

ECMWF computing services, products and outreach activities

Prof. Florian Pappenberger
Director of Forecasts

florian.pappenberger@ecmwf.int



Organisational structure of ECMWF

Policy Advisory Committee
5–20 Members

Technical Advisory Committee
20 Members

Advisory Committee on Data Policy
5–34 Members

COUNCIL
22 Member States

DIRECTOR-GENERAL
F. Rabier
(France)

Scientific Advisory Committee
12 Members

Finance Committee
7 Members

Advisory Committee of Co-operating States
14 Members

Forecast Department
F. Pappenberger
(Germany)

Computing Department
M. Palkovič
(Slovakia)

Administration Department
L. De Castro Neves Filho
(Portugal)

Research Department
A. Brown
(United Kingdom)

Copernicus Services
J-N. Thepaut
(France)



The operational forecasting system

High resolution forecast (HRES) :

- twice per day **9 km** 137 levels, to 10 days ahead

Ensemble forecast (ENS):

- twice per day 51 members, **18 km** 91 levels, to 15 days ahead
- Monday/Thursday 00 UTC extended to 1 month ahead (**Monthly Forecast, 18/36 km**)

Ocean waves: twice per day

- **HRES-WAM**: 10 days ahead at **14 km** (coupled)
- **HRES Stand Alone Wave (SAW) model** : 10 days ahead at **11 km (*)**
- **ENS-WAM**: 15 days ahead at **28 km** (coupled)

Seasonal forecast: once a month

- 51-members, **~35 km** 91 levels, to 7 months ahead
- sub-set of 15 members is run for 13 months every quarter (**30 years of hindcasts**)
- EUROSIP – Multi model seasonal is replaced by Copernicus Seasonal

Model in focus

Integrated Forecasting System (IFS) cycles

- Cycle 43r1:

Upgrade to the dynamical ocean model used for the medium-range ensemble and its monthly extension, new model output (ceiling, height of convective cloud top, height of 0/1 degree wet-bulb temperature, direct solar radiation, wave energy flux magnitude/mean direction, significant wave height of all waves within a range of periods)

- Cycle 43r3:

new radiation scheme, improvement in convection, new aerosol climatology, changes in observation assimilation

- Cycle 45r1

consistent gains in the extended range. A key plank of the upgrade is enhanced dynamic coupling between the ocean, sea ice and the atmosphere. The upgrade extends this coupling to ECMWF's medium-range high-resolution forecasts (9 km horizontal resolution)

- Cycle 46r1

Continuous data assimilation and introduction of a 50-member Ensemble of Data
Assimilations: weakly coupled data assimilation for sea-surface temperature in the tropics; improvements in the wave model, the convection scheme, the radiation scheme and the use of observations.

2016

22 Nov.

43r1

2017

11 Jul.

43r3

2018

6 Jun.

45r1

2019

Q2

46r1

2020

Q2

47r1

Model in focus

BOLOGNA PLANS

48r1

- Single precision – operational implementation (HRES fc, ENS, extended-range)
- **Unified vertical resolution (ENS, extended-range to match existing HRES L137)**
- **ENS horizontal resolution increase to 9-11 km**
- Daily extended-range ensembles (ideally 51 members) *see separate presentation
- Moist physics framework upgrade, multi-layer snow scheme
- pySuite-based analysis suites

49r1

- OOPS and COPE operational implementation
- NEMO 4, SI3
- Multi-layer surface variables / multi-layer soil scheme

Services in focus

Time Critical applications (some examples)

Country	Description	Start TC application
IRELAND	HARMONIE (LAM, resolution 2.5 Km, 65 vertical levels). It uses ECMWF boundary conditions.	2017
IRELAND	Data acquisition (to run DA on ECMWF HPCF)	2017
PORTUGAL	ALADIN (LAM).	2013
ITALY	COSMO-LEPS (LAM ensemble)	2004
GERMANY	Disaster Backup NWP of DWD	2014
HIRLAM consortium	GLAMEPS (LAM ensemble)	2010
SPAIN	HARMONIE (LAM)	2015
AUSTRIA	ALADIN-LAEF (LAM ensemble)	2011
SERBIA	NMMB (LAM – nonhydrostatic multiscale model – NCEP). It uses ECMWF as boundary conditions	2017
UNITED KINGDOM	UKMO SSPS (Site-Specific Post-Processing System)	2013
GREECE	COSMO	2018
SERBIA	Nonhydrostatic Multiscale Model (NMM-B), 4Km resolution (IFS boundary conditions	2018

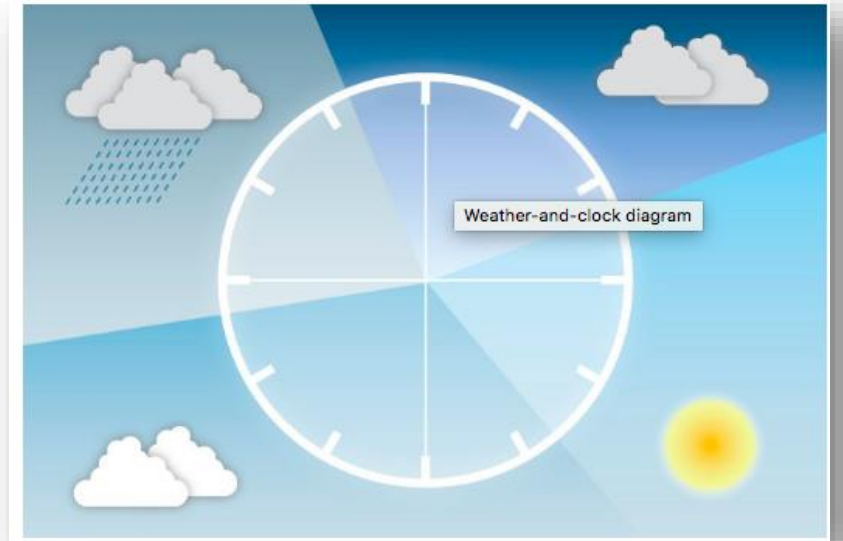
Services in focus

Availability of Boundary Conditions optional programme data

ENS model levels (and more) from the BC optional programme:

- Stored on FDB and available for 30 days
- More information here:
<https://confluence.ecmwf.int/display/UDOC/ENS+BC+model+level+data+in+MARS>

The hourly data and 06/18 UTC forecast runs from its Boundary Conditions optional programme are now available to all users holding a real-time licence, upon request.



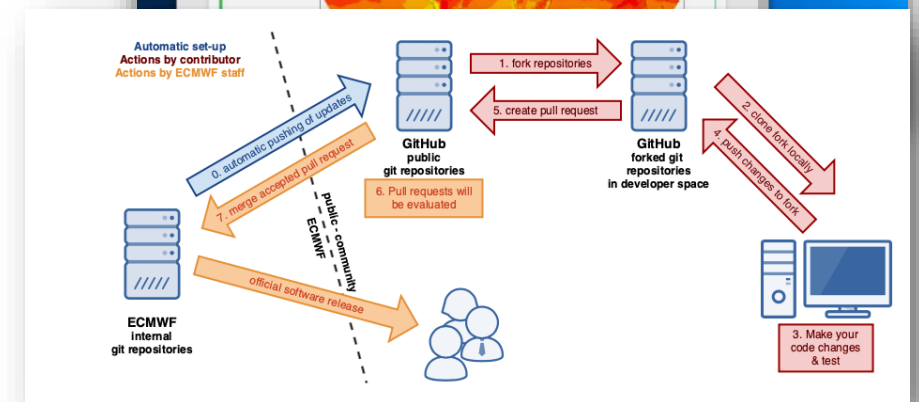
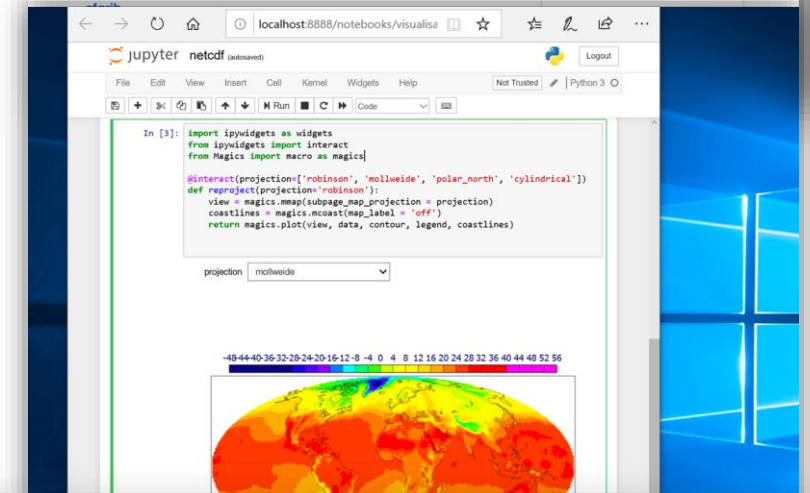
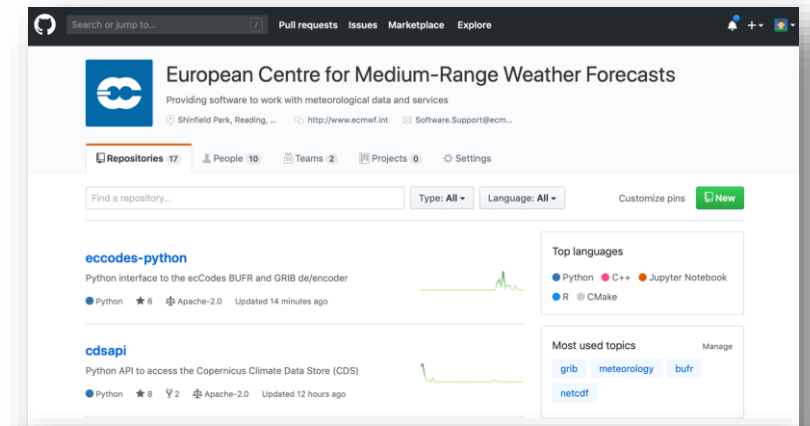
BC optional programme members can request the products via the standard channel:

<https://msaccess.ecmwf.int:9443/do/product/requirements>

Software in focus

Embracing open development for ECMWF software

- ECMWF now available on GitHub
 - Allows for easier code contributions
- Package software on conda & pip
 - Easy reach for Python community
- Ported key libraries to Windows
 - Need help from community
 - Test suites are running from GitHub



Software in focus

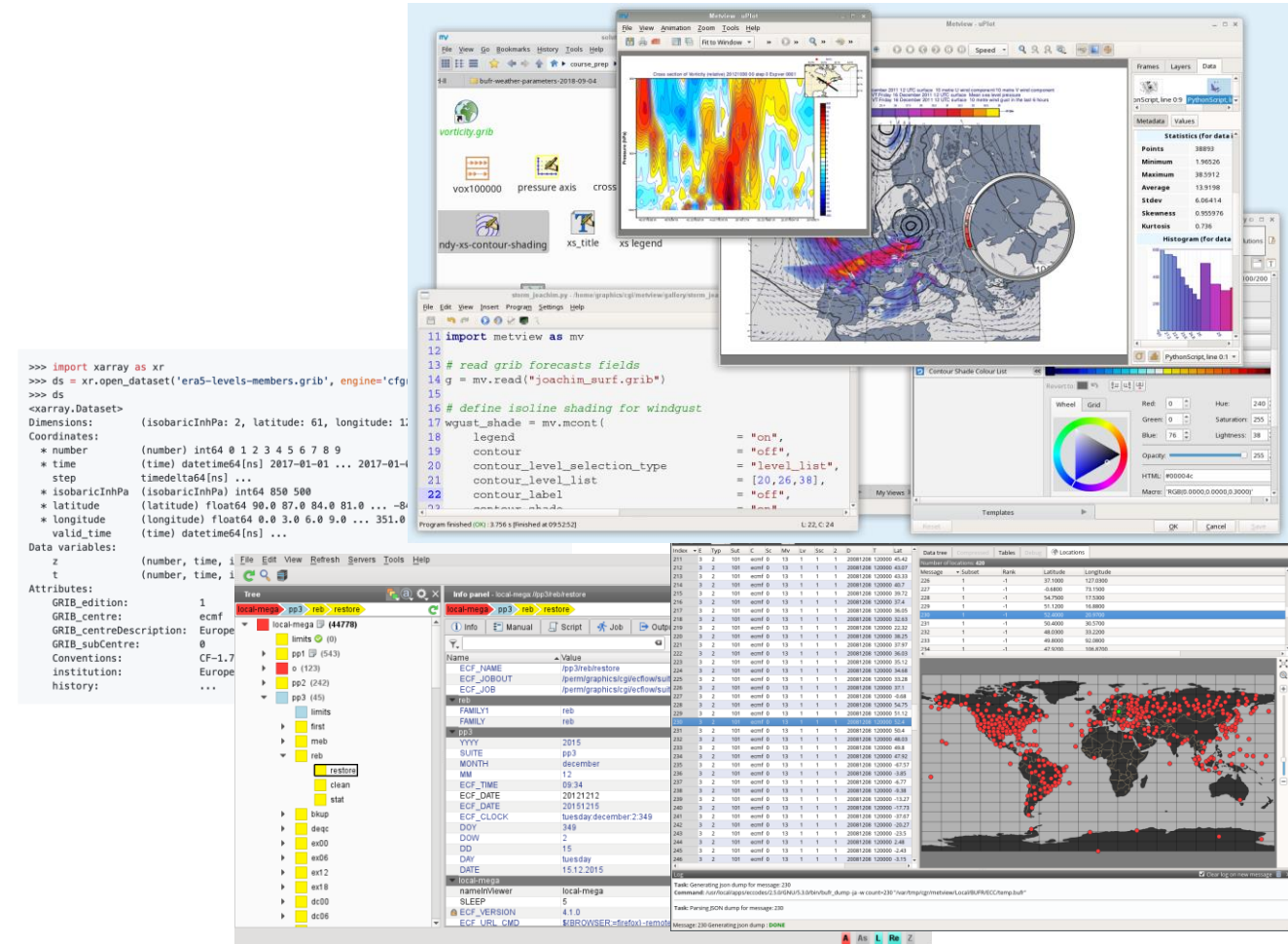
Libraries

- ecCodes
- odb_api
- Magics
- Python modules: cfgrib, pdbufr, web_api

Tools

- ecFlow + ecFlowUI
- Metview
- FDB

Many more miscellaneous codes to support core software packages – not intended for direct usage!

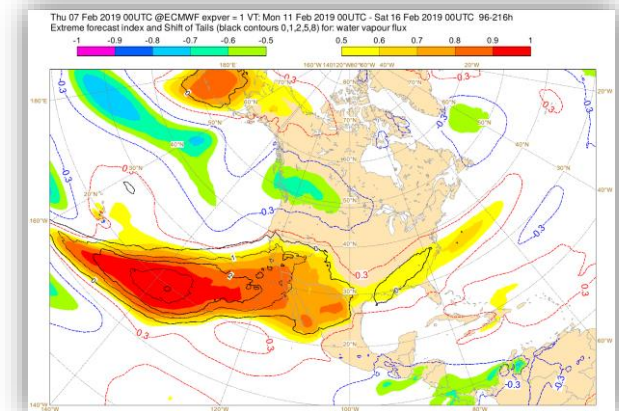
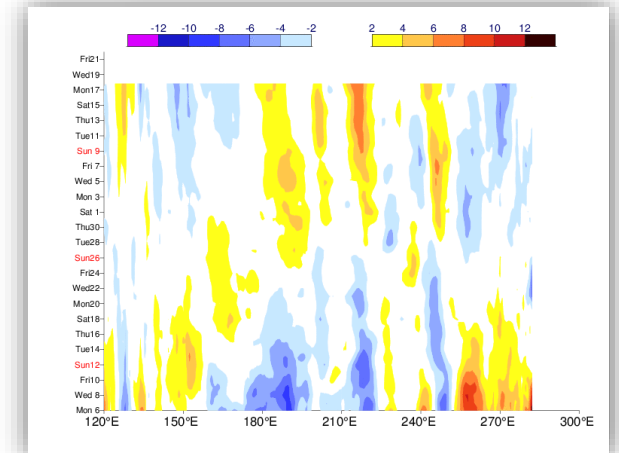
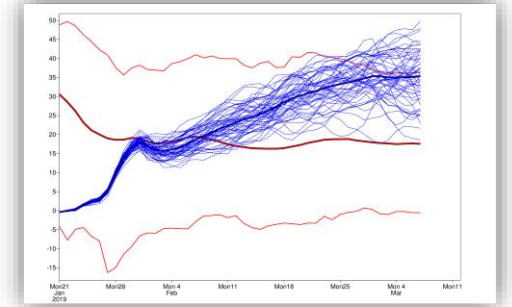


Deprecated software

- Emolib
- BUFRDC
- grib_api
- SMS

Products in focus

- Test products for winter cold spells (medium and extended range)
- Point rainfall in ecCharts
- New forecast output fields (46r1):
 - 200m wind, parameters on PV=1.5, 2
 - Ocean waves
 - Ocean fields
 - Integrated water vapour transport EFI
 - Extended-range EFI
- Reforecasts initialised from ERA5: more consistent model climatology



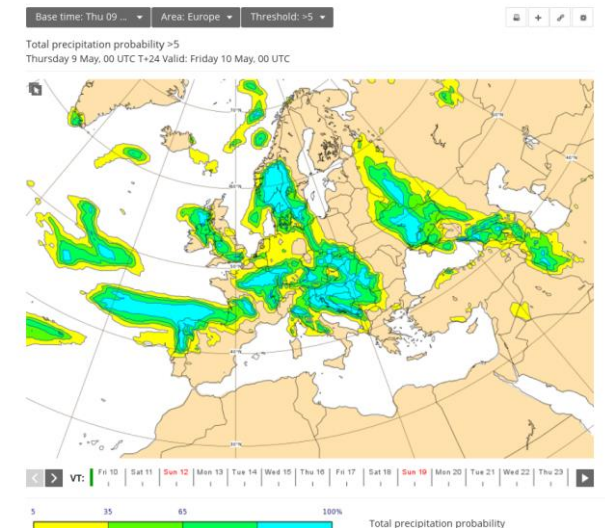
Products in focus

ECMWF is a World Meteorological Centre



WORLD
METEOROLOGICAL
ORGANIZATION

Probabilities: 24hr total precipitation



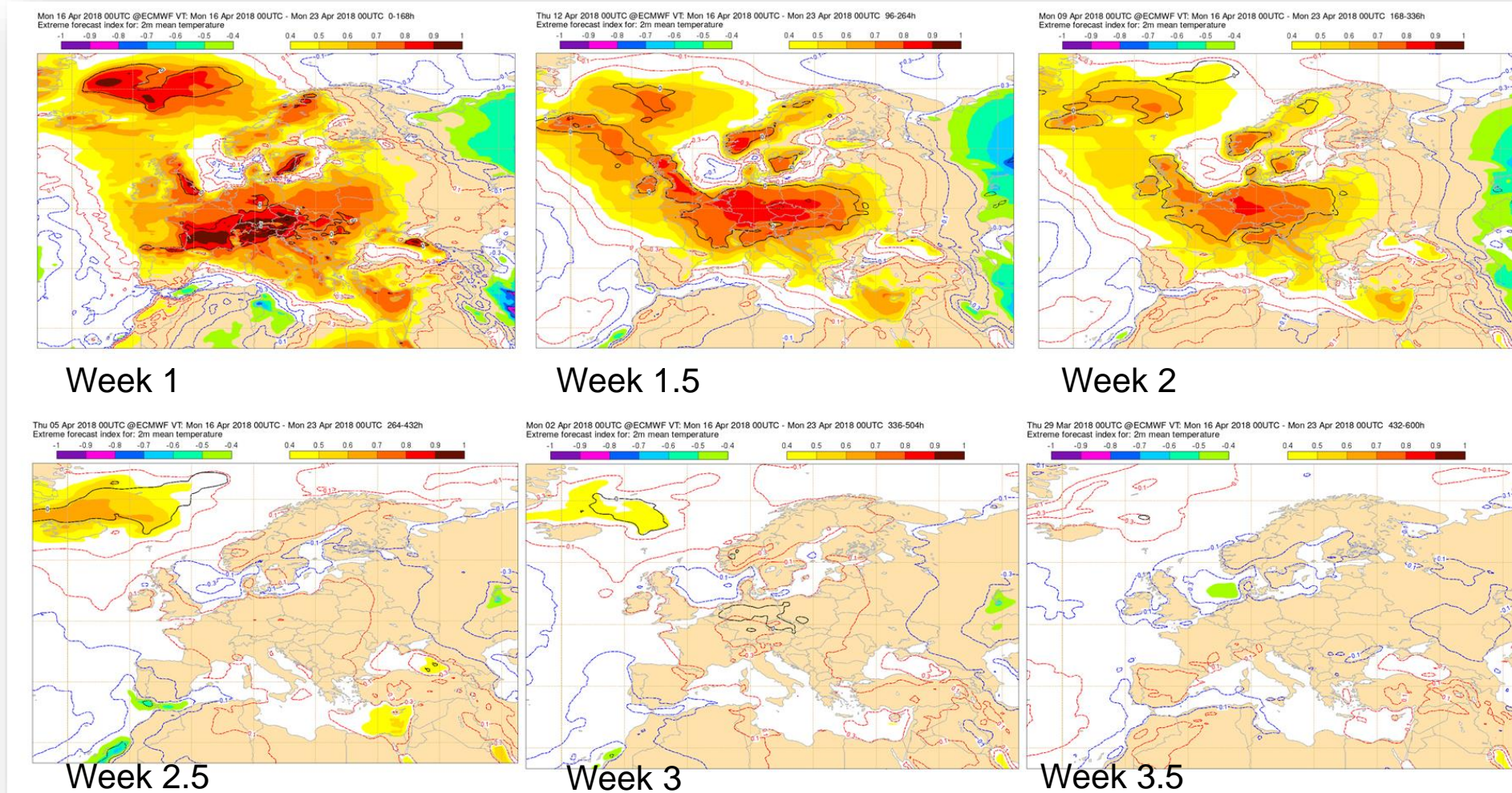
shortName	Description	threshold
tpg<threshold>	Total precipitation of at least <threshold> mm	25, 50, 100 mm
10fgg10	10 metre wind gust of at least 10 m/s	10 m/s
ptsa_gt_<threshold>st dev	Probability of 850hPa temperature standardized anomaly greater than <threshold> standard deviation	1, 1.5, 2 stdev
ptsa_lt_<threshold>std ev	Probability of 850hPa temperature standardized anomaly less than - <threshold> standard deviation	1, 1.5, 2 stdev

- All parameters are in GRIB edition 2
- Parameters available for ENS

Products in focus

Extended range *EFI/SOT*

2018 spring heatwave



Forecast performance in focus

Forecast performance: headline scores

2 primary scores

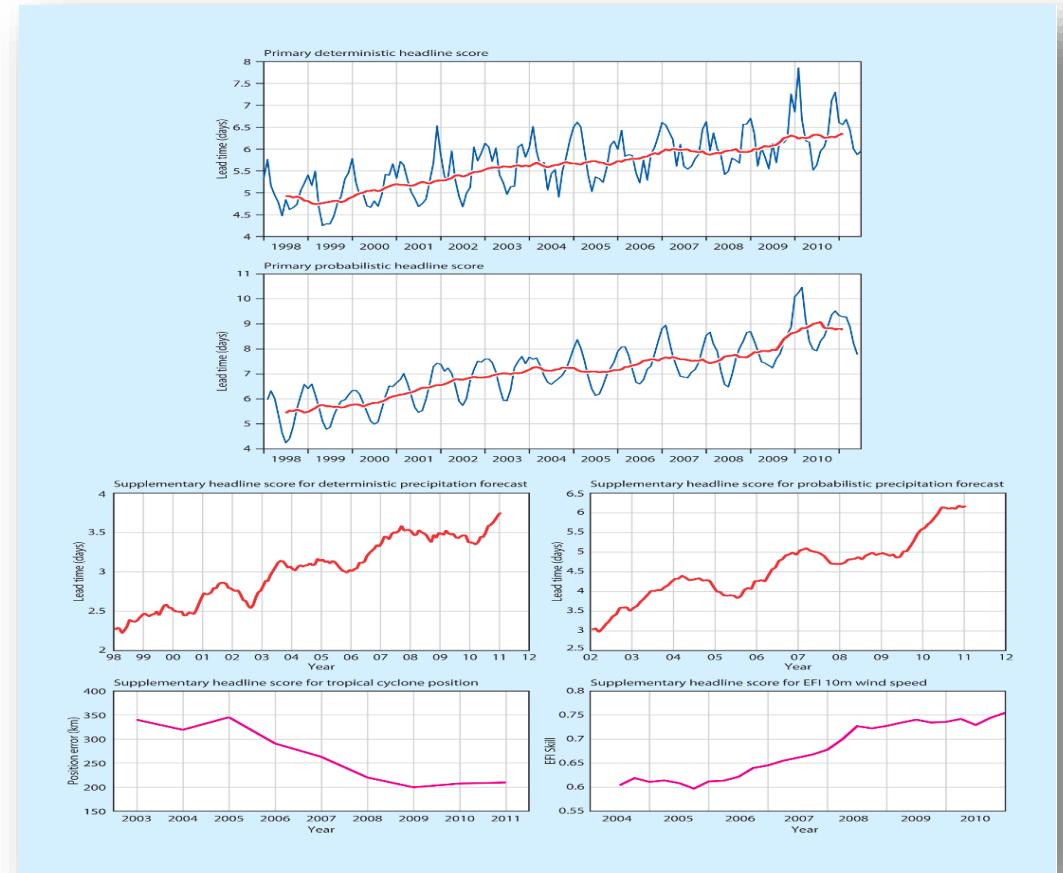
- HRES upper-air skill
- ENS upper-air skill

6 supplementary scores

- Precipitation
- HRES skill
- ENS skill
- Percentage of large temperature errors
- Weekly mean 2m temperature (terciles)

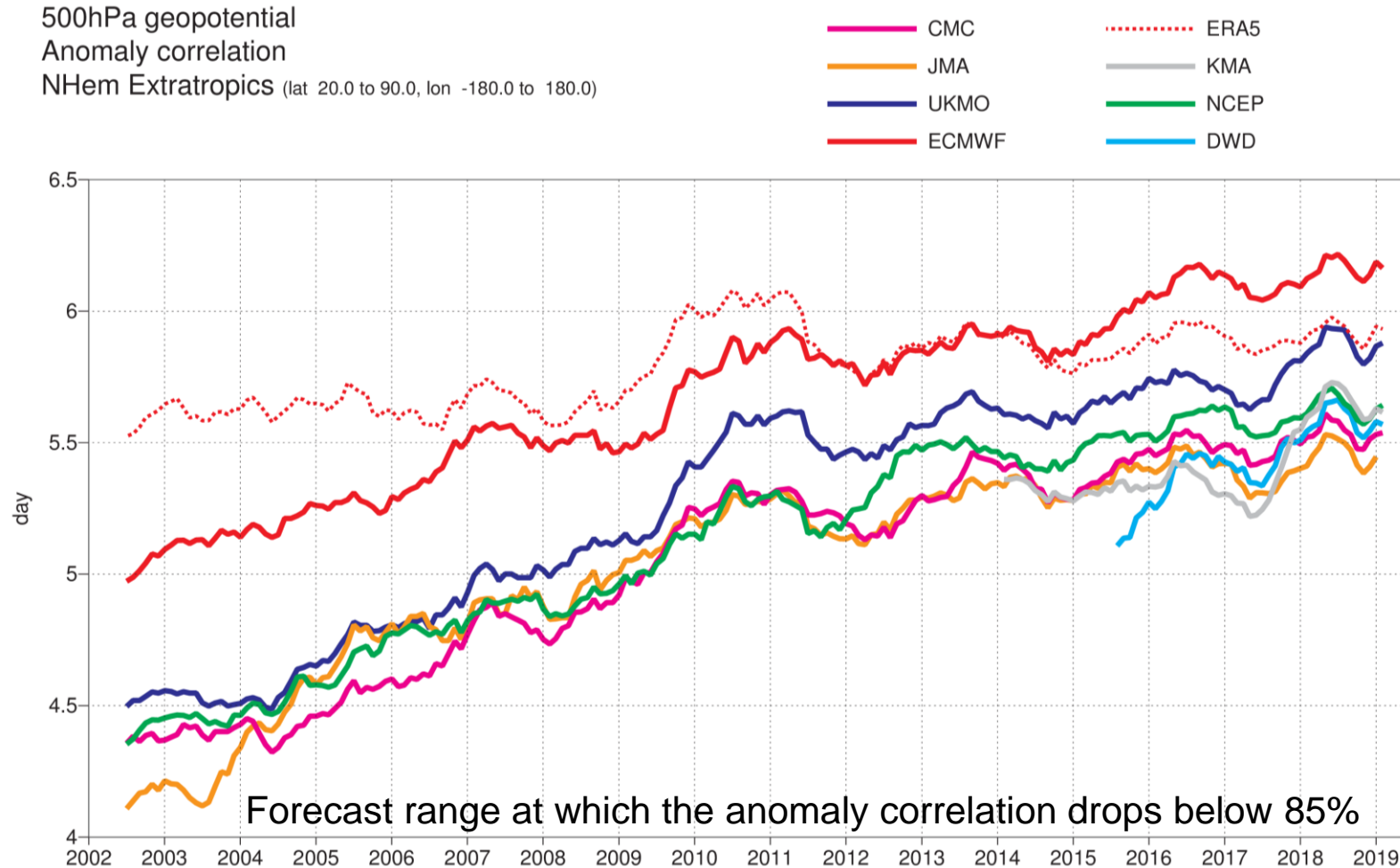
Severe weather

- Tropical cyclone track position error
- EFI skill



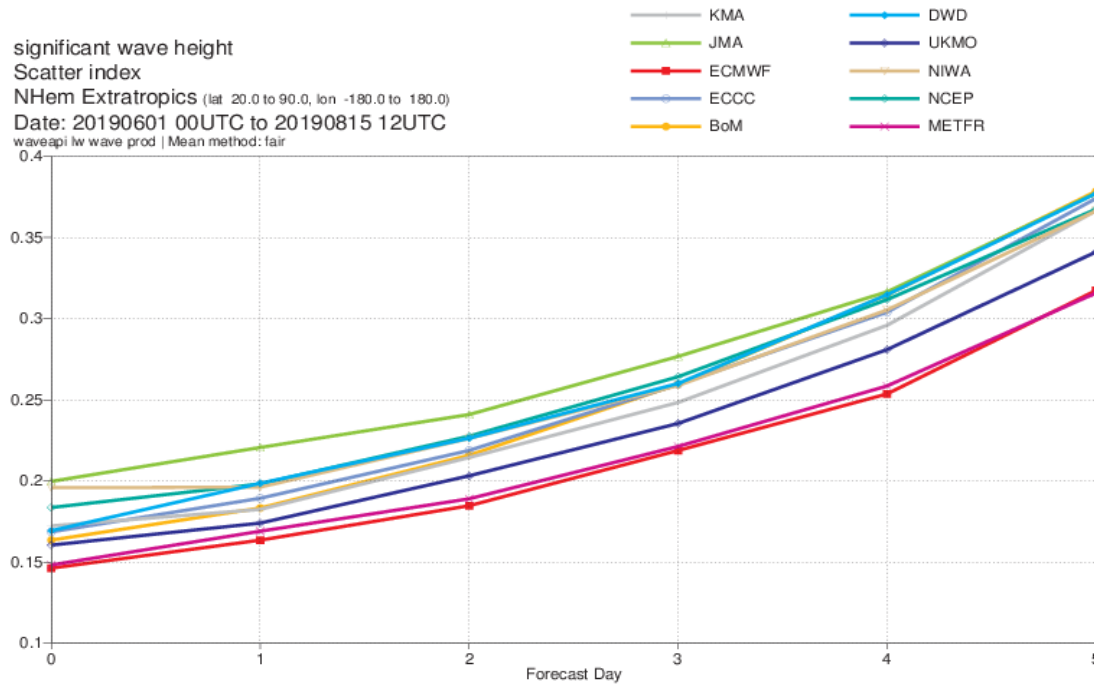
Forecast performance in focus

Comparisons with other centres – Z500 Northern Extratropics

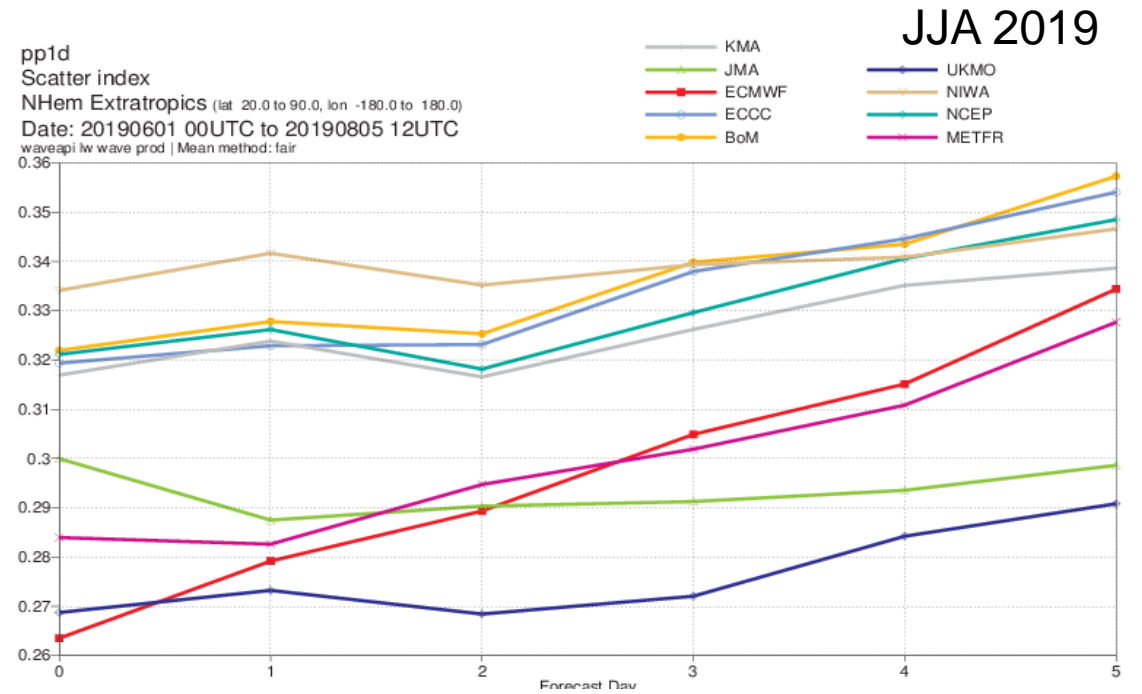
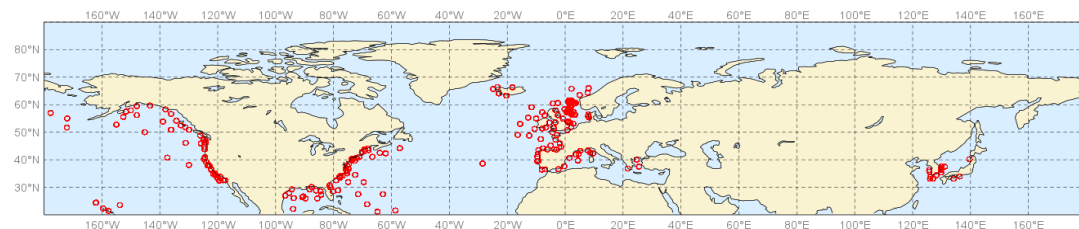


Forecast performance in focus

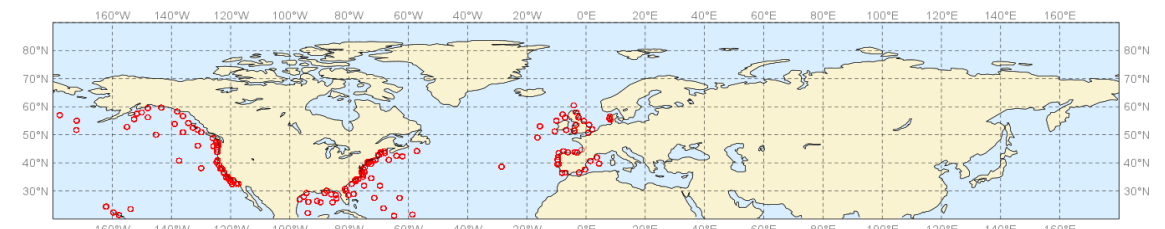
WMO Lead Centre for Wave Forecast Verification (N. Hemisphere extratropics)



Significant wave height

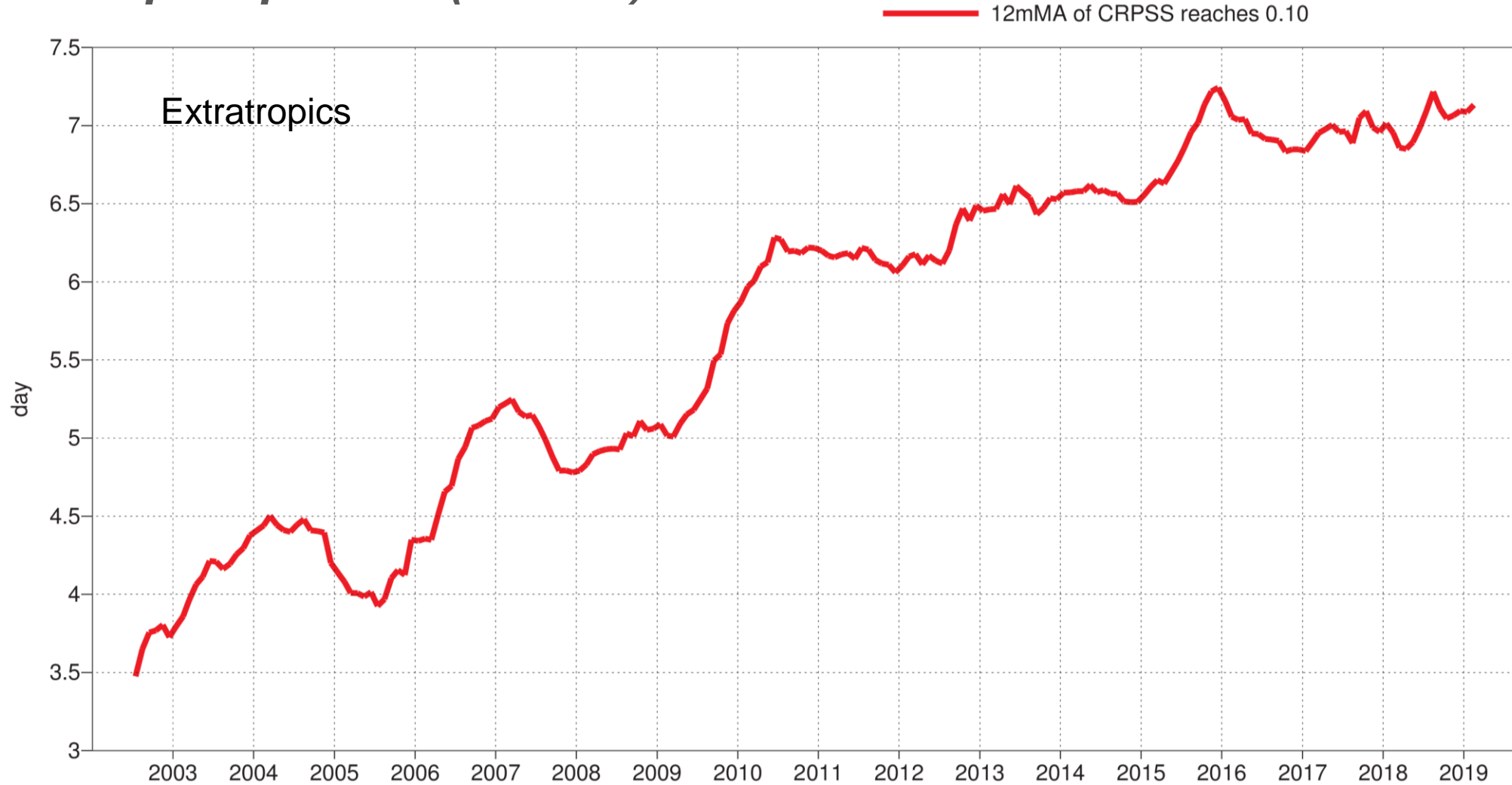


Peak period



Forecast performance in focus

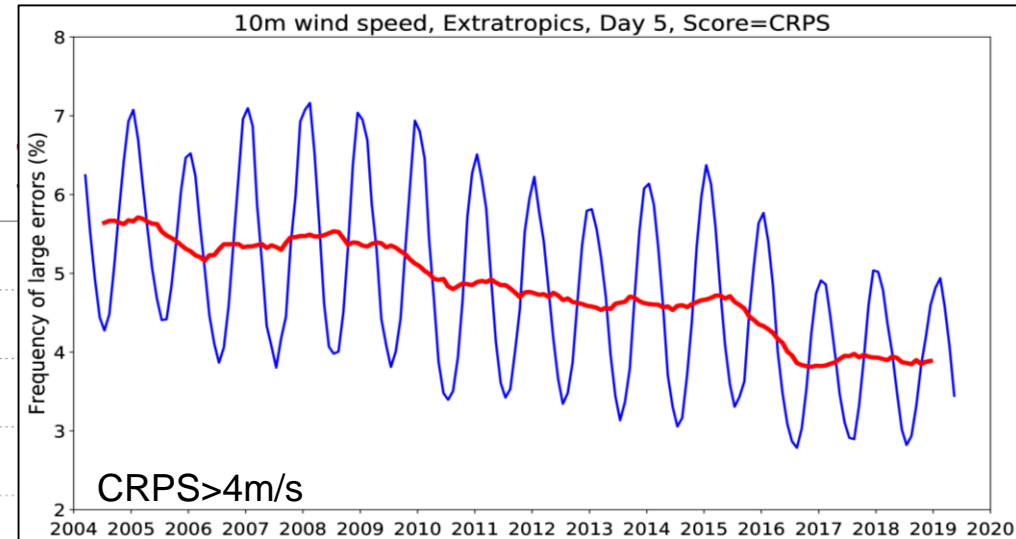
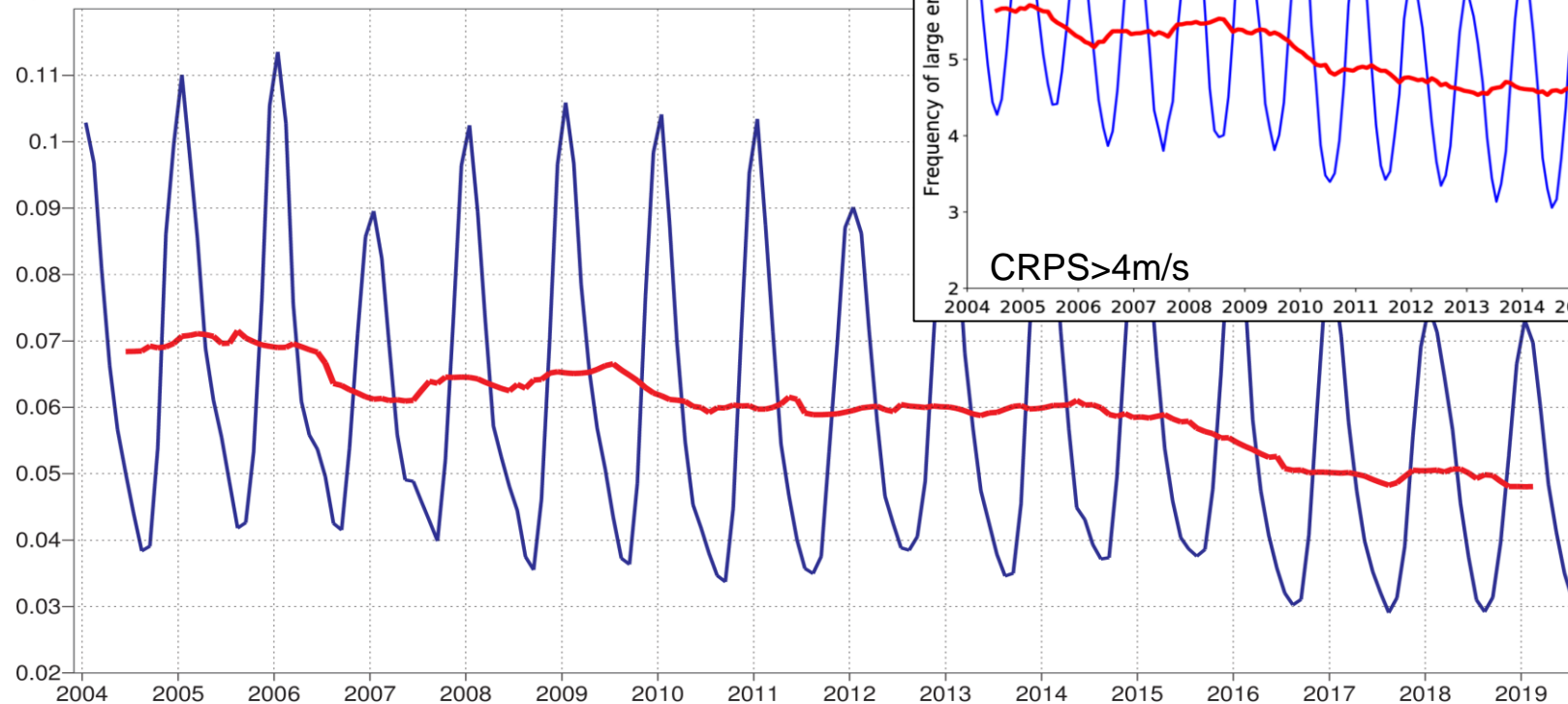
ENS precipitation (CRPSS)



Forecast performance in focus

Frequency of large 2m temperature and wind errors - ENS

2 meter temperature
Fraction of large CRPS value >5.0
Extratropics (lat -90 to -30.0 and 30.0 to 90, lon -180.0 to 180.0)
T+120
oper_ob od enfo 0001



Extra-tropics
Day 5

P(CRPS>5K)

Outreach in focus

Severe event catalogue

Forecast User Home:

<https://software.ecmwf.int/wiki/display/FCST/Forecast+User+Home>

Forecasting issues

Changes to forecasting system

Outreach in focus

User guide to ECMWF products

<https://software.ecmwf.int/wiki/display/FUG/Forecast+User+Guide>

The screenshot shows the ECMWF Forecast User Guide website. The top navigation bar includes the ECMWF logo, 'Spaces', 'Calendars', and a 'Create' button. A search bar is located in the top right. The main content area is titled 'Forecast User Guide' and features a search box with the placeholder text 'Search this user guide for ...'. Below the search box is a quote: *"Behind good forecast practices are often hidden good theories; equally, good theories should provide a basis for good forecast practices."* Professor Tor Bergeron, personal communication, 1974. The central image is a collage of various meteorological forecast products, including maps, charts, and data visualizations. Below the image, there is a paragraph explaining the purpose of the User Guide:

The aim of this User Guide is to help meteorologists make the best use of the forecast products from ECMWF - to increase understanding of the ensemble forecast process, to develop new products, to reach new sectors of society, to satisfy new demands. The User Guide presents the Integrated Forecasting System (IFS) and advises on how best to use the output, not least on how to build up trust in the forecast information. A good forecast that is not trusted is a worthless forecast. The emphasis is on the medium-range forecast products, as this is ECMWF's primary goal, and because medium-range NWP output generally differs significantly from dealing with short-range or seasonal NWP.

 Below this paragraph is another paragraph:

This guide is intended to give an outline of structure and use of the ECMWF IFS and how the high-resolution forecast (HRES), ensemble forecast (ENS), extended range forecast and seasonal forecast models inter-depend and interact. Links to more detailed descriptions of processes are given, mainly at the end of each section, whilst separate online ECMWF training resources are also available to explain aspects of the ECMWF IFS more visually. Education is a key component of the work at ECMWF and further educational material is available through the web site (e.g. Webinars (recordings), Slidecasts (slides and audio recordings), Tutorials, Training lectures (presentations in PDF))

 The left sidebar contains a 'Forecast User Guide' header, 'SPACE SHORTCUTS' with a link to 'Forecast User Home', and a 'PAGE TREE' with a list of sections: 1 Introduction, 2 The ECMWF Integrated Forecasting System - IFS, 3 Availability and Interpolation of NWP output, 4 NWP Evolution versus Reality, 5 Forecast Ensemble (ENS) - Rationale and Construction, 6 Using Deterministic and Probabilistic Forecasts, 7 ENS Products - Dealing with Uncertainty, 8 ENS Products - What they are and how to use them, 9 Physical Considerations when Interpreting Model Output, 10 Interfaces for displaying Model Output, 11 Conclusion, and 12 Appendices. At the bottom left of the sidebar, there is a 'Space tools' icon and a double arrow icon.

Learning in focus

Our offers:

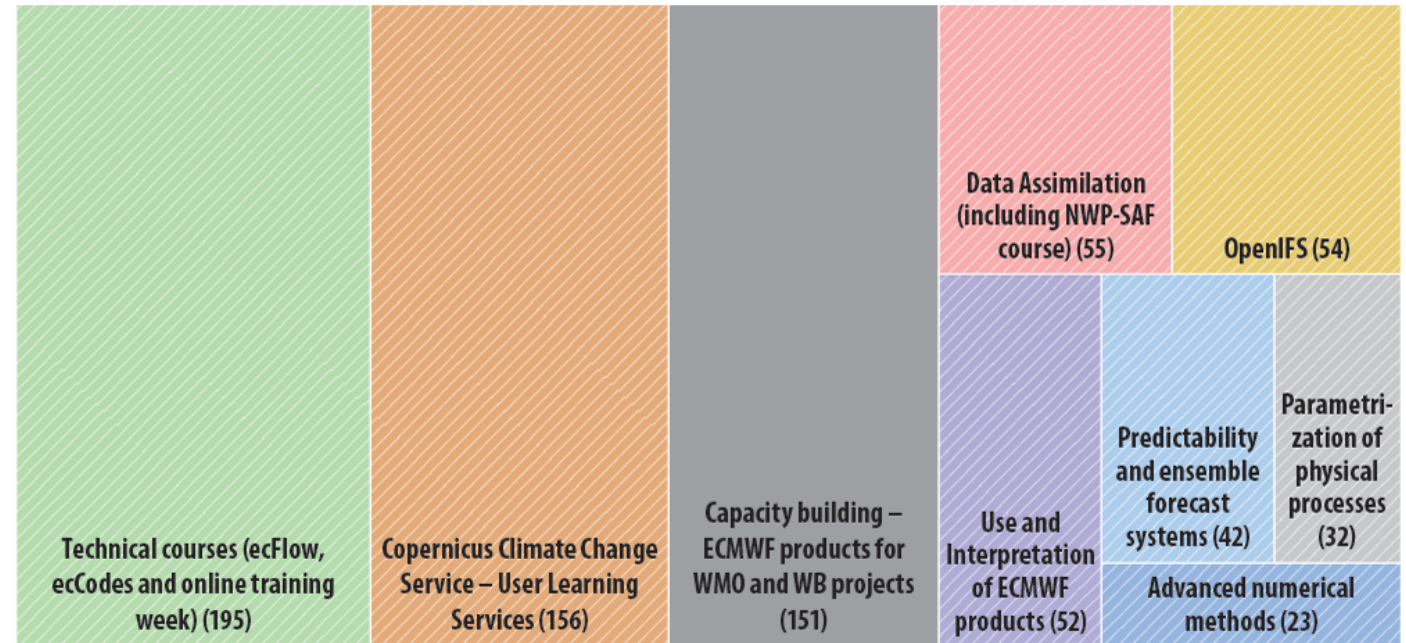
Courses are designed to enable participants to develop an understanding of advanced numerical forecasting and to use ECMWF's services and products effectively. We provide user learning activities within C3S and CAMS

Areas

- Meteorology (NWP and use of products)
- Software/computing

Other learning opportunities

- WMO Fellowship scheme
- Annual seminar



760 learners in 2019!
(September 2019)

Follow us #ECLearn

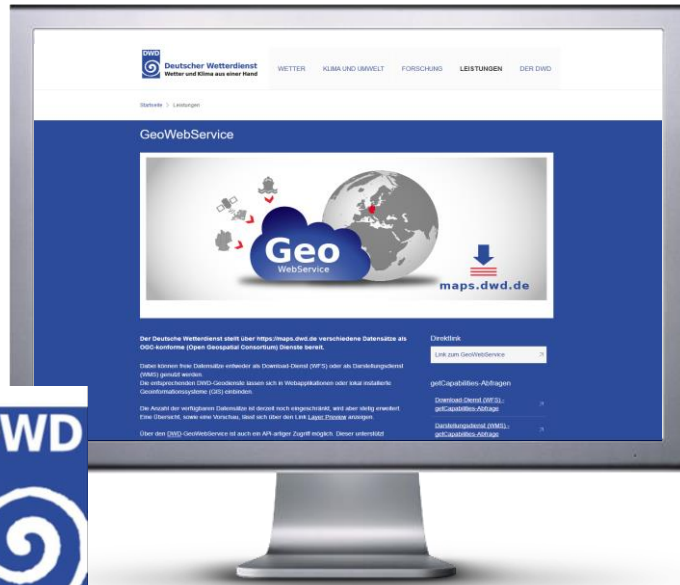
The European Weather Cloud





The European Weather Cloud

OGC Web services
on full ECMWF forecasts
without need of data transfer to DWD



Staff just arrived

**SEES: Synergy of ECMWF
and EUMETSAT Services**
Display simultaneously EUMETSAT
OSI SAF and ECMWF forecasts



In preparation
to start January 2020

**Historical Dataset ML Model
Training / Blending**
Large amounts of historical
forecast data



Coming in 2020

Participants: Switzerland, United Kingdom, France, Germany, Netherlands, Finland, Sweden, Norway, Austria, Denmark, EUMETNET (discussions), ECMWF and EUMETSAT



Highlights for next year

1. **New ECMWF strategy** is currently developed
2. Discussion on moving towards **open data**
3. We are **moving to Bologna**

