

ECMWF Product Development

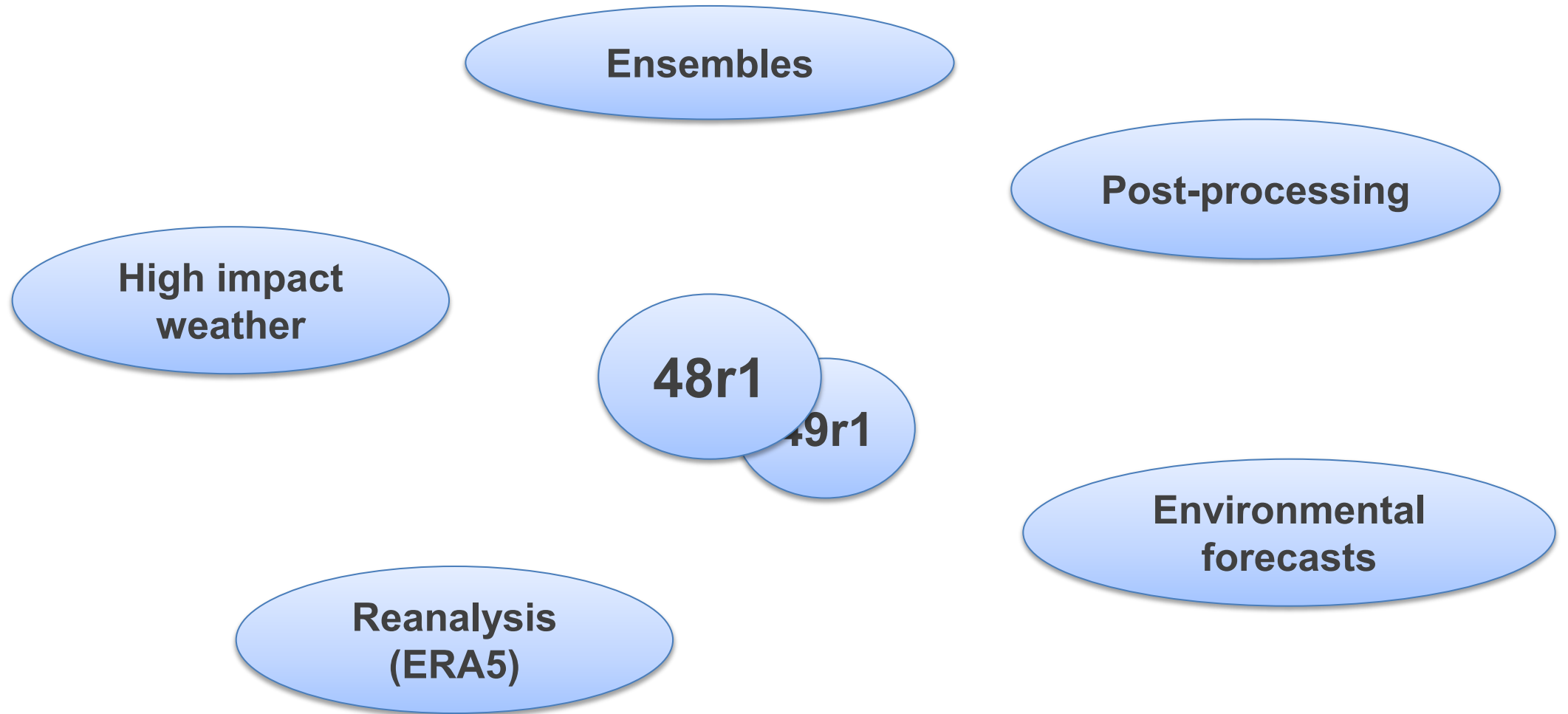
#UEF2023

Matthieu Chevallier, Head of Evaluation, ECMWF

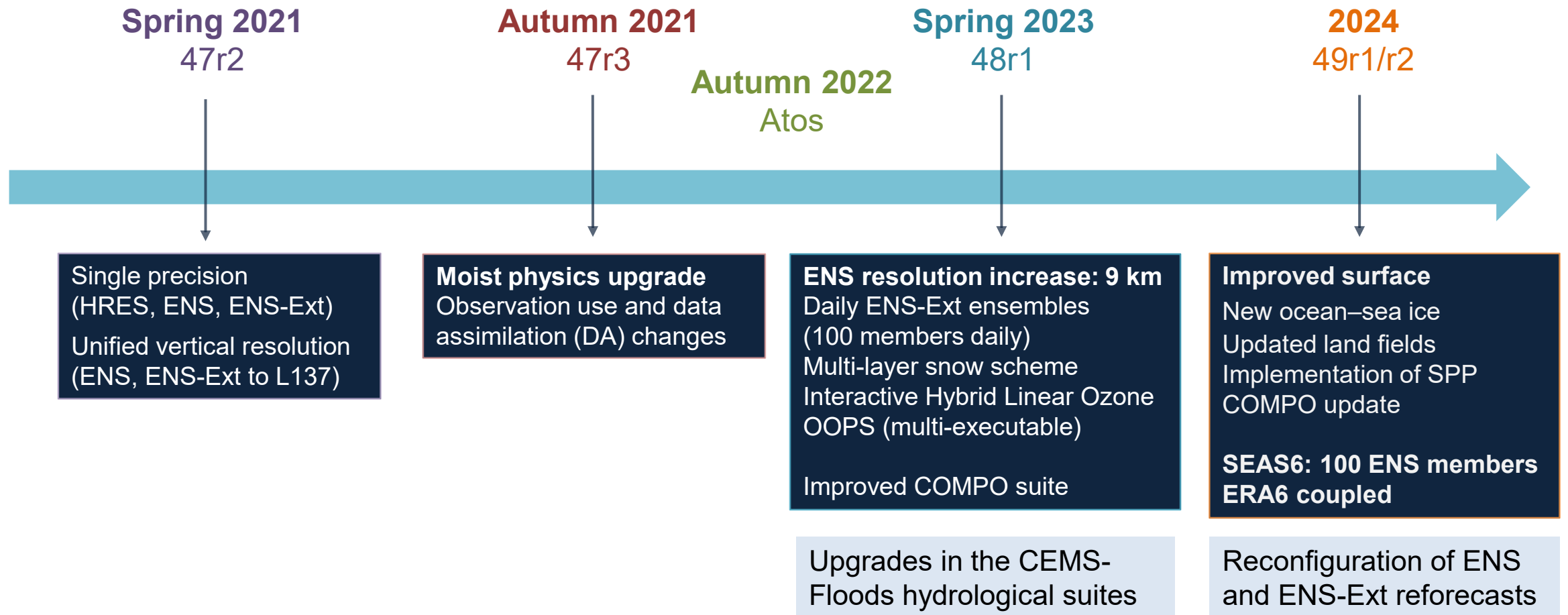
Thanks to all colleagues for inputs



ECMWF Product Development – Outlines



ECMWF Integrated Forecasting System (IFS) upgrades



48r1 – Test data

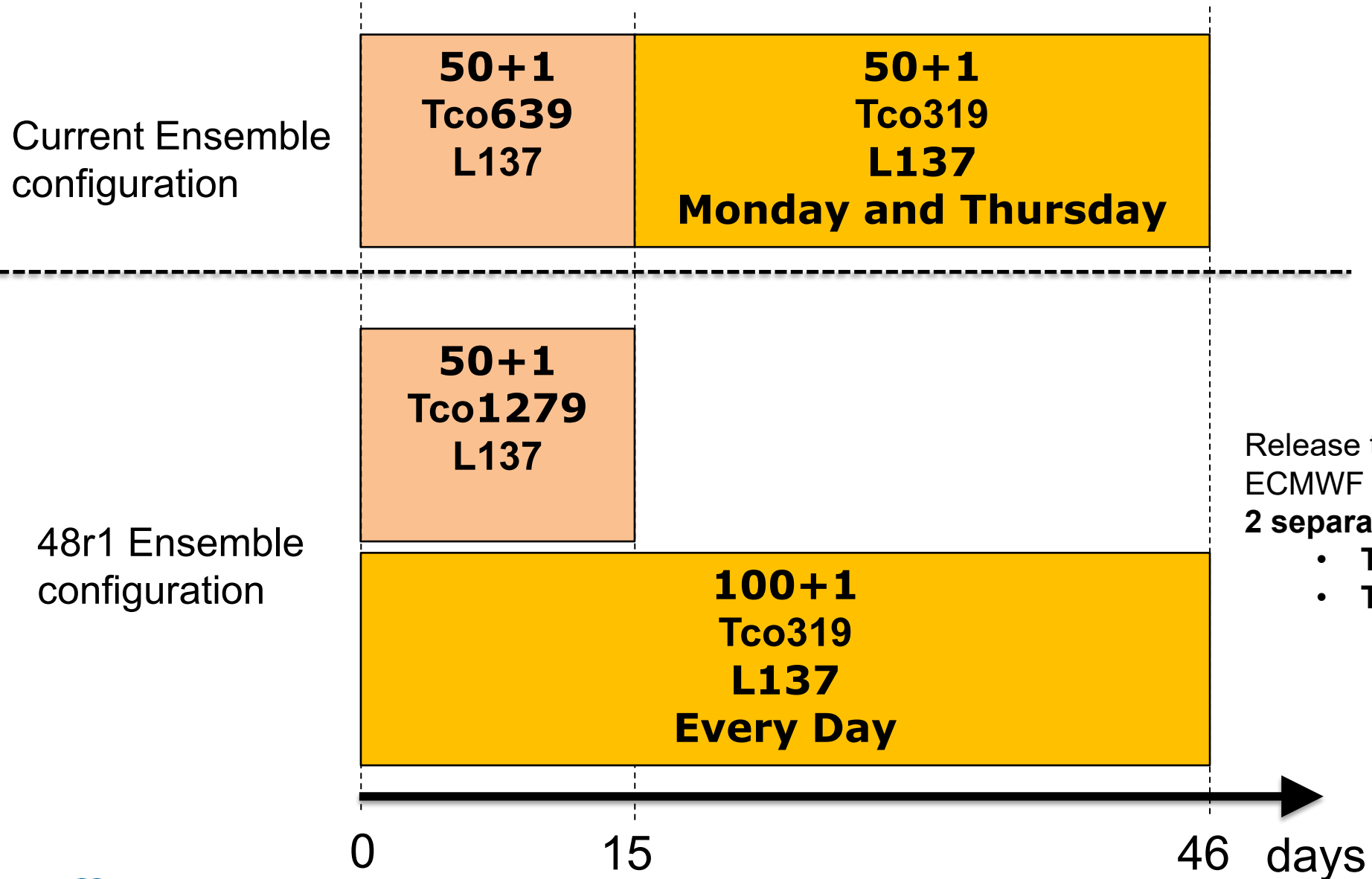
Target date for cycle implementation: 27 June 2023

- Note technical changes
 - GRIB2 gridded data uses CCSDS packing (transparent using ecCodes)
 - Changes in data configuration (stream eefo/enfo... see documentation)
- Tests data is available
 - Via MARS Archive or dissemination (use Test products Requirements Editor)
 - Check that your processing chains work correctly with the test data
 - Changes to data requirements will not be possible **from 21 June**
- Study the 48r1 Implementation page & Watch for updates:
<https://confluence.ecmwf.int/display/FCST/Implementation+of+IFS+Cycle+48r1>
- Please report any issues or feedback via the Support Portal: <https://www.ecmwf.int/en/support>

More info: 48r1 data webinar (1 June)

<https://confluence.ecmwf.int/display/FCST/Implementation+of+IFS+Cycle+48r1#ImplementationofIFSCycle48r1-Webinars>

48r1 – Key configuration changes



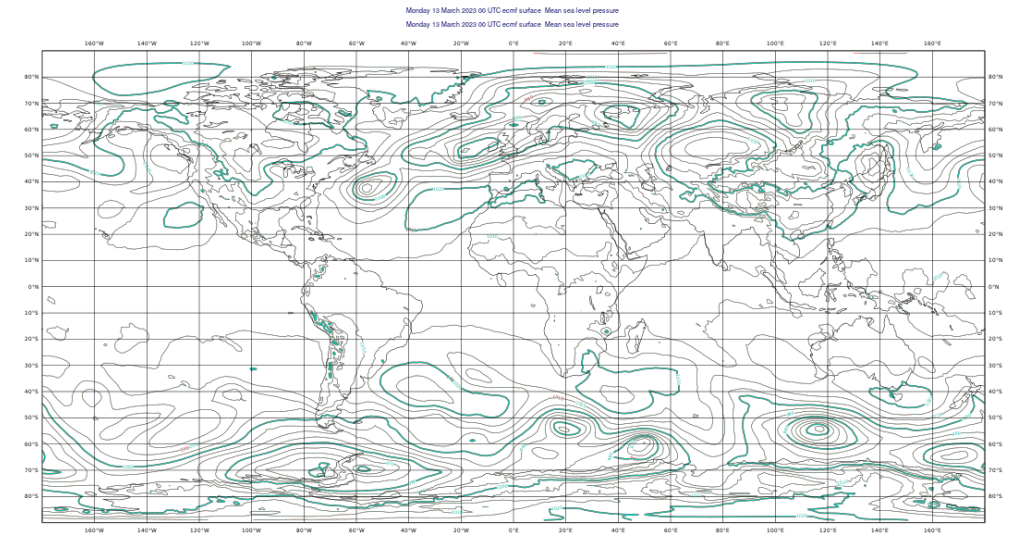
Release times remain the same
ECMWF Seasonal unchanged
2 separate reforecasts 2x/week

- Tco1279 day 0-15 (10+1mb)
- Tco319 day 0-46 (10+1mb)

48r1 – HRES vs ENS Control?

- **In 48r1:** ENS and HRES have the same horizontal resolution...
 - HRES now plays a similar role to ENS “Control” run (unperturbed) for the first 10 days
 - HRES and ENS Control are still 2 separate unperturbed runs
 - HRES is 10-day long, ENS Control is 15-day long
 - HRES still disseminated earlier than the full ENS
- **In 49r1:** both will evolve into computationally identical runs (“ENS Control”).
 - No more HRES

- **As a consequence, in 48r1:**
 - Naming “HRES” is kept
 - “Deterministic” charts use HRES
 - Only HRES is plotted in 10-day meteograms

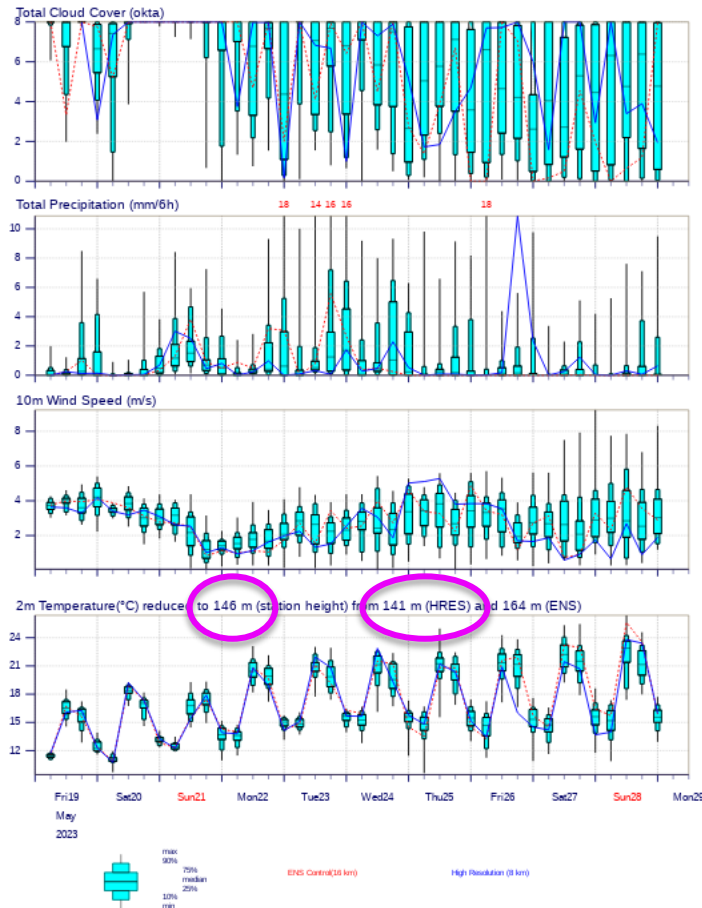


MSLP forecasts in 48r1 init 13 March 2023 – HRES (red) vs ENS Control (turquoise).

48r1 – 10-day meteograms

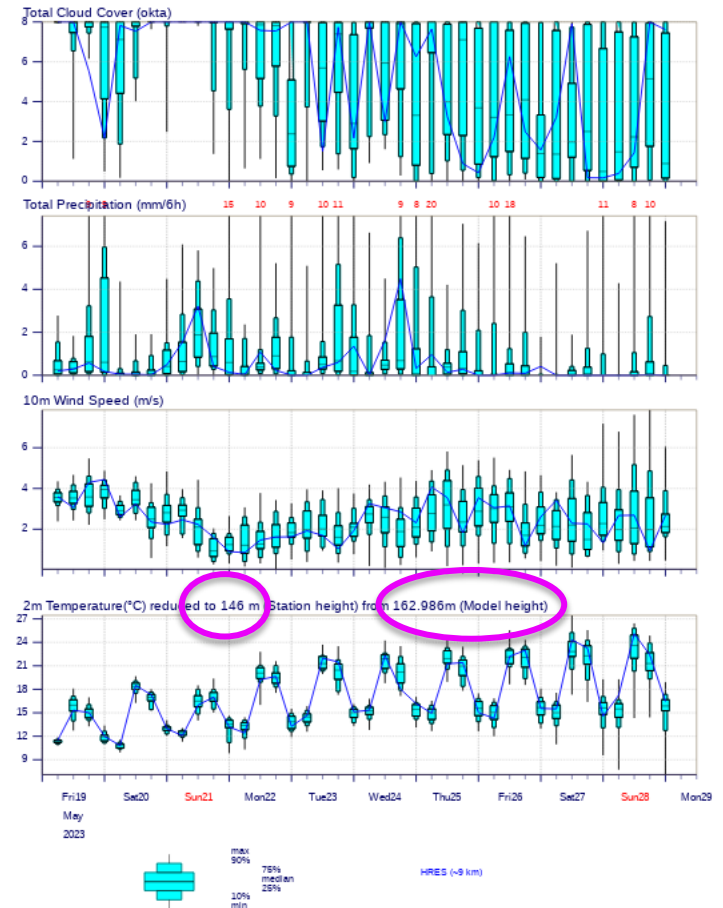
Operational system (47r3)

ENS Meteogram
Toulouse - Midi-Pyrénées - France 43.65°N 1.35°E (ENS land point) 146 m
High Resolution Forecast and ENS Distribution Friday 19 May 2023 00 UTC



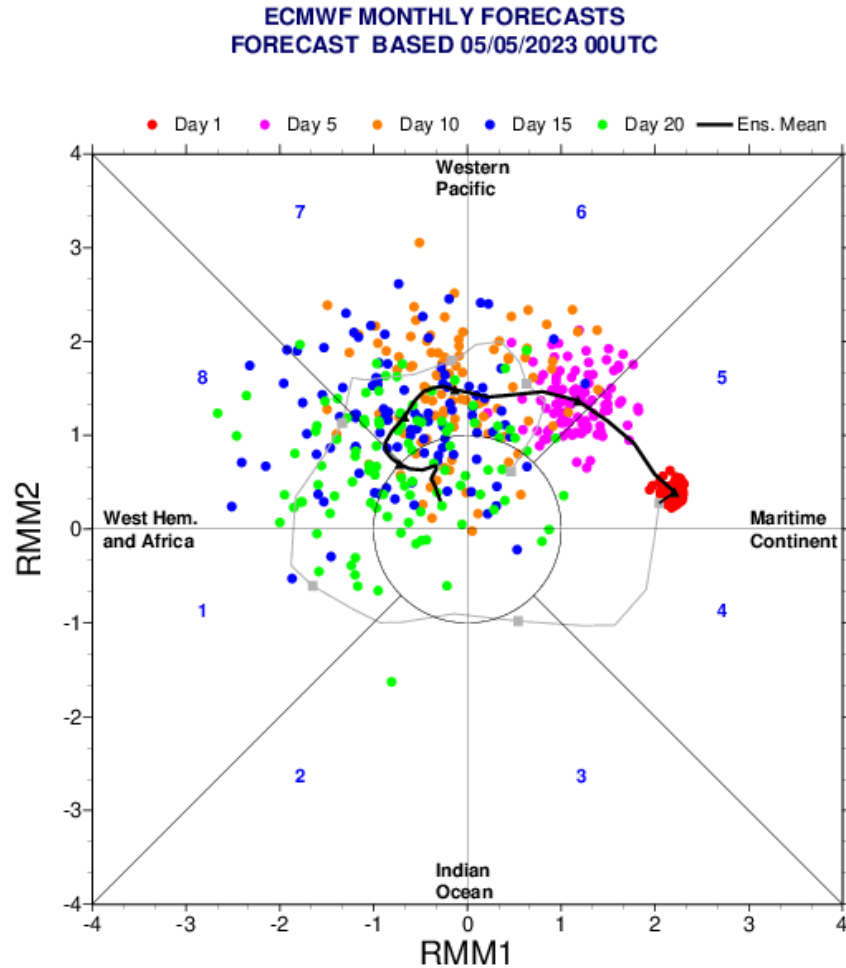
Next cycle (48r1)

ENS Meteogram [0078]
Toulouse - Midi-Pyrénées - France 43.62°N 1.49°E (ENS land point) 146 m
HRES Forecast and ENS Distribution Friday 19 May 2023 00 UTC

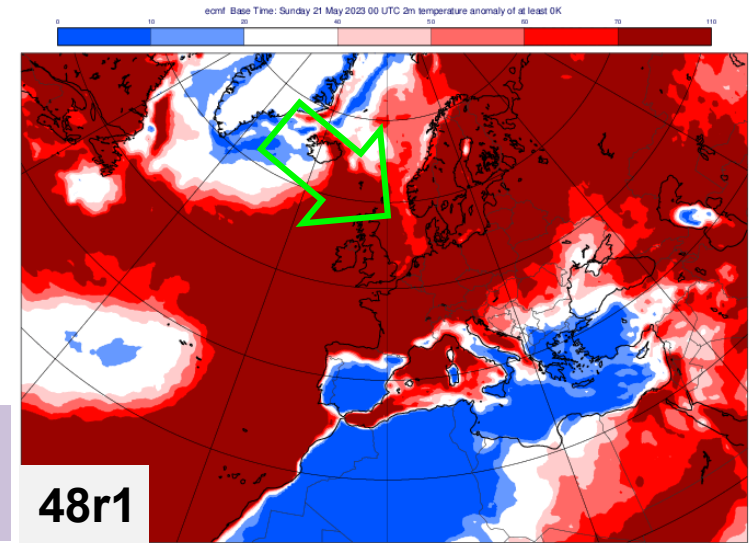


48r1 – ENS-Extended forecast – Daily products

Madden-Julian Oscillation Index

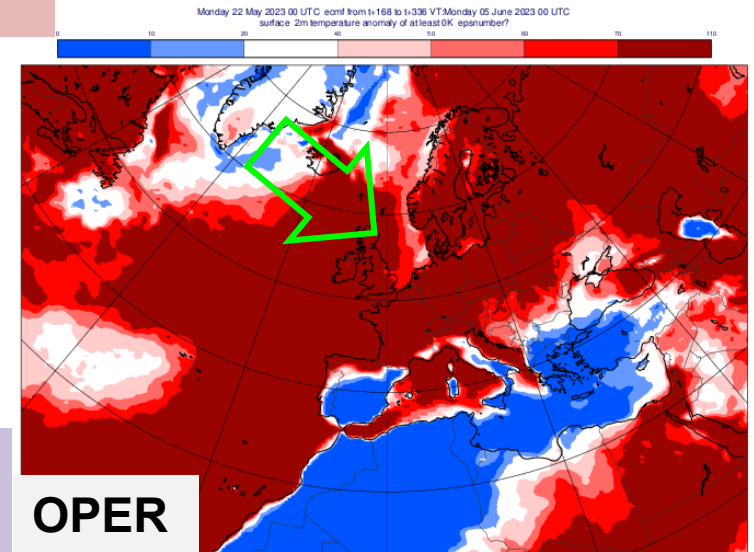


Sun to Wed
(21st to 24th)



Probability of 2mT
weekly anomaly > 0

VT:29 May – 05 JUN



Mon & Thu
(22nd & 25th)

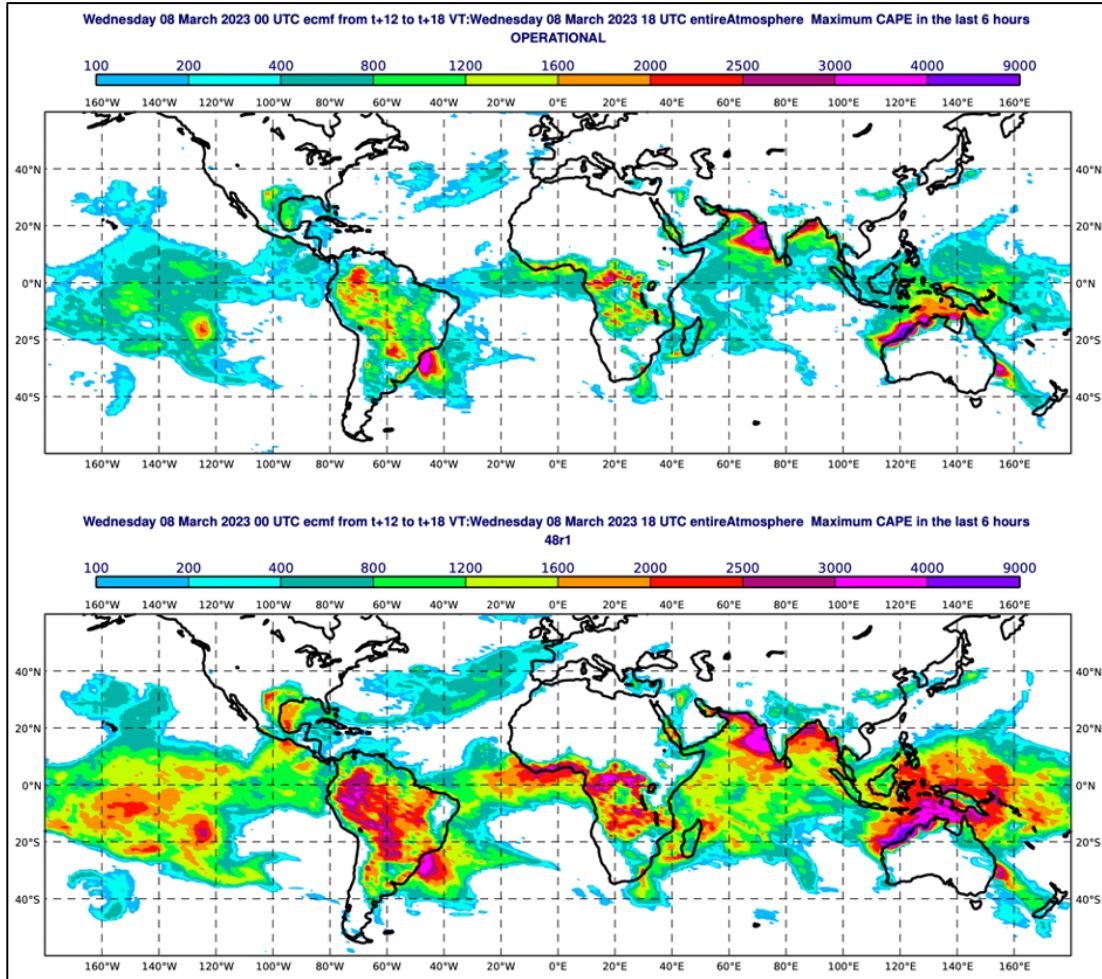
48r1 – New parameters/revised parameters

- New precipitation type (code 12 – “freezing drizzle”)
- Most severe/most frequent precipitation type in the last 1h/3h/6h
- More physically consistent CAPE parameters
- Revised snow parameters due to new multi-layer snow scheme
 - However integrated 'full depth' variables are also retained for backwards compatibility

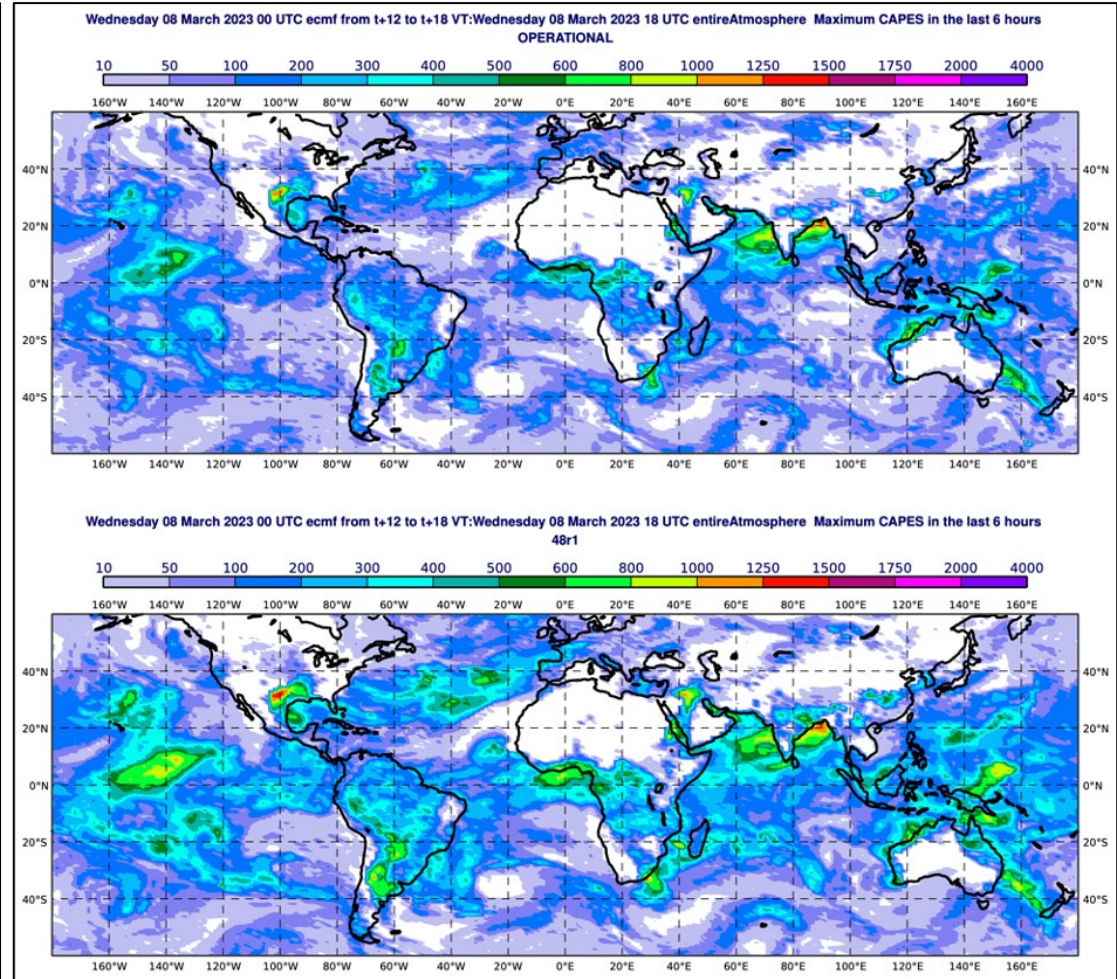
48r1 – High impact weather – convective hazards

Revised parameter

mxcape6 and mxcapes6 use MUCAPE in 48r1



6h max CAPE



6h max CAPE-shear

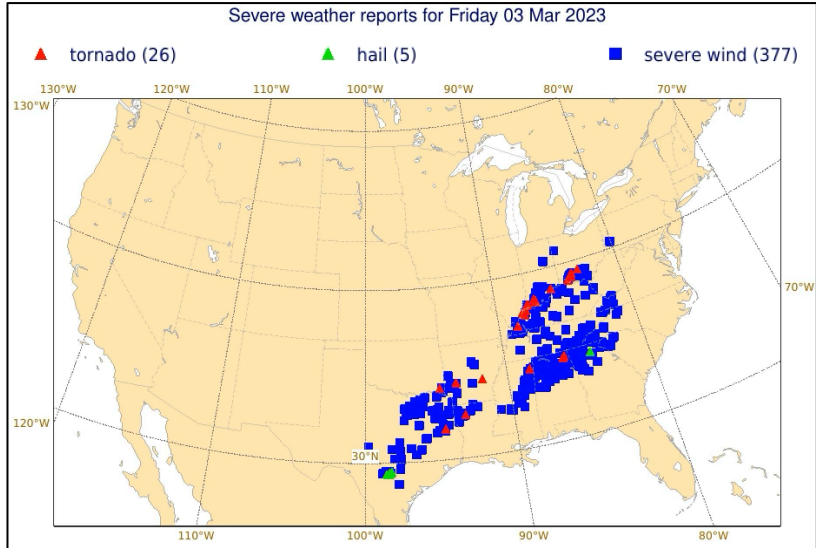
47r3

48r1

48r1 – High impact weather – convective hazards

Revised parameter

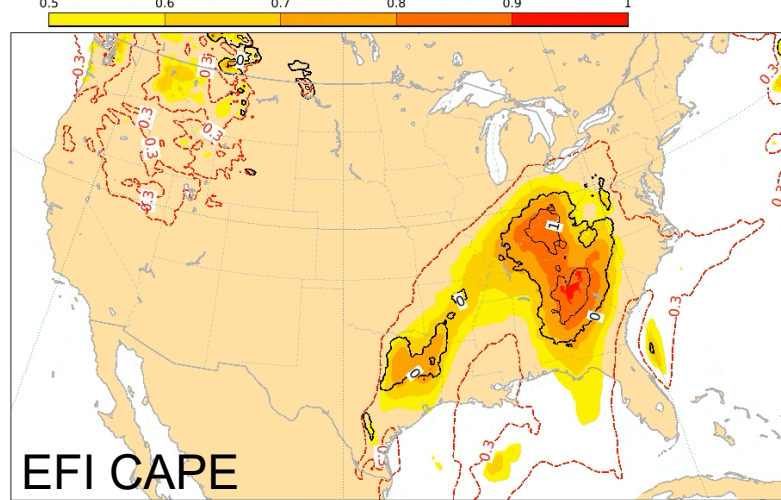
These new MUCAPE-based variables are then inherited into EFI/SOT computations



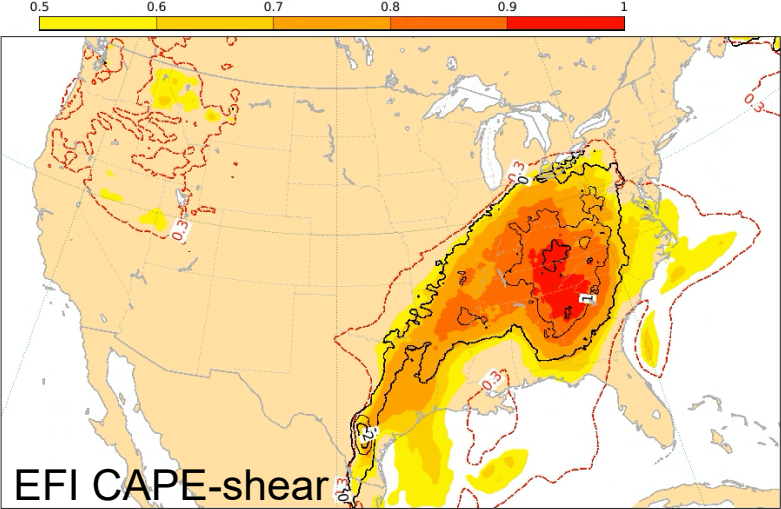
Example: Severe Convection – USA, 2-3 March 2023

Operational = 47r3

Thu 02 Mar 2023 00UTC @ECMWF expver = 1 VT: Fri 03 Mar 2023 00UTC - Sat 04 Mar 2023 00UTC 24-48h
Extreme forecast index and Shift of Tails (black contours 0,1,2,5,8) for: CAPE

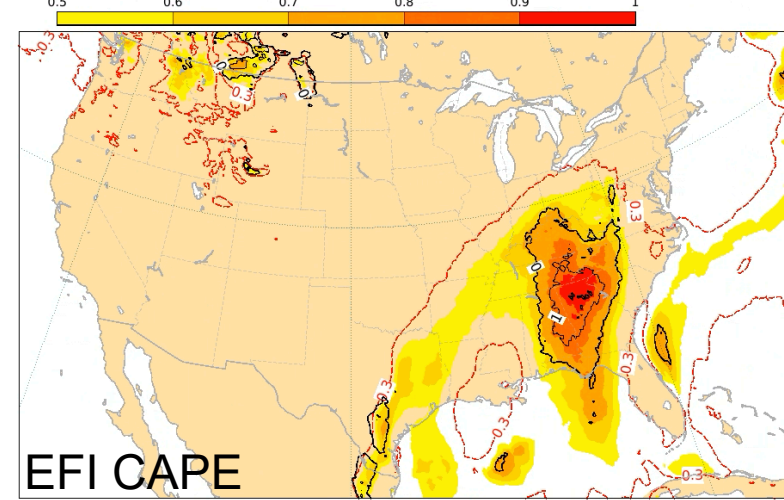


Thu 02 Mar 2023 00UTC @ECMWF expver = 1 VT: Fri 03 Mar 2023 00UTC - Sat 04 Mar 2023 00UTC 24-48h
Extreme forecast index and Shift of Tails (black contours 0,1,2,5,8) for: CAPE-shear

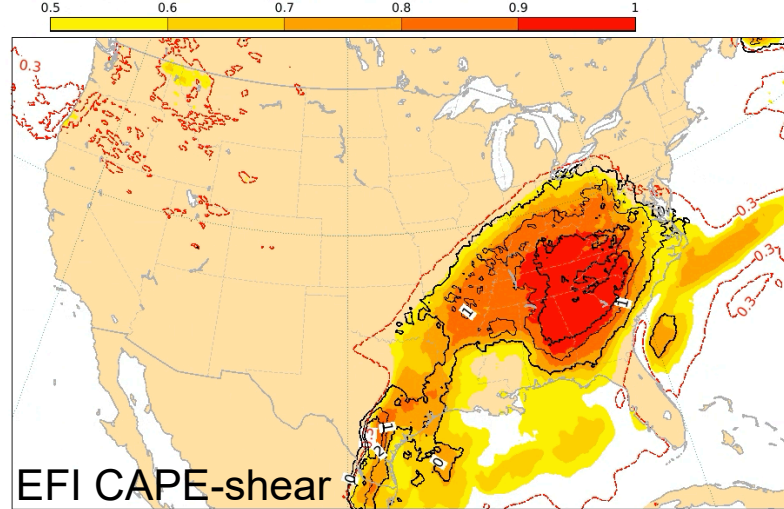


48r1

Thu 02 Mar 2023 00UTC @ECMWF expver = 78 VT: Fri 03 Mar 2023 00UTC - Sat 04 Mar 2023 00UTC 24-48h
Extreme forecast index and Shift of Tails (black contours 0,1,2,5,8) for: CAPE



Thu 02 Mar 2023 00UTC @ECMWF expver = 78 VT: Fri 03 Mar 2023 00UTC - Sat 04 Mar 2023 00UTC 24-48h
Extreme forecast index and Shift of Tails (black contours 0,1,2,5,8) for: CAPE-shear



48r1 – High impact weather – “Freezing drizzle”

Revised parameter

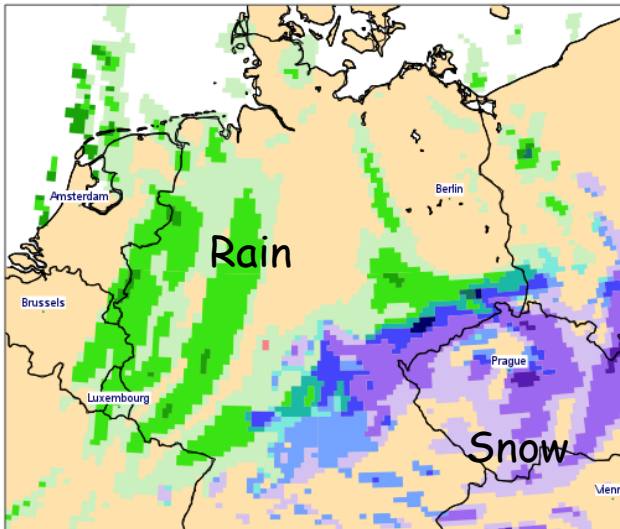
Freezing drizzle (= supercooled warm-rain process at sub-0°C temperatures)

- Often light but prolonged precipitation can create icy surface, hazardous weather!
- Different formation process to freezing rain, **pre-48r1 freezing drizzle is not predicted in the IFS**
- New/revised microphysics in **48r1 allows freezing drizzle prediction**
- New **WMO code 12** in “Precipitation Type” parameter: will appear in ENS Precip-Type Meteograms, and on related map plots

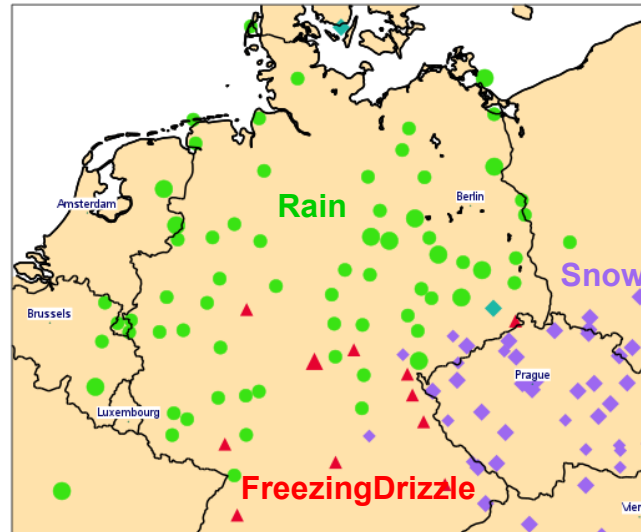
Example case study: Germany 19 December 2017

Operations at the time

No indication of freezing drizzle

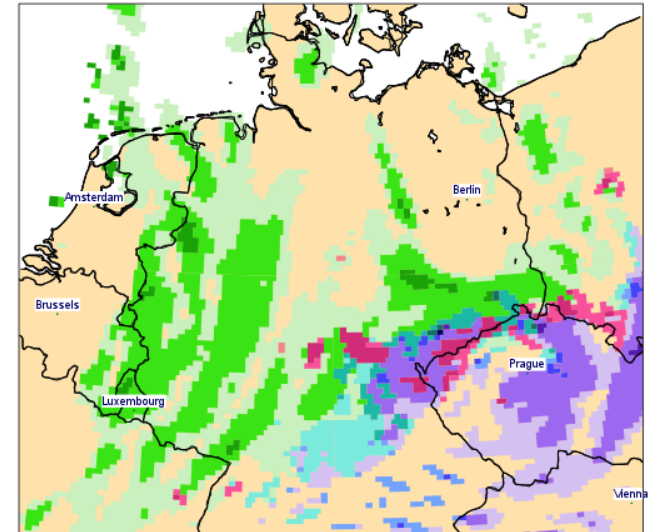


Observed precipitation-type



New physics in 48r1

Freezing drizzle predicted in the area



rain / mix rain-snow / wet snow / snow / ice pellets / freezing rain / freezing drizzle

48r1 – New parameters for precipitation type

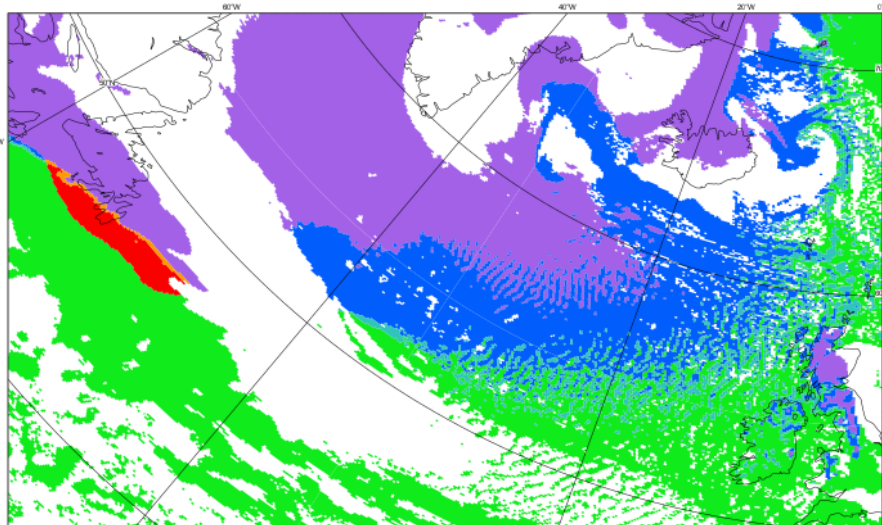
"Precipitation type" is only valid at the output time,

New parameters store the "**most frequent**" and "**most severe**" precipitation type occurrence in the last 1 hour, 3 hours or 6 hours, depending on forecast lead time.

6 new parameters:

Precipitation type (most severe) in the last 1/3/6 hours

Precipitation type (most frequent) in the last 1/3/6 hours



Precipitation types in the IFS and order of severity

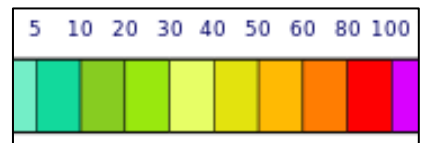
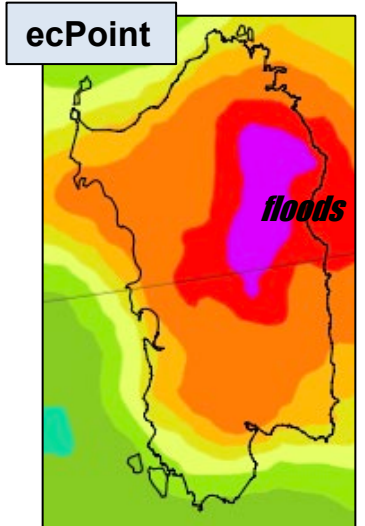
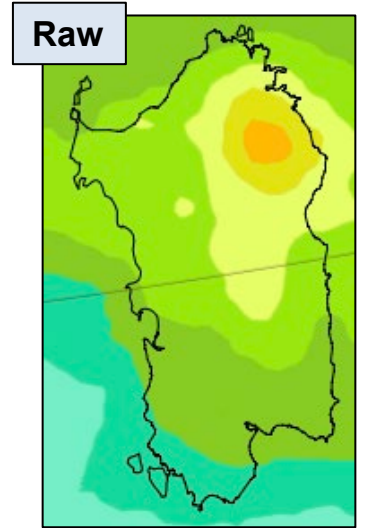
Code	Precipitation Type	Severity
3	Freezing rain	7
12	Freezing drizzle	6
6	Wet snow	5
5	Snow	4
8	Ice pellets	3
7	Mixture of rain and snow	2
1	Rain	1
0	No precipitation	0

New parameters

48r1 – ecPoint

ecPoint (point forecast) with 48r1

- 48r1 medium range resolution change presents challenges and opportunities:
 - ecPoint application becomes less useful at higher resolutions, as sub-grid variability (e.g. value range in gridbox) will diminish in proportion
 - So we adapt the output to an 18km grid (TCO639, as in the current cycle), using conservative interpolation
 - Calibration and post-processing then proceed on the 18km grid
 - In so doing we exploit the benefits of the higher resolution runs, whilst at the same reducing specificity - effectively incorporating some neighbourhood information spread, which has anyway been shown to be beneficial at high resolution
 - Apologies for the non-availability of 48r1 ecPoint test data so far (technical challenges!)
- Meanwhile:
 - ecPoint output available in MARS soon!
 - The open source ecPoint-calibrate GUI will be adapted to a more-easily-supported web interface – a longer term initiative

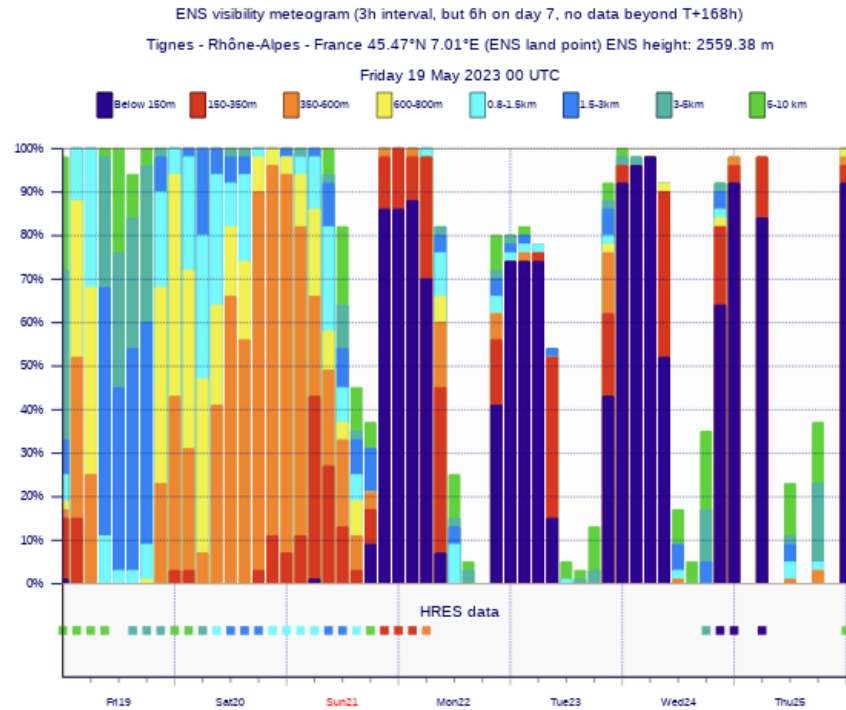


12h-rainfall (mm), 99th percentile, Sun 21 May 2023

New visibility meteograms

- Operational product since 11 May 2023 (with 47r3)

Aviation visibility range



“General-purpose” visibility range





Climate
Change

Status of the ERA5 global reanalysis

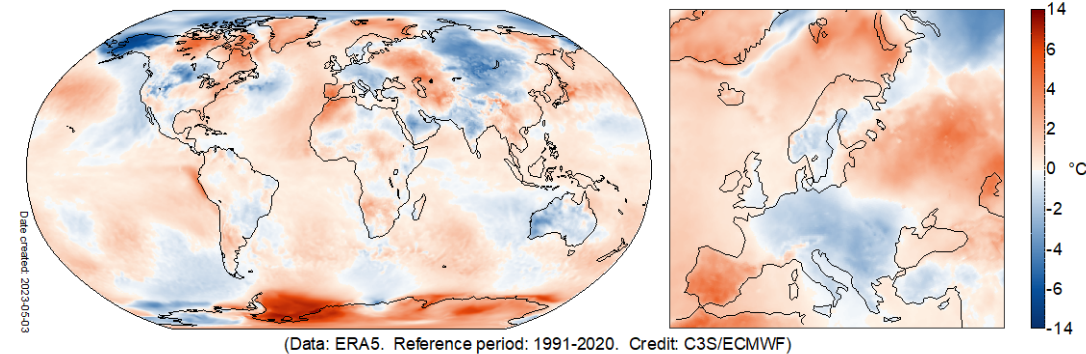
ERA5: A full-observing-system global reanalysis for the atmosphere, land surface and ocean waves

- Produced at ECMWF, by the **Copernicus Climate Change Service**
- Over 115,000 CADS users, ~700 Tbyte of downloads per week
- ERA5 Journal paper 2020 (doi.org/10.1002/qj.3803) > 8,500 citations
- Daily updates **5 days behind real time from 1940 onwards**
- **Hourly snapshots at 31km resolution** up to about 80km height
- **Uncertainty estimate** from a 10-member ensemble at half resolution
- **ERA5-Land**: Dynamically downscaled land product at **9km**, 1950 onwards, 5 days behind real time.
- Total dataset is about 12 petabyte

ECMWF Annual Seminar 2023 on “Earth System Reanalysis”

<https://events.ecmwf.int/event/326/> (4-8 September, Reading)

Surface air temperature anomaly for April 2023



(Data: ERA5. Reference period: 1991-2020. Credit: C3S/ECMWF)



PROGRAMME OF
THE EUROPEAN UNION



Observation usage:

- Over 100 billion so far

Usage of external (gridded) products ‘as is’:

- SST and sea-ice cover
- GHGs, aerosols, TSI, (diagnostic) ozone

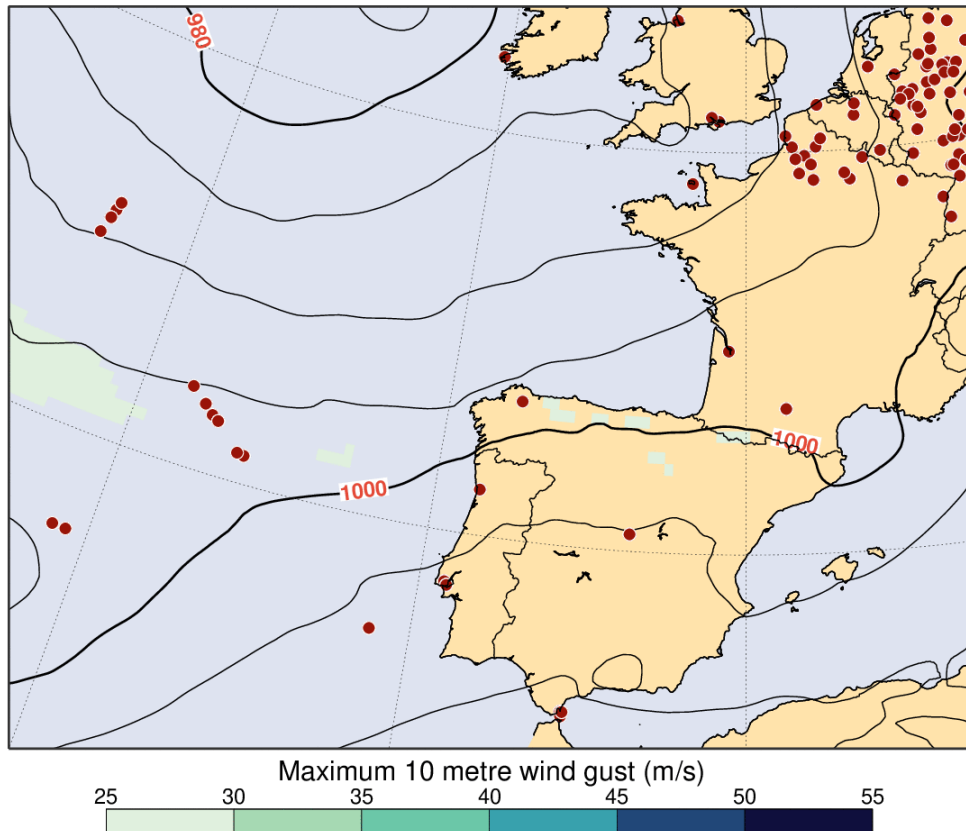




Climate
Change

An extension back to 1940 was recently made available: over 83 years of hourly snapshots

ERA5 14 February 1941, 18 UTC

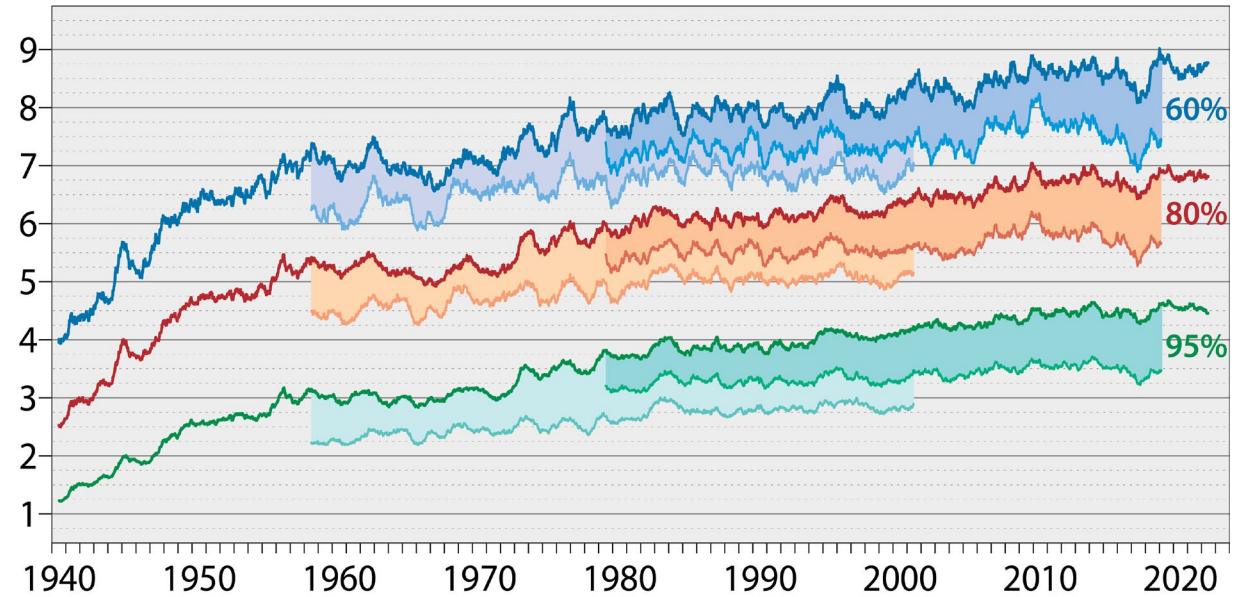


Iberian storm case of 1941

Range (days) when 365-day mean 500hPa height AC (%) falls below threshold

— ERA5 — ERA-Interim — ERA-40

(b) Europe



Skill of 10-day forecasts initialized from ERA verified against ERA





Emergency Management

CEMS – GloFAS hydrological reanalysis – DOI: [10.24381/cds.a4fdd6b9](https://doi.org/10.24381/cds.a4fdd6b9)

Gridded river discharge at 3 arcmin (~5km) everywhere in the world (except Antarctica)

Freely available without restriction of use

Daily time series 1980-2022

Experimental product released in the Copernicus Climate Data Store since Nov 2022

Near-real time update expected Q3 2023

Overview Download data Documentation

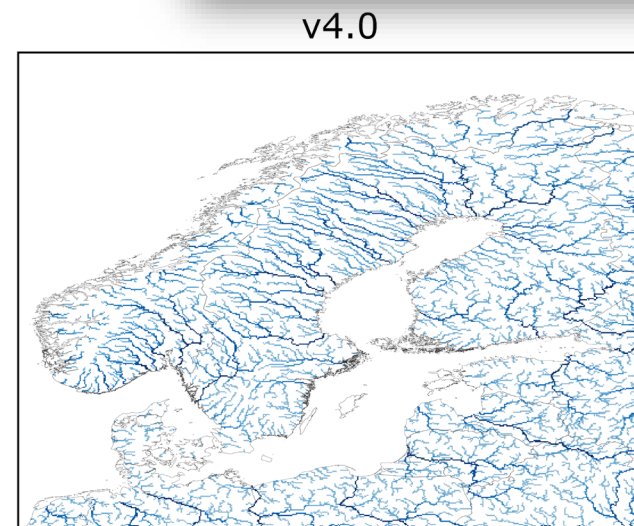
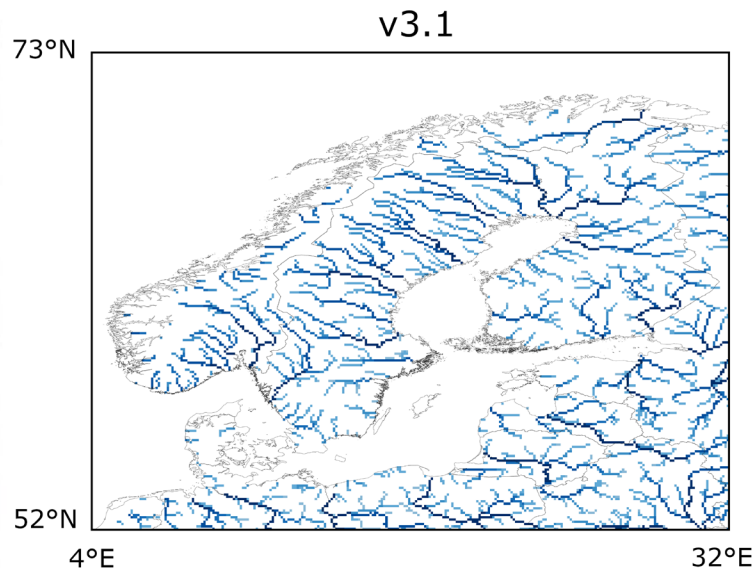
System version ?

Operational

Version 3.1

Pre-release

Version 4.0

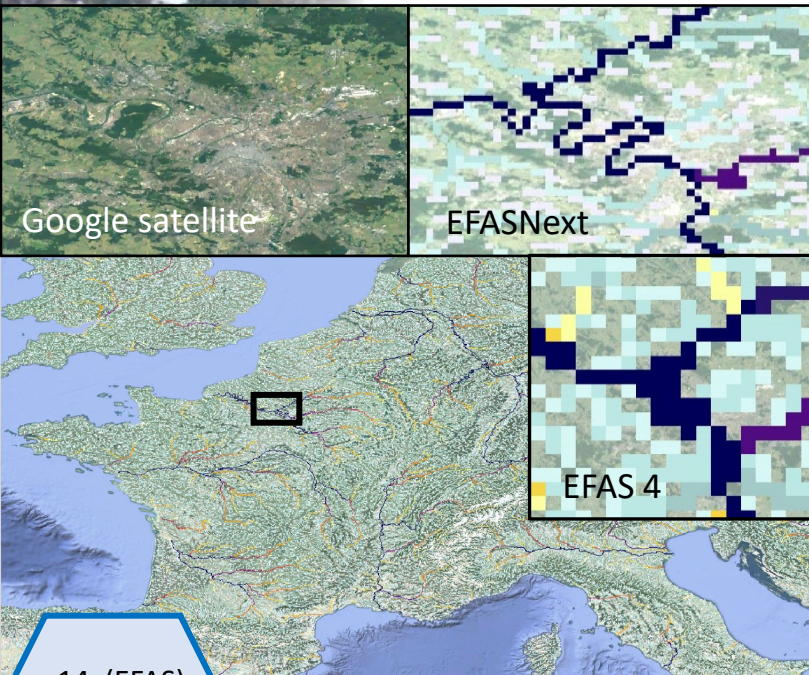


CEMS is managed by the **Joint Research Centre** of the European Commission, run operationally by the **CEMS Hydrological Computational Centre (ECMWF)** with other service providers



Emergency Management

CEMS – EFAS and GloFAS cycle upgrades

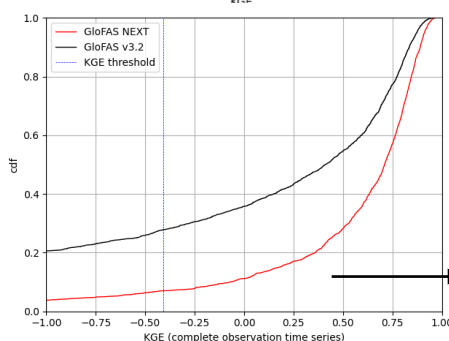
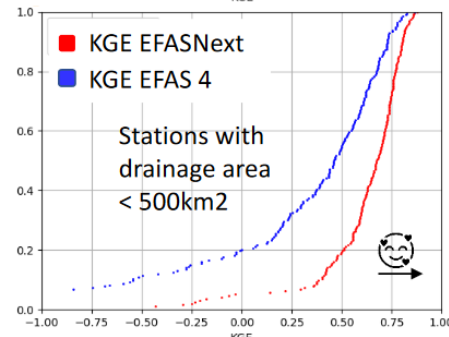
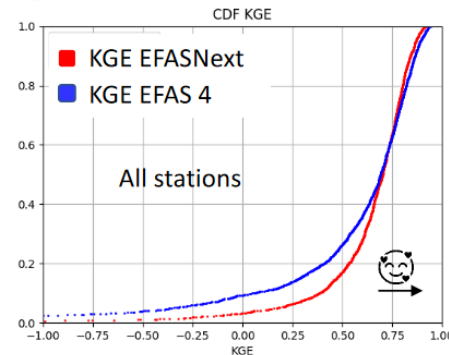


x 14 (EFAS) model grid cells

Better hydrological simulations (KGE score) for both EFAS and GloFAS

www.efas.eu

10+ year research, tech. development and data collection



HIGHER SPATIAL RESOLUTION

Increased resolution

GloFAS: 10km to 5km; EFAS: 5km to ~1.4km

- Better representation of hydro properties spatial variability
- Better representation of river network

RECENT AND COMING RELEASES

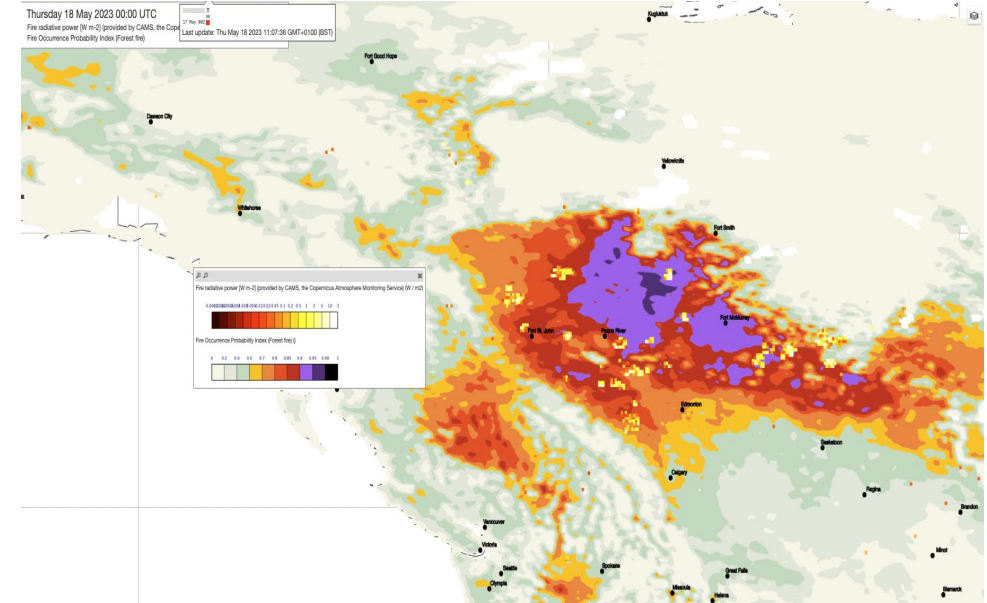
- **June/July 2023**: candidate release phase starting for medium-range forecasts
- **Summer 2023**: testing phase with more products released (experimental)
- **September 2023**: full operational release EFAS



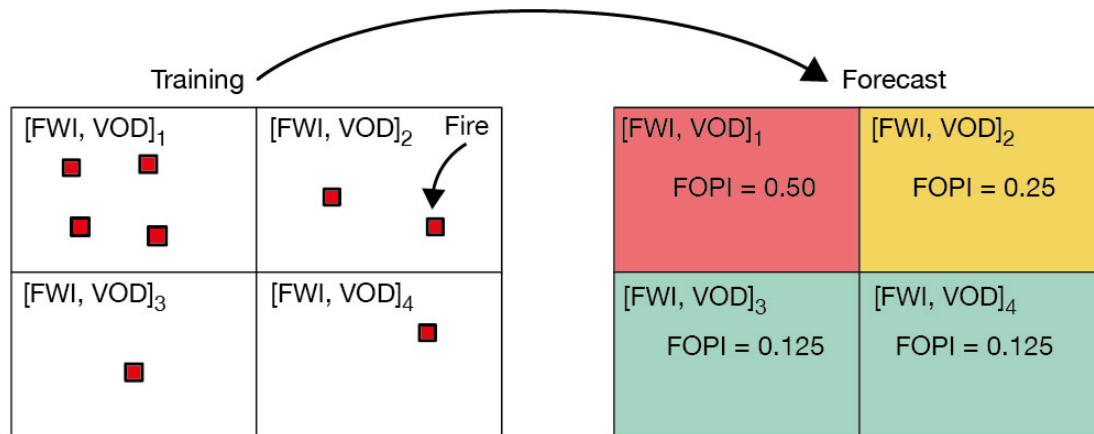
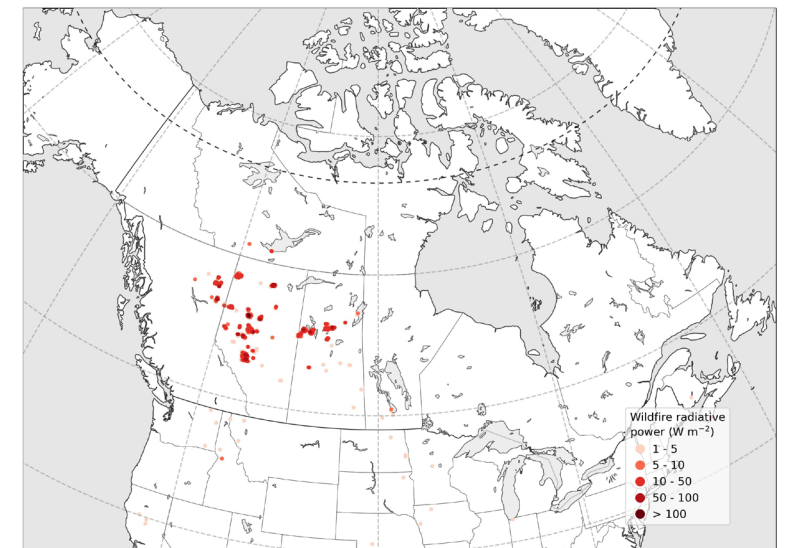
Fire – New fire risk index – Fire Occurrence Probability Index (FOPI)

Fire Danger forecast usually relies on weather (temperature, relative humidity, wind speed, rainfall) anomalies and does not consider fuel availability.

FOPI is a transformation of the Fire Warning Index (FWI) where values are modulated by the availability of fuel assessed through VOD observations.



GFASv1.2 Total Fire Radiative Power: 2023-05-01 - 2023-05-15



F. Di Giuseppe: Accounting for fuel in fire danger forecast: the fire occurrence probability index (FOPI), *Env. Res. Letters* (2023)

Perspectives

- **Cycle 48r1** – <https://confluence.ecmwf.int/display/FCST/Implementation+of+IFS+Cycle+48r1>
 - A move towards full-ensemble approach at ECMWF
 - Lots of novel opportunities with the new ENS/ENS-Extended configurations (e.g “dual-resolution combined products”)
- Significant enhancements coming in Environmental forecasting
- **Cycle 49** will go one step beyond: new SEAS6, reforecast restructuring for ENS and ENS-Extended...
- Work ongoing **More in next ECMWF presentations/posters #UEF2023 + Speakers' Corner**
 - High impact weather Products: more EFIs, improved forecast on convective hazards (collaboration with ESSL), post-processing (e.g. DestinE)...
 - Multi-system Ensemble Products, e.g. Seasonal Forecasting (C3S)
 - New era with Machine Learning data-driven forecasting models...
- **Development of new products and enhancement of existing ones aim at responding to Users' needs – feedback is essential!**

User guide to ECMWF forecast products

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

The screenshot shows the Confluence interface for the 'Forecast User Guide' page. The top navigation bar includes the ECMWF logo, 'Spaces', 'Calendars', and a 'Create' button. A search bar is located on the right. The page title is 'Forecast User Guide'. Below the title is a search box for the user guide and a quote by Professor Tor Bergeron from 1974. The main content area features a collage of various meteorological charts and maps, including a 'Chart Dashboard' and 'ecCharts'. A left sidebar contains a 'PAGE TREE' with 12 numbered items, such as '1 Introduction', '2 The ECMWF Integrated Forecasting System - IF', and '12 Appendices'. At the bottom of the sidebar are 'Space tools' and a double arrow icon.

ECMWF Spaces Calendars Create

Forecast User Guide

Pages

Search this user guide for ...

"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

Chart Dashboard

ecCharts

Space tools

SPACE SHORTCUTS

- Forecast User Portal

PAGE TREE

- 1 Introduction
- > 2 The ECMWF Integrated Forecasting System - IF
- > 3 Availability and Interpolation of NWP output
- > 4 NWP Evolution versus Reality
- > 5 Forecast Ensemble (ENS) - Rationale and Consi
- > 6 Using Deterministic and Probabilistic Forecasts
- > 7 ENS Products - Dealing with Uncertainty
- > 8 ENS Products - What they are and how to use t
- > 9 Physical Considerations when Interpreting Mod
- > 10 Interfaces for displaying Model Output
- 11 Conclusion
- > 12 Appendices

Thank you

#UEF2023