

ECMWF Forecast Products

Recent Advances, Future Directions

Matthieu Chevallier
Head of Evaluation, ECMWF

Contributions from many colleagues at ECMWF and beyond – Thank you !

UEF 2025 – 16 September 2025



© ECMWF September 16, 2025

Forecast performance

IFS

Feedback

Verification

Your presentations !

AIFS

Meteograms

Open data

User engagement

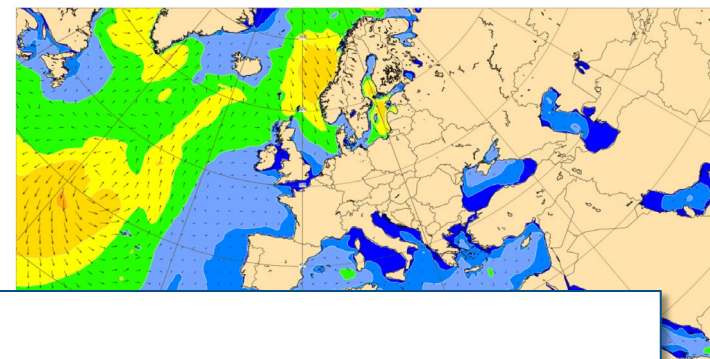
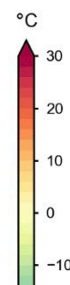
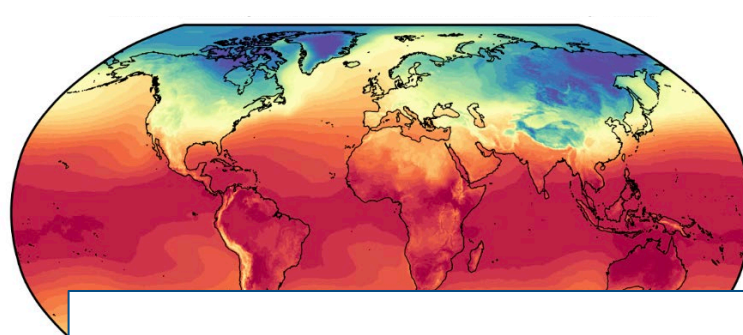
AI

Poster session

Weather Stations

Forecast data provision across multiple timescales

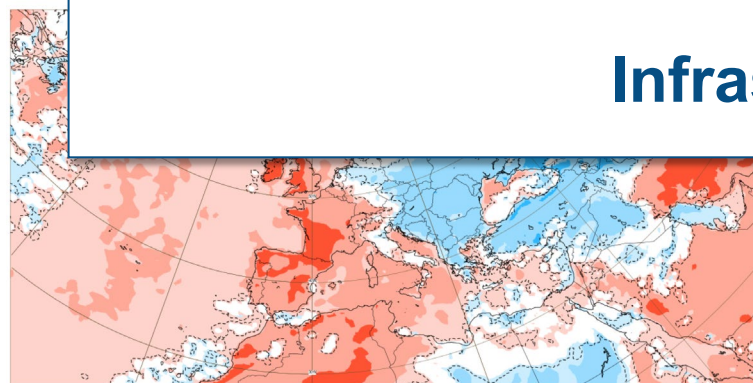
ERA5 monthly
mean
2m temperature
– Jan 2016



Significant Wave
Height (m)
– 04 Nov 2024

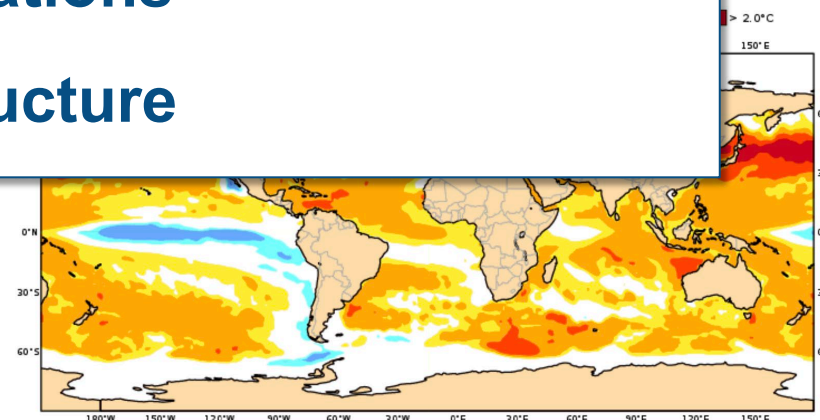
**Earth System
Observations
Infrastructure**

2m temperature
anomaly
– 04-11 Nov
2024



Extended range: Surface temperature weekly mean anomaly, significance level: 10 % (C)
-10 -8 -6 -4 -2 0 2 4 6 8 10

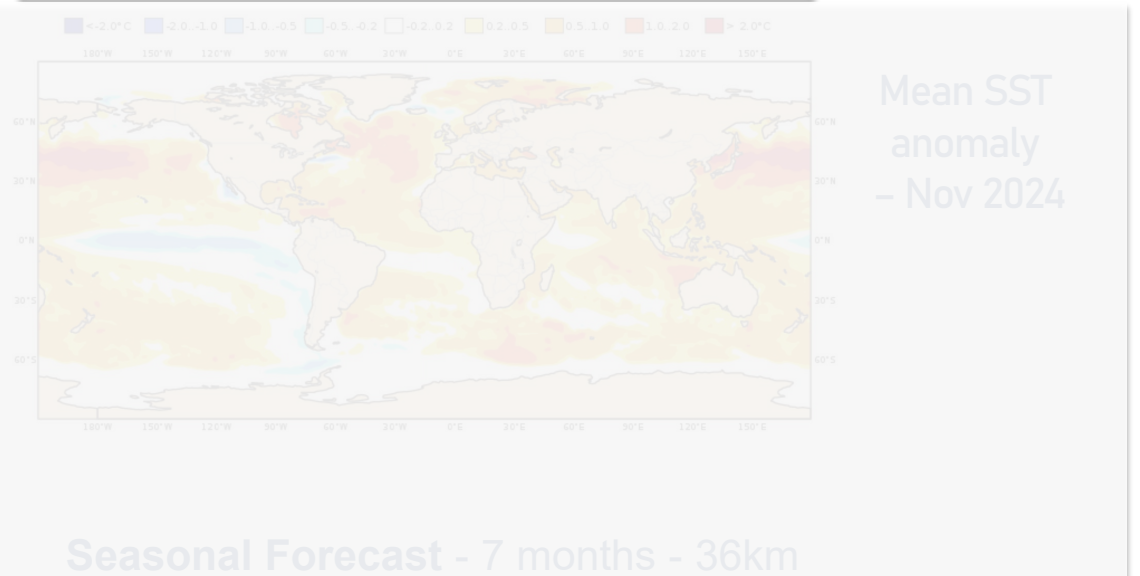
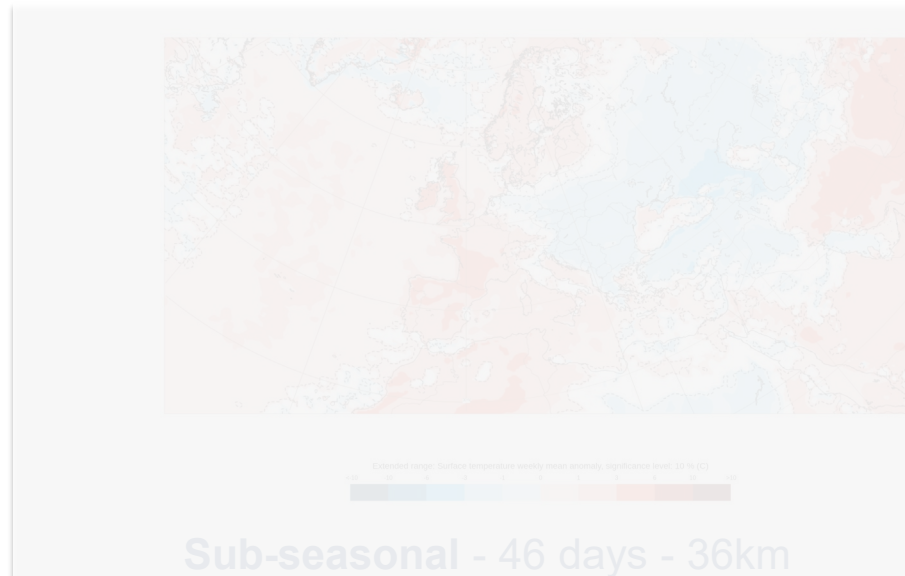
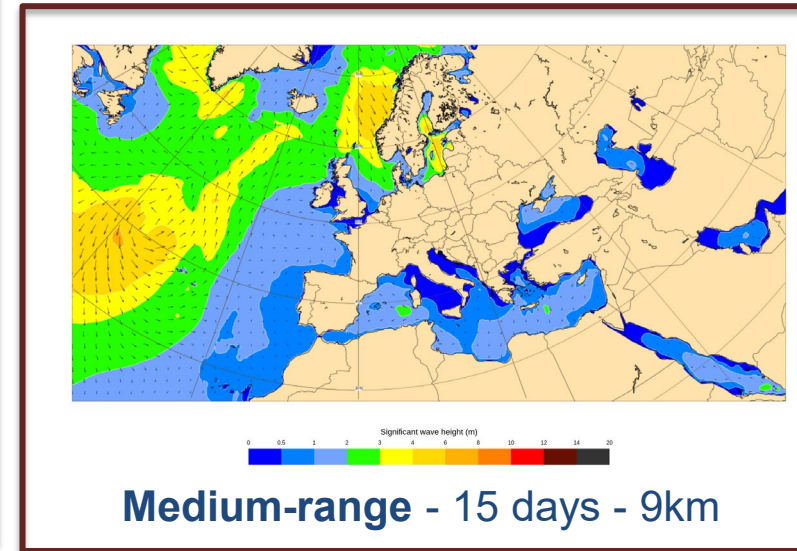
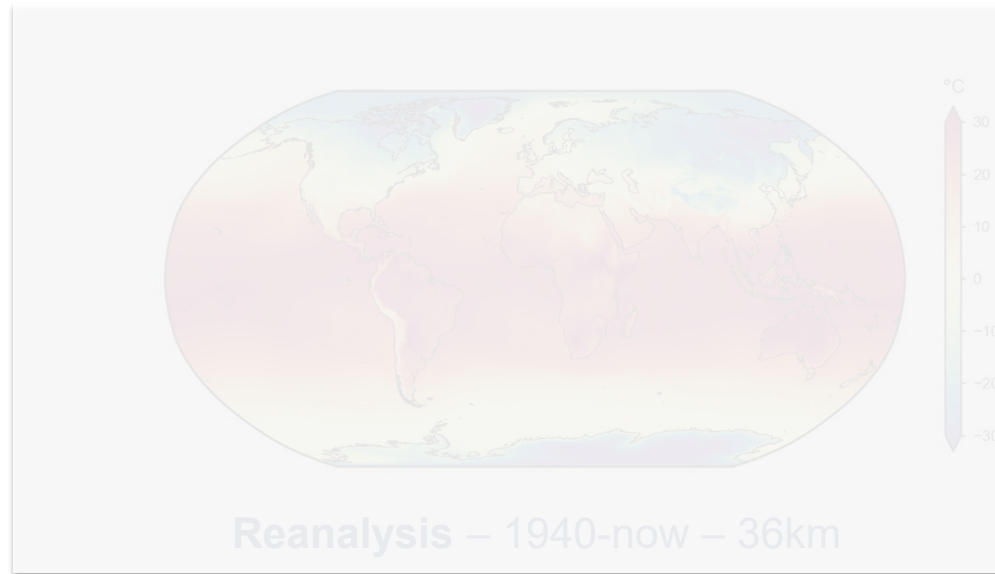
Sub-seasonal - 46 days - 36km



Mean SST
anomaly
– Nov 2024

Seasonal Forecast - 7 months - 36km

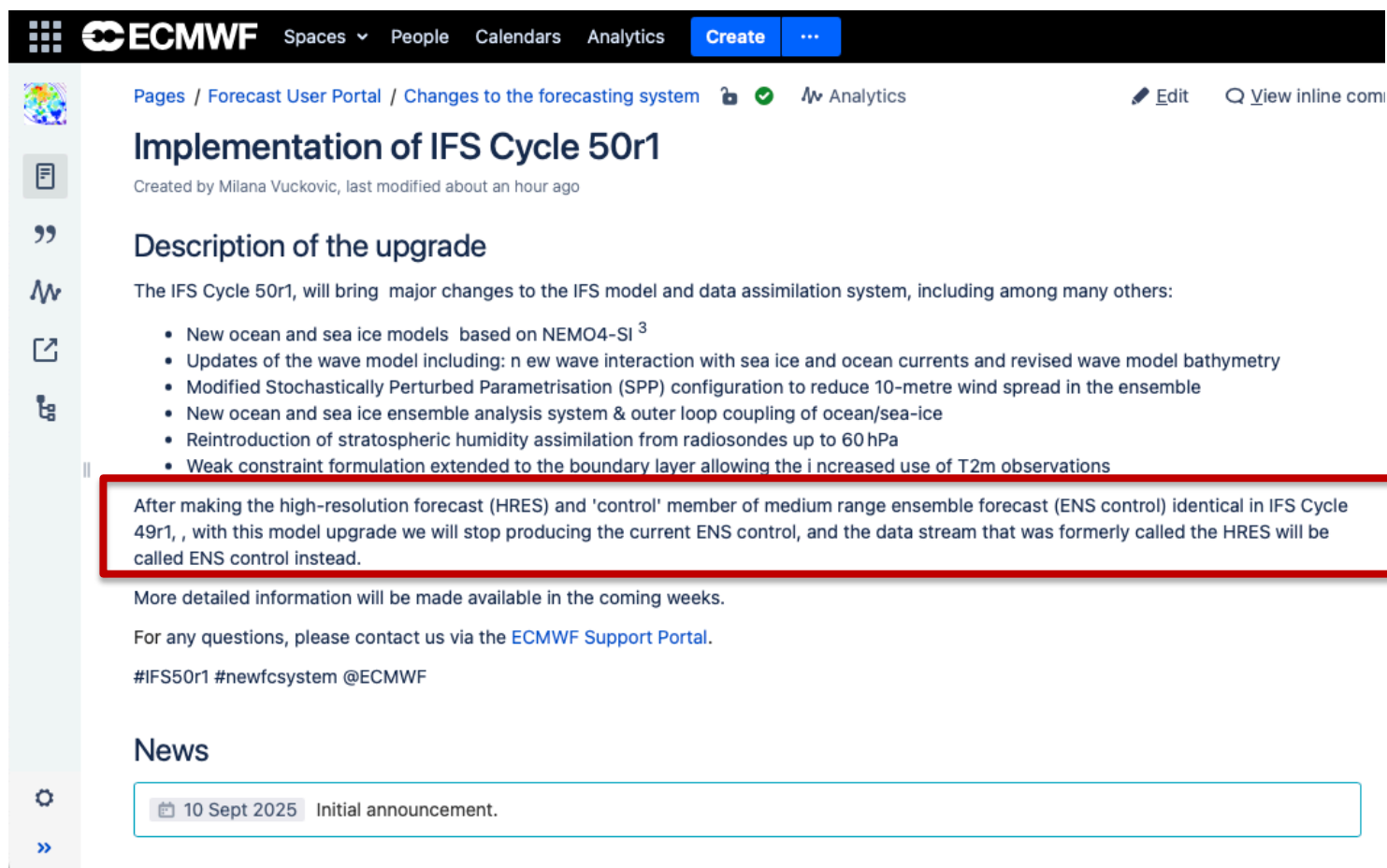
Forecast data provision across multiple timescales



Medium-range forecasts

With **IFS Cycle 48r1**: 51-member medium-range ENS forecast at 9km resolution (same as HRES).

With **IFS Cycle 49r1**: HRES and ENS control member are bit-identical (still 2 runs produced).



The screenshot shows the ECMWF Forecast User Portal. The page title is "Implementation of IFS Cycle 50r1", created by Milana Vuckovic. The main section is "Description of the upgrade", which lists several changes to the IFS model and data assimilation system. A red box highlights a key announcement: "After making the high-resolution forecast (HRES) and 'control' member of medium range ensemble forecast (ENS control) identical in IFS Cycle 49r1, with this model upgrade we will stop producing the current ENS control, and the data stream that was formerly called the HRES will be called ENS control instead." Below this, it states that more detailed information will be available in the coming weeks and provides a link to the ECMWF Support Portal. The page also includes a "News" section with a date filter set to "10 Sept 2025" and an "Initial announcement" entry.

Pages / Forecast User Portal / Changes to the forecasting system

Implementation of IFS Cycle 50r1

Created by Milana Vuckovic, last modified about an hour ago

Description of the upgrade

The IFS Cycle 50r1, will bring major changes to the IFS model and data assimilation system, including among many others:

- New ocean and sea ice models based on NEMO4-SI³
- Updates of the wave model including: new wave interaction with sea ice and ocean currents and revised wave model bathymetry
- Modified Stochastically Perturbed Parametrisation (SPP) configuration to reduce 10-metre wind spread in the ensemble
- New ocean and sea ice ensemble analysis system & outer loop coupling of ocean/sea-ice
- Reintroduction of stratospheric humidity assimilation from radiosondes up to 60 hPa
- Weak constraint formulation extended to the boundary layer allowing the increased use of T2m observations

After making the high-resolution forecast (HRES) and 'control' member of medium range ensemble forecast (ENS control) identical in IFS Cycle 49r1, with this model upgrade we will stop producing the current ENS control, and the data stream that was formerly called the HRES will be called ENS control instead.

More detailed information will be made available in the coming weeks.

For any questions, please contact us via the [ECMWF Support Portal](#).

#IFS50r1 #newfcsystem @ECMWF

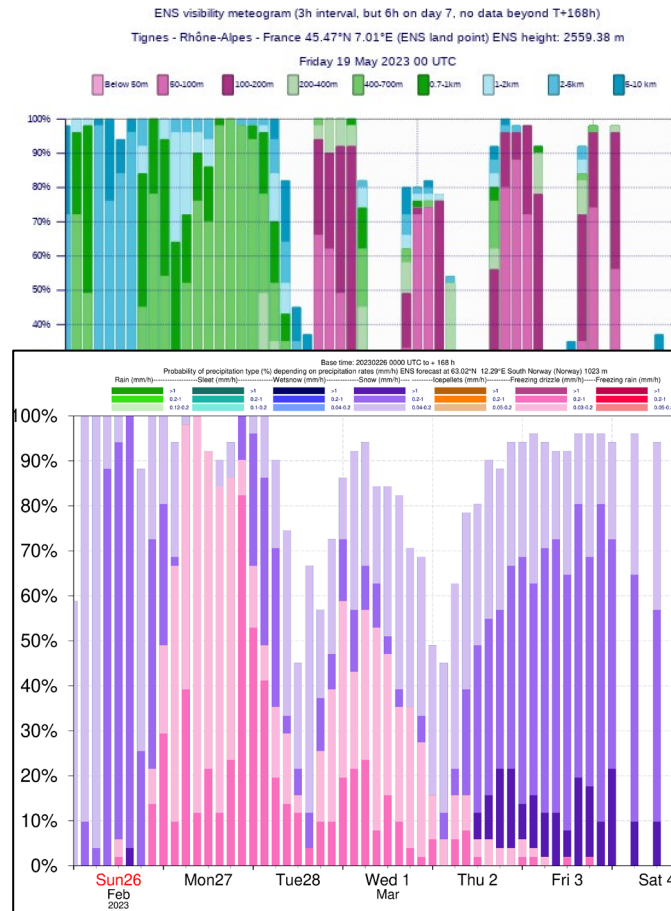
News

10 Sept 2025 Initial announcement.

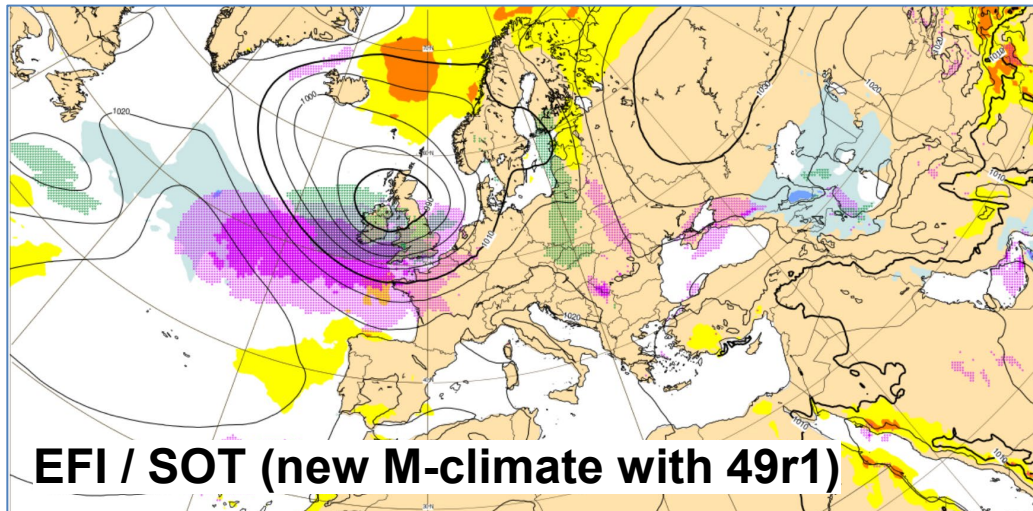
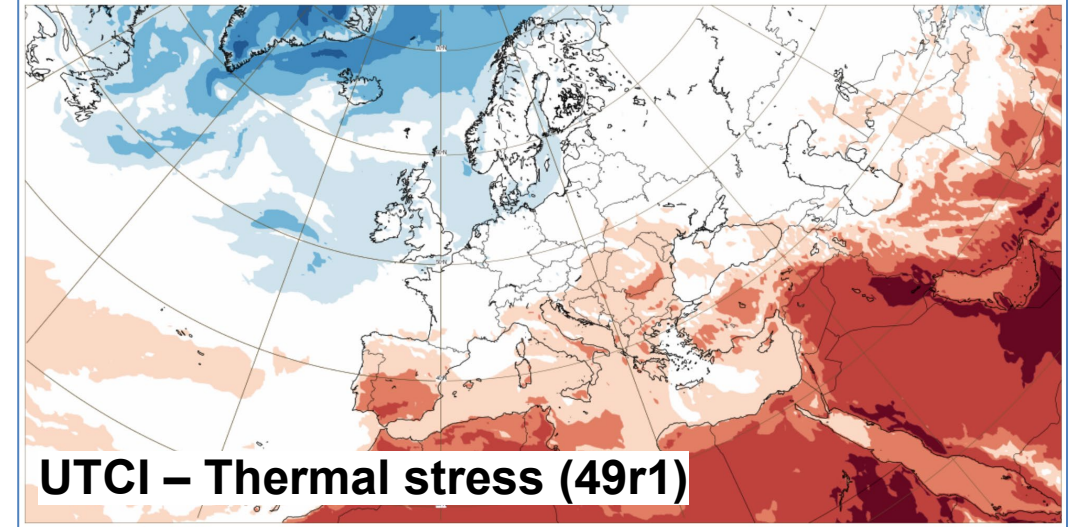
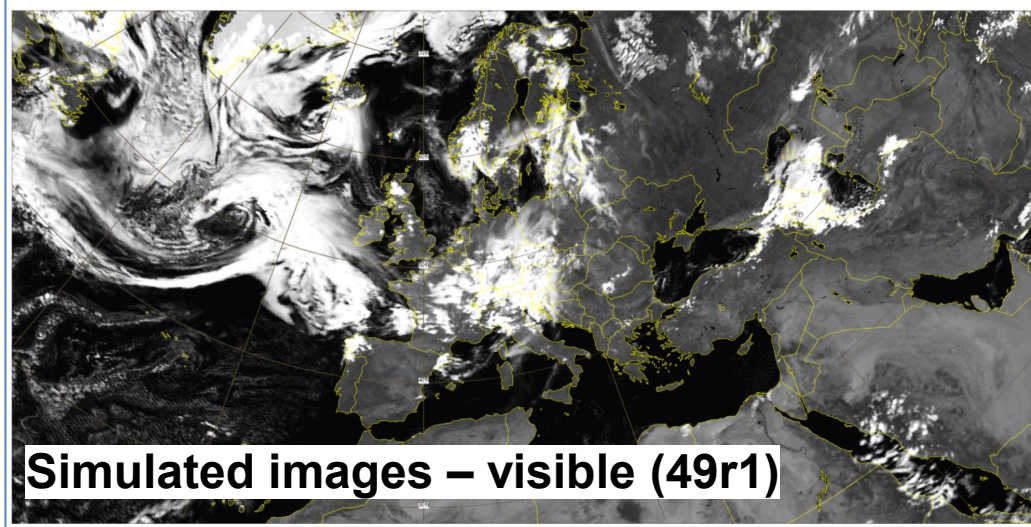


Medium-range forecasts

Meteograms



Medium-range forecasts



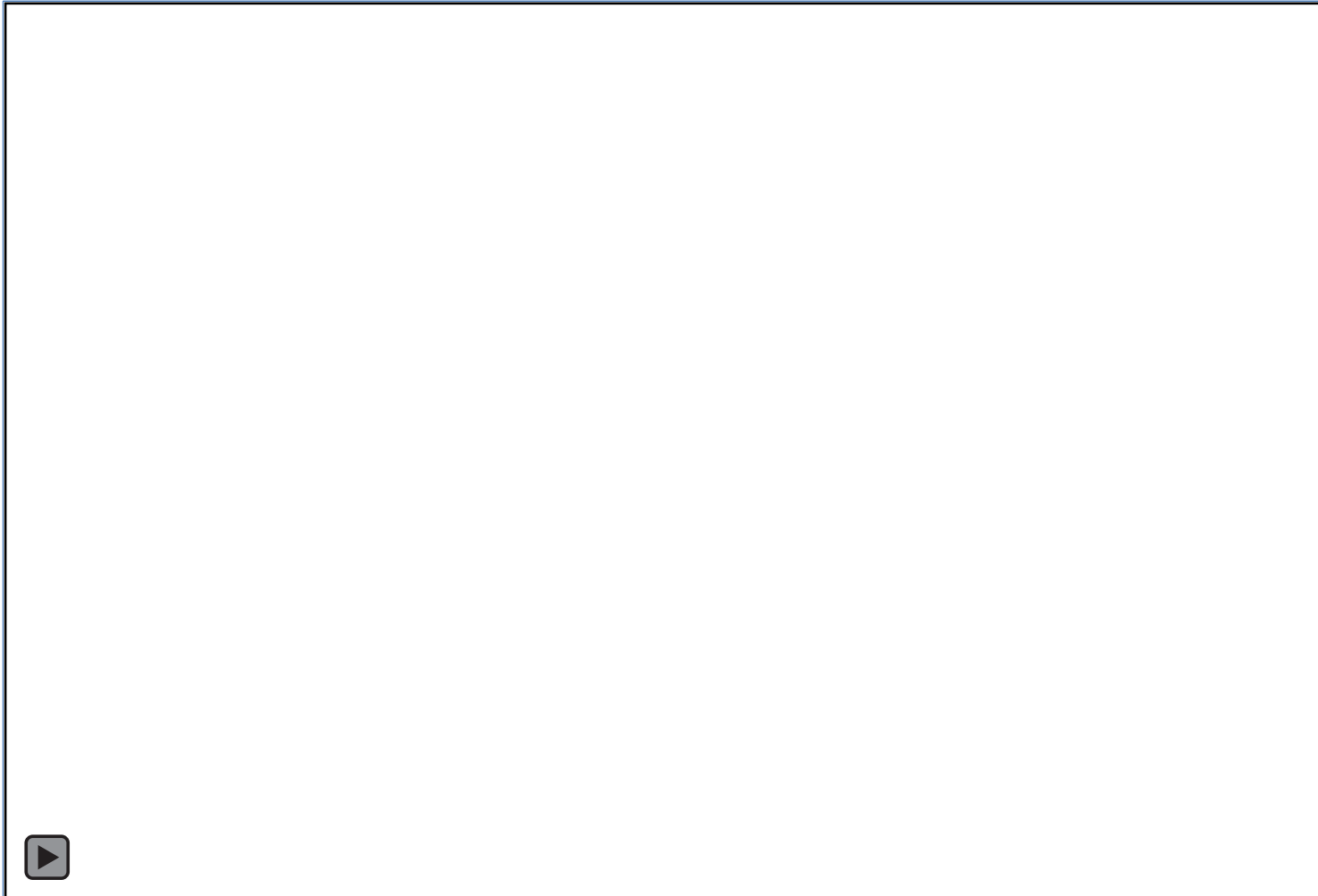
Support forecast users

Severe/high-impact weather forecasts

Beyond weather: impacts

Medium-range forecasts

Extratropical cyclone database – a collaboration with the UK Met Office

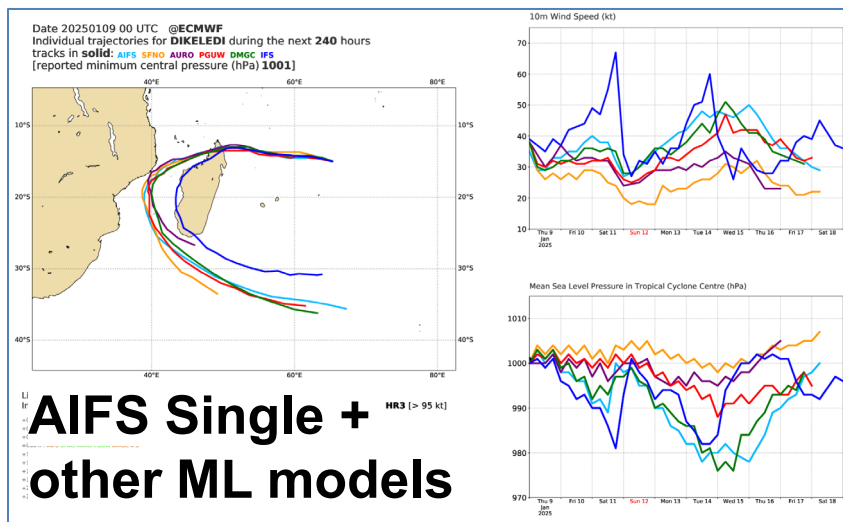
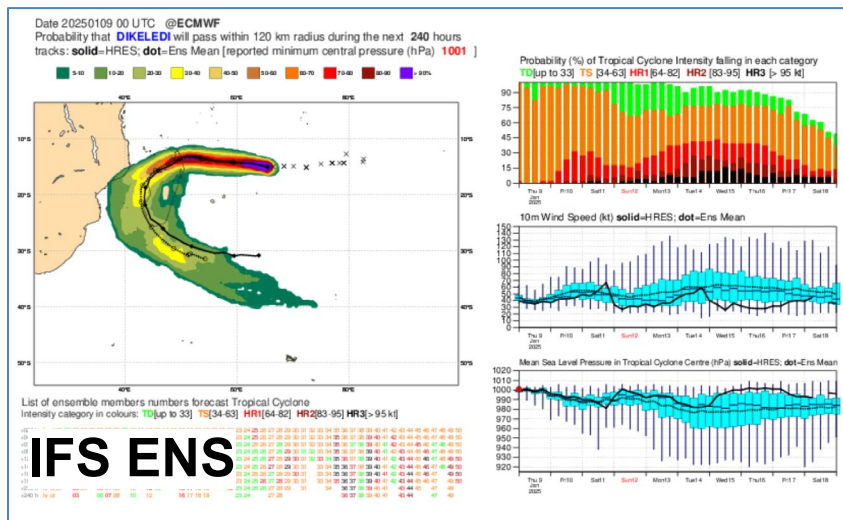


New version since December 2024
Coming:

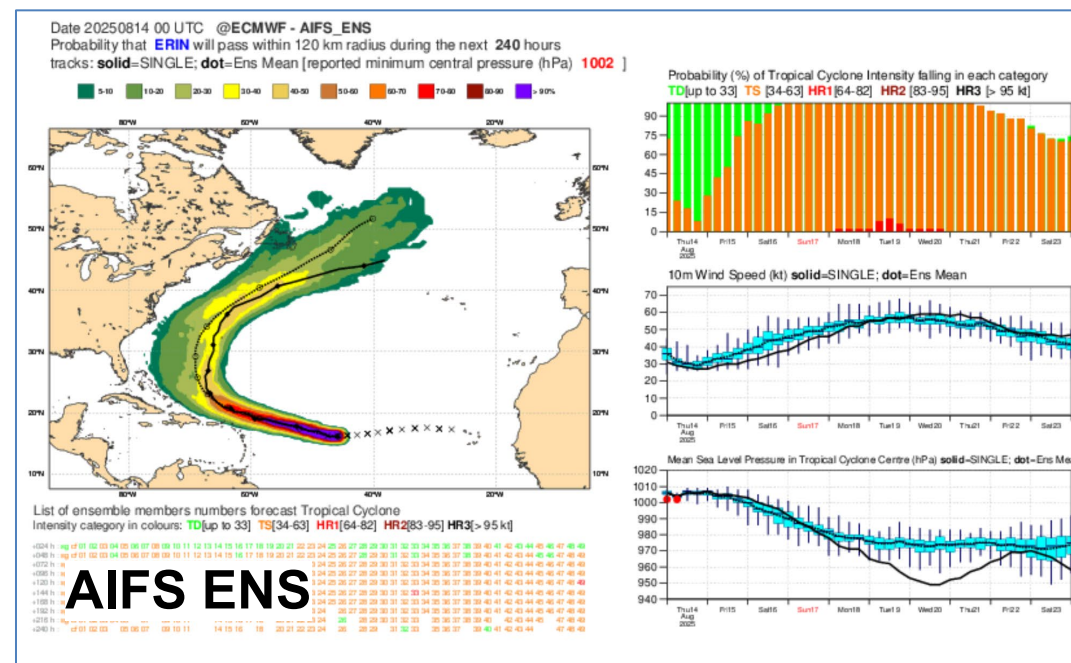
- 6-hourly time step (12h for now)...
- AIFS?



Medium-range forecasts



Tropical cyclones – IFS and AIFS !



Evaluation and intercomparison with meteorological services and WMO RSMC (e.g. Météo France/La Réunion)

What next for the AIFS?

- Expanded products – waves, snow depth, raised model top – in upcoming AIFS 2.

- Beyond in **medium-range forecasting**:

- Further expansion to ocean in 2026.
- EFI in 2026.
- Higher temporal resolution – 1-hourly data – in 2026.
- Higher spatial resolution also in development.
- Interested to hear your thoughts on product expansion.

- Real-time sub-seasonal system with dissemination by 2026
– Including reforecasts.

- Real-time AIFS composition forecasts.

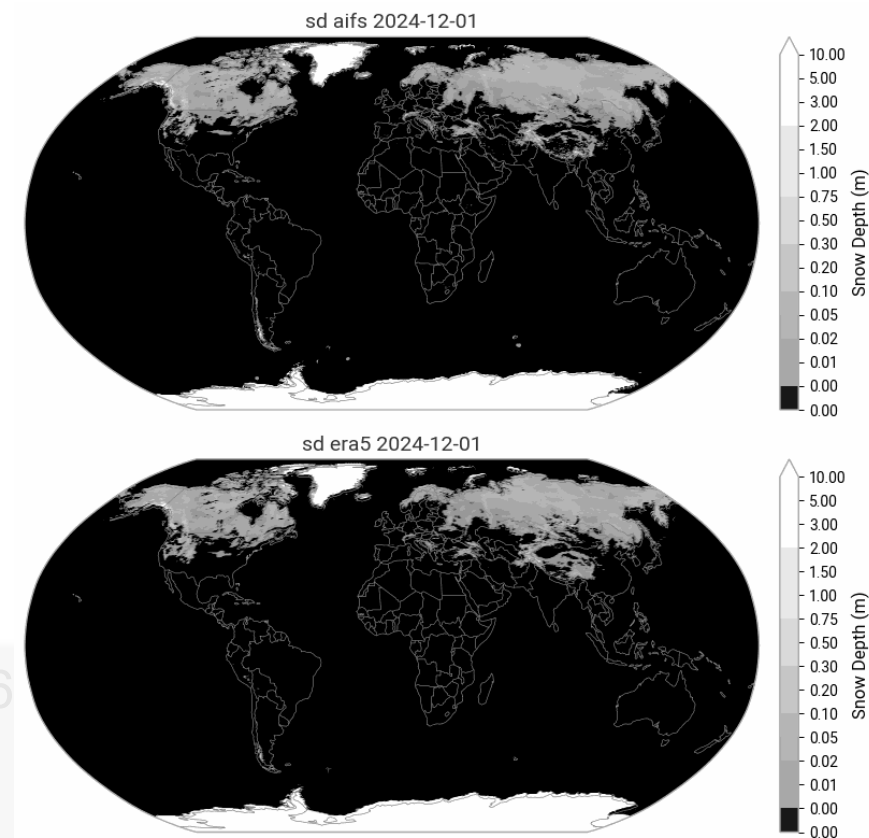
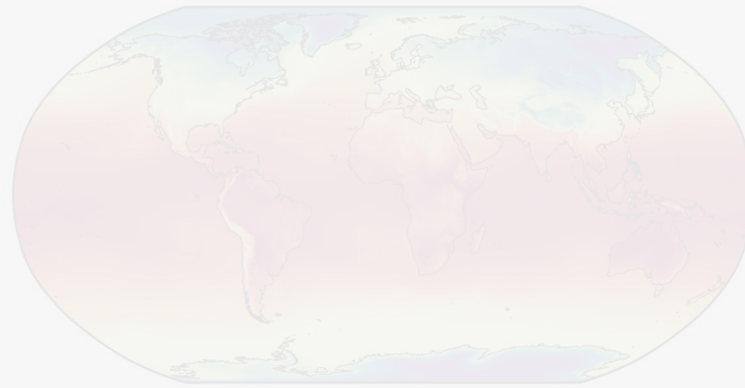
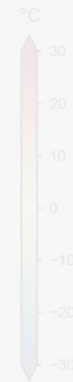


Fig: snow depth in the AIFS (top) and ERA5 (bottom)

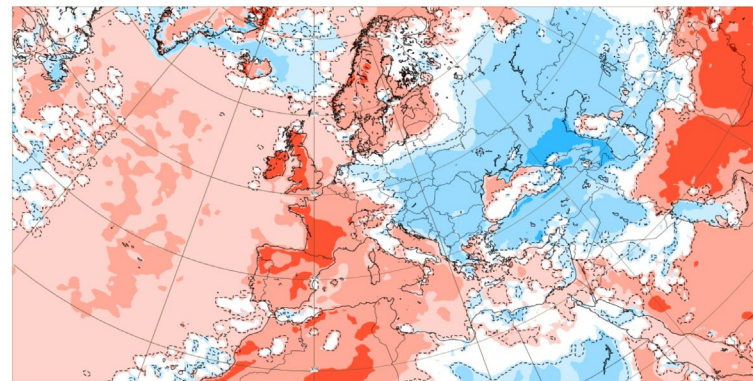
Forecast data provision across multiple timescales



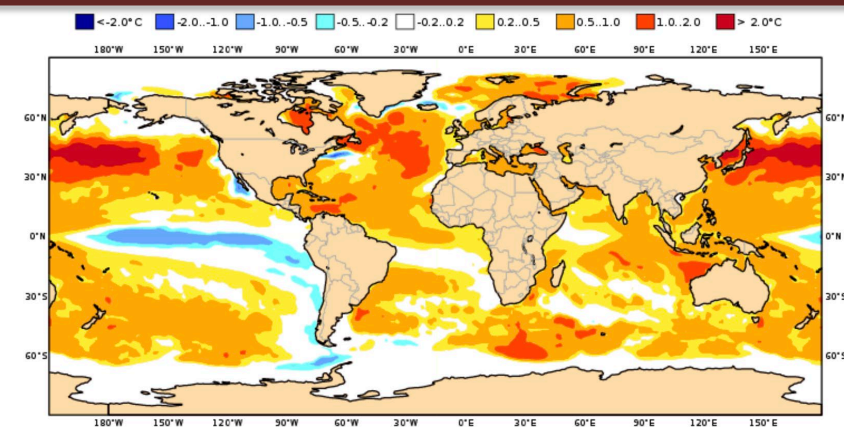
Reanalysis – 1940-now – 36km



Medium-range - 15 days - 9km



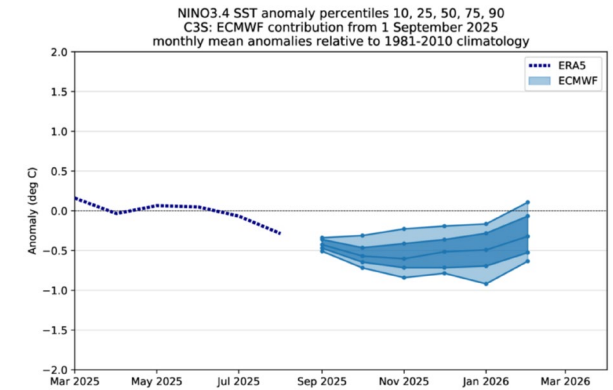
Sub-seasonal - 46 days - 36km



Seasonal Forecast - 7 months - 36km

Seasonal forecasts

- **Upgrade of ECMWF Seasonal forecasting system in 2026**
 - Larger ensembles, more frequent updates, longer forecasts (up to 2 years).
 - Graphical products will be displayed on ecCharts!

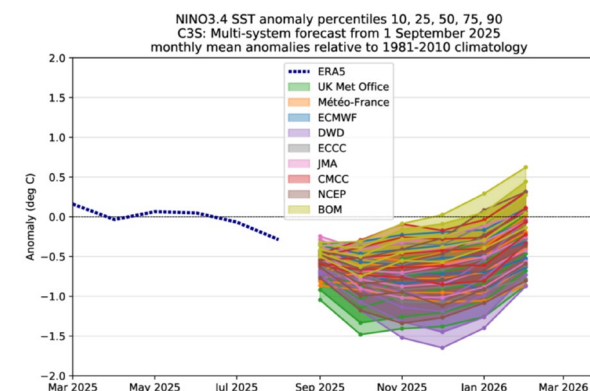
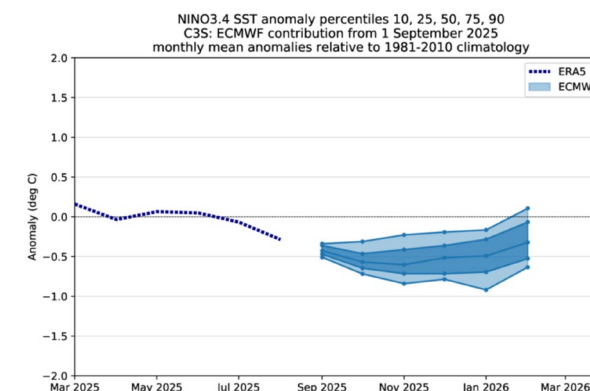
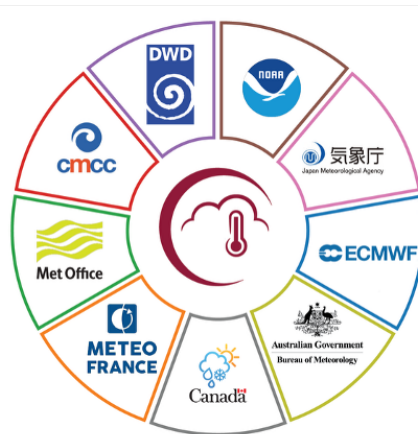


PROGRAMME OF
THE EUROPEAN UNION



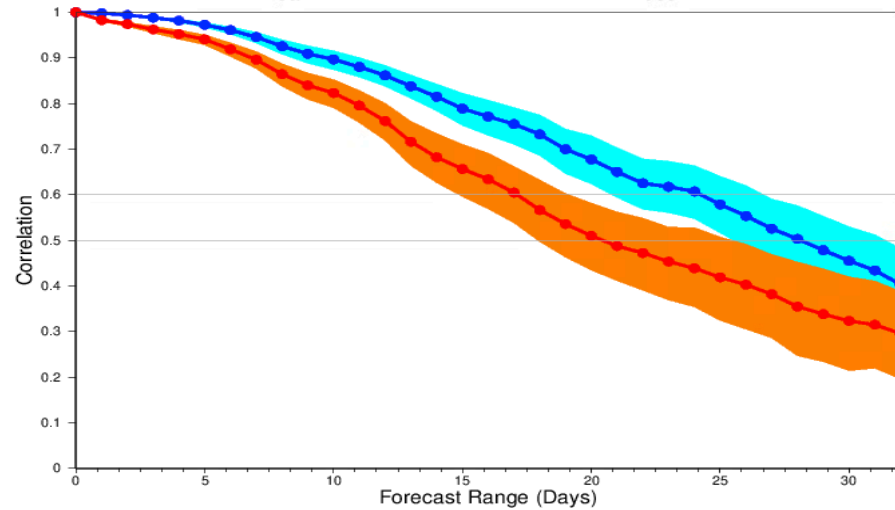
Seasonal forecasts

- **Upgrade of ECMWF Seasonal forecasting system in 2026**
 - Larger ensembles, more frequent updates, longer forecasts (up to 2 years).
 - Graphical products will be displayed on ecCharts!
- **Multi-system seasonal forecasts**
 - Continuous enhancement of contributing systems
 - New graphical products
 - A new member in 2025 (Bureau of Meteorology, Australia)

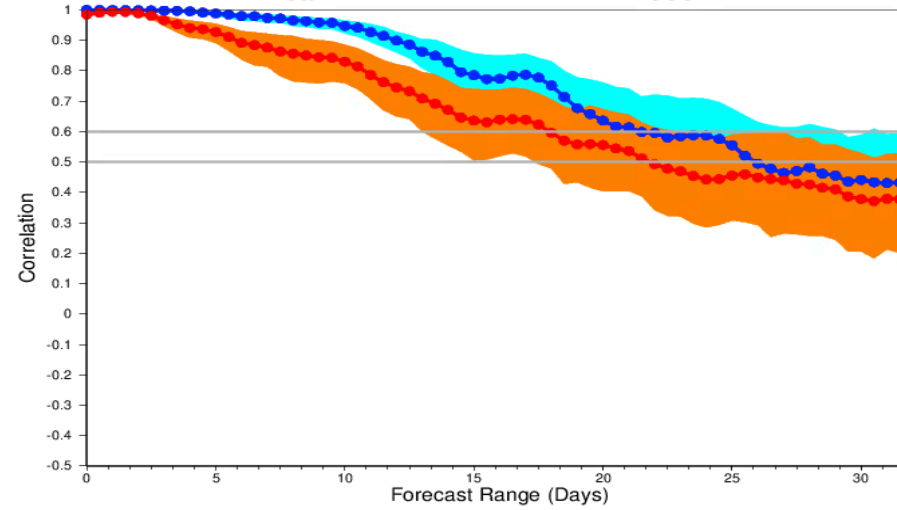


Sub-seasonal forecast – improvements in 20 years

MJO 28 days (+8 days)

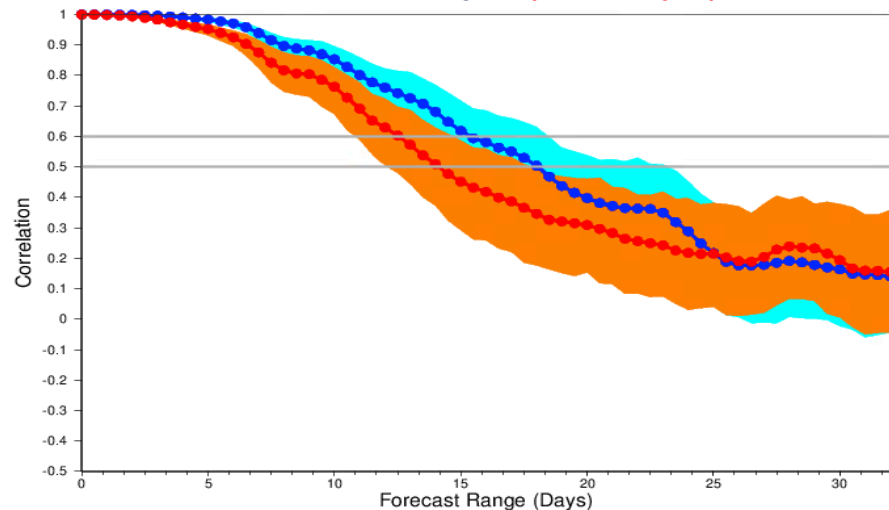


SSW 26 days (+4 days)

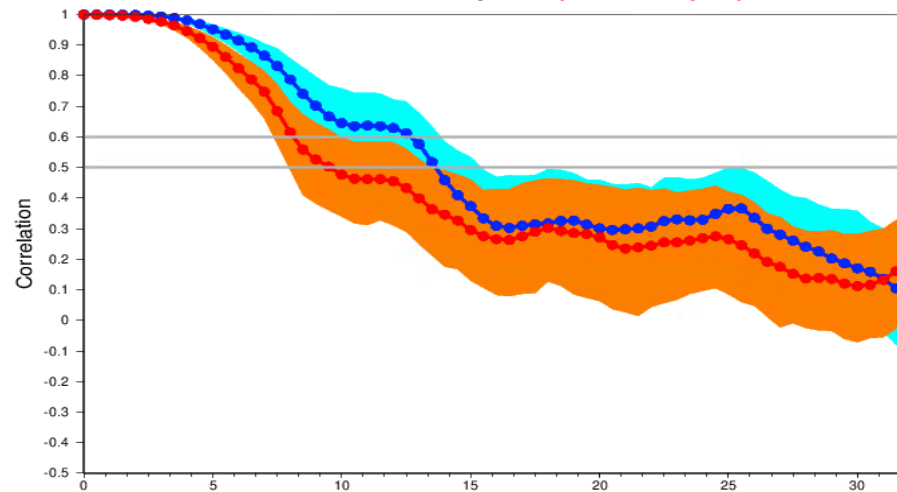


48r1 (2024)
28r1 (2004)

PNA 18 days (+4 days)



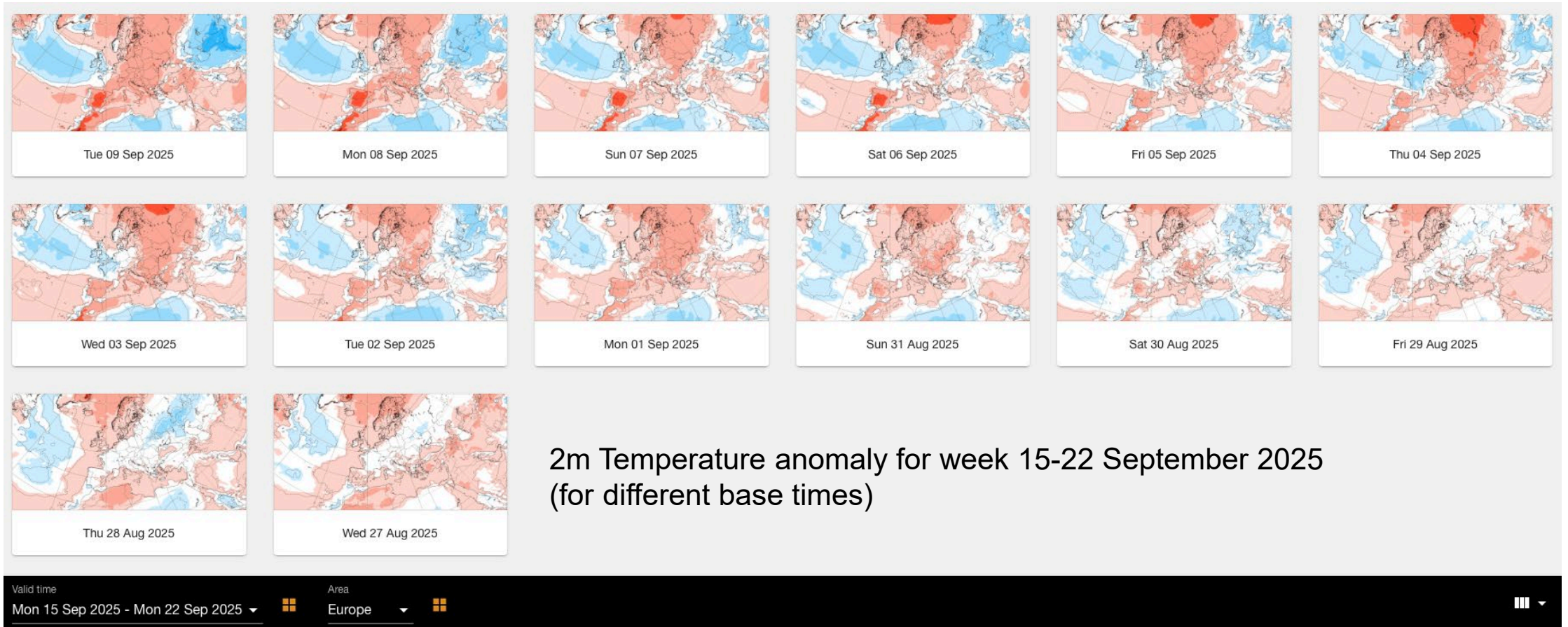
NAO 14 days (+4 days)



Sub-seasonal forecast – changes in products

With **IFS Cycle 48r1**: 101-member (TCo319) **forecast** running every day from day 0 to day 46.

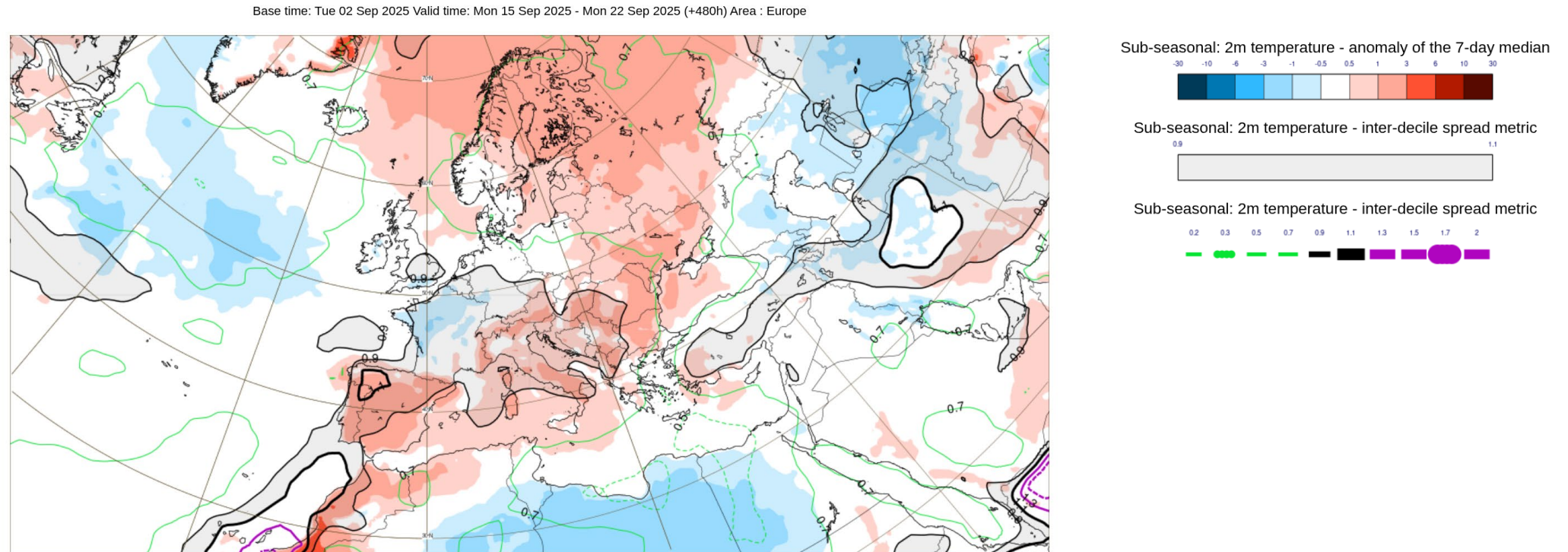
With **IFS Cycle 49r1**: new Sub-seasonal **reforecast** initialised every odd day of the month (new model Climate).



Sub-seasonal forecast – supporting users in use and interpretation

Work with Member and Co-operating States on **user-relevant verification and products** (2025-2027)

A **new experimental product** for sub-seasonal forecast interpretation (introduced in June 2025 in OpenCharts)

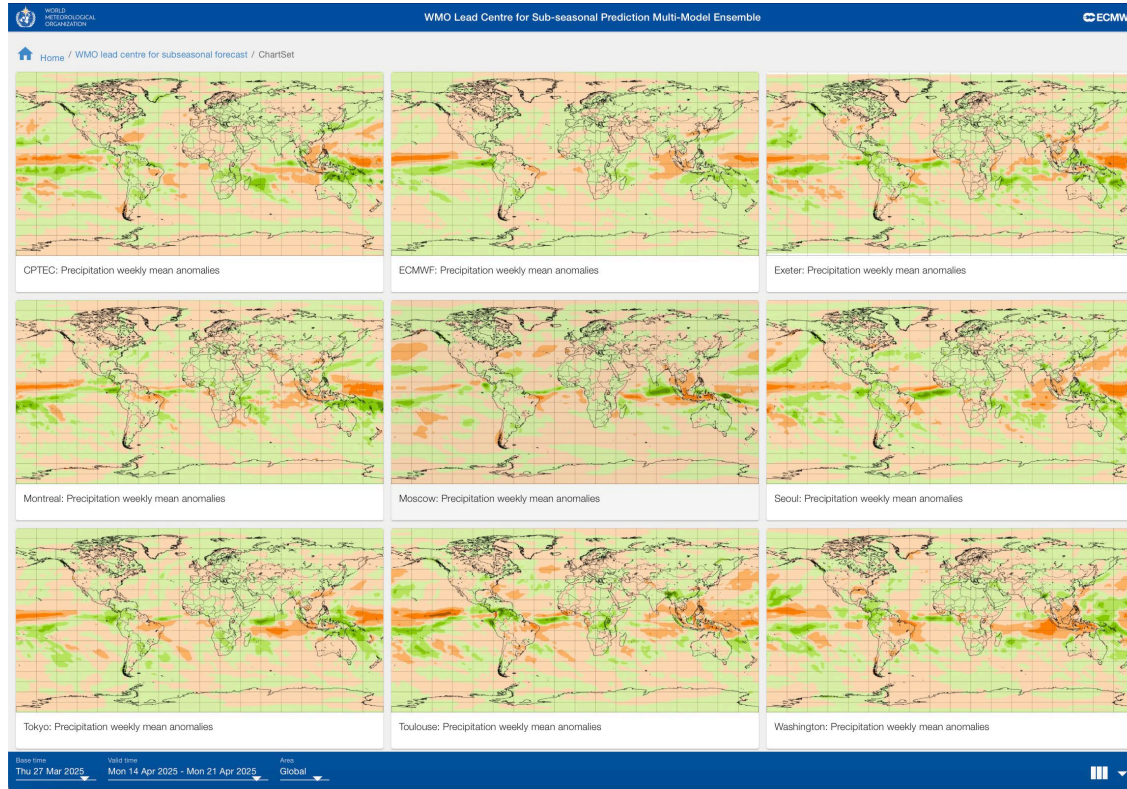


Quantile-based weekly guidance map

Sub-seasonal forecast – multi-system

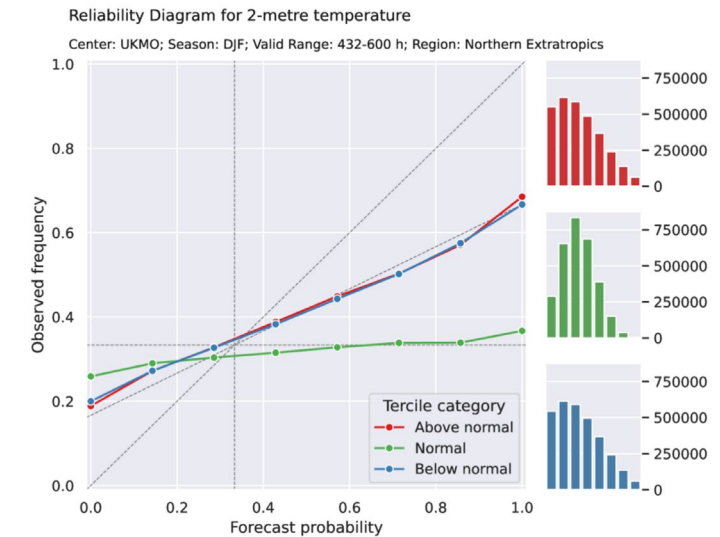
ECMWF hosts WMO Lead Centre for **Sub-seasonal Predictions Multi-Model Ensemble** (since 2023).

Built on the legacy of the WWRP/WCRP **S2S** project and relies on S2S archive infrastructure.



Near real-time forecast charts (updated weekly)

Exeter - Reliability of tercile category forecasts

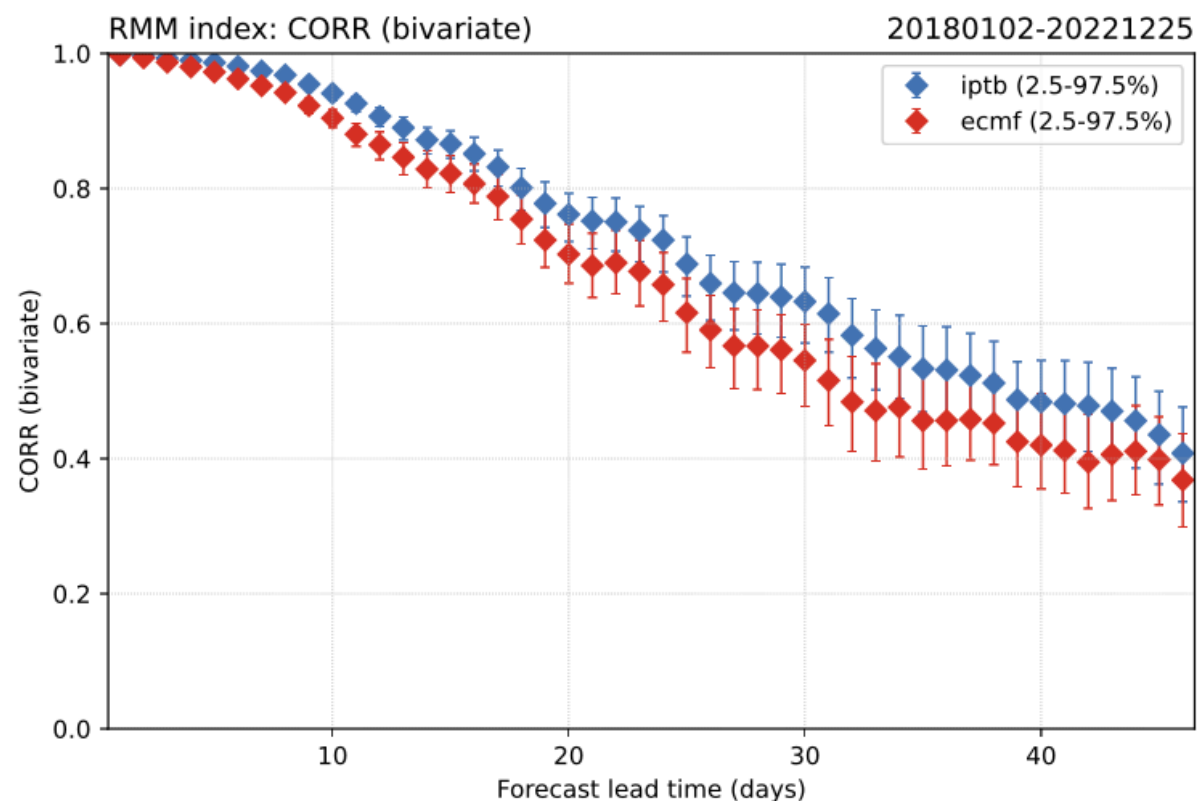


Verification statistics from reforecasts



Sub-seasonal forecast – with AI

AIFS for subseasonal vs IFS

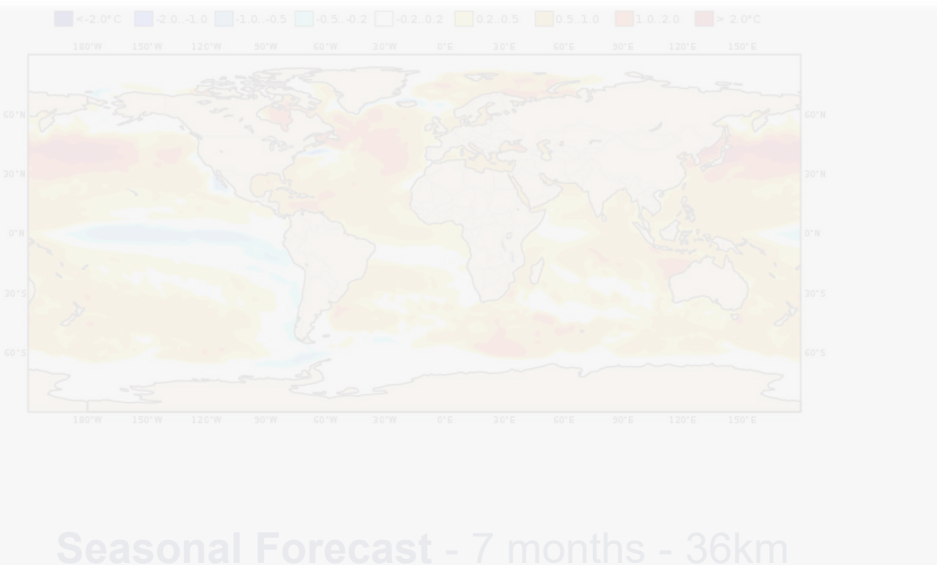
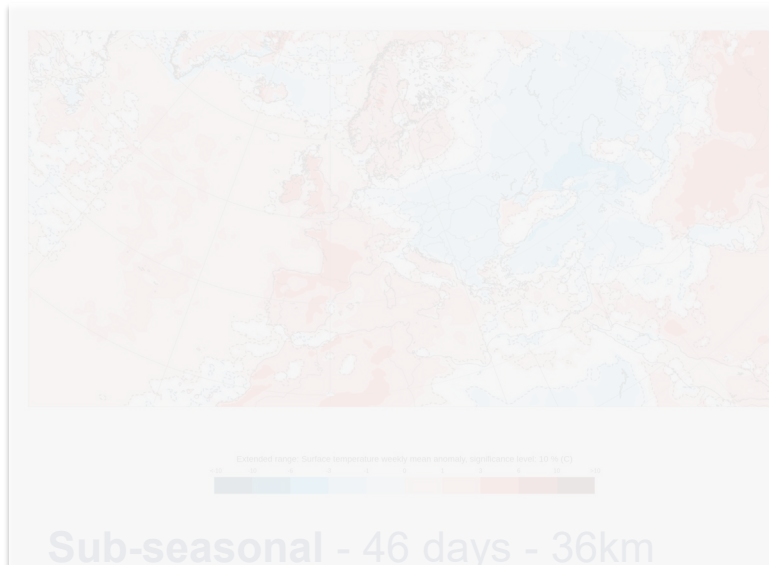
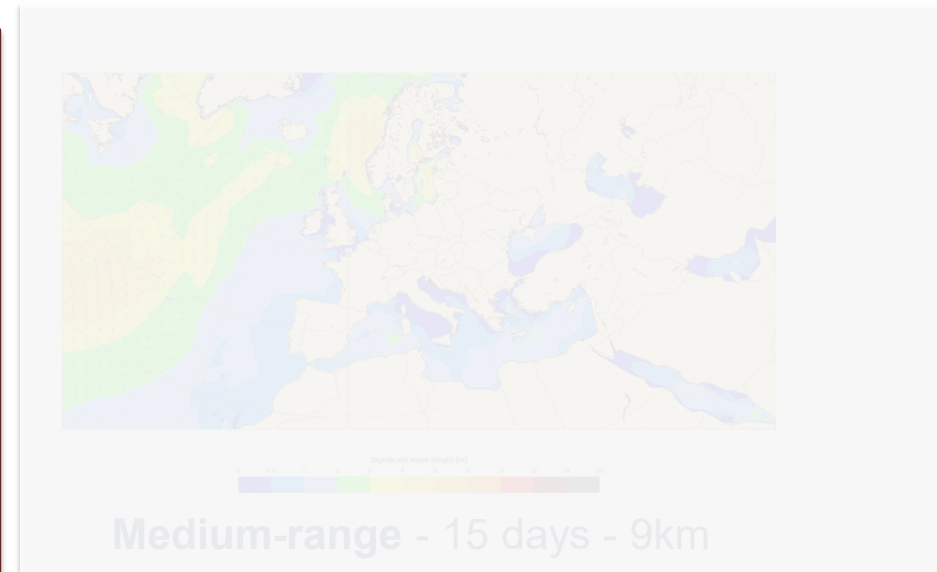
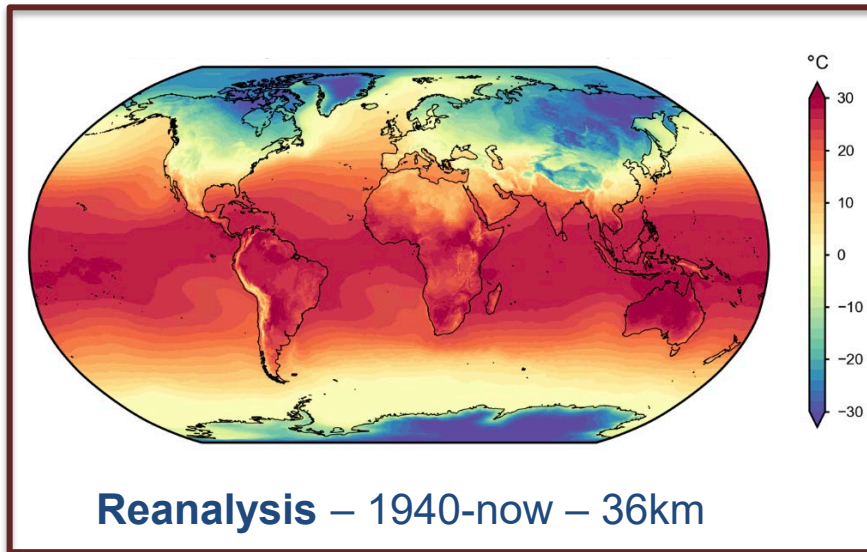


Evaluation:

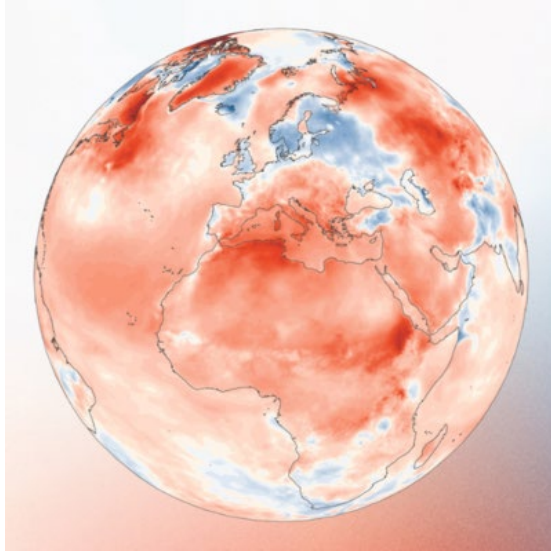
- 5-year evaluation period (2018-2022)
- Weekly initialized reforecasts
- **MJO correlation in week 3 and 4 is improved by ~10% wrt to IFS**
- AIFS shows improvement upon IFS up to week 4 in the troposphere

Real-time AIFS sub-seasonal system with dissemination in 2026.

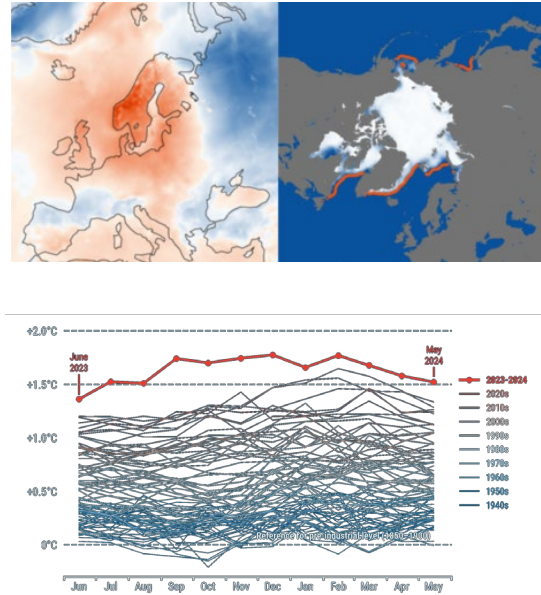
Forecast data provision across multiple timescales



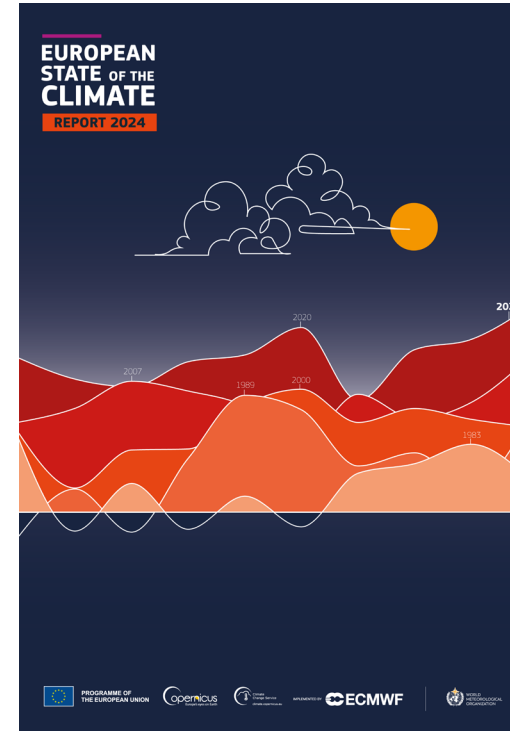
Climate Monitoring



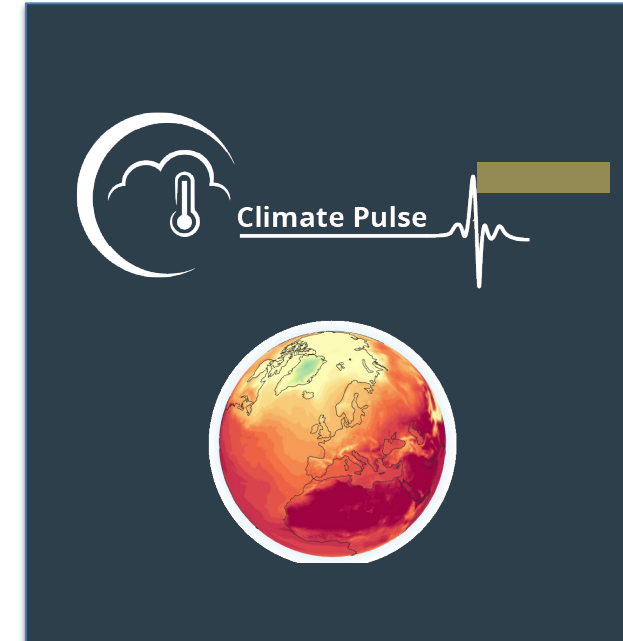
Global Climate Highlights



Monthly Bulletins



European State of the Climate



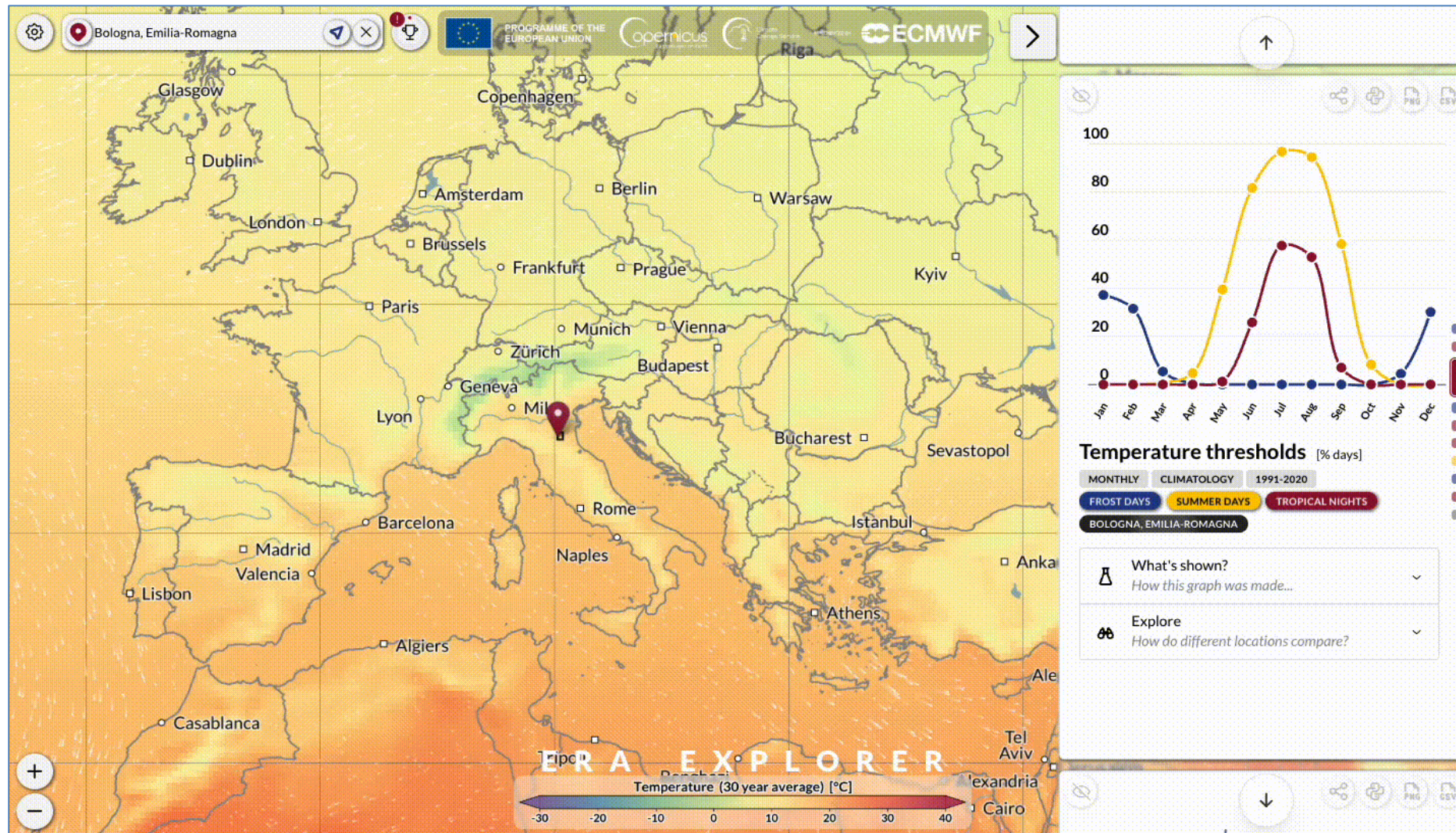
Climate Pulse

Reanalysis – climate statistics

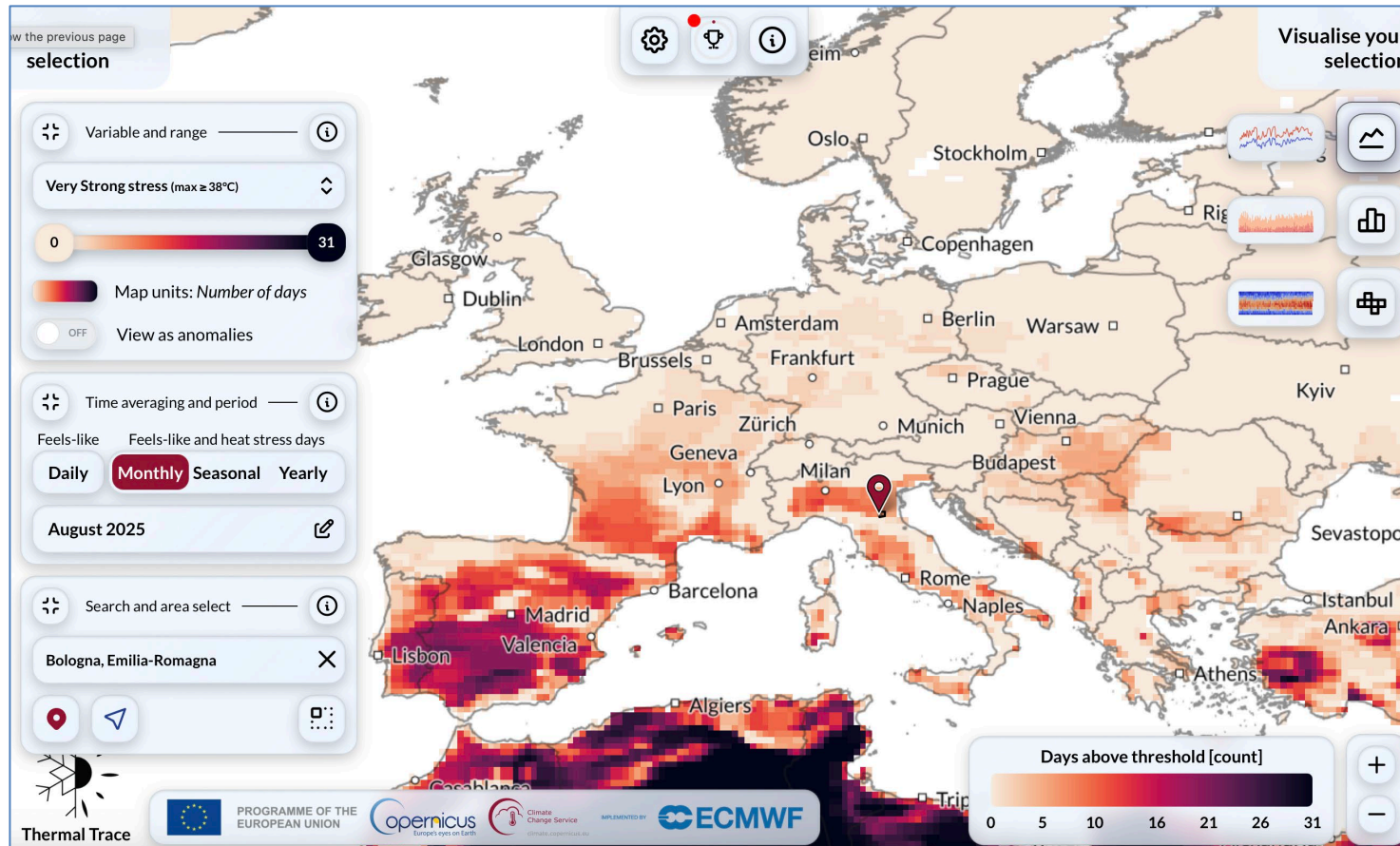
ERA Explorer

Powered by the Climate
Data Store

Built on a new ZARR
archive of selected
ERA5 variables



Reanalysis – monitoring



Thermal Trace

Visualising decades (80+ years) of heat and cold stress data

Based on ERA5-HEAT – Universal Thermal Comfort Index (UTCI)



ECMWF forecast product development

- Driven by science and innovation... and users' needs
- Keywords: high-impact weather, ensembles, Earth System, climate monitoring, verification, accessibility, graphical products, open data... machine learning !
- Programmes (e.g., Copernicus, Destination Earth), projects, and collaborations as support for development and value multipliers.
- Engagement and co-development with Member and Co-operating States is instrumental.
- **The future: user-oriented products, fueled with machine learning, accessible, more integrated, more and more co-development.**

Forecast user resources

ECMWF

Spaces

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Analytics

Create

Forecast User Guide

Analytics

SPACE SHORTCUTS

Forecast User Portal

Search this space

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Section 3 Availability and Interp

Section 4 NWP Evolution versu

Section 5 Forecast Ensemble (E

Section 6 Using Deterministic a

Section 7 ENS Products - Dealin

Section 8 ENS products - What

Section 9 Physical consideratio

Section 10 Interfaces for displa

Section 11 Conclusion

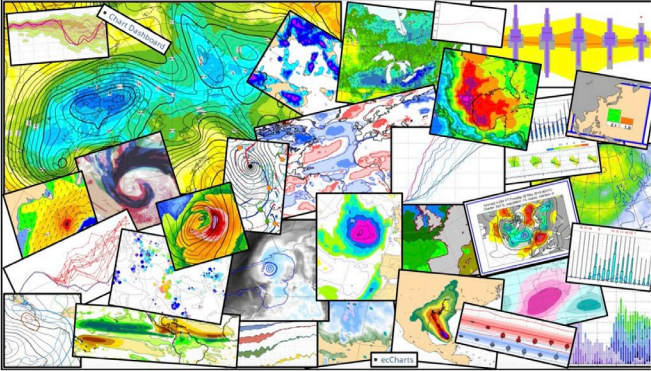
Section 12 Annexes

Space tools

Forecast User Guide

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



Forecast User Guide

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Section 3 Availability and Interpolation of N...

Section 4 NWP Evolution versus Reality

Section 5 Forecast Ensemble (ENS) - Ration...

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Section 7 ENS Products - Dealing with Unce...

Section 8 ENS products - What they are and...

Section 9 Physical considerations when inter...

Section 10 Interfaces for displaying Model O...

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Section 12 Annexes

Training | Workshops | Seminars | Education material | eLearning

Training course: Use and interpretation of ECMWF products

Universal Tr...

SUPINF Scr...

Metview4 - o...

[SUPINF-21]

Users - EC...


Sup...

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

Pages / Forecast User Home

Severe Event Catalogue

Created by Florian Pappenberger, last modified by Linus Magnusson on Sep 22, 2014



ECMWF | Reading | 6-9 October 2025

Your feedback is key!

EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

Pages / Forecast User Home

Known IFS forecasting issues

Created by Timothy Hewson, last modified on Dec 12, 2017

Please note that numbering/ordering does not indicate/imply any sort of priority. Recent entries/changes/updates are shown in green. Greyed out means no longer current, but these issues can be relevant when examining archived forecasts.

| Topic / title | Description | Related activities |
|--|---|---|
| 2m Temperature | | |
| T1. 2m temperature in the presence of Inversions | In common with all models, 2m temperature forecasts from the IFS tend to have much larger errors, on average, during low level inversion situations, which are particularly common at high latitudes in winter. The basic physical explanation is that a set change in atmospheric energy content has a much larger impact on screen temperature in inversion situations than in unstable situations, because the energy change is committed through a much smaller depth of the atmosphere (e.g. metres rather than kilometres). The lower the inversion, the larger is the potential error. There is also sensitivity here to the method we use to interpolate between air temperature at the lowest model level (~10m) and skin temperature (2m temperature) a diagnostic, not direct model output. | New reporting practices for radiosonde data ("BLUF" messages), being introduced around the world, could alleviate this problem somewhat, by providing model analyses with a much more detailed representation of the near surface layers. |
| T2. City temperatures too low | Due to the urban heat island effect not being represented, screen temperatures in large urban areas, particularly cities, are commonly too low compared to observations. The problem can be accentuated in winter by snow cover. | 'Urban tiles' to be introduced in land surface scheme in due course. |
| T3. Screen temperatures fall too much near coasts | As a consequence of the radiation grid being larger than the model grid (due to computational constraints) night-time radiative cooling over land near to the coast is often too rapid. This is because cooling progresses according to T ⁴ , and at near-coast points T is approximately the average temperature of the land (and warmer) ocean. As a result screen temperatures drop too much - related errors can sometimes exceed 10C. The problem is enhanced (i) when there is snow cover, (ii) at high latitudes, and (iii) where coasts have a convex shape (land-relevant). | Improvements due to radiation code 'fixes' were introduced with cycle 41R2 in March 2016. In example cases the impact of these changes has been very positive. More substantial radiation code changes are likely in the longer term. |
| T4. Meteoграм temperature issues in complex topography | In addition to the normal problems of representing screen temperatures in complex topography in current-generation global models, the user should be aware that the method by which screen temperatures on MeteoGrams are generated from model screen temperatures assumes a standard lapse rate (6.5°C drop per km increase in altitude), and so if the difference in height between the site chosen, and the nearest model gridpoint (as shown in the EN5gram title) is large, the scope for large errors/biases increases. This is especially true in winter-time when inversions are more common: by definition an inversion implies a temperature increase with height, not a decrease, so the temperature correction applied could even be in the wrong direction. This issue is compounded by 2m Temperature issue T1 above. | Resolution upgrade in March 2016 (41R2) has helped. Re-calibration project should help even more. |
| T5. China "cold spot" | In products that intrinsically display 2m temperature output in some 'anomaly' form - such as monthly forecast anomalies, seasonal forecast anomalies, and in the shorter ranges EPI and SOT - there has been a semi-permanent winter-time 'cold spot' over eastern China. It is not real in the sense that temperatures are not always below | |

Pages / Forecast User Portal

Known AIFS Forecasting Issues


Created by Meghan Plummeridge, last modified by Timothy Hewson on Feb 25, 2025







Please note that numbering/ordering does not imply priority. Recent updates are shown in green. Greyed out means no longer current, but these issues can be relevant when examining archived forecasts.

Any enquiries related to the content of this page should be raised via the [ECMWF Support Portal](#) (mentioning the "Known AIFS forecasting issues" page).

| Topic / title | Description | Related activities / comments |
|--|--|---|
| General issues | | |
| G1. Overly smooth forecasts. | A result of the mean-squared-error optimization in training AIFS Single is to deliver smooth fields. This can be seen in energy spectra, where there is less energy at length scales less than 1000km. This feature increases to a small extent with lead time. One example area would be objective fronts - identification of such requires the nearby thermal gradient to exceed a threshold; then in practice total front length will reduce with forecast lead time as gradient peaks get smoothed out. | Whilst this behaviour is also a well-known characteristic of an ensemble mean, the issue is less pronounced in AIFS. Plus, successive AIFS implementations have managed to further reduce the smoothing effect. |
| G2. Underestimation of small-scale extremes | AIFS resolution is ~28km. Where the spatial extent of extreme values is smaller the AIFS cannot and should not represent peak values. Examples include topographically- or convectively-forced localised rainfall extremes, low level wind extremes around tropical cyclones or extreme extra-tropical cyclones, localised temperature extremes in complex topography (e.g. in valleys or on mountain tops). | AIFS output exhibits the same behaviour, but for the current medium range ensemble the issue is much less because gridlength is much smaller. In AIFS such issues are exacerbated by G1. |
| G3. Parameter consistency | As the AIFS lacks hard physical constraints between variables there is more scope for inter-parameter consistency to be lacking at specific locations at specific times. | Ordinarily this is not a major problem, but there have, for example, been cases of precipitation without cloud. T1 provides a more substantive example. |
| Low level winds | | |
| W1. Underestimation of wind speeds around cyclones | For both tropical and extra-tropical cyclones the AIFS has a slow bias, underestimating the strongest winds. | |
| Cloud cover | | |

Stay tuned ! IFS Cycle 50r1


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Implementation of IFS Cycle 50r1


Created by Milana Vuckovic, last modified about an hour ago



Description of the upgrade

The IFS Cycle 50r1, will bring major changes to the IFS model and data assimilation system, including among many others:

- New ocean and sea ice models based on NEMO4-SI³
- Updates of the wave model including: new wave interaction with sea ice and ocean currents and revised wave model bathymetry
- Modified Stochastically Perturbed Parametrisation (SPP) configuration to reduce 10-metre wind spread in the ensemble
- New ocean and sea ice ensemble analysis system & outer loop coupling of ocean/sea-ice
- Reintroduction of stratospheric humidity assimilation from radiosondes up to 60 hPa
- Weak constraint formulation extended to the boundary layer allowing the increased use of T2m observations




After making the high-resolution forecast (HRES) and 'control' member of medium range ensemble forecast (ENS control) identical in IFS Cycle 49r1, , with this model upgrade we will stop producing the current ENS control, and the data stream that was formerly called the HRES will be called ENS control instead.


More detailed information will be made available in the coming weeks.


For any questions, please contact us via the [ECMWF Support Portal](#).

#IFS50r1 #newfcssystem @ECMWF



News

 10 Sept 2025 Initial announcement.



Q1 2026

Stay informed ! Migration to GRIB2

- **Full GRIB2 introduced in operation in Cycle 50r2 ~Q3 2026**
- [Migration to GRIB edition 2 Information page](#)
 - ecCodes changes to parameters
 - Details for how to access test data
 - Updated regularly
- ecCodes [release notes](#)
- Sign up to the mailing list - mtg2@lists.ecmwf.int

Mailing List

Users who wish to receive regular updates about the progress in the migration to GRIB2 can subscribe to the mailing list mtg2@lists.ecmwf.int.

To subscribe, send an email to sympa@lists.ecmwf.int with the subject "SUBSCRIBE mtg2@lists.ecmwf.int".

- Watch the Migration to GRIB2 webinar recording on YouTube



ECMWF Spaces

Migration to Grib 2 - User Space

Pages

Blog

PAGE TREE

- The mapping of parameters in GRIB
- Migration to GRIB2 - changes to enc
- Migration to GRIB2 - sample static c
- GRIB edition 2 template example for
- Migration to GRIB2 - new in ecCode
- Migration to GRIB2 - new WMO par
- About GRIB data format

Pages

Migration to GRIB edition 2 Information page

Created by Paul Dando, last modified by Milana Vuckovic on Jul 18, 2025

This space gives an overview of the **migration to GRIB edition 2**, informs about the **progress**, and will be **continuously updated**. It is complementary to the existing documentation at ECMWF and used to merge and link relevant information. Code and file examples will also be published here.

The space also contains a short [introduction into GRIB editions 1 and 2](#) including the advantages of GRIB2 over GRIB1.

The information presented on this page is subject to further change. To receive notifications of any updates please "watch" this page (requires log in) or subscribe to the mailing list 📧.

Search MTG2 space

Stay in the loop!

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MTG2 webinar 2024

Online computing training week ...

Migration to GRIB2

Online computing training week 2024

Sébastien Villaume
Migration technical lead and coordinator
sebastien.villaume@ecmwf.int

With Robert Osinski, Robert Osinski, Matthew Griffith, and many others across ECMWF

ECMWF

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Thank you

Matthieu.Chevallier@ecmwf.int

