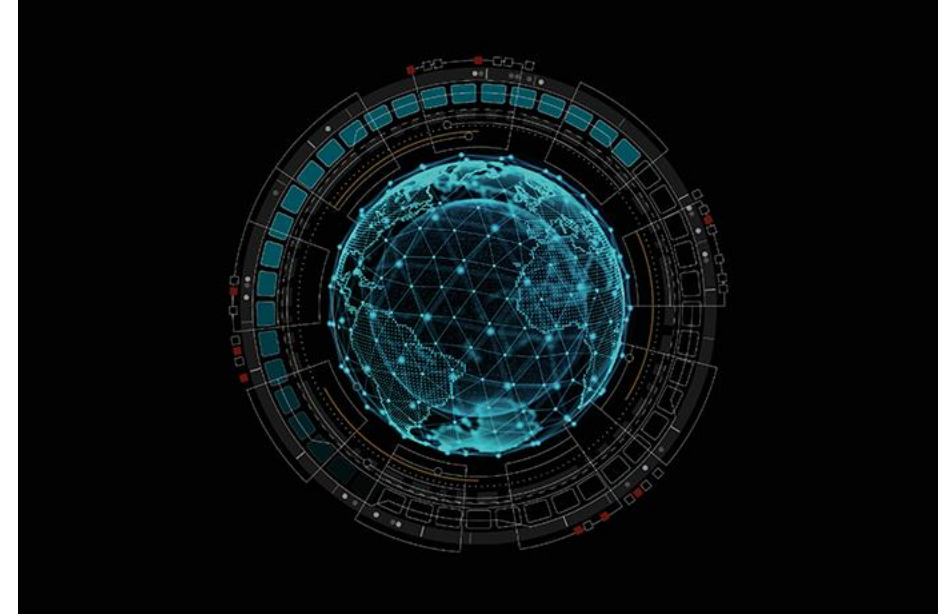


# ECMWF Product Development

#UEF2024

Matthieu Chevallier, Head of Evaluation  
Forecast and Services Department, ECMWF

Thanks to many colleagues for inputs

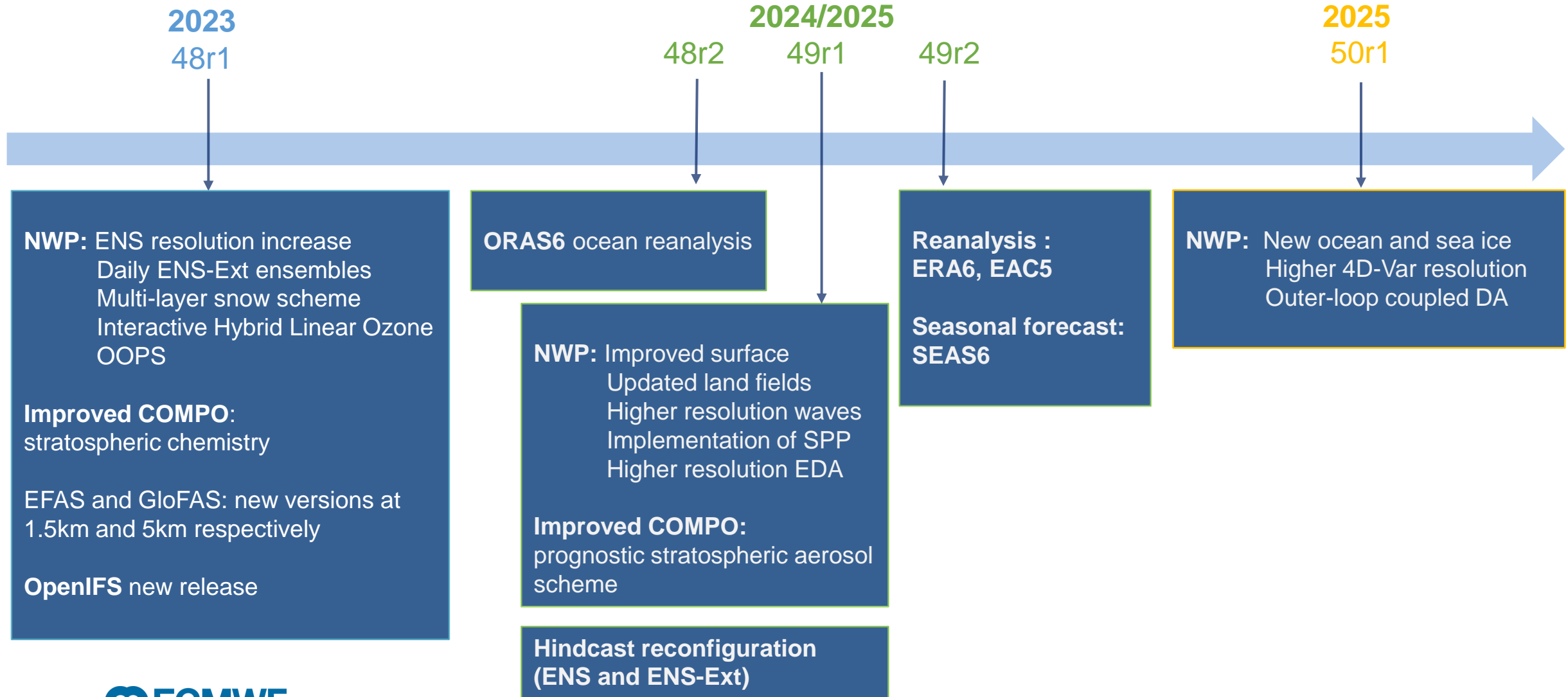


# ECMWF Product Development – Outlines

**Last IFS upgrade – Cycle 48r1**  
**Coming IFS upgrade – Cycle 49r1**  
**Recent new products (2023-2024)**  
**Upcoming product developments**

## Current and upcoming IFS Cycles

# Integrated Forecast System (IFS) upgrades





# 48r1 – HRES vs ENS Control ?

- **In 48r1:** ENS members and HRES have the same horizontal resolution...
  - HRES now plays a similar role to ENS “Control” run (**unperturbed**)
  - HRES and ENS Control are still 2 separate unperturbed runs (outputs are different)
  - HRES 00 and 12 UTC are 10-day long, ENS Control 00 and 12 UTC are 15-day long
  - HRES still disseminated earlier than the full ENS

- **In 49r1 (October 2024):**
  - Both will be made computationally identical.
  - Both will run to 15 days for 00 and 12 UTC

- **In 50r1 (October 2025):**
  - Current “ENS Control” run will be stopped.
  - Data stream currently called ”HRES” will be the “Control” run.

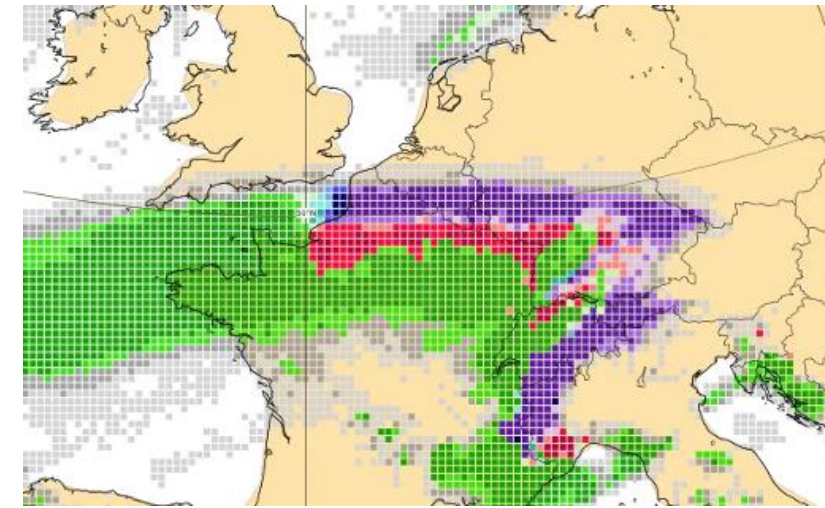
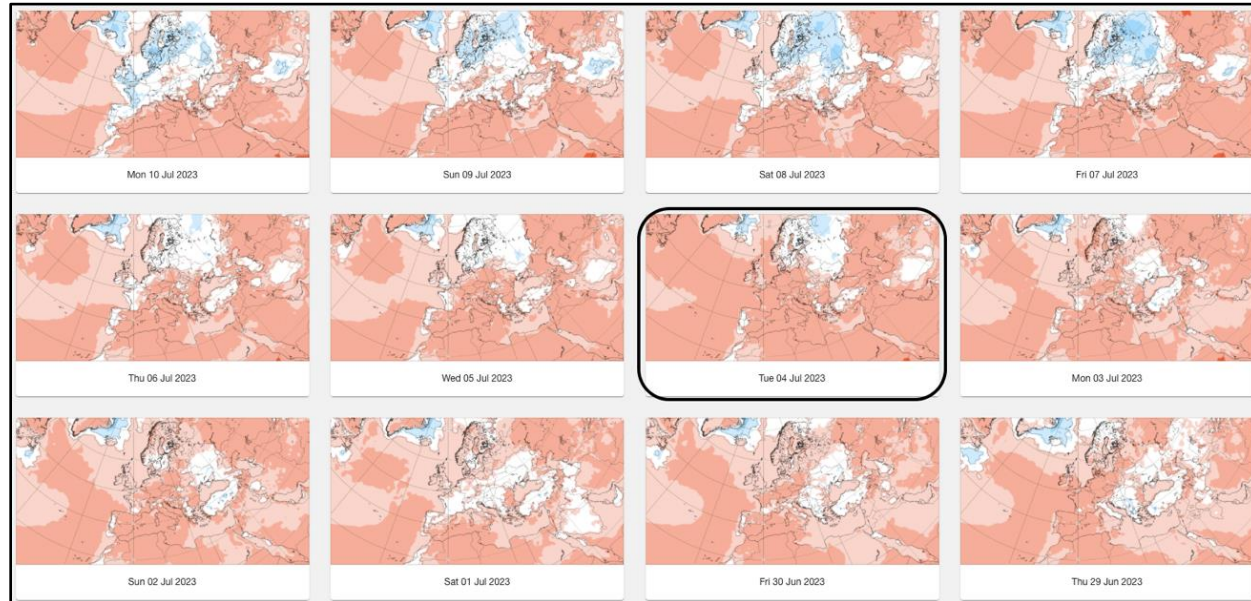
- **As a consequence, in 48r1:**
  - **Naming “HRES” is kept**
  - **“Deterministic” charts use HRES**
  - **Only HRES is plotted in 10-day meteograms**

The screenshot shows the ECMWF website header with navigation links: Home, About, Forecasts, Computing, Research, Learning, Publications. Below the header is a secondary navigation bar with links: Who we are, What we do, Jobs, Media centre, Suppliers, Location. The main content area features a news article titled "Plans for high-resolution forecast (HRES) and ensemble forecast (ENS) control run" dated 5 March 2024. The article includes a "Share" button and a meteorological map showing pressure and temperature contours over a geographical region.



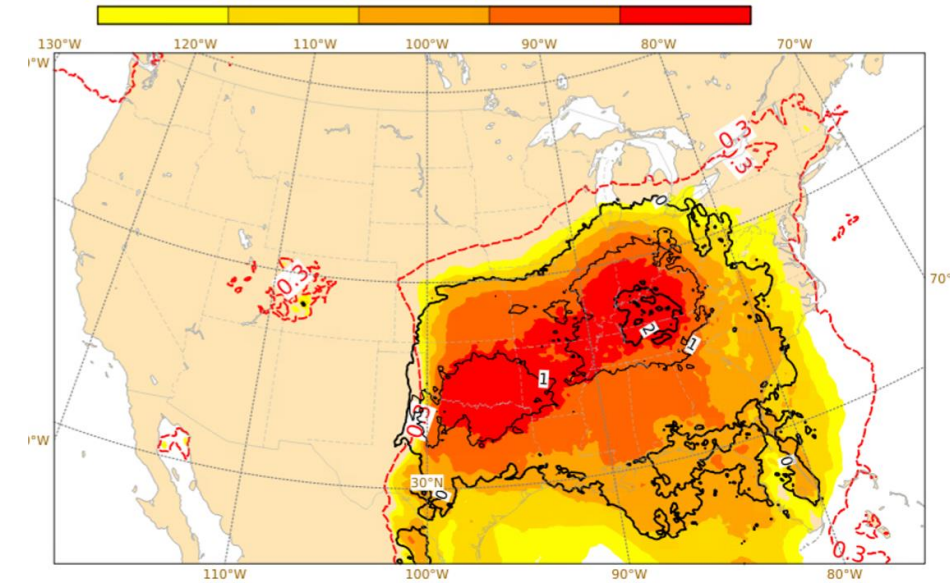
# 48r1 – new Parameters, new Products

- Precipitation types: freezing drizzle, most severe/frequent in last 1/3/6h
- Adjusted versions of CAPE and CAPE-shear EFI – collab with ESSL
- New meteograms
- Daily extended-range products

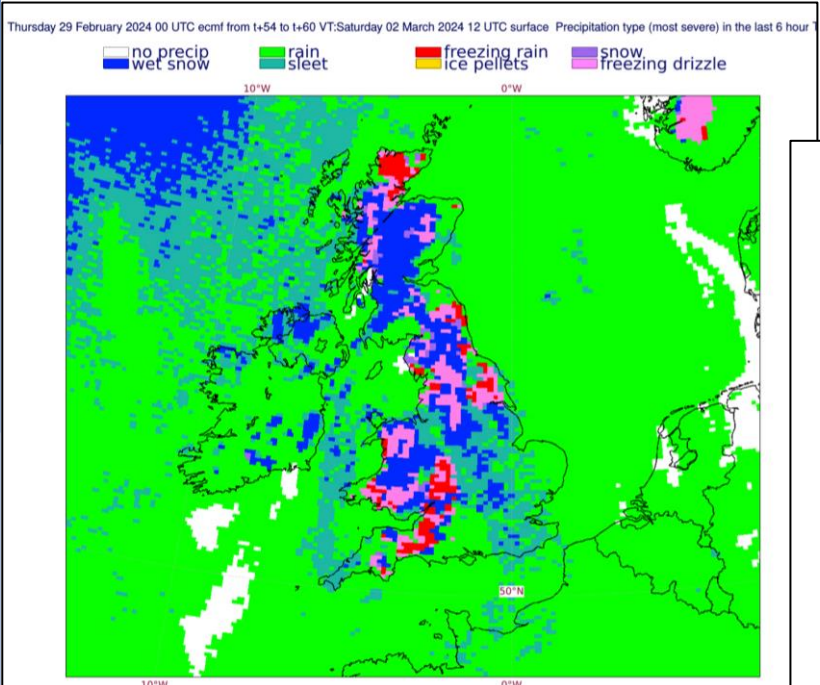
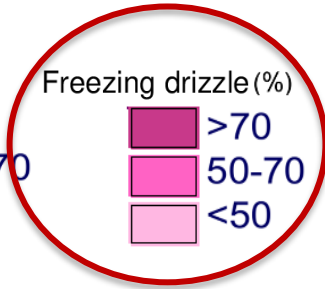
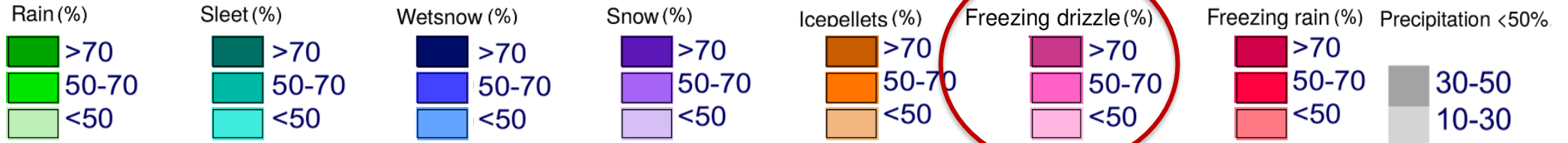


24 May 2024 00UTC @ECMWF t+48-72h; VT: 26 May 2024 00UTC - 27 May 2024 00UTC  
Extreme forecast index and Shift of Tails (black contours 0,1,2,5,8) for: CAPE-shear

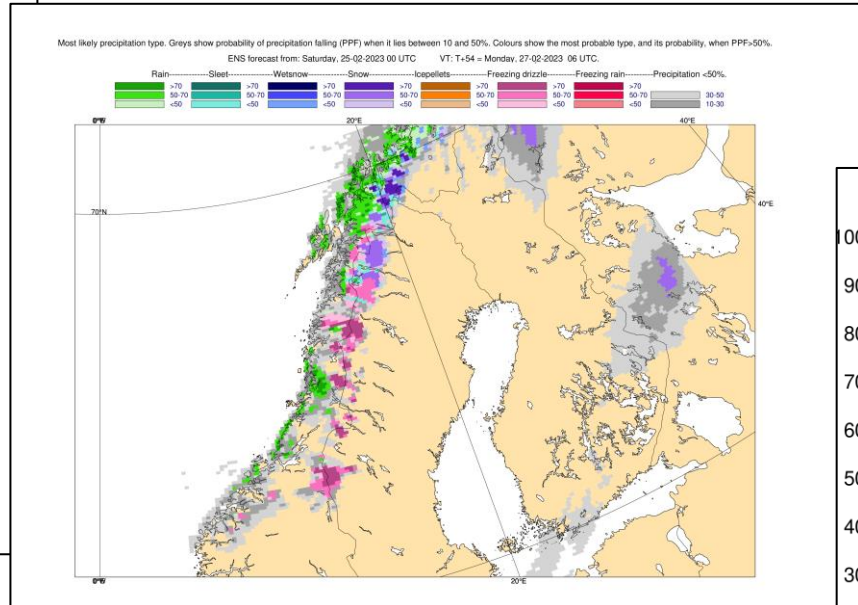
0.5    0.6    0.7    0.8    0.9    1



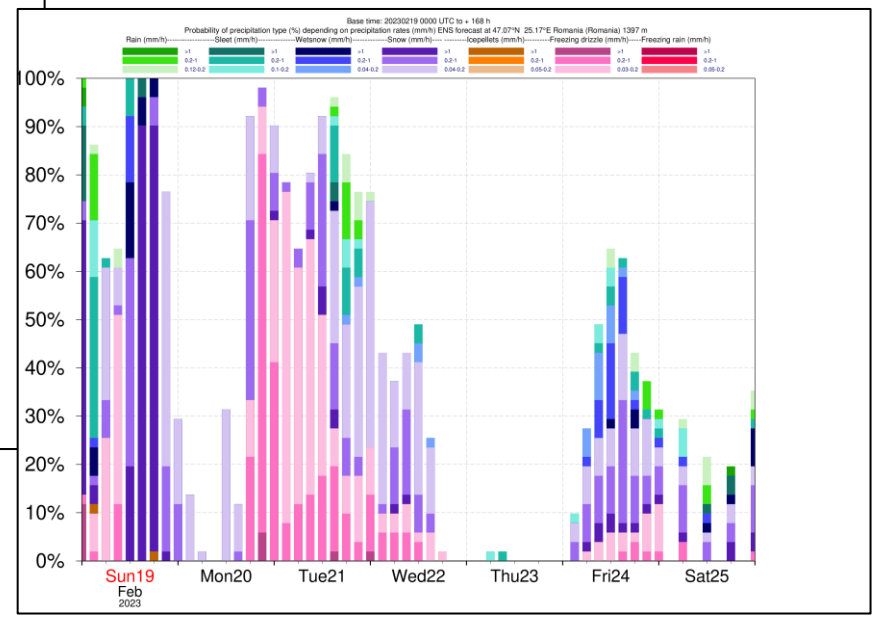
# 48r1 – precipitation type products



Most severe precipitation type in the last 6h



Most probable precipitation type



Precipitation type meteograms



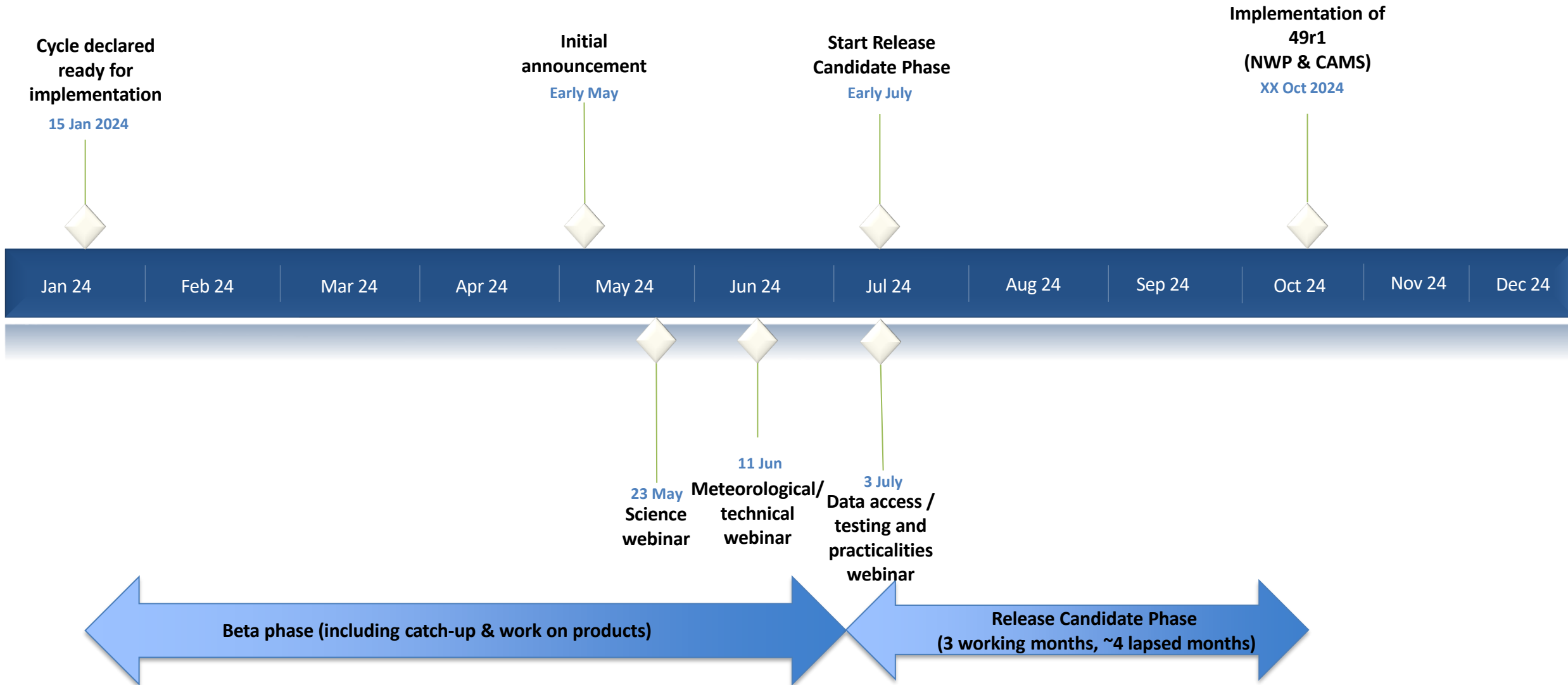
## Model Changes

- Wave model and convection package
- Land-surface model updates
- Activation of the Stochastically Perturbed Parametrisations (SPP) scheme
- Physics and numerics contributions
- Atmospheric composition package

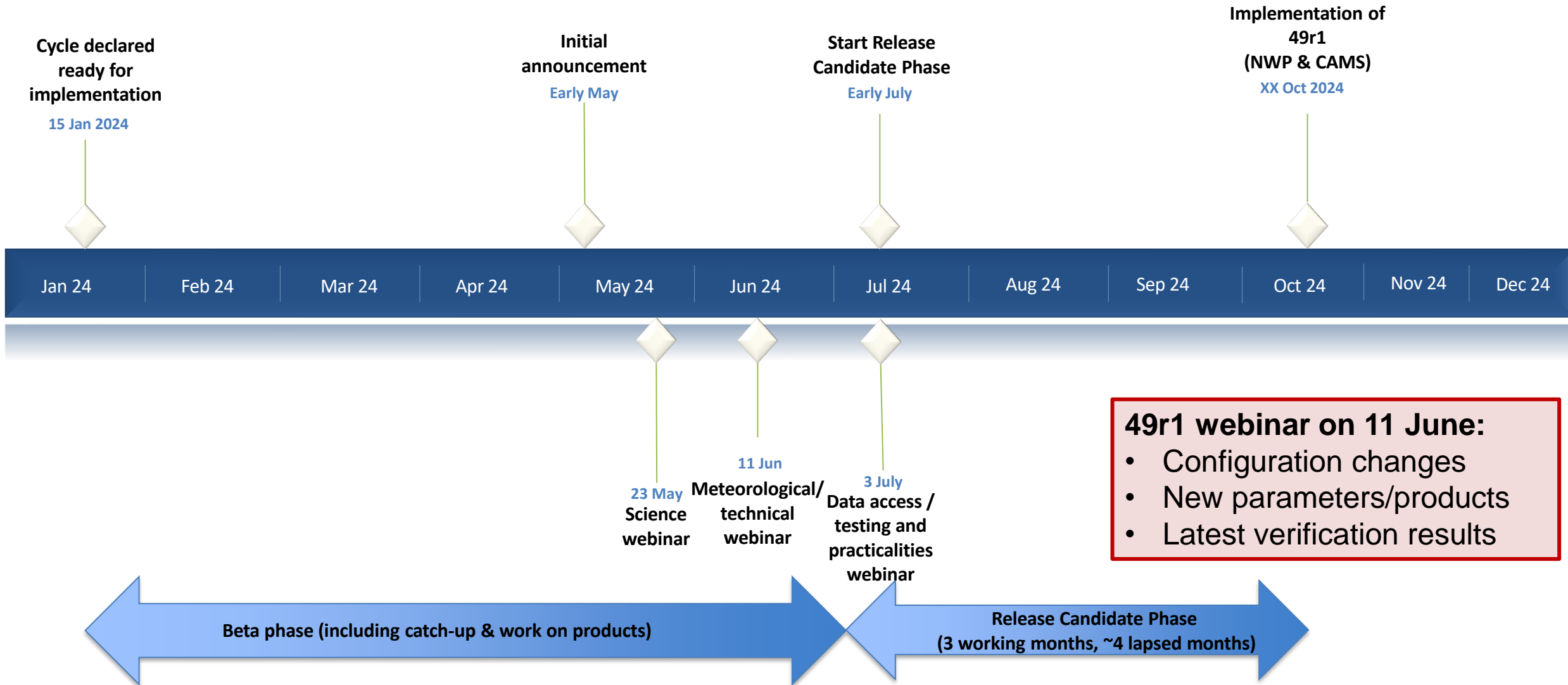
## Data assimilation changes

- Microwave and RTTOV assimilation package
- Non-microwave observations package
- T2m assimilation package
- VarQC and stratospheric balance assimilation package
- Land-surface assimilation package
- Updates to EDA

# 49r1 – release candidate phase starting soon!



# 49r1 – release candidate phase starting soon!



# 49r1 – new reforecast configurations for medium-range and extended-range

## In Cycle 48r1

**Extended-range:** 10 perturbed + 1 control forecasts **every Monday and Thursday**, over past 20 years.

**Medium-range:** 10 perturbed + 1 control forecasts **every Monday and Thursday**, over past 20 years

## In Cycle 49r1

**Extended-range:** 10 perturbed + 1 control forecasts **every odd days (1,3,5,...)**, over past 20 years (excluding 29 February).

**Medium-range:** 10 perturbed + 1 control forecasts **every 2 odd days (1,5,9,...)**, over past 20 years (excluding 29 February).



## Recent product developments (2023-2024)

# Visibility meteograms

- Operational product since 11 May 2023
- Collaboration with Member and Cooperating States (KNMI, OSMZ)

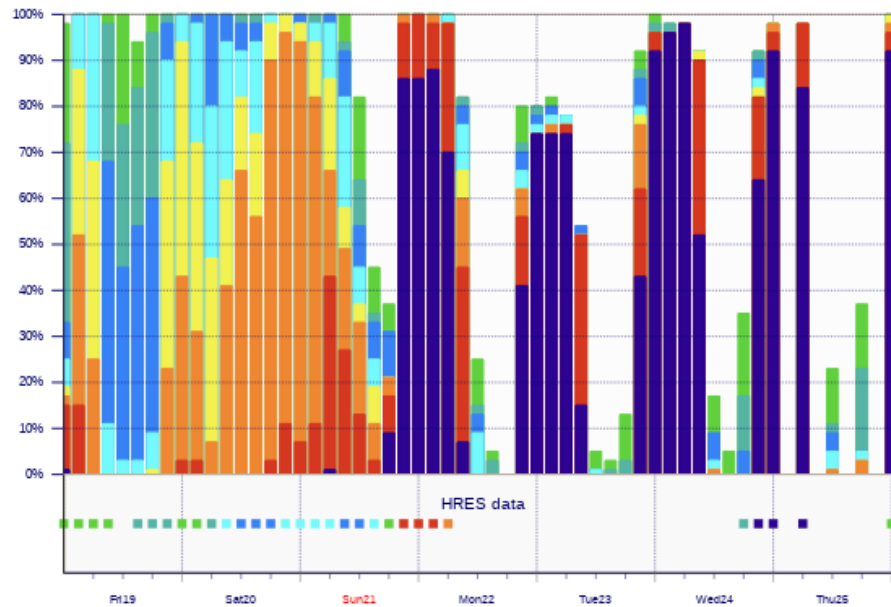
## Aviation visibility range

ENS visibility meteogram (3h interval, but 6h on day 7, no data beyond T+168h)

Tignes - Rhône-Alpes - France 45.47°N 7.01°E (ENS land point) ENS height: 2559.38 m

Friday 19 May 2023 00 UTC

Below 150m 150-350m 350-600m 600-800m 0.8-1.5km 1.5-3km 3-5km 5-10 km



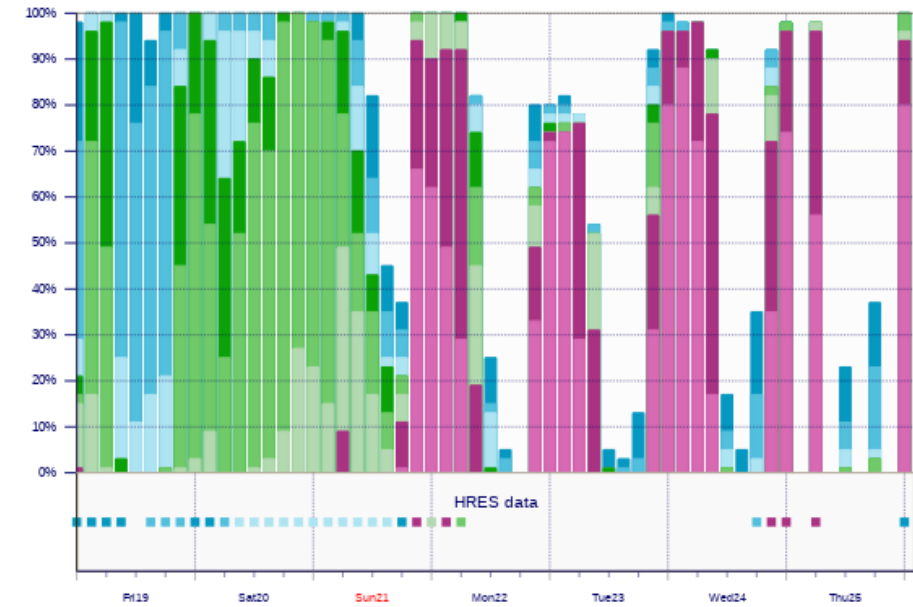
## “General-purpose” visibility range

ENS visibility meteogram (3h interval, but 6h on day 7, no data beyond T+168h)

Tignes - Rhône-Alpes - France 45.47°N 7.01°E (ENS land point) ENS height: 2559.38 m

Friday 19 May 2023 00 UTC

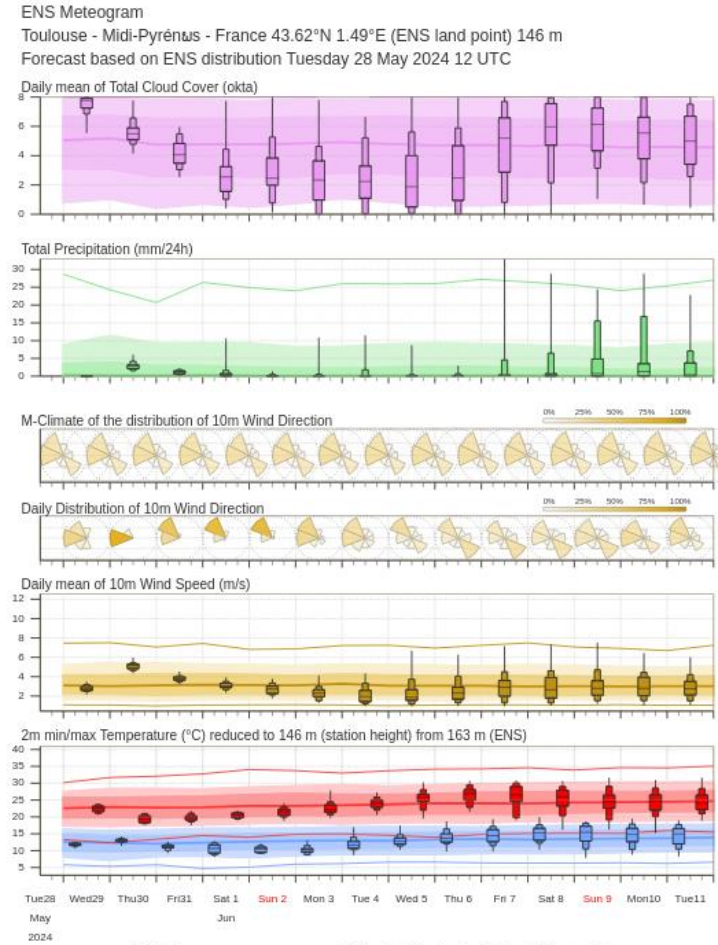
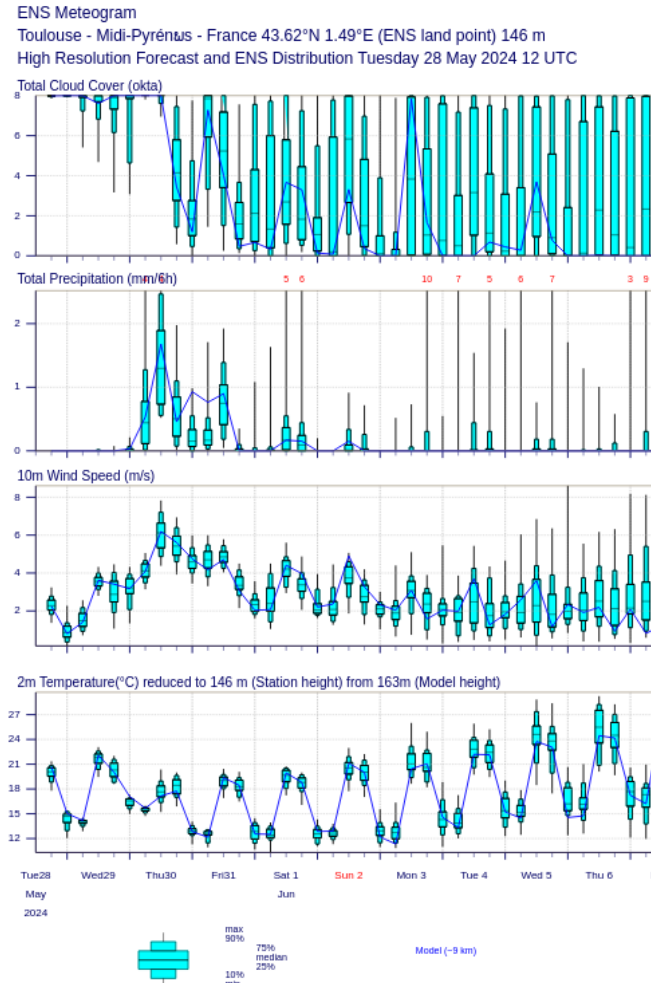
Below 50m 50-100m 100-200m 200-400m 400-700m 0.7-1km 1-2km 2-5km 5-10 km





# New parameters in ENS meteograms

- Collaboration with Member and Cooperating States (DWD)



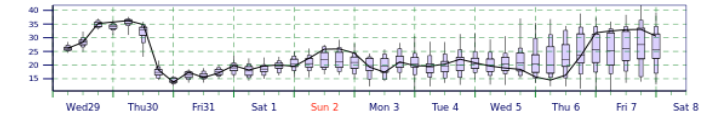
M-Climate: this stands for Model Climate. It is a function of lead time, date (+/-15days), and model version. It is derived by rerunning a 11 member ensemble over the last 20 years twice a week (1980 realisations). M-Climate is always from the same model version as the displayed ENS data.

## New 10 days meteogram widget

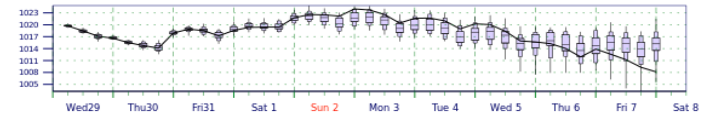
Location: 43.6°N 1.44°E, Toulouse, France

**NEW!!**

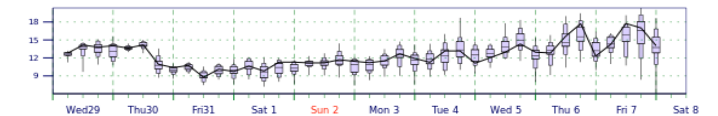
10-day epsgram total column water (mm)  
Base date: Wednesday 29 May, 00 UTC



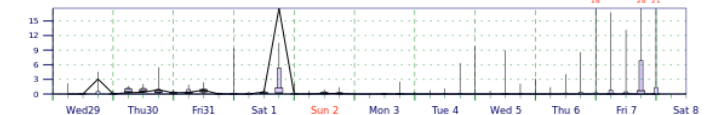
10-day epsgram MSLP (hPa)  
Base date: Wednesday 29 May, 00 UTC



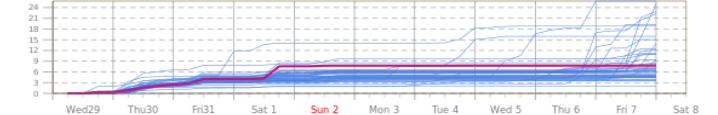
10-day epsgram 2m dew point Temperature (C)  
Base date: Wednesday 29 May, 00 UTC



Max total precipitation rate (mm/h) from all model timesteps in previous 6h  
Base date: Wednesday 29 May, 00 UTC



10-day epsgram accumulated total precipitation (ENS MEMBERS)  
Base date: Wednesday 29 May, 00 UTC

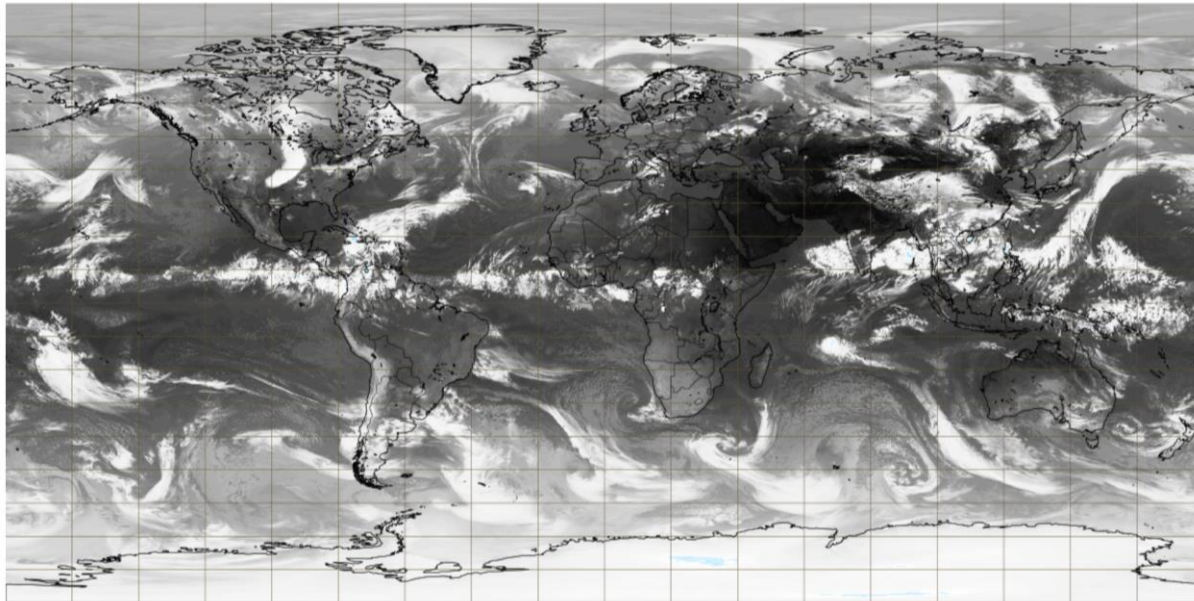


# Simulated (satellite) image

- Upward flux of radiation as would be detected by a weather satellite
- Derived from model temperatures and cloud layers
- Cloud-related fields in a format familiar to forecasters

## Infra-red channels

Base time: Tue 28 May 2024 12 UTC Valid time: Wed 05 Jun 2024 06 UTC (+186h) Area : Global



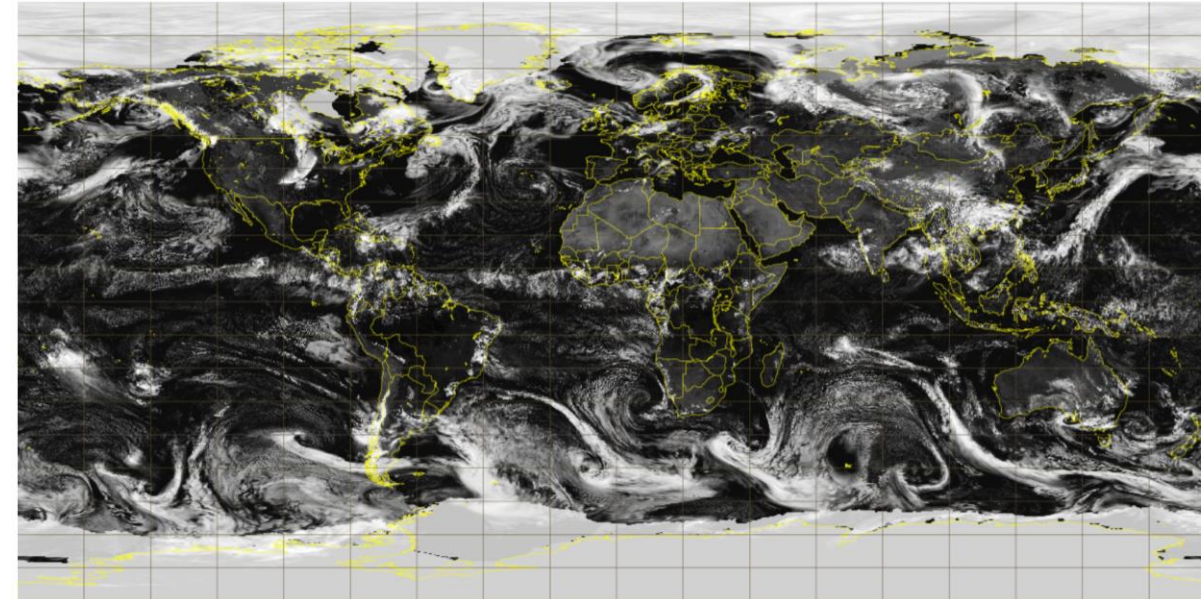
Simulated image: infrared (IR) channel (C)



## Visible channels

NEW!!

Base time: Tue 28 May 2024 12 UTC Valid time: Wed 05 Jun 2024 06 UTC (+186h) Area : Global Channel : Visible reflectance at 0.635 microns



Simulated image: Visible reflectance at 0.635 microns (reflectivity)



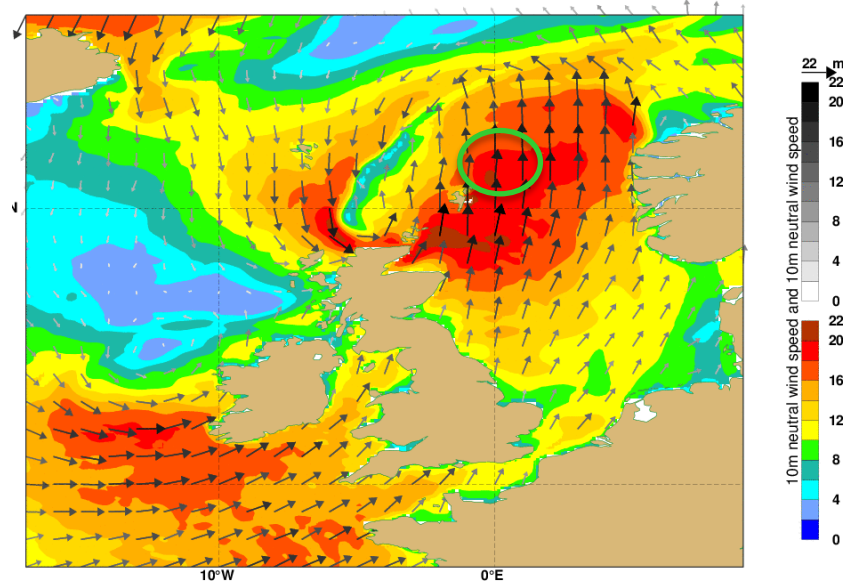
Cristina Lupu's talk (Speakers' Corner)



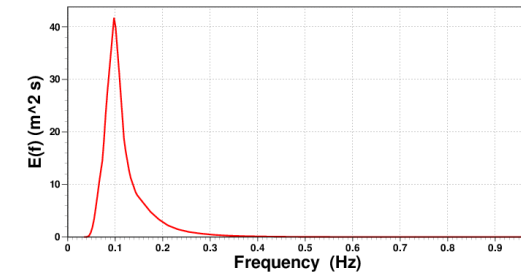
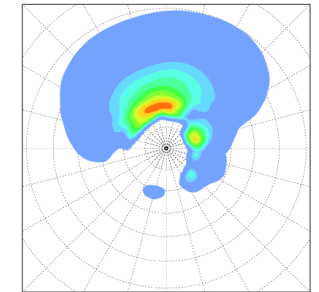
# Wave products

- 2D wave spectra routinely output
- Significant wave height
- Peak period
- Mean period(s) from weighted integration of the 2D spectrum
- Integrated mean direction
- ...

Sunday 27 March 2016 06 UTC ecwf t+0 VT: Sunday 27 March 2016 06 UTC 10 m 10 metre wind speed/10 metre wind direction  
 Sunday 27 March 2016 06 UTC ecwf t+0 VT: Sunday 27 March 2016 06 UTC 10 m 10 metre wind speed  
 Sunday 27 March 2016 06 UTC ecwf t+0 VT: Sunday 27 March 2016 06 UTC 10 m 10 metre wind speed  
 expver= 0001, Stand alone wave model,  
 Shading: 10m neutral wind speed, Arrows: (intensity: 10m neutral wind speed, direction: 10m wind direction)



NORMALISED 2-D SPECTRUM for 0001 wave od  
 06:00Z on 27.03.2016  
 at P0003 (62.00 , 0.00)  
 Hs= 6.08 m, Tm= 9.50 s, Tp= 10.15 s  
 Peakedness Qp = 1.18, Directional Spread = 0.64  
 MWD = 354 degrees PWD = 340 degrees  
 Propagation direction is with respect to North  
 North is pointing upwards  
 Concentric circles are every 0.05 Hz



Search products...

Range

- Medium (15 days)
- Extended (42 days)
- Long (Months)

Type

- Forecasts
- Verification

Component

- Surface
- Atmosphere

Product type

- High resolution forecast (HRES)
- Ensemble forecast (ENS)
- Combined (ENS + HRES)
- Extreme forecast index
- Point-based products
- Experimental: AIFS
- Experimental: Machine learning models
- Atmospheric composition

<p><b>Significant wave height and mean direction</b></p> <p>At any location over the oceans, there is a spectrum of waves which describes how much wave energy is present for given wave frequencies and direction of propagation...</p>	<p><b>Total swell: significant wave height and mean direction</b></p> <p>Wave height is the vertical distance between trough and crest. Wave period is the time between the passage of one wave crest and the next. The arrow direction is the direction the waves are moving towards...</p>	<p><b>Windswept: significant wave height and mean direction</b></p> <p>Significant windswept wave height can be shown to correspond to the average wave height of the top one-third highest windsea waves. Wave heights are shown in metres using colour shading...</p>	<p><b>Mean wave period and mean wave direction</b></p> <p>Mean wave period is the spectrally averaged period of the waves. Wave periods are shown in seconds using colour shading. 86" ticks on the middle icon to the bottom right for the scale...</p>
<p><b>Total swell: mean period and mean direction</b></p> <p>Mean total swell wave direction is the spectrally averaged propagation direction of the swell waves (weighted by wave height) of the part of the spectrum that is NOT windsea...</p>	<p><b>Windswept: mean period of waves and direction</b></p> <p>Mean windswept wave direction is the spectrally averaged direction of propagation of the windswept waves (weighted by wave height). Arrow length is proportional to the speed of wave propagation...</p>	<p><b>Significant wave height of all waves with various periods</b></p> <p>Significant wave height can be shown to correspond to the average wave height of the top one-third highest waves. The wave period of windsea is generally &lt; 15s...</p>	<p><b>Ocean waves energy flux</b></p> <p>These charts show the wave energy flux (in kW m&lt;sup&gt;-1&lt;/sup&gt;) calculated as the integral, over all forecast wave frequencies and wave directions, of the product of the wave group speed and the two-dimensional energy wave spectrum...</p>

## Wave model related changes in Cycle 49r1

- ecWAM on same Tco grid as atmosphere.
- Number of frequencies in wave spectra output reduced from 36 to 29 frequencies.
- Modified wind input parameterisation.
- Sea state dependent heat and moisture fluxes.
- Hourly wave data assimilation instead of 6-h.
- New wave parameters output

# Data-driven experimental forecasts available on OpenCharts

The screenshot displays the ECMWF OpenCharts interface. At the top, the navigation bar includes the ECMWF logo, the word "Charts", and links for "Help" and "Log in". Below the navigation bar, the main content area is divided into a left sidebar and a main grid of product cards.

**Left Sidebar:**

- Home / Charts catalogue
- Search products...
- Range
  - Medium (15 days)
  - Extended (42 days)
  - Long (Months)
- Type
  - Forecasts
  - Verification
- Component
  - Surface
  - Atmosphere
- Product type
  - High resolution forecast (HRES)
  - Ensemble forecast (ENS)
  - Combined (ENS + HRES)
  - Extreme forecast index
  - Point-based products
  - Experimental: AIFS
  - Experimental: Machine learning models
  - Atmospheric composition
- Parameters
  - Wind
  - Mean sea level pressure
  - Temperature

**Main Grid of Product Cards:**

- Card 1 (Top Left):** Latest forecast. **Experimental: AIFS (ECMWF) ML model: Mean sea level pressure and 850 hPa wind speed.** Description: AIFS (ECMWF): a deep learning-based system developed by ECMWF. It is initialised with ECMWF HRES analysis. AIFS operates at 0.25° resolution.
- Card 2 (Top Middle-Left):** Latest forecast. **Experimental: FourCastNet ML model: Mean sea level pressure and 850 hPa wind speed.** Description: FourCastNet v2-small: a deep learning-based system developed by NVIDIA in collaboration with researchers at several US universities. It is initialised with ECMWF HRES analysis. FourCastNet operates at 0.25° resolution.
- Card 3 (Top Middle-Right):** Latest forecast. **Experimental: FuXi ML model: Mean sea level pressure and 850 hPa wind speed.** Description: FuXi: a deep learning-based system developed by researchers at Fudan University. It is initialised with ECMWF HRES analysis. FuXi operates at 0.25deg resolution.
- Card 4 (Top Right):** Latest forecast. **Experimental: GraphCast ML model: Mean sea level pressure and 850 hPa wind speed.** Description: GraphCast (Google DeepMind): a deep learning-based system developed by Google DeepMind. It is initialised with ECMWF HRES analysis. GraphCast operates at 0.25° resolution.
- Card 5 (Bottom Left):** Latest forecast. **Experimental: Pangu-Weather ML model: Mean sea level pressure and 850 hPa wind speed.** Description: Pangu-Weather: a deep learning-based system developed by Huawei. It is initialised with ECMWF HRES analysis. Pangu-Weather operates at 0.25° resolution.
- Card 6 (Bottom Middle-Left):** Latest forecast. **Experimental: AIFS (ECMWF) ML model: 500 hPa geopotential height and 850 hPa temperature.** Description: AIFS (ECMWF): a deep learning-based system developed by ECMWF. It is initialised with ECMWF HRES analysis. AIFS operates at 0.25° resolution.
- Card 7 (Bottom Middle-Right):** Latest forecast. **Experimental: FourCastNet ML model: 500 hPa geopotential height and 850 hPa temperature.** Description: FourCastNet v2-small: a deep learning-based system developed by NVIDIA in collaboration with researchers at several US universities. It is initialised with ECMWF HRES analysis. FourCastNet operates at 0.25° resolution.
- Card 8 (Bottom Right):** Latest forecast. **Experimental: FuXi ML model: 500 hPa geopotential height and 850 hPa temperature.** Description: FuXi: a deep learning-based system developed by researchers at Fudan University. It is initialised with ECMWF HRES analysis. FuXi operates at 0.25deg resolution.

# A new observation dashboard

- **A quick near-real time access to the configuration and health status of the observations used and monitored at ECMWF**
- System designed to serve expert and non-expert users
  - Based on ECMWF use of the data in IFS DA.
  - Highlight automatically flagged anomalies (availability and quality)
  - Detailed description of the obs system configuration (what is used and what is monitored only)
- Quick access to detailed timeseries (from the alarm system and on-demand observation monitoring system)
- Automatically update with new observations (after few days) and delete of obsolete data (after period of non-reporting).
- Future updated will allow anomalies from other sources to be included (e.g. EUMETSAT UNS system, WMO incidents management systems, etc).

<https://obsstatus.ecmwf.int/>



Observations Monitoring Dashboard

Showing data from **2024/05/30 step 00:00 UTC (latest)** ▼

hide channels with no anomalies

- Microwave observations
  - AMSR2
  - SSMIS
  - MWHS2
  - GMI
  - AMSUA
  - MHS
  - ATMS
  - SMAP
  - SMOS
- Infrared observations
  - GNSS Radio Occultation
- Geostationary radiances
- Atmospheric Motion Vectors
- Ozone
- Satellite altimetry
- Scatterometer winds
- In-situ observations
- Ocean observations

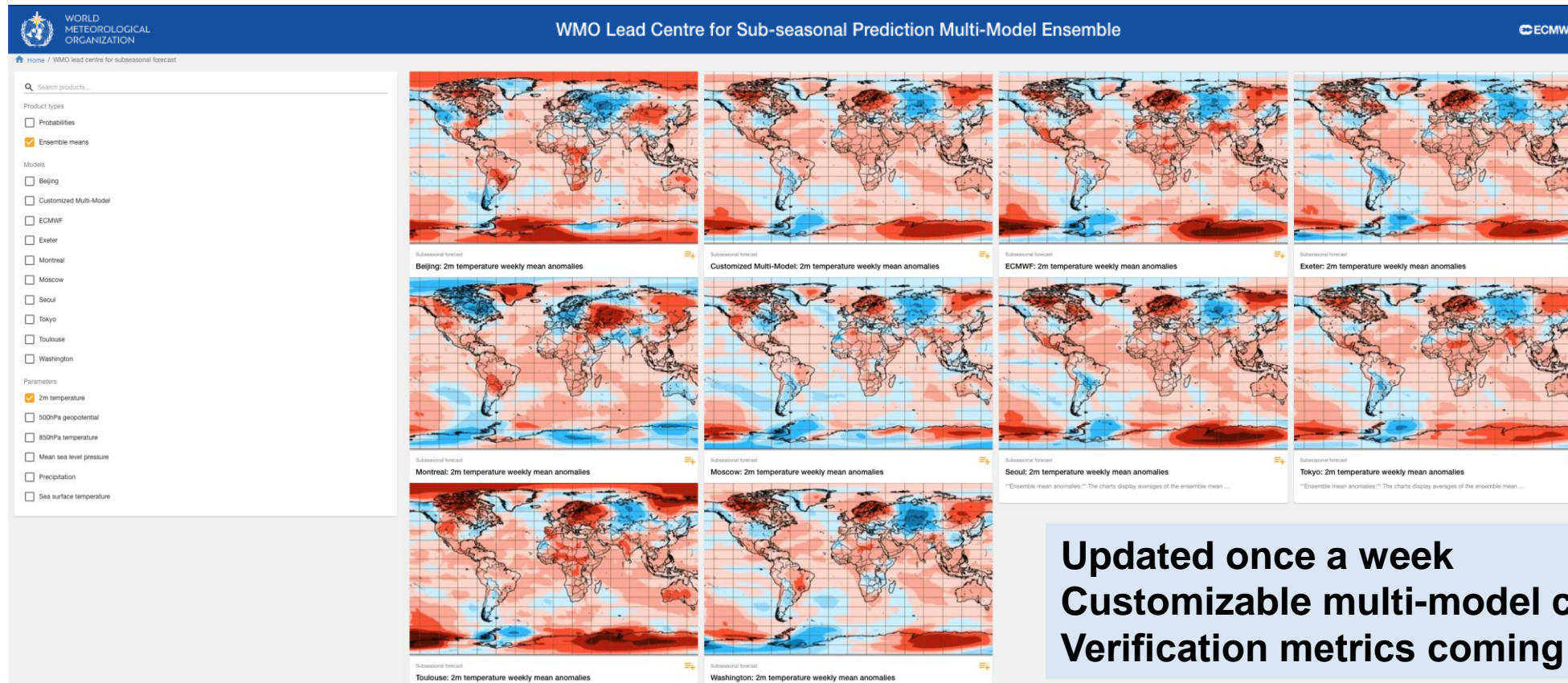
This dashboard provides a summary of availability, quality and usage of observations received at ECMWF. Observations are grouped in categories to reflect the data type and observed geophysical parameters. The availability and quality status is provided by the ECMWF automatic data checking system. The status is displayed using a traffic light system:

- The product group is Nominal.
- The product group is degraded. Click on the group to reveal the sub-groups affected.
- The product group is affected by severe anomalies or quality or availability. Click on the group to reveal the sub-groups affected.
- The channel/layer is monitored only.



# Subseasonal forecasts – WMO Lead Centre

- ECMWF designated Lead Centre for Sub-seasonal Predictions Multi-Model Ensemble (LC-SSPMME) in WMO WIPPS.
- Built on the legacy of the WWRP/WCRP S2S project and relies on S2S archive infrastructure.
  - Near-real-time forecasts from ECMWF and 8 centres contributing to S2S database.



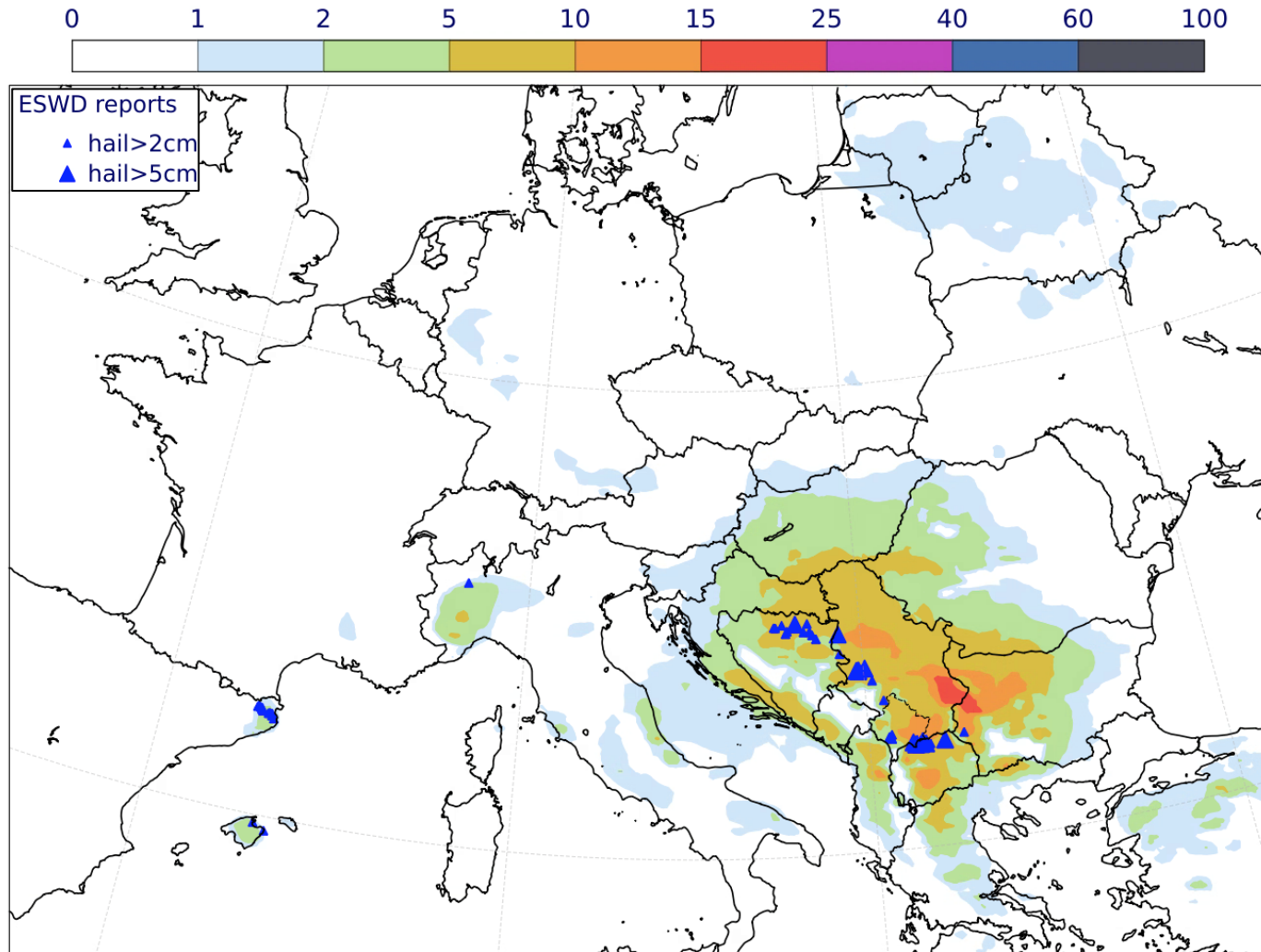


# Upcoming developments

- New variables constantly being added to ecCharts/OpenCharts **Cihan Sahin's talk (Thursday pm)**
- Cyclone Database Product updates (2024) **Tim Hewson (Speakers' Corner)**
- 6h and 24h Point Rainfall forecast (ecPoint) (2024)
- EFI with new "M-Climate" (reforecast reconfiguration – 49r1) (2024)
- Named tropical cyclone products into ecCharts (e.g. Strike Probabilities) (2024)
- Extended Range forecast plumes (2024), and other XR product options **Tim Hewson (Speakers' Corner)**
- Convective hazards (hail, wind gusts) – collaboration with ESSL (2024/25)
- More products from Machine Learning forecast models (esp AIFS) (2024-...) **AI session (Thursday am)**
- Blending outputs of different ensemble runs (lagged and dual-resolution 9km/36km over day 0-15) (2024-... ). **Nigel Roberts (Speakers' Corner)**
- Many developments in environmental forecasts and services (Copernicus) **Stijn Vermoote's talk (Wed pm)**
- Upgrade of ECMWF seasonal forecast system – SEAS6 (2025)

# Upcoming developments – Convective hazards probabilistic products

Friday 17 May 2024 00 UTC ECMWF ENS T+96-120h  
VT: Tuesday 21 May 2024 00 UTC - Wednesday 22 May 2024 00 UTC  
ARCHAMO Probability of Hail > 2cm in 40 km radius



- Collaboration project with ESSL
- Additive Regression Convective Hazard Models (AR-CHaMo) – ESSL’s statistical model for forecasting convective hazards trained with ERA5, ESWD reports and ATDnet lightning data
- Predictors derived from ECMWF’s ENS used to run AR-CHaMo models
- Resolution: O640 (~18 km)
- Testing during ESSL’s testbed 2024
- Probability of:
  - Hail > 2cm
  - Hail > 5 cm
  - Severe convective wind gusts

# User guide to ECMWF forecast products

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

ECMWF Spaces Calendars Create

Forecast User Guide

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

Pages 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

## How to Find:

Type: "forecast user guide" into google and use the first link !

# Thank you

#UEF2024

#IFS49r1 #newfcsystem @ECMWF