AI Weather Quest ECMWF

Enhancing sub-seasonal predictions with AI/ML: A competition by ECMWF

Quest Launch Webinar

An overview of the new competition, its background, its guidelines and its engagement tools

ECMWF

Destination Earth

WORLD METEOROLOGICAL ORGANIZATION

Agenda

- **Presentations (25 minutes)**
  - ✓ Introduction to the Quest
  - ✓ Background of the competition
  - ✓ Rules, evaluation and resources
  - ✓ Engagement tools
- **Q&A (30 minutes)**

This session is being recorded.
The recording will be made available online after the webinar. If you do not wish to appear, please turn off your camera.

Please mute your microphone.
Please keep yourselves muted during presentations. You are welcome to take the floor or ask questions in the chat during the Q&A.

Special thanks to the Advisory Board for supporting the conception of the competition.

Introduction to the Quest

What is the AI Weather Quest?

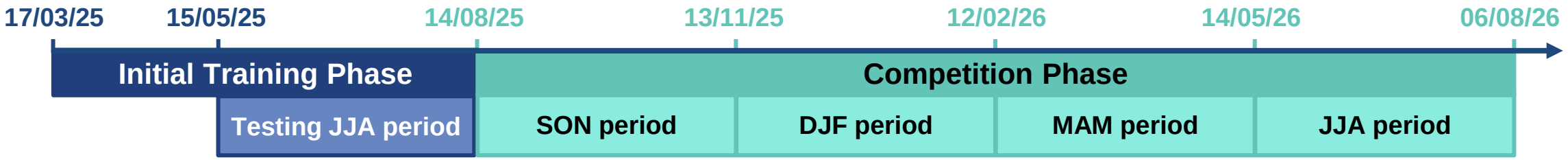
A **global competition,** organised by ECMWF and endorsed by WMO, for the **best-performing AI/ML models for sub-seasonal weather predictions**.

What are the objectives?

Stay on top of AI/ML developments in cutting-edge models.
Create a standardised approach for benchmarking AI/ML models.
Bring together AI/ML experts and climate scientists.

Who is it for?

For **anyone who can leverage AI/ML to improve weather predictions!** Gain **global recognition** for your work, **increase your knowledge** about AI/ML-based forecasting models, and **make connections.**

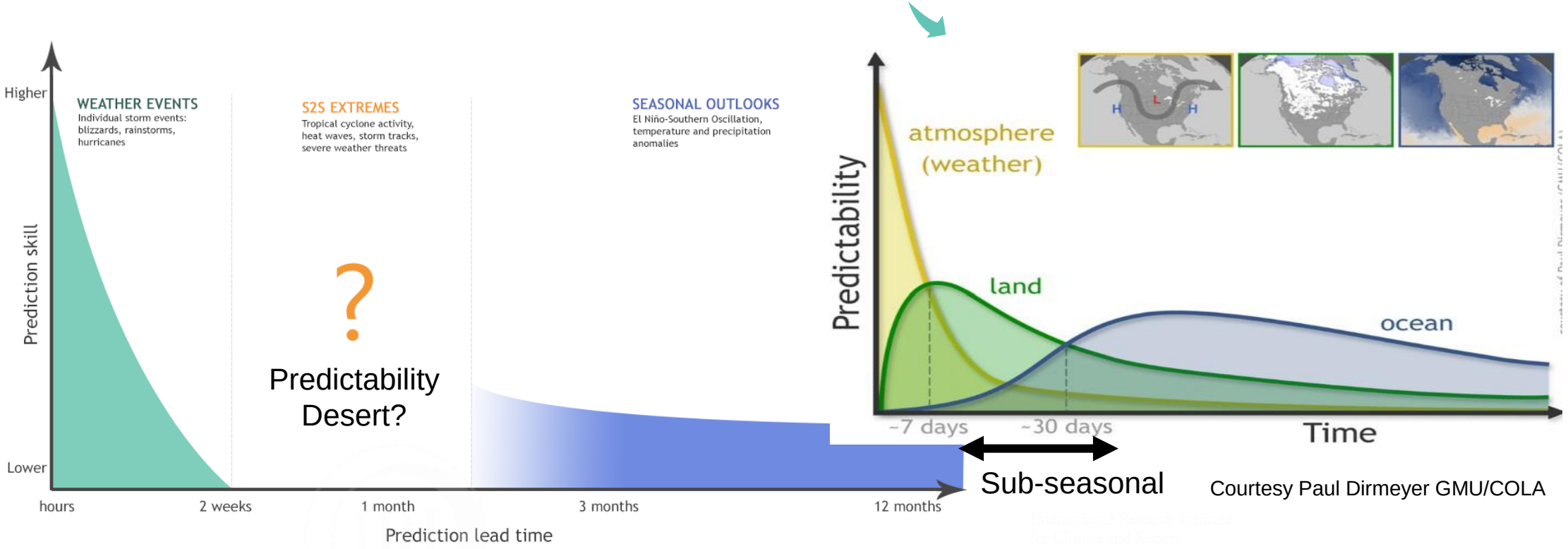


Initial Training Phase: Develop and refine your AI/ML models.
Competition Phase: Submit weekly, real-time forecasts over as many 13-week periods as you choose.

Background of the competition

What is sub-seasonal prediction?

- ✓ Weather prediction beyond two weeks but less than a season = the “gap” between weather and climate forecasts.
- ✓ Important time scale for many applications (e.g. plan reservoir levels for flood control, irrigate and apply nutrients for agriculture, anticipating demand and production of energy).
- ✓ S2S predictability comes mostly from land and ocean, but also from atmospheric initial conditions.

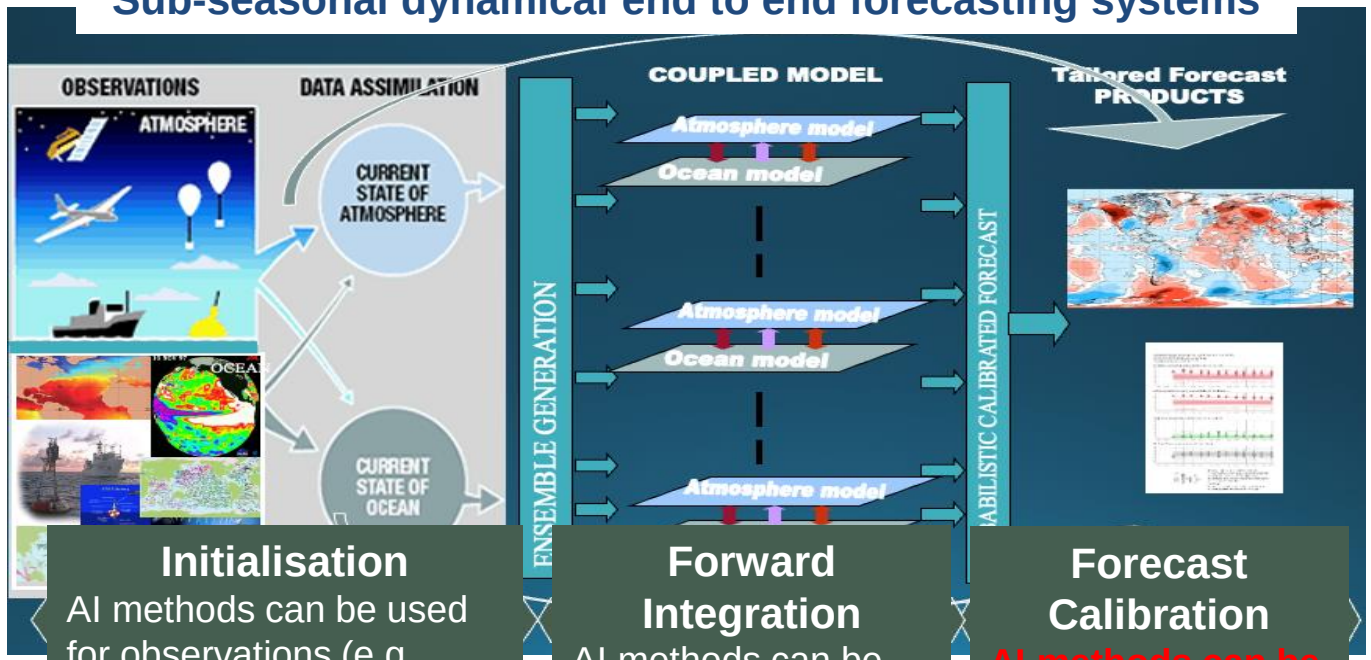


Adapted from: iri.columbia.edu/news/qa-subseasonal-prediction-project

Background of the competition

Use of Artificial Intelligence for improved Sub-seasonal prediction

Sub-seasonal dynamical end to end forecasting systems



Initialisation
AI methods can be used for observations (e.g. black listing of obs.) and data assimilation.

Forward Integration
AI methods can be used for improved model physics parameterization.

Forecast Calibration
AI methods can be used for improved model calibration / product generation

AI methods as alternatives to dynamical models

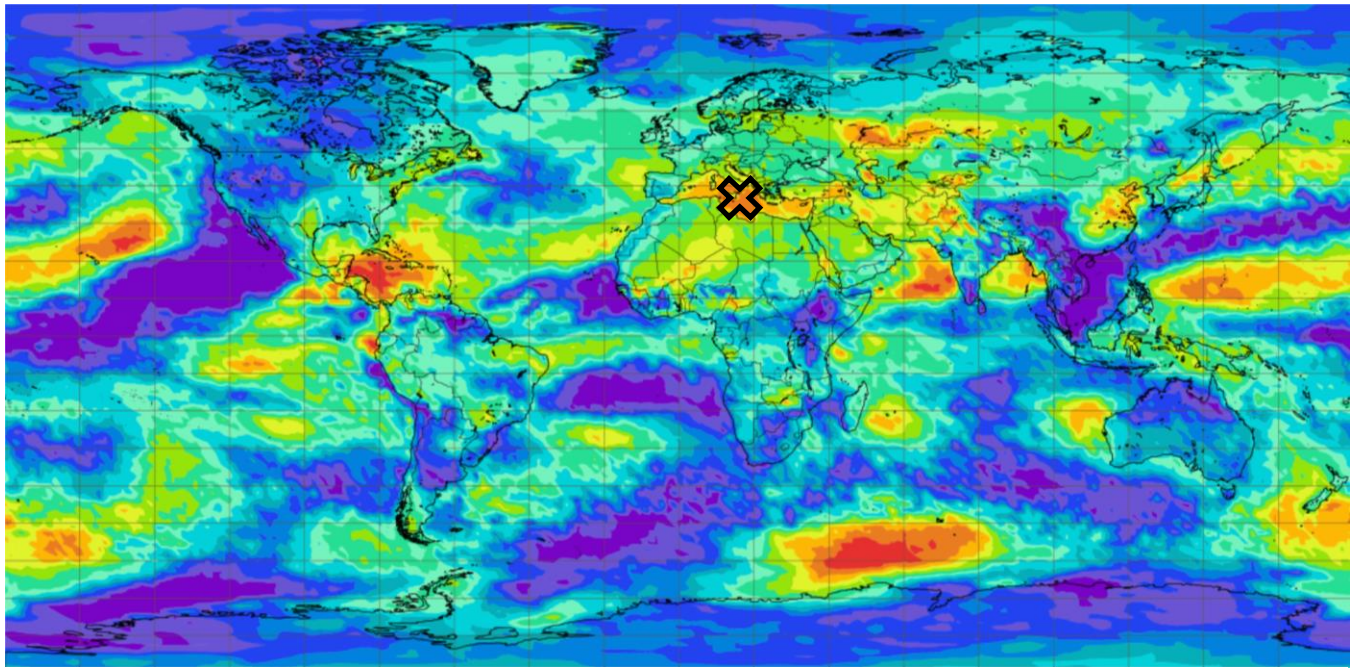
Main questions for the AI Weather Quest

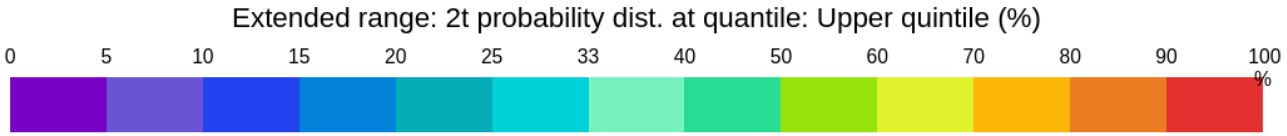
- Can data driven AI methods be a substitute to dynamical models?
- Can AI methods produce better calibration/multi-model combination?

Background of the competition

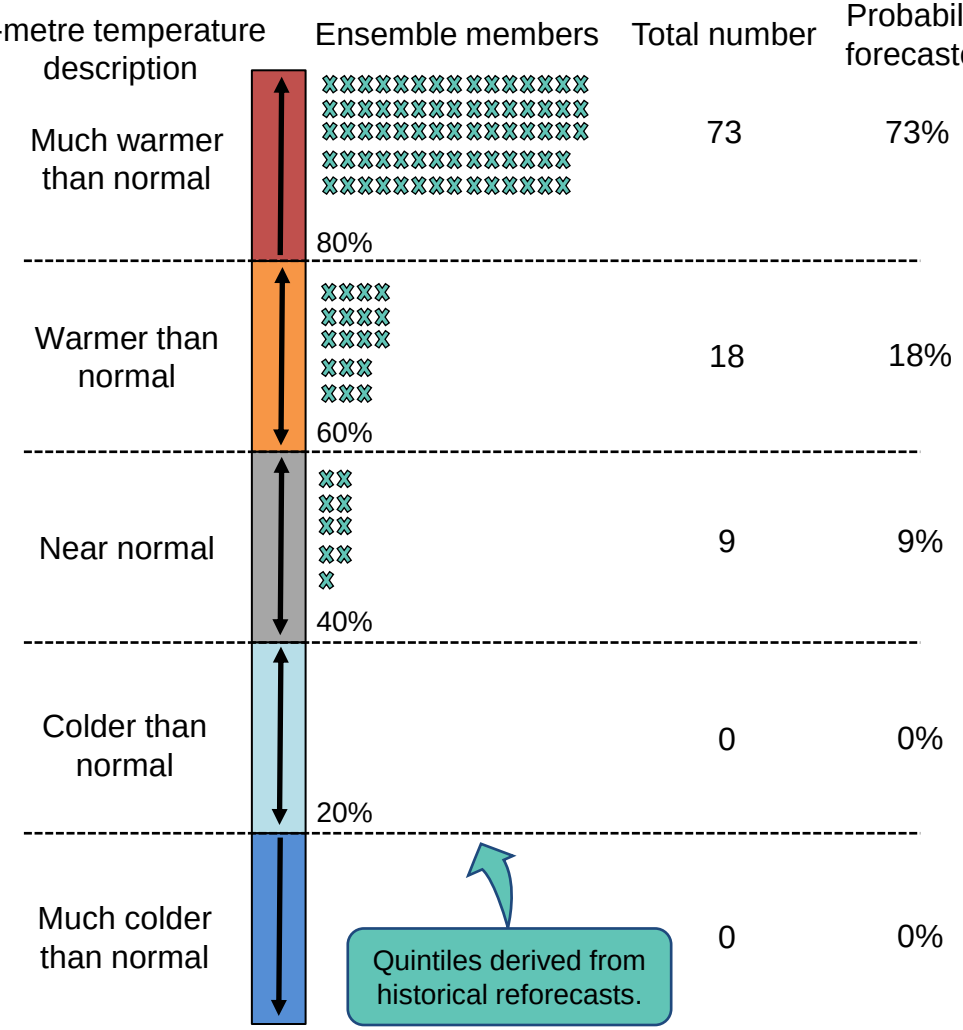
Example of sub-seasonal prediction from ECMWF

Probability of 2-metre temperature being ‘much warmer than normal’ (80-100%) between 24th to 31st March 2025.
Forecast issued on 10th March 2025 (week 3 lead time).





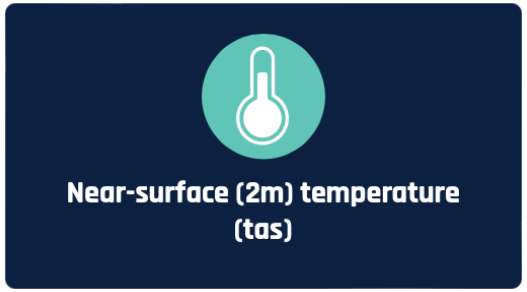
Example for Central Mediterranean



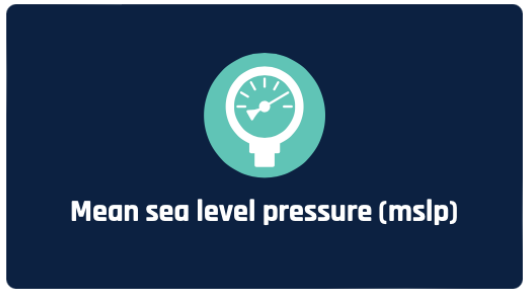
Rules, evaluation and resources

Forecast parameters

Global probabilistic quintile forecasts at a **1.5 latitude/longitude resolution.**



Weekly averages.



Weekly averages.

Weekly accumulations.

Two lead times:
Days 19 to 25
Days 26 to 32

Forecast limit per team

Each team can submit a set of forecasts from **three different AI/ML models**.

Maximum expectations

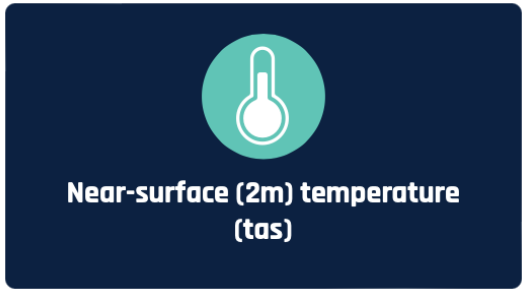
Teams can therefore submit between **1 to 18 forecasts**:
3 models x 3 variables x 2 lead times.

To a submit a forecast, you must be registered to the **AI Weather Quest**!

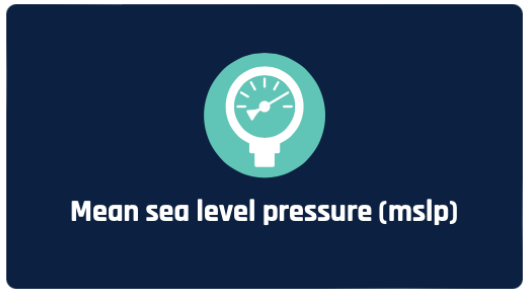
Rules, evaluation and resources

Forecast evaluation

Global probabilistic quintile forecasts at a **1.5 latitude/longitude resolution.**



Weekly averages.
Six-hourly ERA5T.
Land-dominated regions (>= 80%).



Weekly averages.
Six-hourly ERA5T.
Global.

Weekly accumulations.
Hourly ERA5T.
Land-dominated regions (>= 80%).

Two lead times:
Days 19 to 25
Days 26 to 32

Weekly leaderboards

Leaderboards will display:

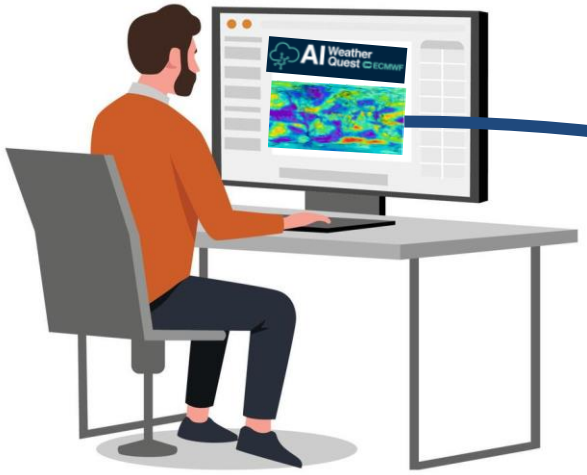
- **Ranked probability skill scores (RPSSs)** associated with the latest forecasts.
- Period-aggregated RPSSs across all previous weeks within the competitive period.

Competition winners

Teams with the top-performing models, determined by the **highest period-aggregated RPSSs**, will be celebrated. The Quest will also spotlight exceptional models.

To be ranked, you must **submit forecasts every week** with a given model across the entire 13-week period and **complete a model questionnaire**.

Rules, evaluation and resources

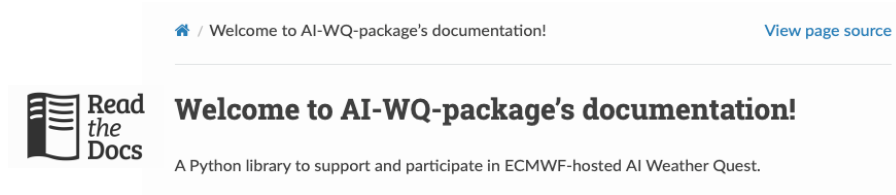


Forecast submission

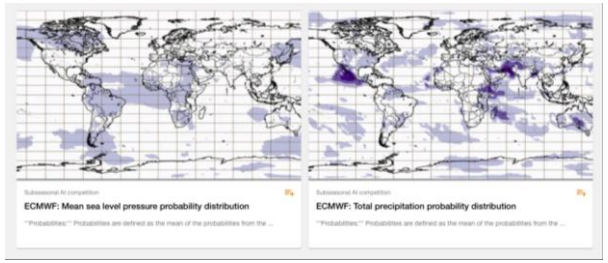
AI-WQ-package 1.0.0

```
pip install AI-WQ-package
```

Designed a **Python-package, AI-WQ-package** to support forecast submission.



On **day 5**, quintile probabilities from all **forecast submissions** will be **viewable online**.



Only data available before the forecast submission window opens should be used!

Week number	Day of week						
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0				1	2	3	4
1	5	6	7	8	9	10	11
2	12	13	14	15	16	17	18
3	19	20	21	22	23	24	25
4	26	27	28	29	30	31	32
5	33	34	35	36	37	38	39
6	40	41	42	43	44	45	46

Legend: Forecast submission window | First forecast period | Second forecast period | Publication of evaluation results

ECMWF

Destination Earth

WORLD METEOROLOGICAL ORGANIZATION

Rules, evaluation and resources

Forecast evaluation

After the two forecasting windows have passed, forecasts will be **evaluated against ERA5T**.

By **Day 37**, the latest ranked probability skill scores (RPSSs) will be published online.

Participants can effortlessly **download recent observations**, including historical quintile boundaries, and **self-assess their own forecasts**.

Historical quintiles derived from past **20 years of ERA5**.

Week number	Day of week						
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0				1	2	3	4
1	5	6	7	8	9	10	11
2	12	13	14	15	16	17	18
3	19	20	21	22	23	24	25
4	26	27	28	29	[illegible]	31	32
5	33	34	35	36	37	38	39
6	40	41	42	43	44	45	46

Legend: Forecast submission window | First forecast period | Second forecast period | Publication of evaluation results

Rules, evaluation and resources

Initial training data

Post-processed historical datasets of:

- Weekly means of ERA5 near-surface temperature and mean sea level pressure.
- Weekly accumulations of ERA5 precipitation.

Potential data sources

- **Initial atmospheric data** available from **ECMWF's Open Data catalogue**.
- **Dynamical sub-seasonal forecast data** available through multiple catalogues including World Weather Research Programme/World Climate Research Programme (WWRP/WCRP) sub-seasonal to seasonal public data portal.

What we are not supporting

- Individual requests for data retrieval and model-development support.
- Access to high-performance computing resources (except for European members leveraging European initiatives).
- Development of bespoke sub-seasonal forecast products.

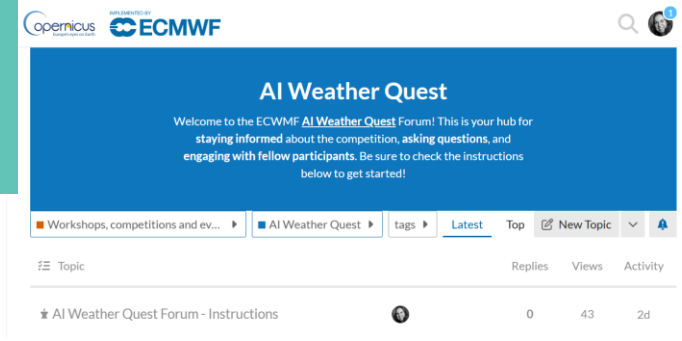
You can use **any observational or forecast dataset** to train your AI/ML forecast model.

The AI Weather Quest offers a unique opportunity to:

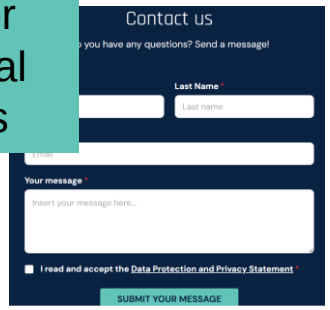
- **Benchmark cutting-edge advancements** in AI/ML forecasting on sub-seasonal timescales.
- Unite a community of experts leading the **future of forecast development**.
- Share state-of-the-art ML/AI sub-seasonal forecasts with a **diverse range of users**.

Engagement tools

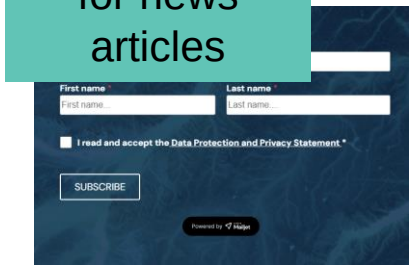
A **forum** for announcements, general inquiries and discussions



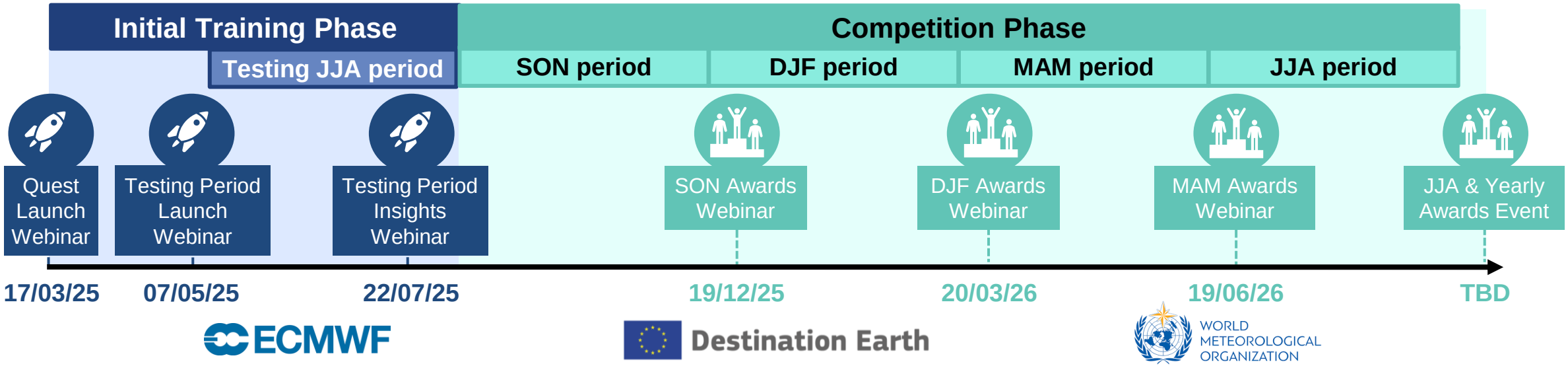
A **contact form** for individual matters



A **newsletter** for news articles



Regular **webinars** throughout the competition to ask your questions and spotlight your results



ECMWF

Destination Earth

WORLD METEOROLOGICAL ORGANIZATION

Q&A

Feel free to ask your questions!

- *Raise your hand to speak*
- *Type your questions in the chat*

Thanks!

To everyone involved in the organisation of the AI Weather Quest.

See you for the next webinar!

The Testing Period Launch webinar will take place on May 7th 2025.

Additional slide: Evaluation

Weekly Ranked Probability Skill Score (RPSS)

Every week we will compute the RPSS associated with the latest set of forecasts.

$$RPSS = 1 - \frac{RPS}{RPS_{clim}} \; where \; RPS = \sum_{k=1}^{K}(Y_k - O_k)^2 \; and \; RPS_{clim} = \sum_{k=1}^{K}(P_k - O_k)^2$$

In addition, we will compute period-aggregated RPSSs through comparing ranked probability scores (RPS) at every temporal and spatial point.

$$\mathrm{RPSS}^*(F) = 1 - \frac{\frac{1}{T}\frac{1}{L}\sum_{\ell=1}^{L}\sum_{t=1}^{T}\mathrm{RPS}(F_{\ell,t}, y_{\ell,t})}{\frac{1}{T}\frac{1}{L}\sum_{\ell=1}^{L}\sum_{t=1}^{T}\mathrm{RPS}(F_{\ell,t}^{\mathrm{clim}}, y_{\ell,t})},$$

We will not solely take an average of weekly RPSSs as this does guarantee the best comparison between observations and forecasts.

Currently the AI WQ Python Package only enables you to compute single weekly RPSSs.