - Z 500hPa Northern hemisphere

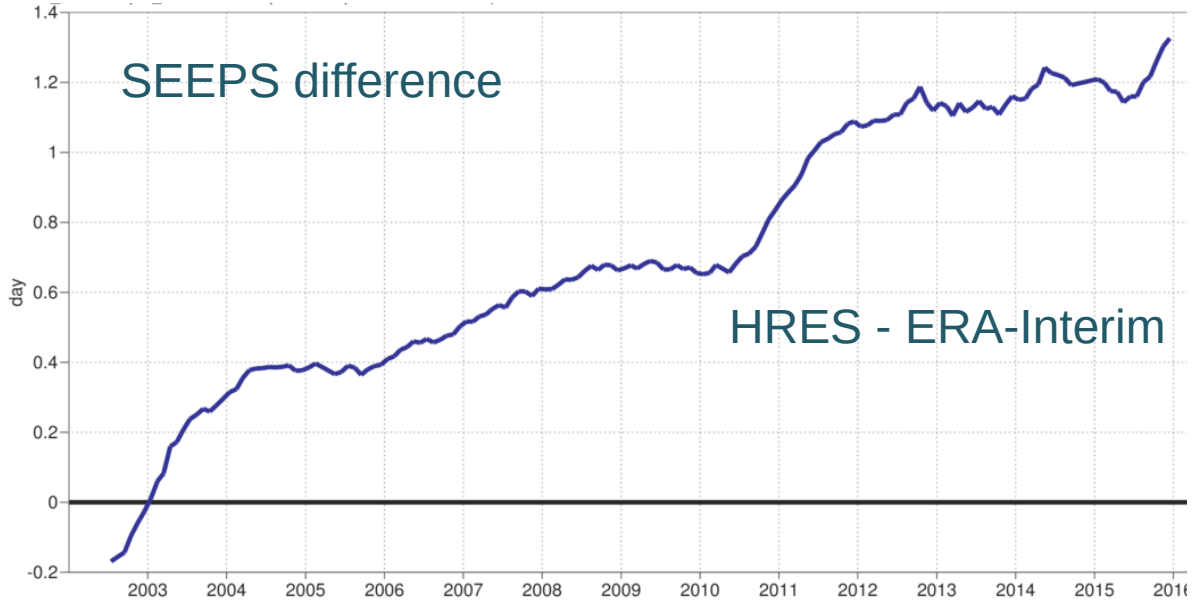


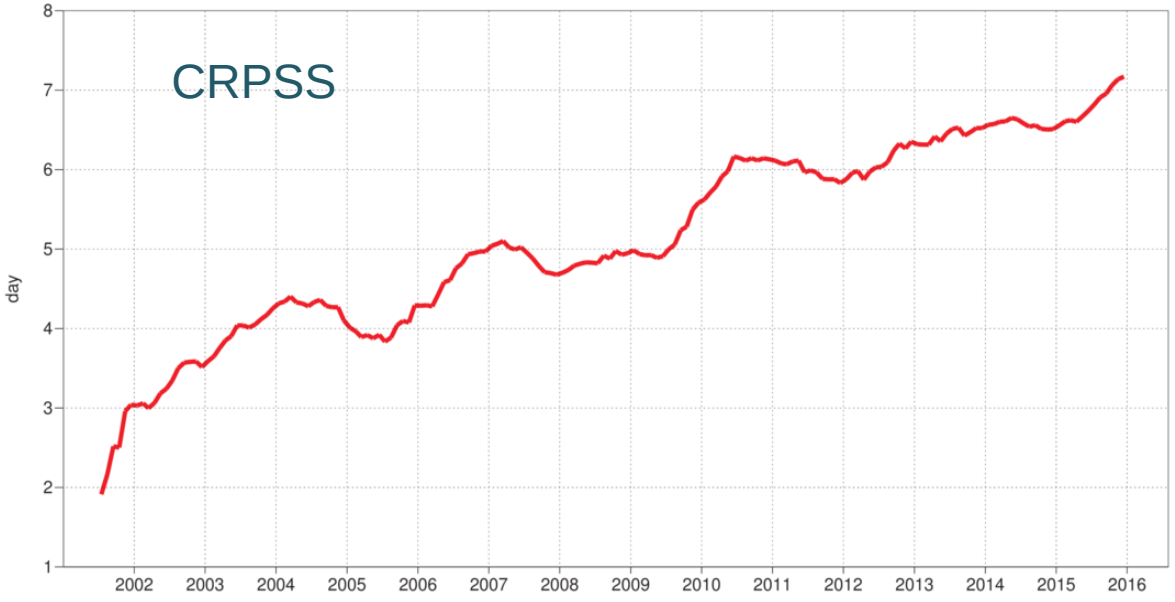
WMO scores - Z 500hPa Northern hemisphere



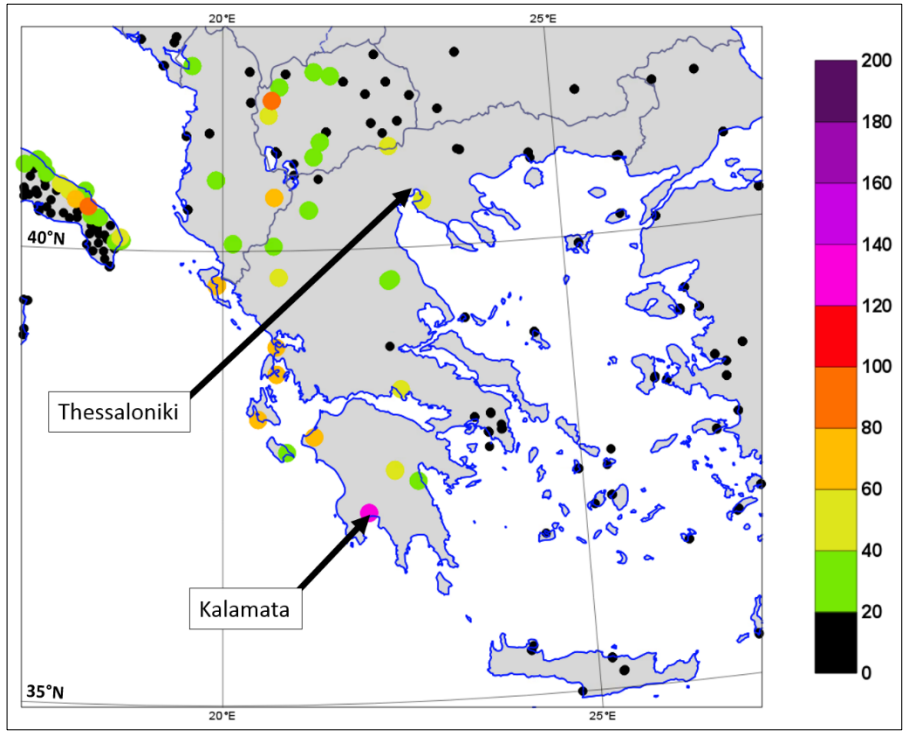
Ensemble forecasts - T 850hPa over Europe

Precipitation scores for high resolution and Ensemble

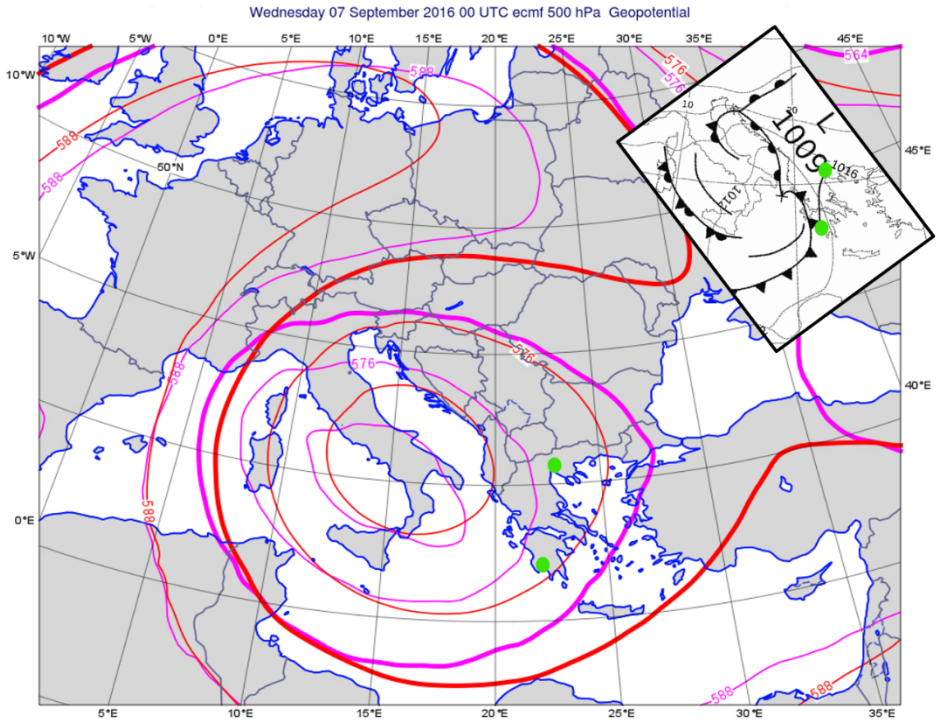




Case study: The benefit of Ensemble to predict Greek floods

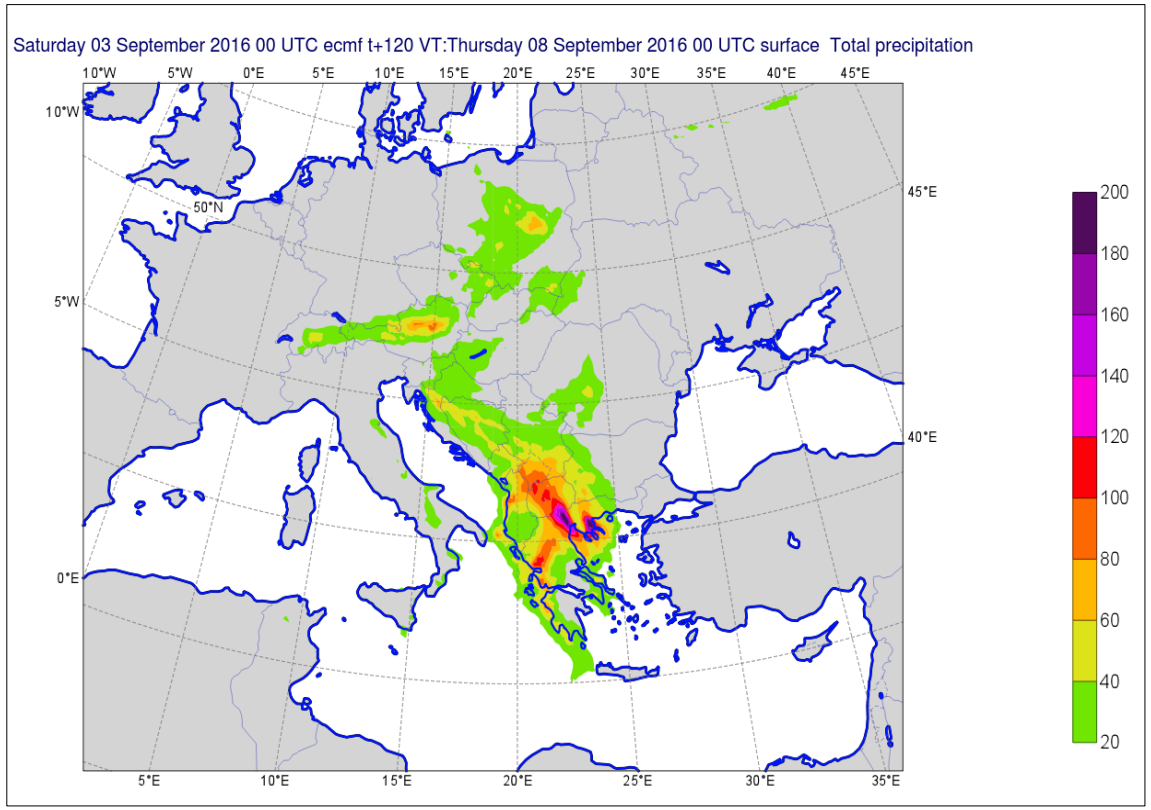


24-hour totals on 7 September 2016



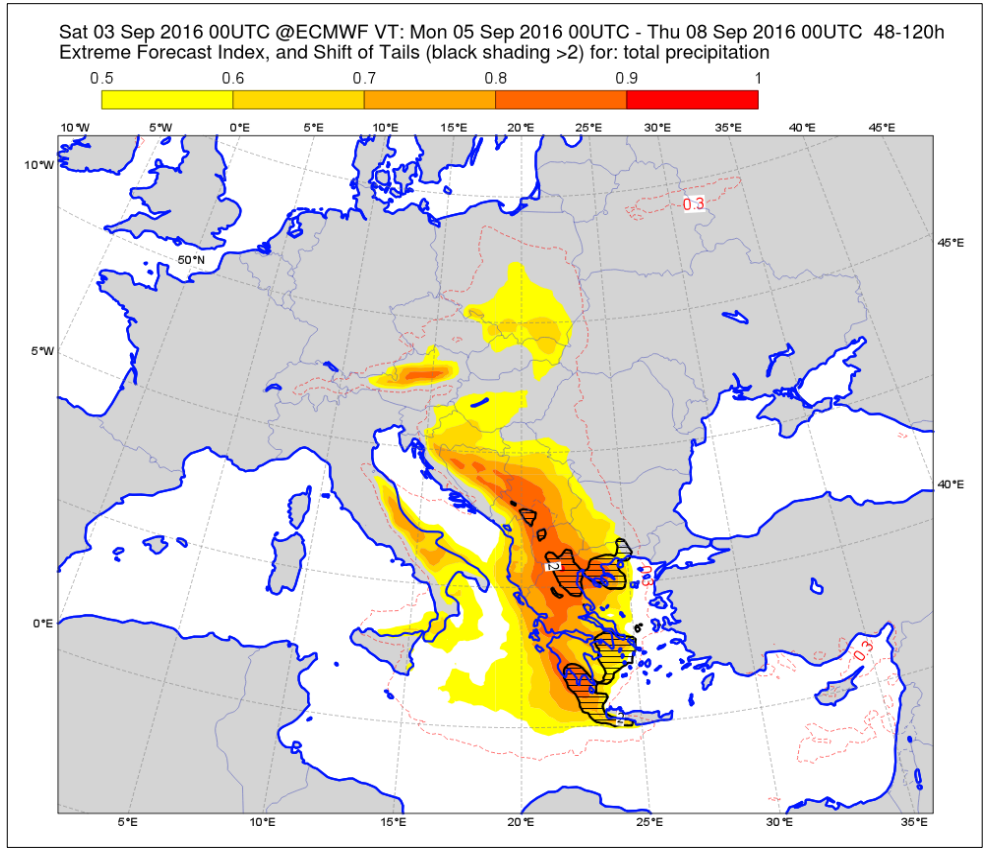
4-day forecast ENS mean (red), analysis (pink)

Case study: The benefit of Ensemble to predict Greek floods



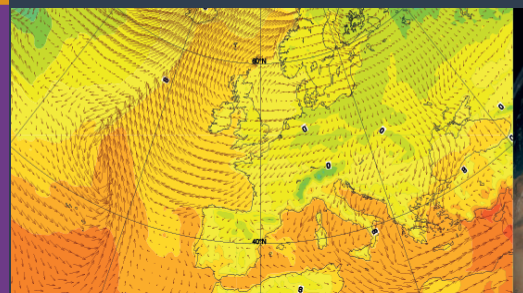
Accumulated 2 to 5 day precipitation from HRES

Case study: The benefit of Ensemble to predict Greek floods



Accumulated 2 to 5 day precipitation from ENS

3. SUSTAINING HIGH PERFORMANCE COMPUTING



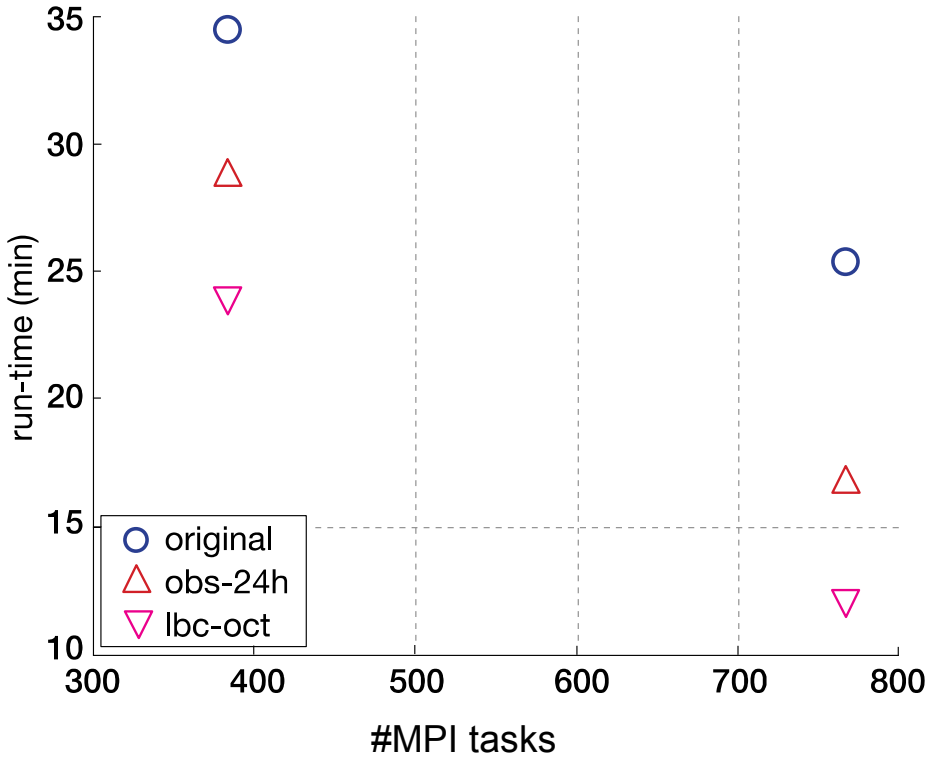


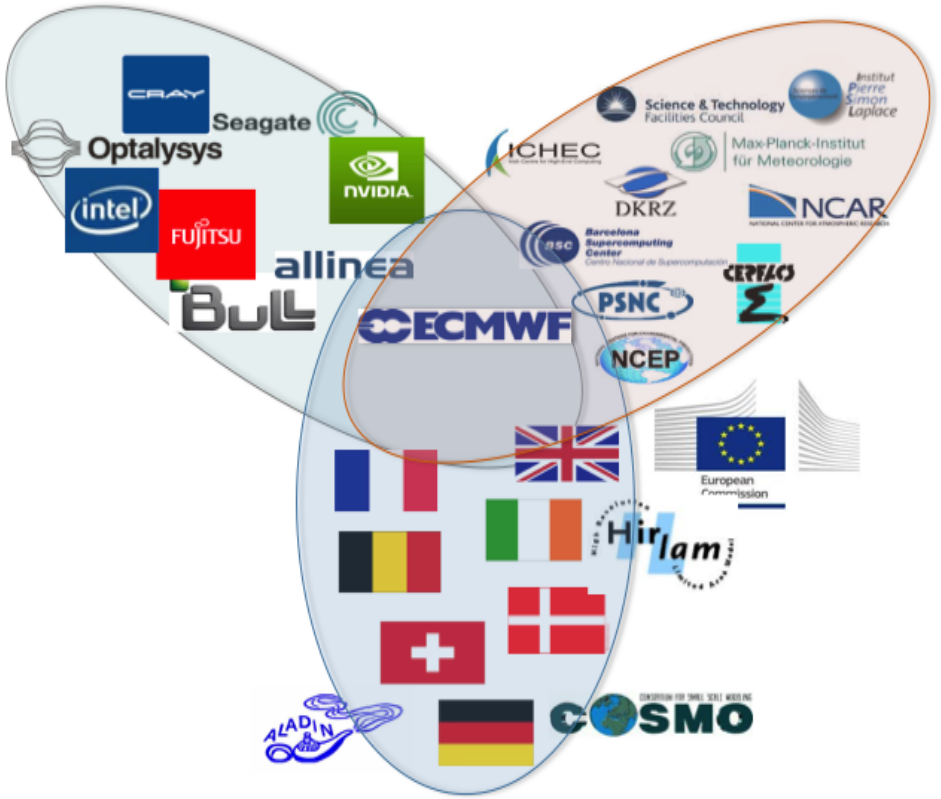
Scalability

Within 4 years, ESCAPE and NextGenIO will have completed their tasks, generating:

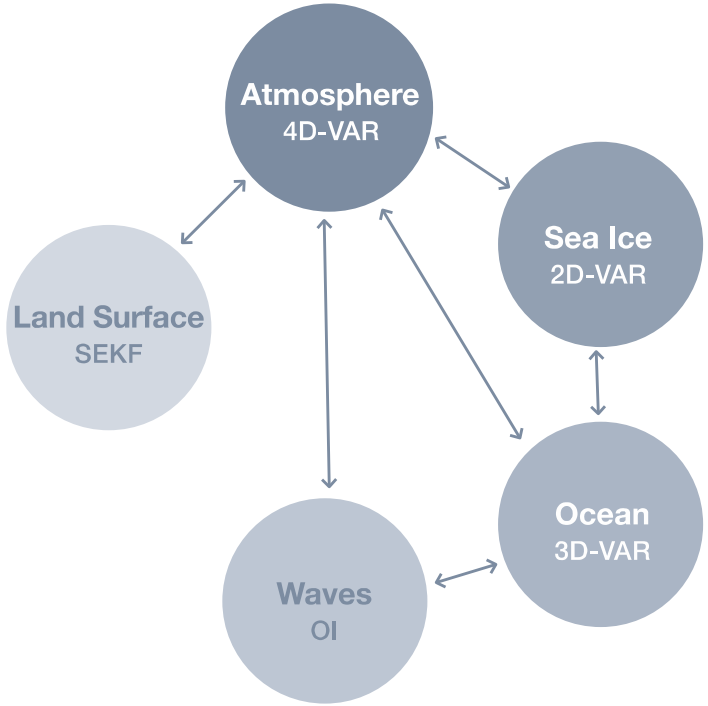
- Workflow improvements for the observations pre and post processing and model output
- 7 most costly elements of the forecast model (IFS) –Dwarfs, will have improved efficiency or been replaced with alternatives
- We will have learnt to make the most of GPUs
- Co-design hardware applications through bilateral agreements with computing vendors

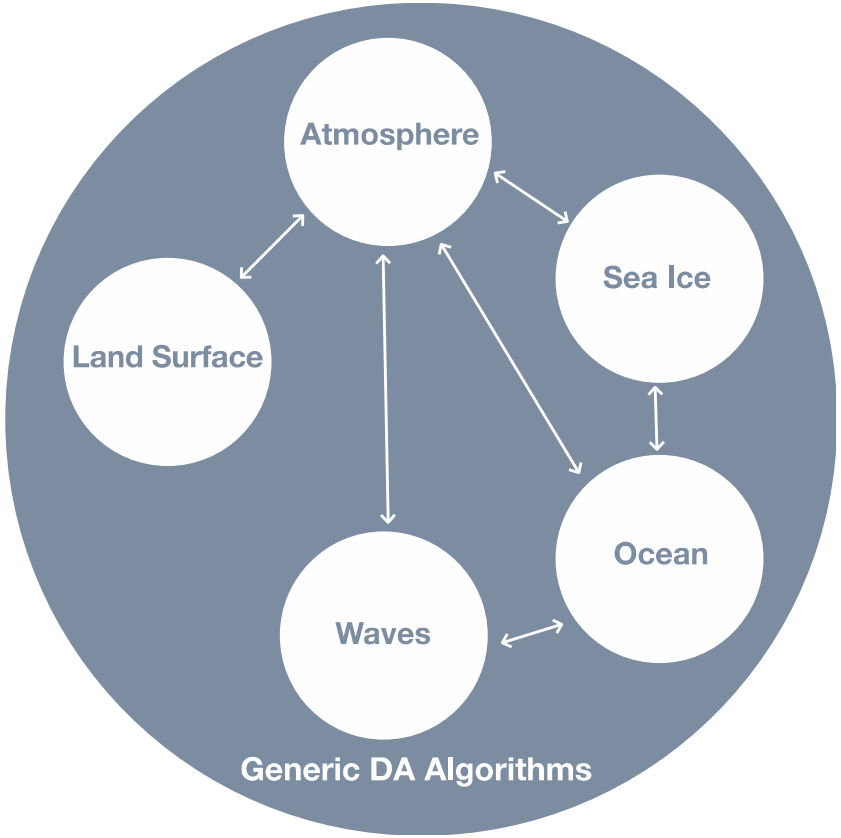
Scalability collaborative approach



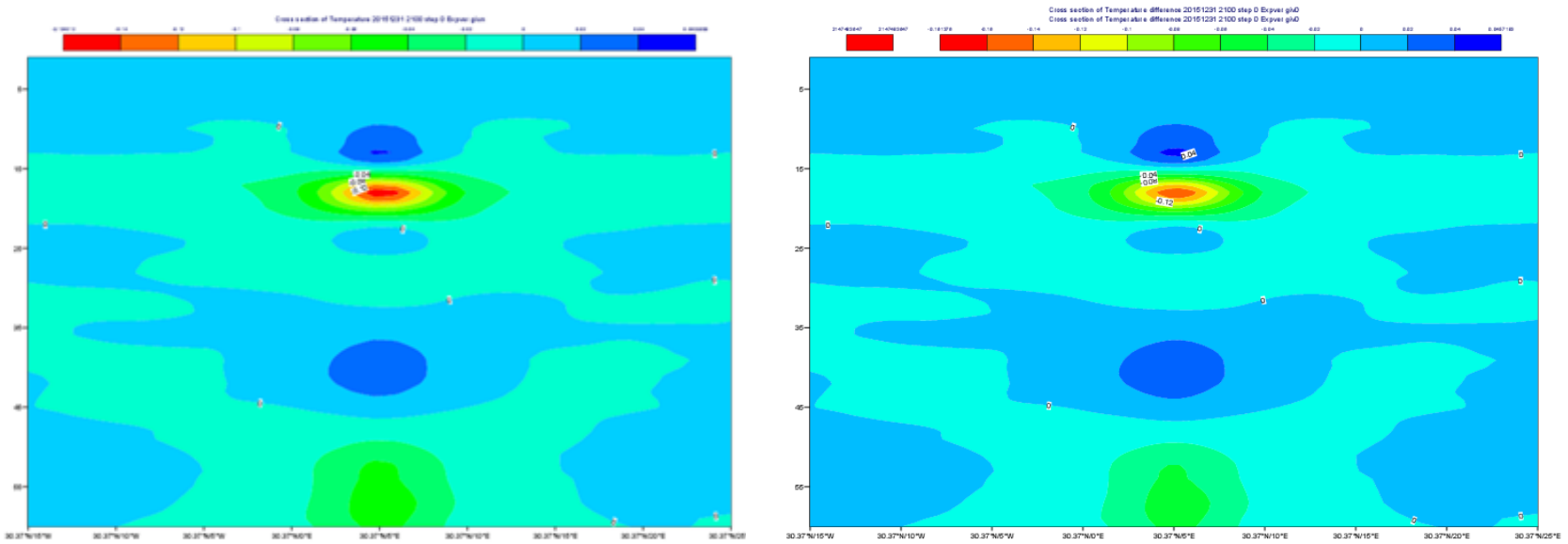


Scalability: OOPS



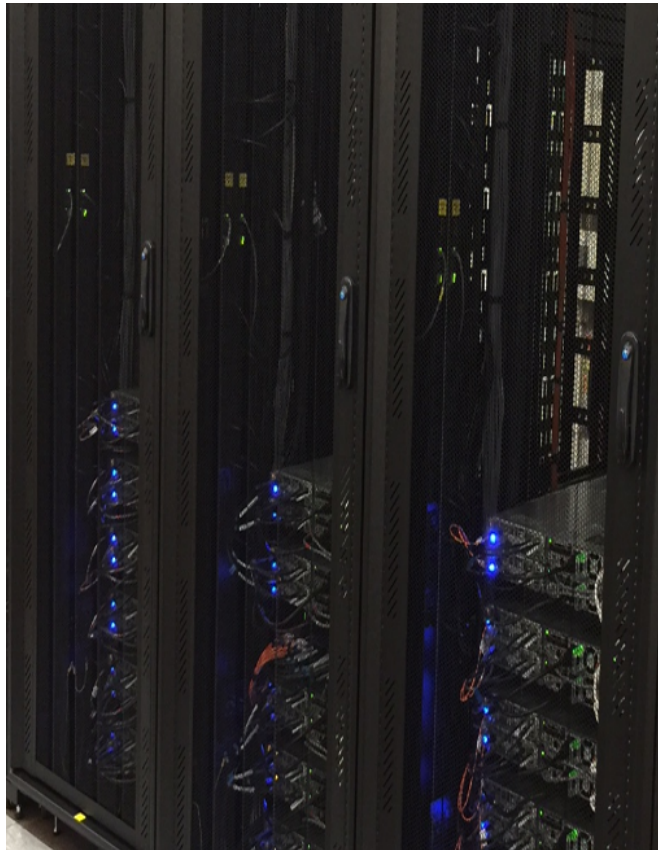


Scalability: Testing OOPS

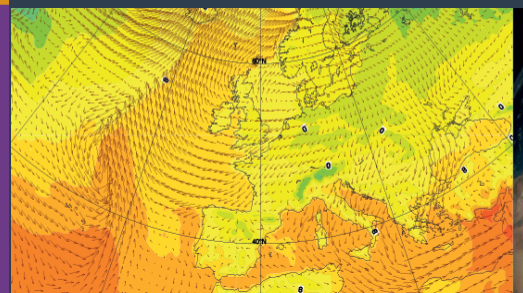


Cross section of increments in the IFS and OOPS

High Performance Computing: testing Phase 2 new additions



4. SUPPORTING ECMWF





Brexit?

Staff
Recruitment
External funding
Exchange rate…

Staff and funding: adding value through external funding

APPLICATE

Evaluating the contribution of selected observations to analysis accuracy and predictive skill

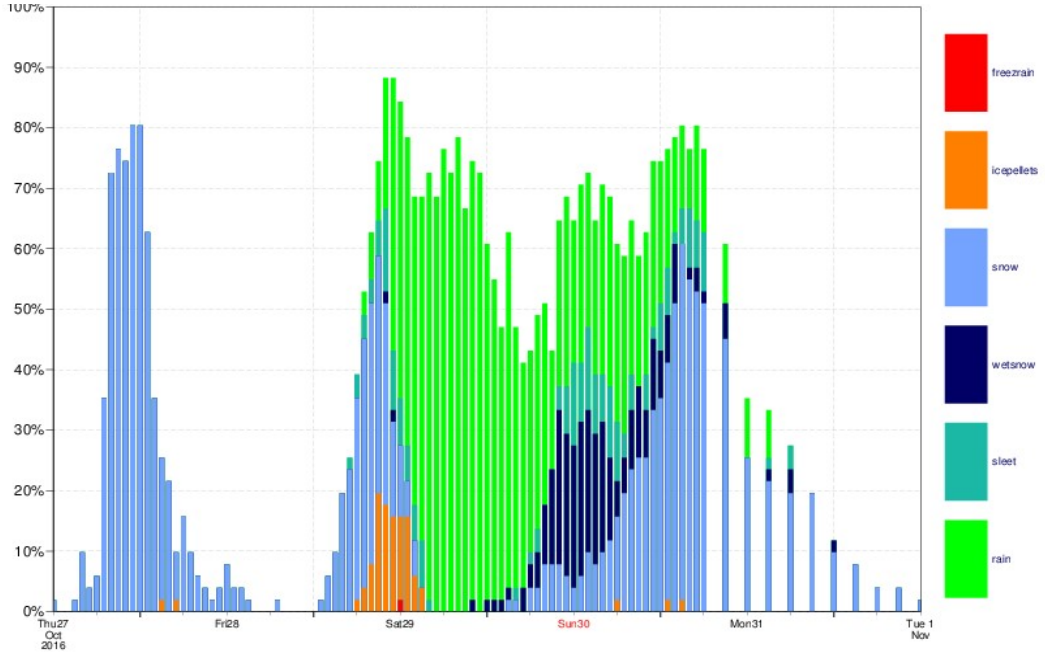
Staff and funding: adding value through external funding

APPLICATE

Evaluating the contribution of selected observations to analysis accuracy and predictive skill

ANYWHERE

Instantaneous probability of precipitation type derived from the ensemble forecast

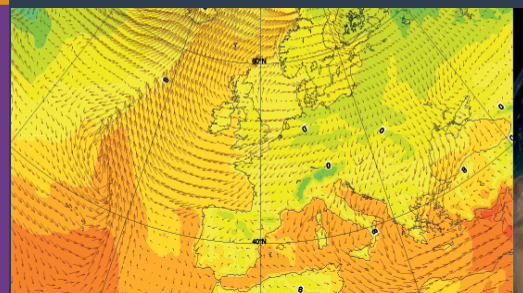


Accommodation

Future of ECMWF data centre timeline…

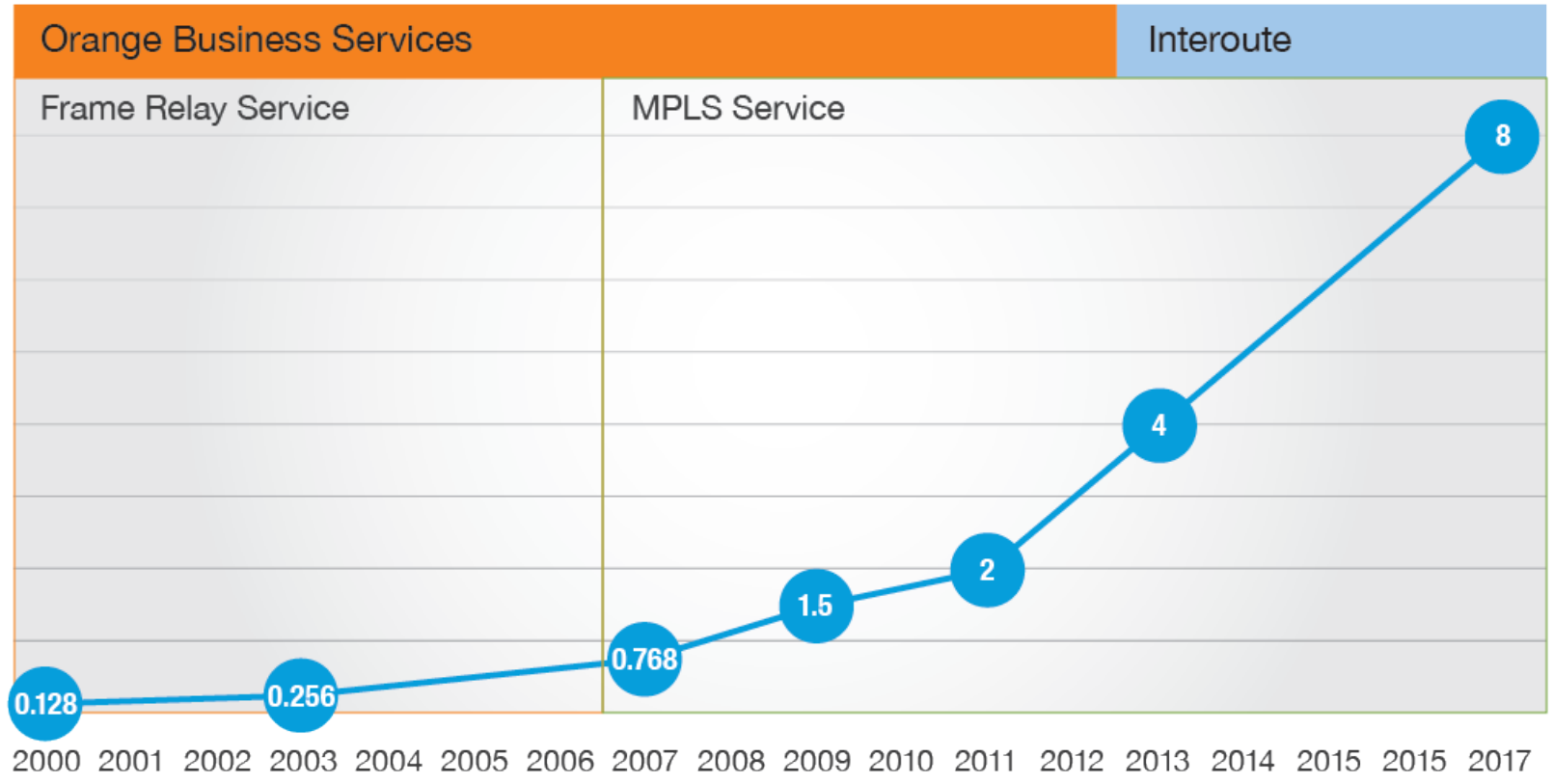
20 December
7 February
28 February

5. SERVING MEMBER & CO-OPERATING STATES

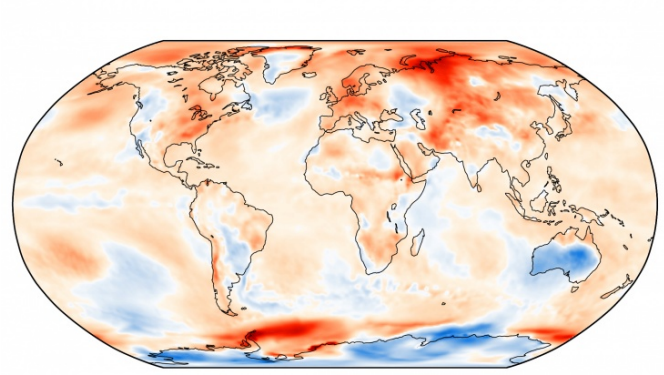




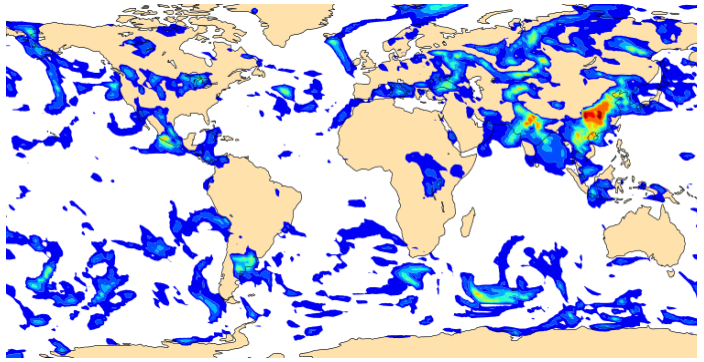
Making deliverables and expertise available
RMDCN Basic package speed (in Mbps)



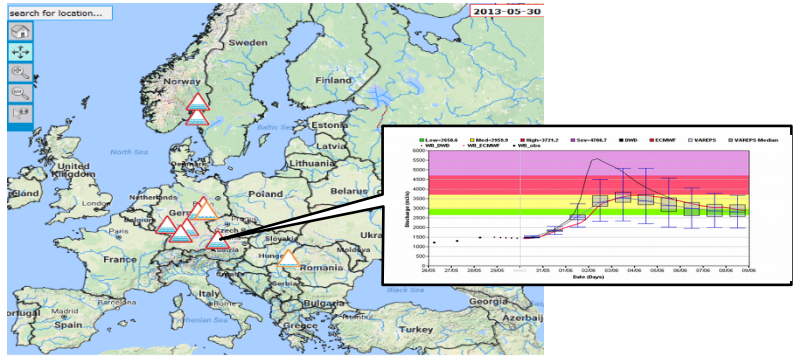
Environmental services



Surface air temperature anomaly for September 2016 relative to the September average for the period 1981-2010. Source: ERA-Interim.



Twice-daily global forecasts up to 5 days of aerosol concentrations



Twice-daily multi-model probabilistic flood forecasts up to 15 days
>50 European forecasting centres as partners

Delivering environmental information