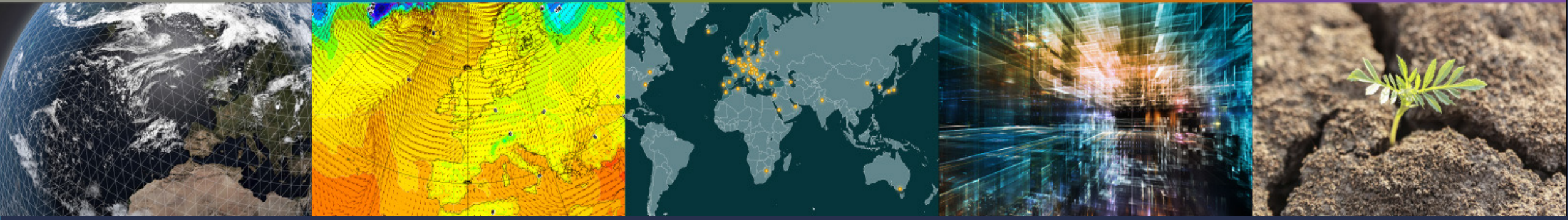
ECMWF research and products in support to coastal resilience

Andrea Montani
(andrea.montani@ecmwf.int)

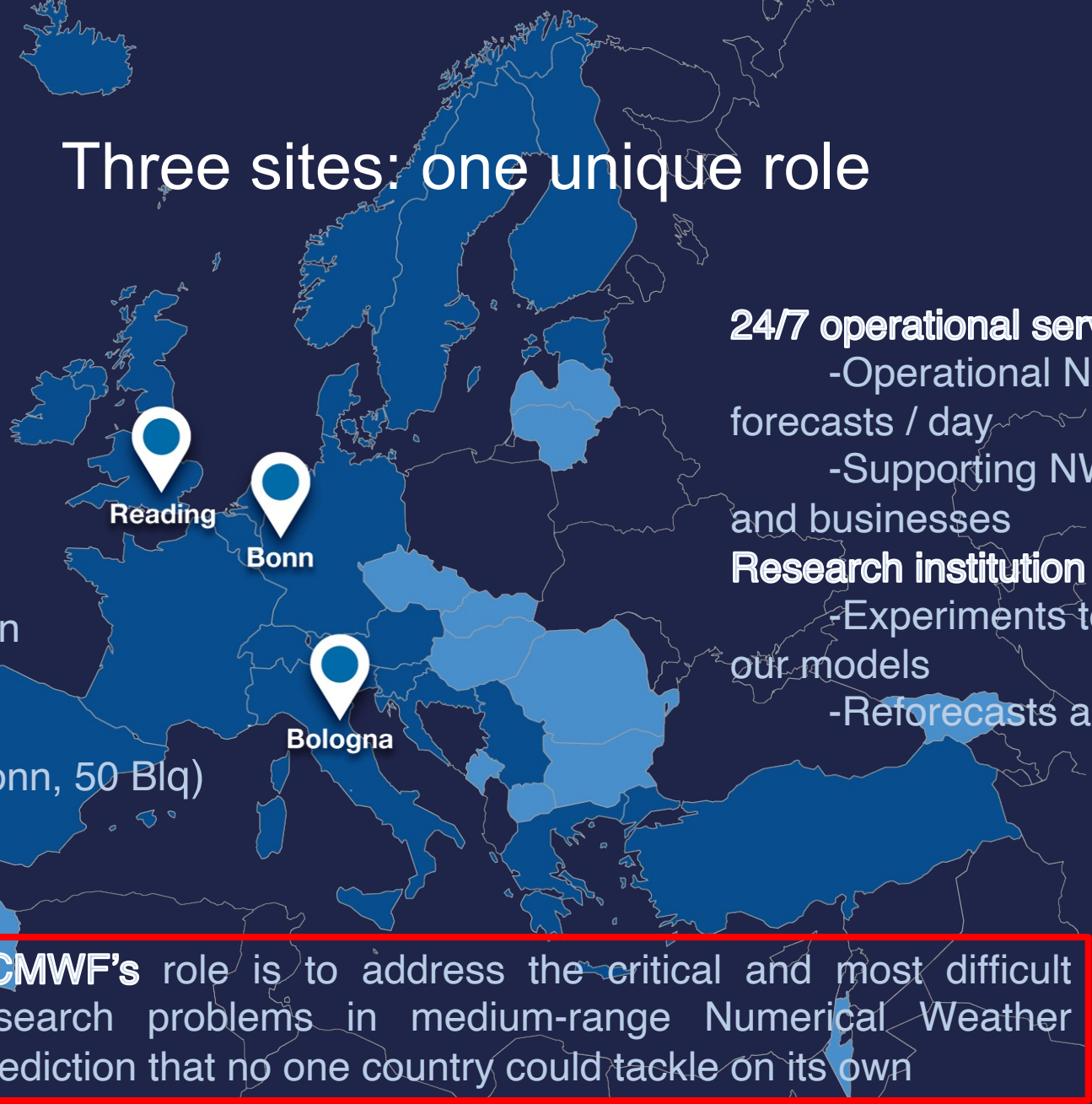
Workshop ''Sharing best practices in the sustainable management of coastal environments'' – 12 December 2023



Who are we? What do we do?

ECMWF: European Centre for Medium-range Weather Forecasts

Three sites: one unique role



ECMWF was established in 1975

- Intergovernmental Organisation
- 23 Member States
- 12 Cooperating States
- > 450 staff + (250 Rdg, 150 Bonn, 50 Blq)

24/7 operational service

-Operational NWP - 4x HRES+ENS forecasts / day

-Supporting NWS (coupled models) and businesses

Research institution

-Experiments to continuously improve our models

-Reforecasts and Climate Reanalysis

ECMWF's role is to address the critical and most difficult research problems in medium-range Numerical Weather Prediction that no one country could tackle on its own

Collaboration with the EU

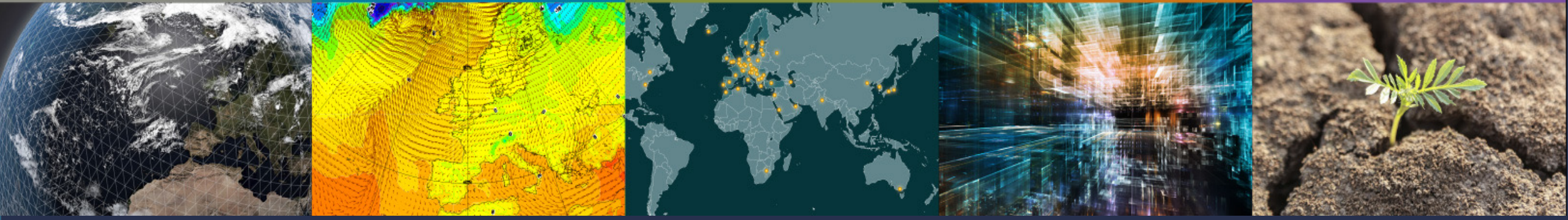
PROGRAMME OF THE EUROPEAN UNION

Copernicus
Europe's eyes on Earth

IMPLEMENTED BY ECMWF

- *Entrusted entities of the EU initiative DestinE*
- *Develop and operate the 1st two high priority twins*
  - *Extreme Digital Twin*
    - *To support decision making for real-time response to extreme events*
  - *Climate Adaptation Digital Twin*
    - *To support efforts of defining and planning activities linked to climate change adaptation*

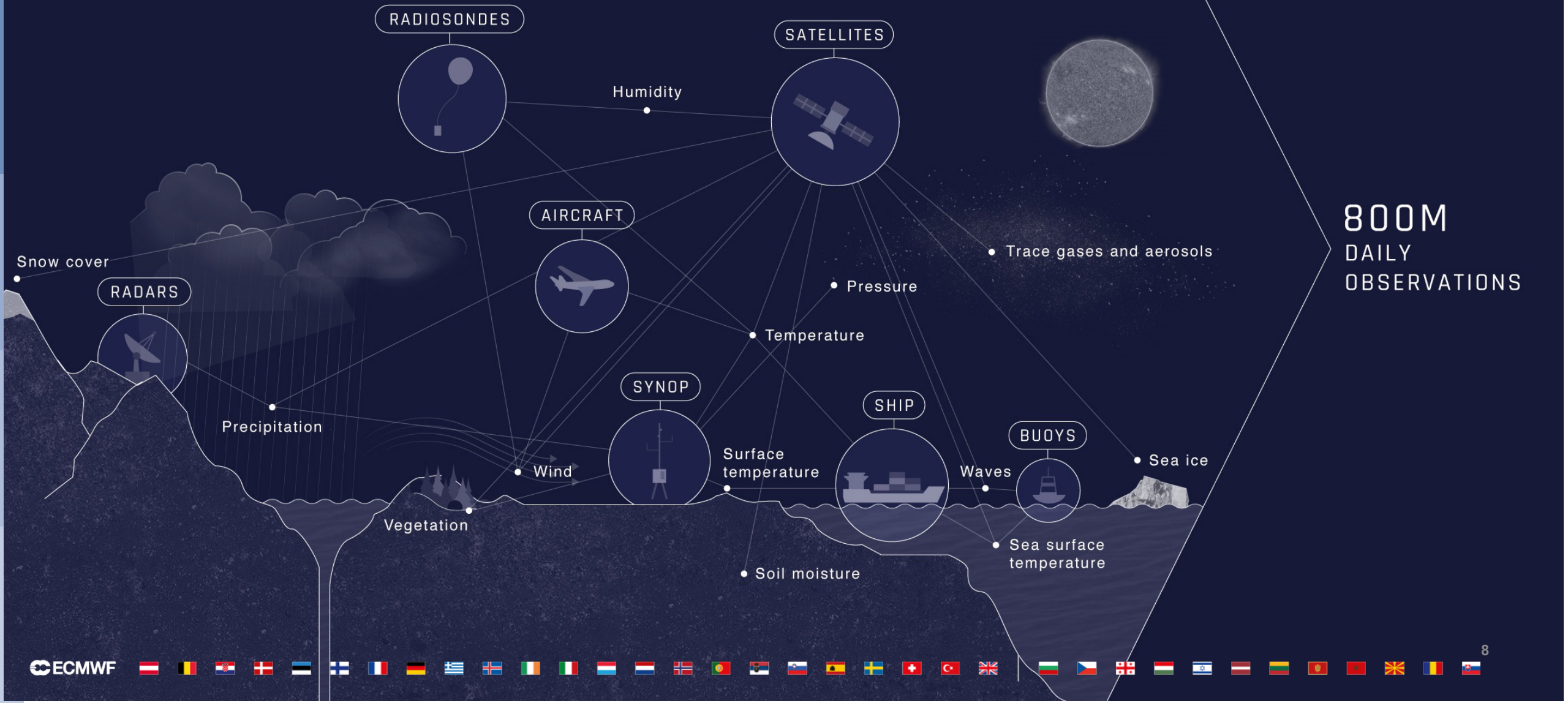
- *Operating the Copernicus Climate Change (C3S) and Atmosphere Monitoring (CAMS) Services*
- *contributing EFAS and FIRE to the Copernicus Emergency Management Service,*
- *Building CAMS emission services (co2+…)*



How do we do it?

CAPTURING THE WEATHER

To predict the future, we observe the present. Every day, we absorb 800 million observations to create a detailed snapshot of Earth's weather.



Numerical Weather Prediction Workflow

800M observations /day

Data acquisition

80M observations /day

Pre-processing

Forecast model run

Product generation

HPC

Service users

EWC-System users

Internet
Leased lines
RMDCN

Public CSP

Data dissemination

Web Services

Cloud infrastructure

Storage

Archive

Data Handing system

Frontend

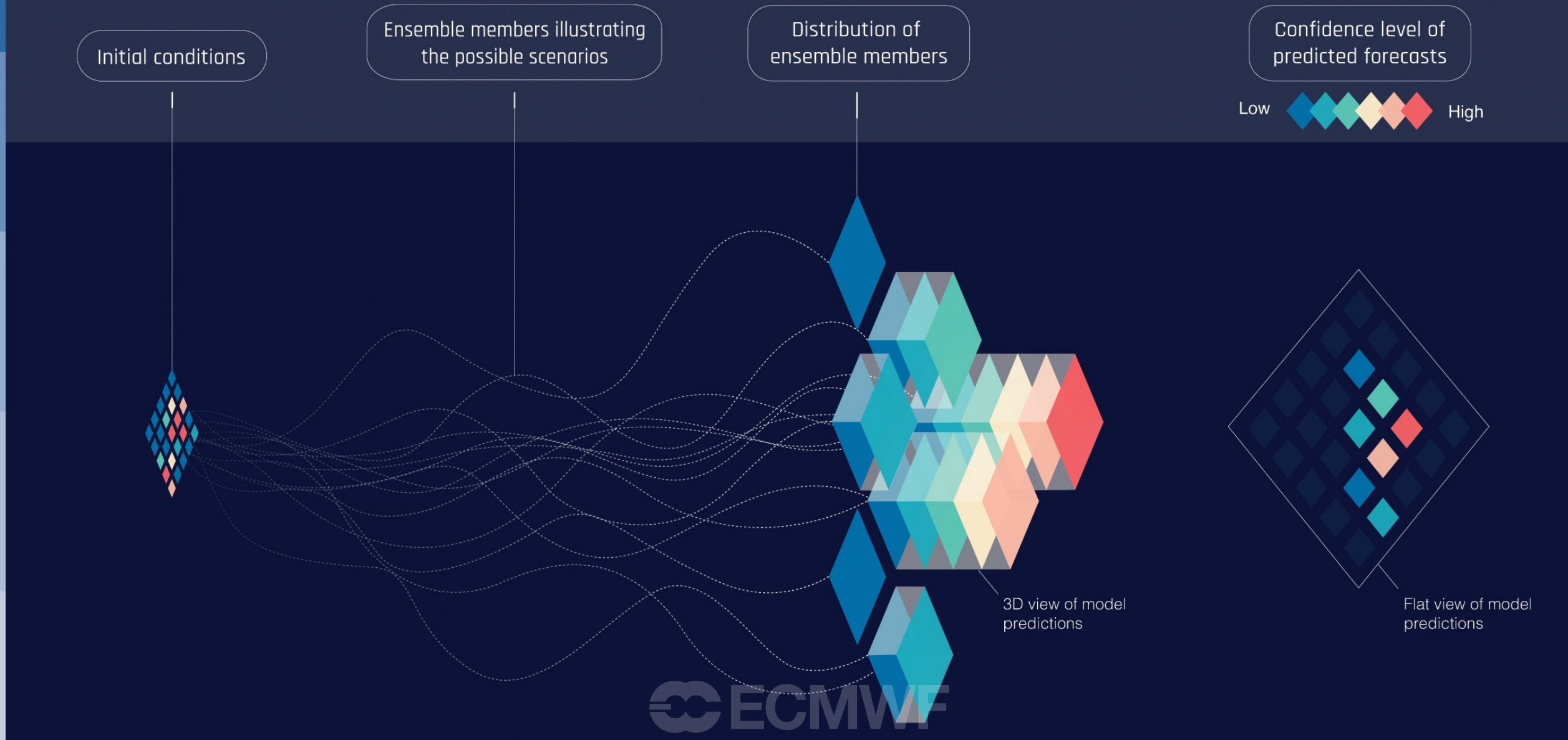
Backend

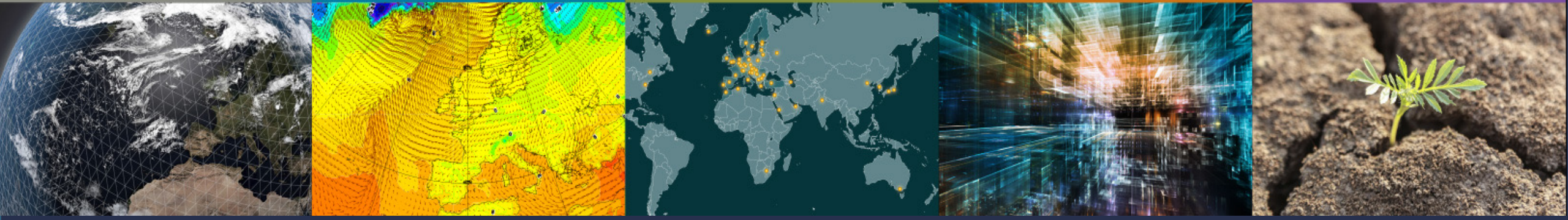
Applications

European Weather Cloud

ECMWF

ECMWF ENSEMBLE PREDICTION



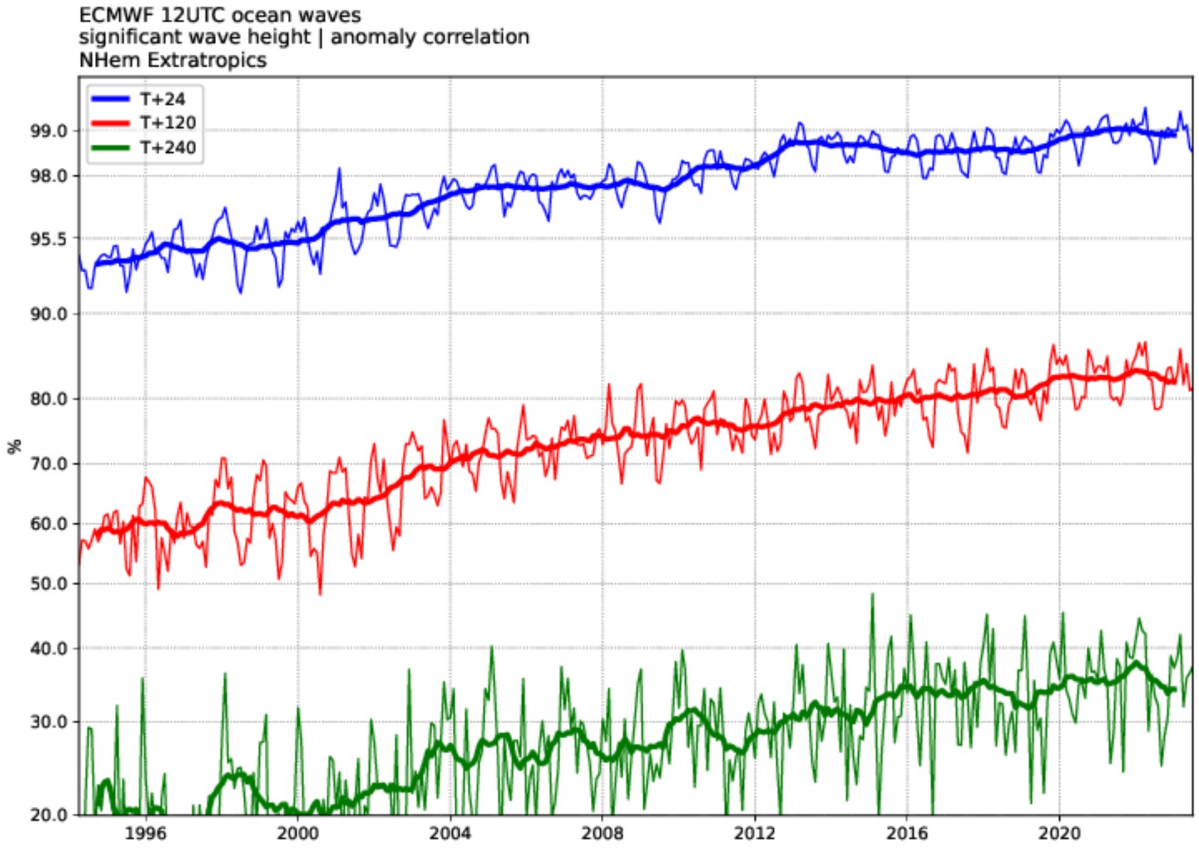


What do we do to support coastal resilience?

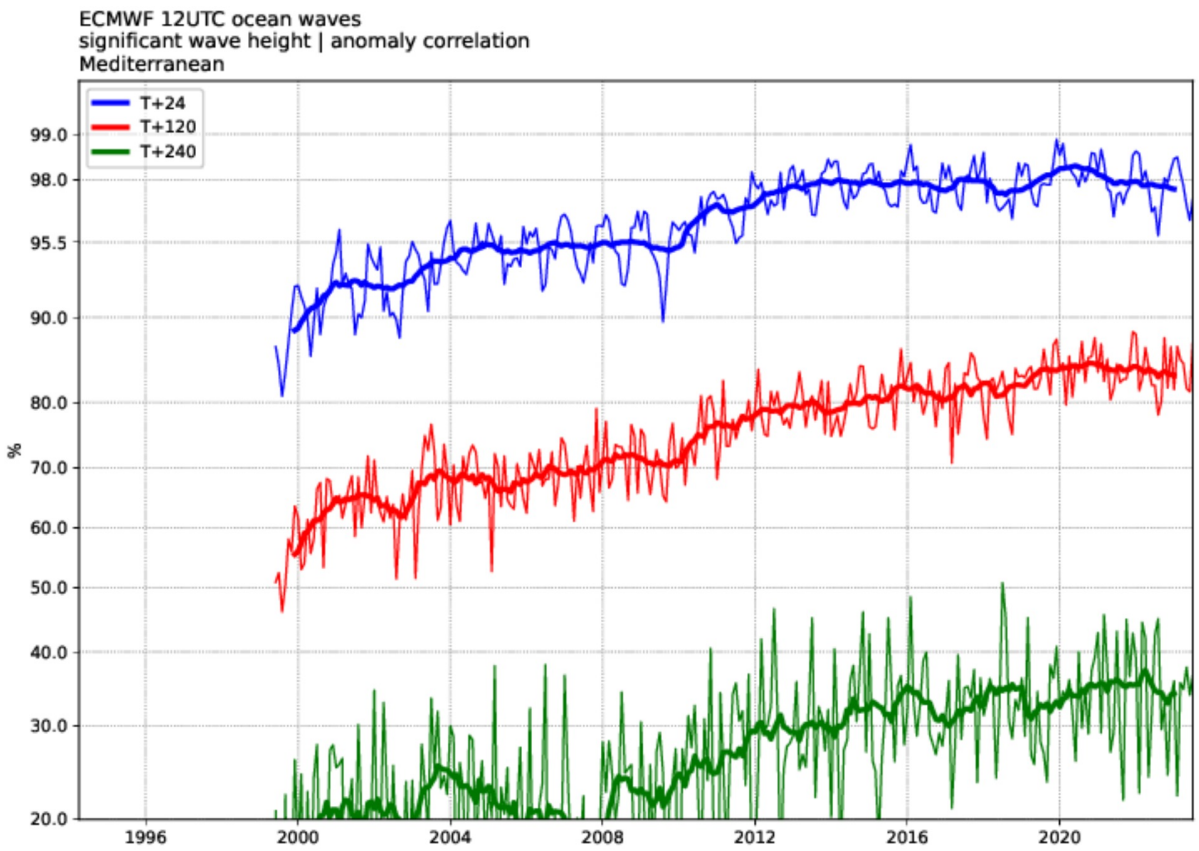
- Provisioning of WAM model at 14 km (deterministic) and 28 km (ensemble mode) - in 2024, upgrade of the model
- **Monitoring of the skill of WAM model**
- **In the framework of Destination Earth, tests of high-resolution atmospheric model coupled with WAM**
- **More and more products freely available under https://charts.ecmwf.int**

Monitoring of the skill

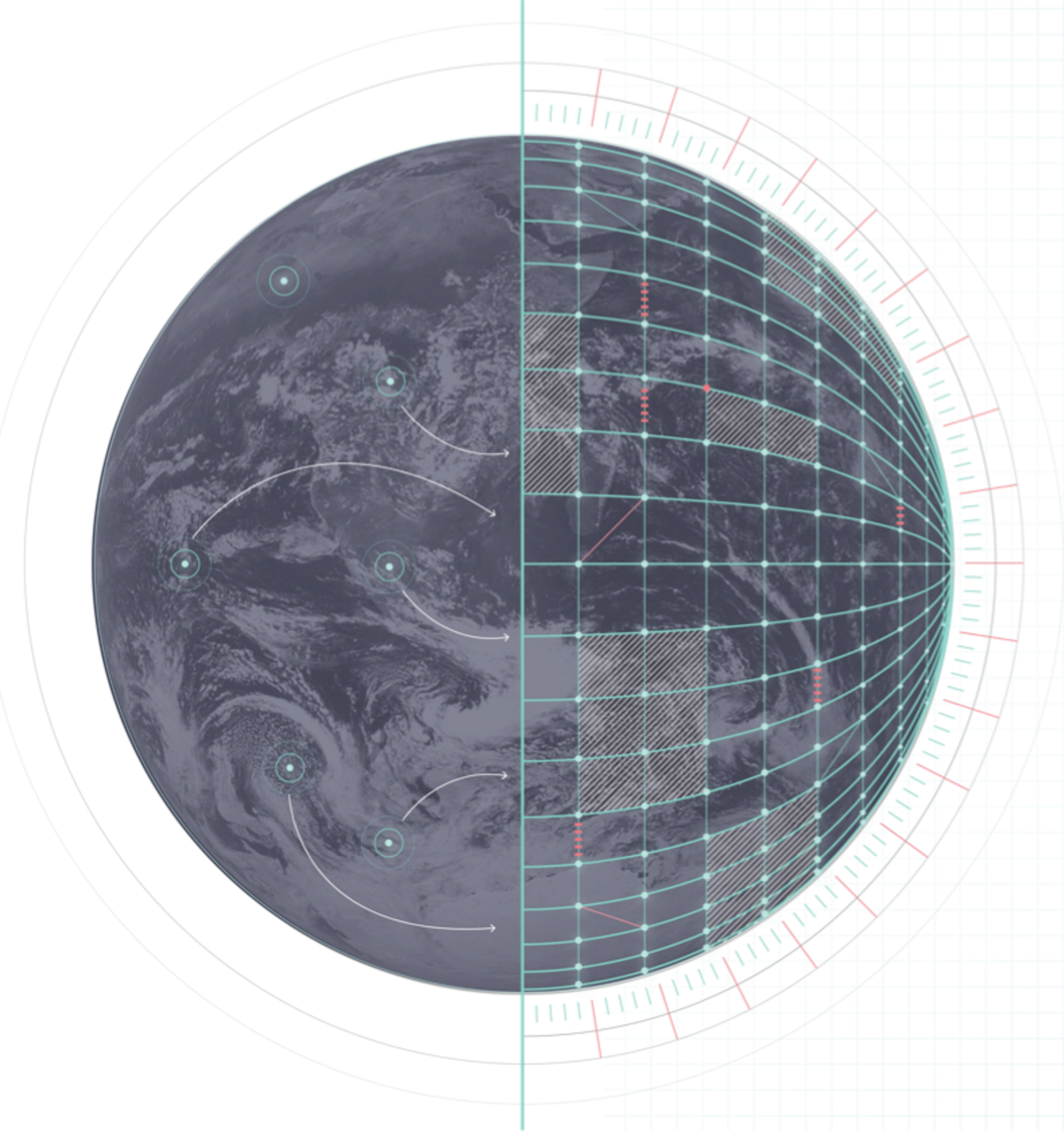
Area: 30-90N



Area: Mediterranean



thin lines: the monthly mean
thick lines: 12-month mean centred on each month



DESTINATION EARTH

ECMWF activities towards the development of a Digital Twin of the Earth

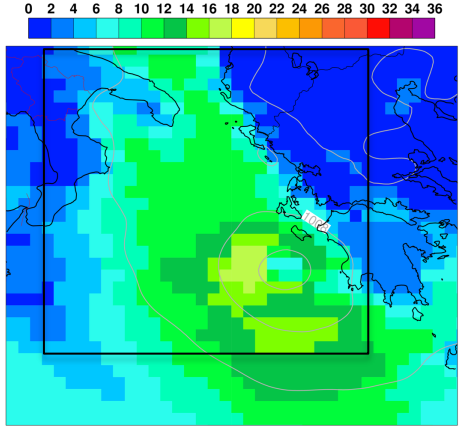
Funded by the European Union

ECMWF

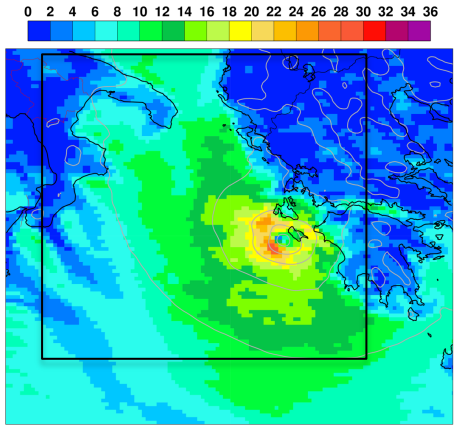
Tests of high-resolution atmospheric model coupled with WAM

Catalogue of extreme cases #2 : Medicane Ianos (17 Sep 2020)

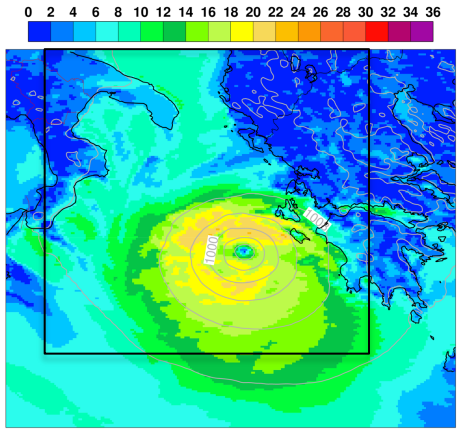
mslp and 10m wind



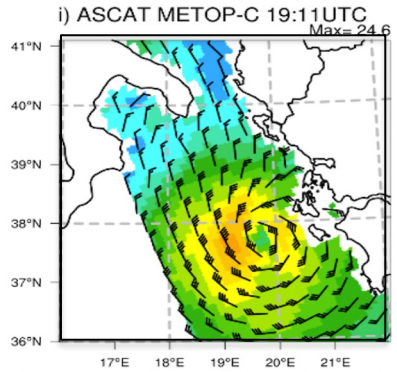
IFS 48r1 29 km



IFS 48r1 9 km



IFS 48r1 4.5 km



Observations (ASCAT)
Prat et al. (2021)

fcst: 20200915 00 UTC T+66h

E. Gascon & J. Kousal

More and more wave products freely available under https://charts.ecmwf.int

Home / Significant wave height and mean direction

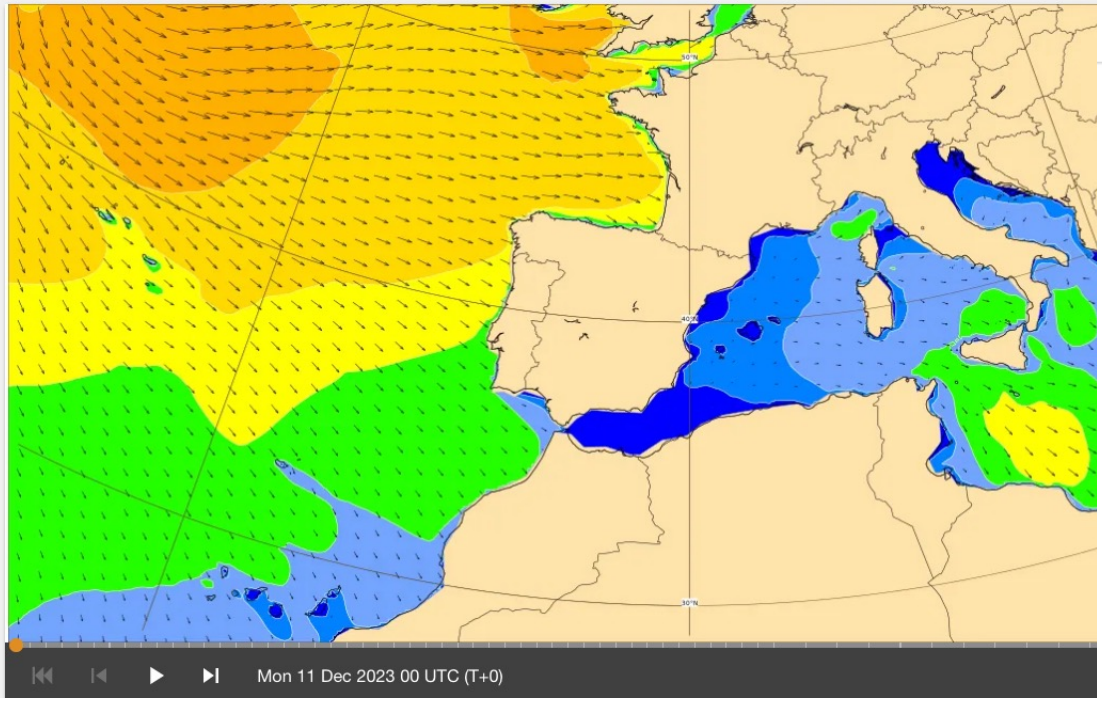
Significant wave height and mean direction

High resolution forecast

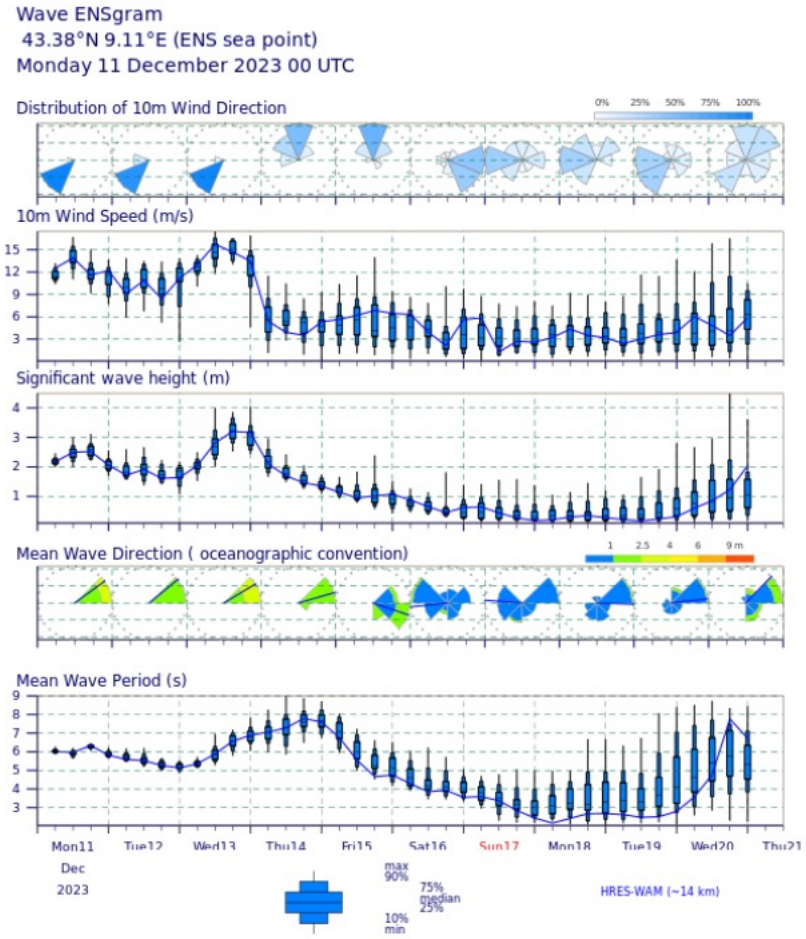
Base time
Mon 11 Dec 2023 00 UTC

Valid time
Mon 11 Dec 2023 00 UTC (T+0)

Area
South West Europe



ENS METEOGRAMS



Aritificial Intelligence to support coastal resilience

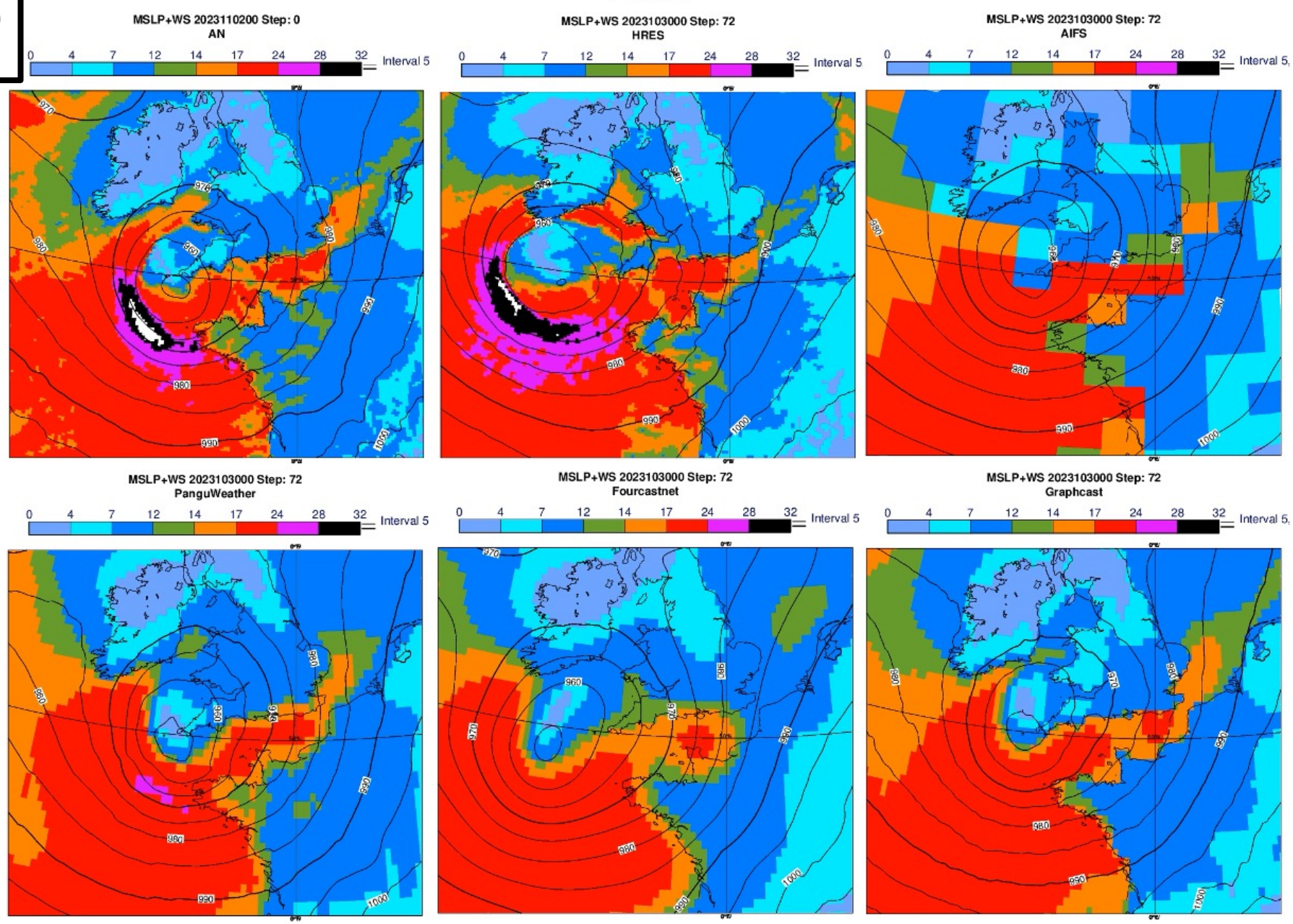
- 20 new colleagues working on AI
- We run twice a day (starting at 00 and 12UTC) the following:
  - AIFS (ECMWF) ML model
  - Nvidia ML model
  - Google ML model
  - Huawei ML model
- All models are trained with ECMWF re-analysis (ERA5, 0.25 deg).
- AIFS algorithm is being tested at the moment and AIFS is run at 1 deg of resolution.
- The others AI models are run at 0.25 deg.
- Surface winds and mean-sea-level pressure fields are available, not yet ocean waves.

Ciara storm (Nov 2023): non-AI and AI models

truth	non-AI (ECWMF)	AIFS (ECMWF)
Pangu-Weather	FourCastNet	GraphCast

mean-sea-level-pressure
10m wind-speed

T+72h



ECMWF EUROPEAN CENT

Grazie per l’attenzione!