DESTINATION EARTH AND AI CAPACITY FOR PREPAREDNESS

Tiago Quintino, ECMWF

On behalf of ECMWF & 100 partner organisations

EuroHPC Joint Undertaking

Funded by the European Union

Destination Earth implemented by ECMWF esa EUMETSAT

W ECMWF?

Established in 1975, Intergovernmental Organisation

- 23 Member States | 12 Cooperating States
- 500+ staff

24/7 operational service

- Operational NWP – 4x forecasts / day [00z, 06z, 12z, 18z]
- Supporting NWS (coupled models) and businesses

Research institution

- Experiments to continuously improve our models
- Reforecasts and Climate Reanalysis

Destination Earth

- Operates the DestinE Digital Twin Engine (DTE)
- Operates 2 Digital Twins
  - Extreme Weather
  - Climate Change

Operate 2 EU Copernicus Services

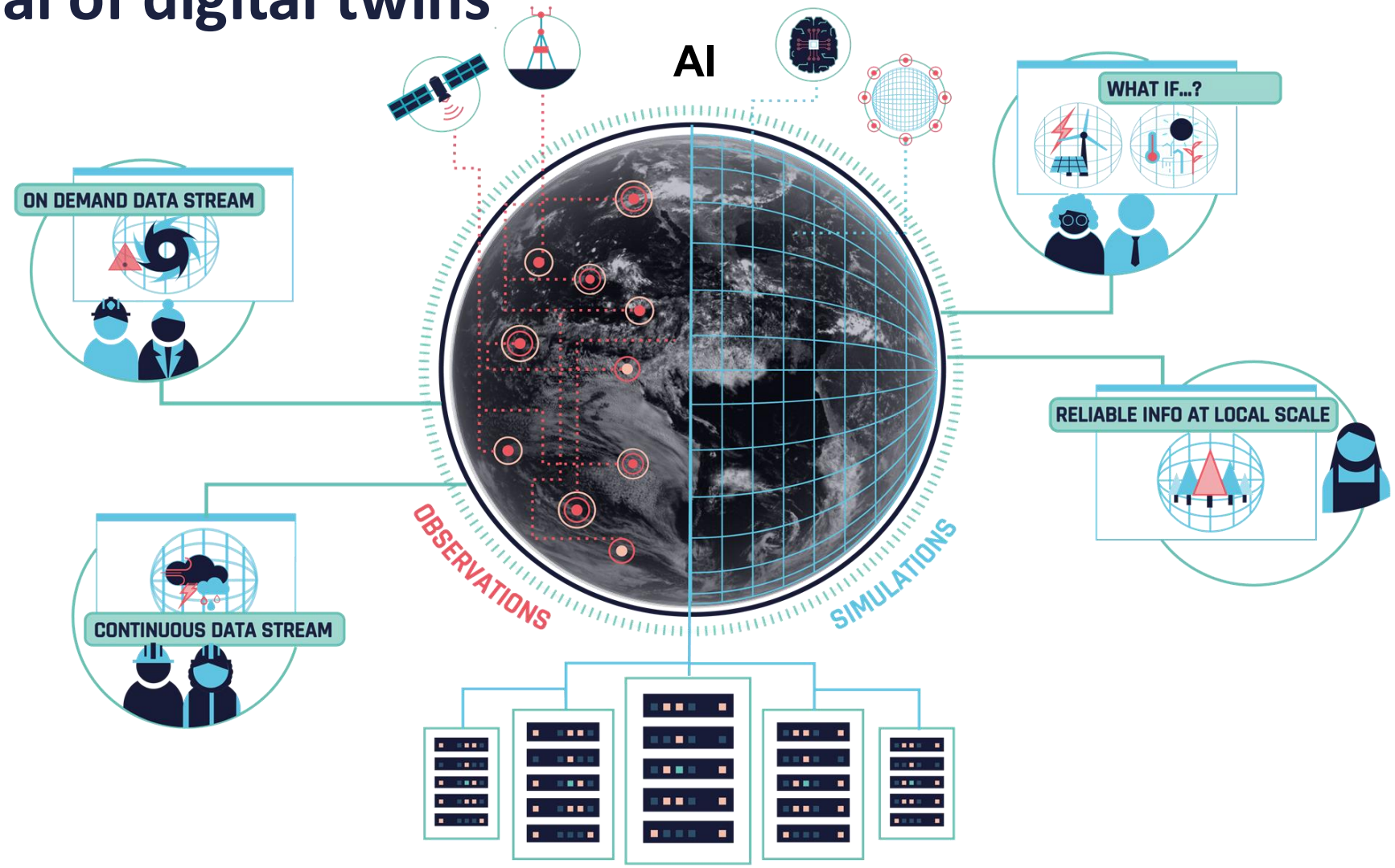
- Climate Change Service (C3S)
- Atmosphere Monitoring Service (CAMS)
- Support Copernicus Emergency Management Service CEMS

Reading, GB

Bonn, DE

Bologna, IT

The potential of digital twins



Digital twins for exploring plausible what if questions

WEATHER-INDUCED EXTREMES DIGITAL TWIN

A few days ahead

What specific adaption measure can limit the consequences of recent and future events?

CLIMATE CHANGE ADAPTATION DIGITAL TWIN

Multi-decadal timescales

How will different scenarios change droughts and heatwaves ? How will this impact European food production?

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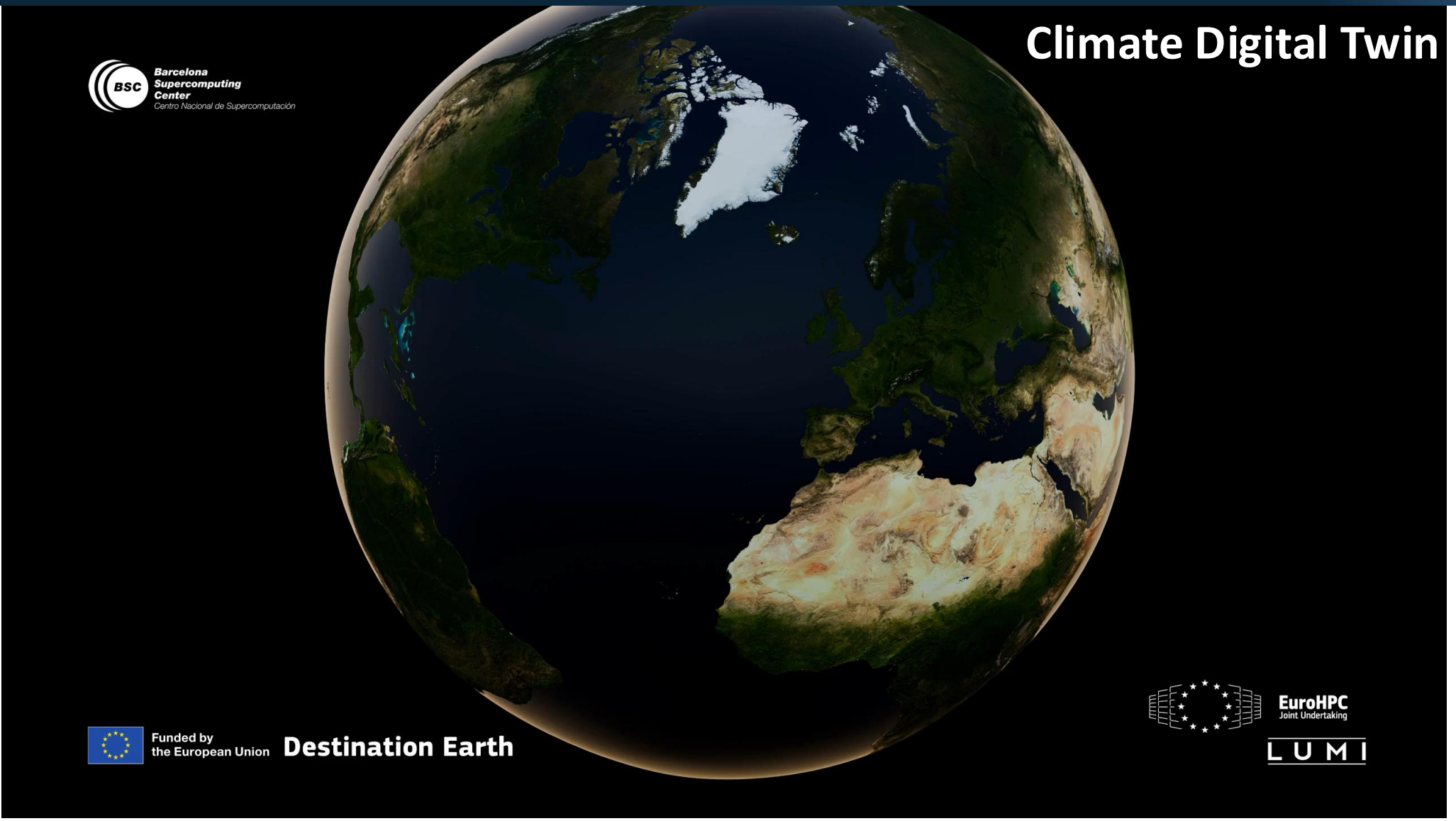
Climate Digital Twin



Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Funded by the European Union **Destination Earth**

EuroHPC Joint Undertaking
LUMI

HPCwire 2024 READERS' CHOICE AWARDS
Top HPC-Enabled Scientific Achievement

HPCwire 2024 READERS' CHOICE AWARDS
Best Use of HPC in Physical Sciences

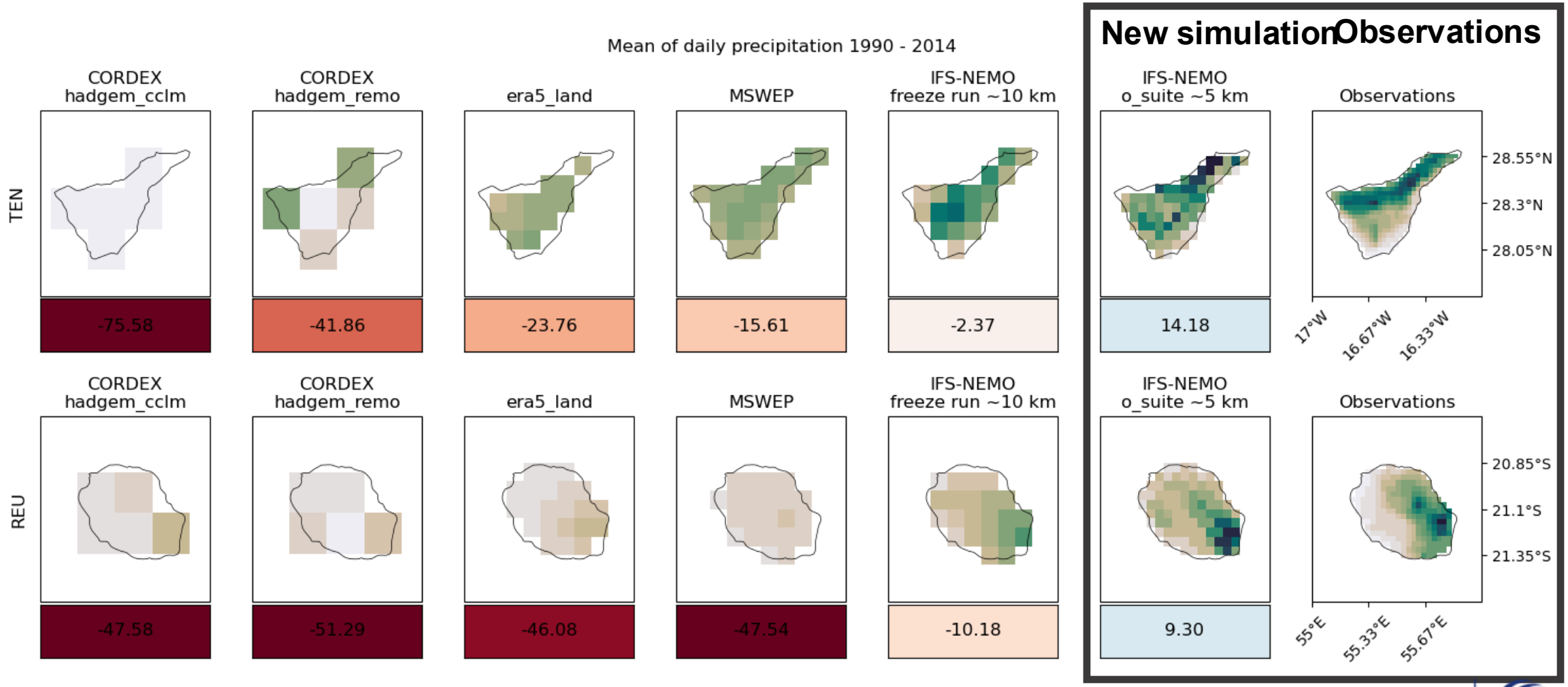
CSC

ECMWF

Finalist for Gordon Bell prize for climate modelling

Climate Digital Twin

Aims to towards operationalize an end-to-end framework producing bespoke climate information



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EXTREME DT

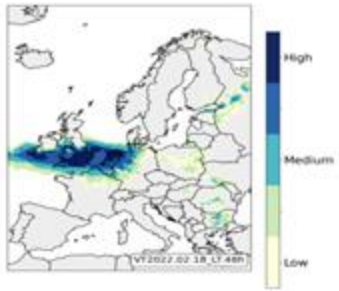
Aims to operationalize an end-to-end framework producing bespoke extremes information

Global simulations

IFS-NEMO

- Run daily
- 4 days
- 4.4 km

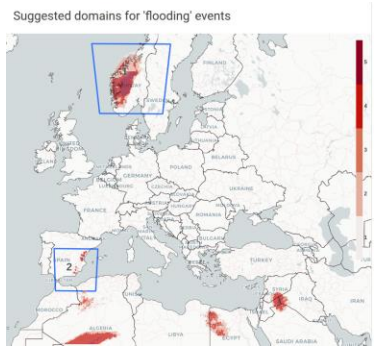
Detection/Configuration



IFS ensemble (9km)

- Detection of extremes
- Wind, precipitation, CAPE, surge…

Regional simulations



ALARO, AROME, HARMONIE-AROME

- Run in real-time for hundreds of cases
- Flexible domain
- 2 days
- 750-500m

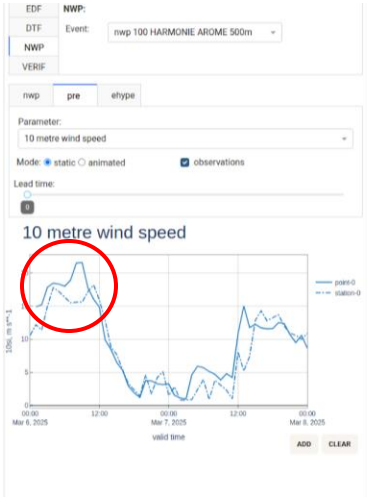
Impact sector models

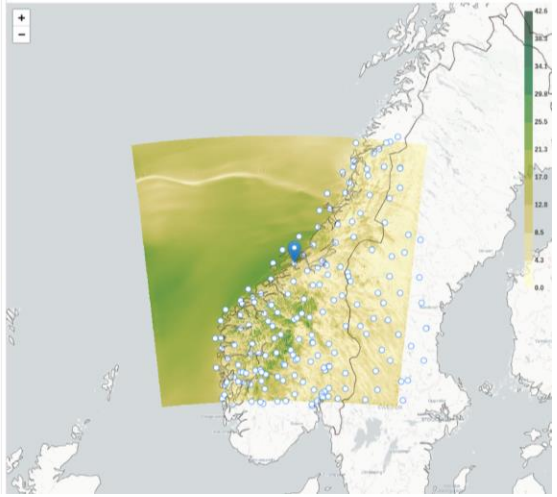
- Floods, renewable energy, air quality, storm surge, thermal comfort, fire
- User-relevant information

SUB-KM SCALE INFORMATION COMPLEMENTS EXISTING PREDICTION SYSTEMS

Supporting events

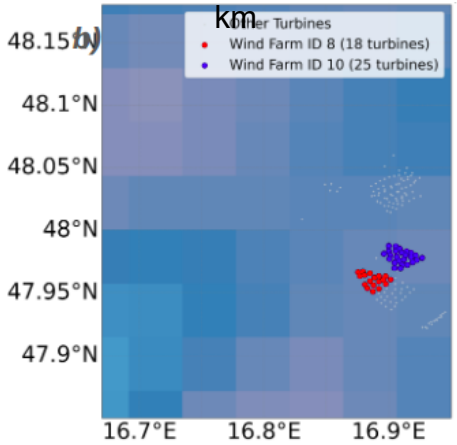
FIS Nordic World Ski Championships 2025

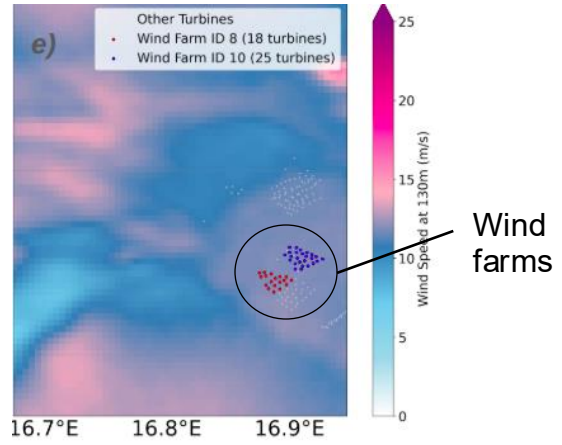




Wind energy

Wind energy production in Austria

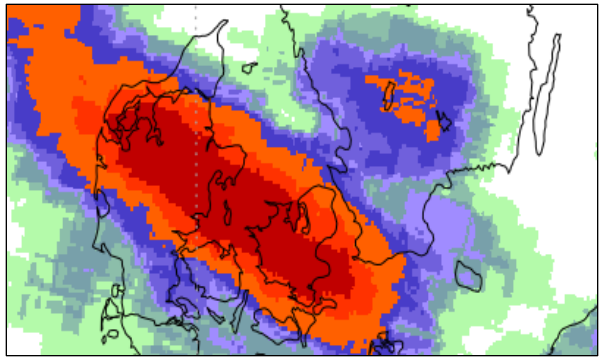




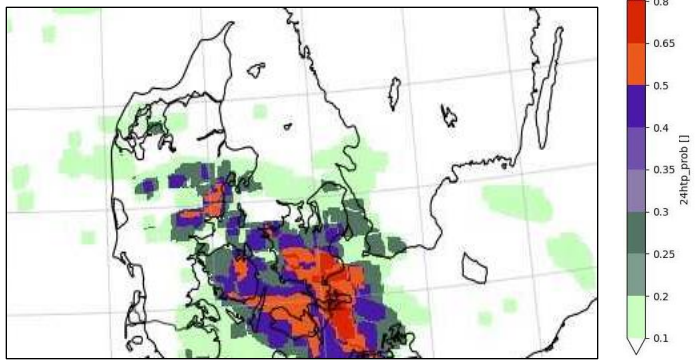
Likelihood of extremes

Probability of exceedance of 50 mm/day over 24h in the ensemble forecast (6 members)

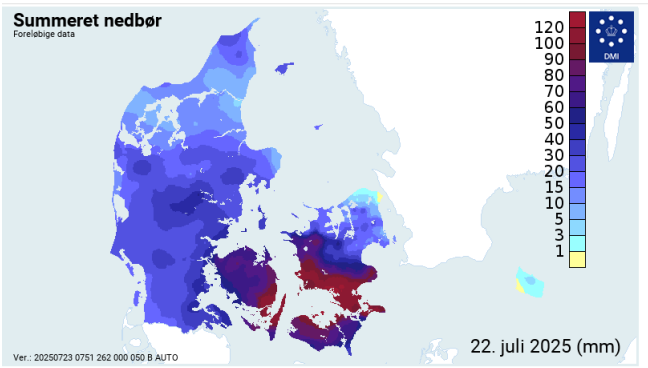
Harmonie-Arome 2 km



Harmonie-Arome 750 m

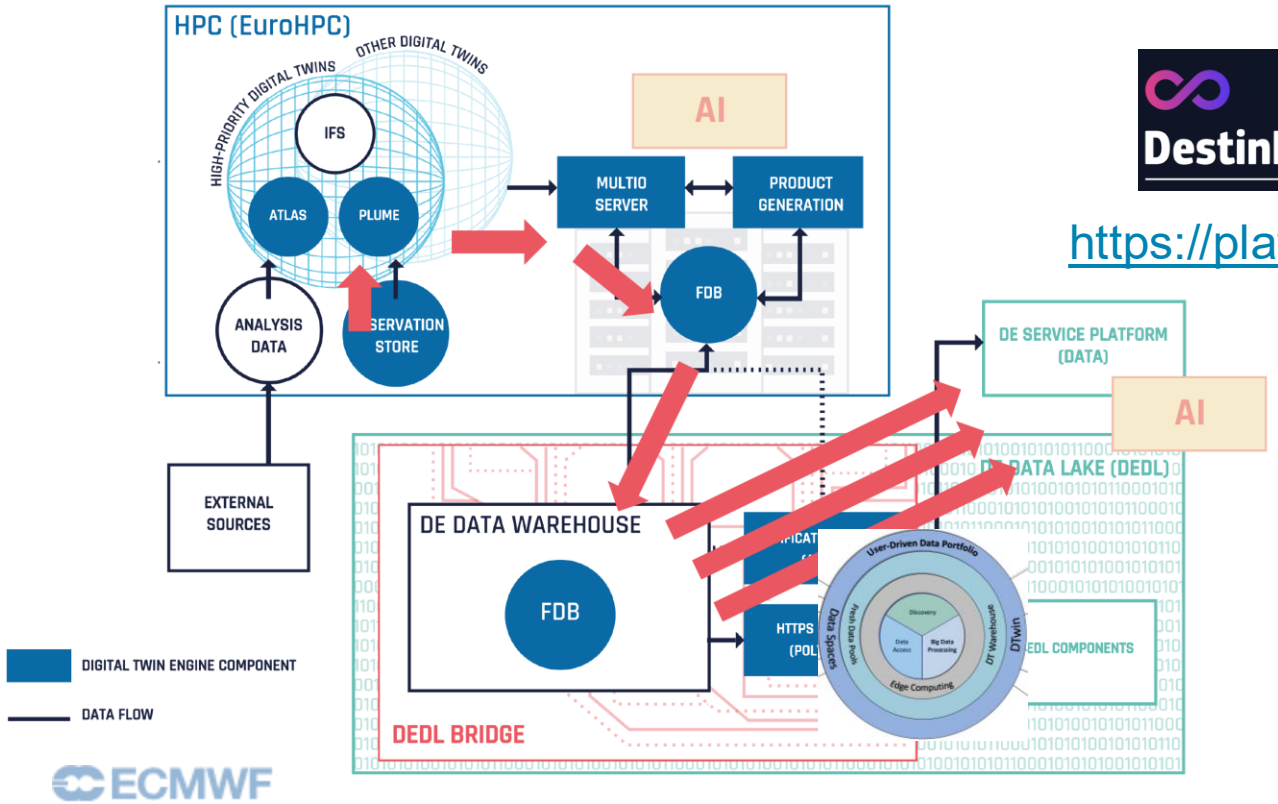


Observations



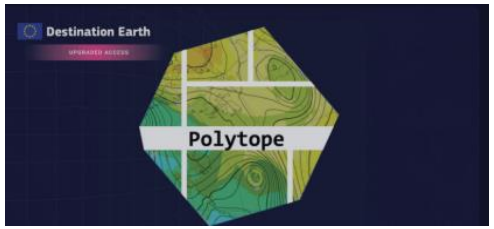
Digital Twin Engine

Routinely used to operate complex Earth-system and impact-sector workflows on EuroHPC, and provide software solutions and services for accessing, handling and interacting with the digital twins data on distributed infrastructures



DestinE Platform

https://platform.destine.eu/

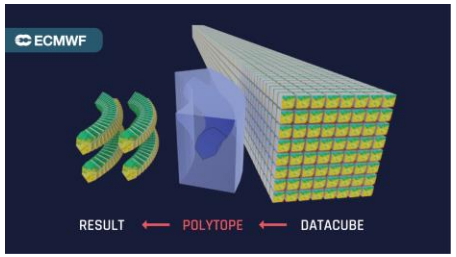


WMO WIS2.0 compatible data access

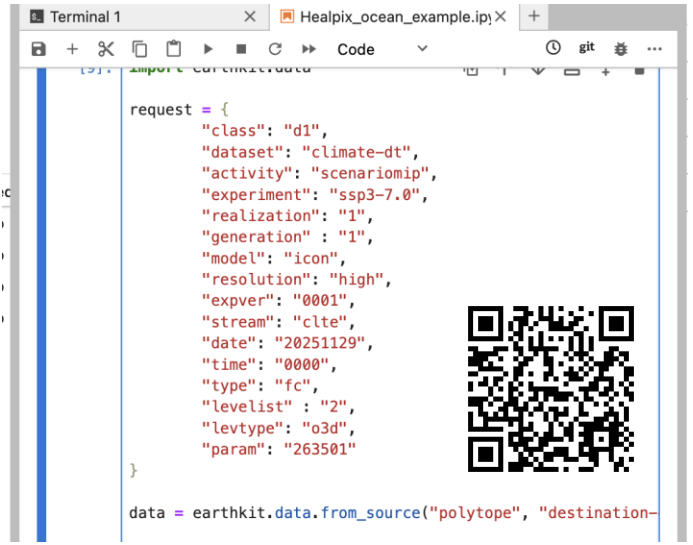
https://pygeoapi.io/

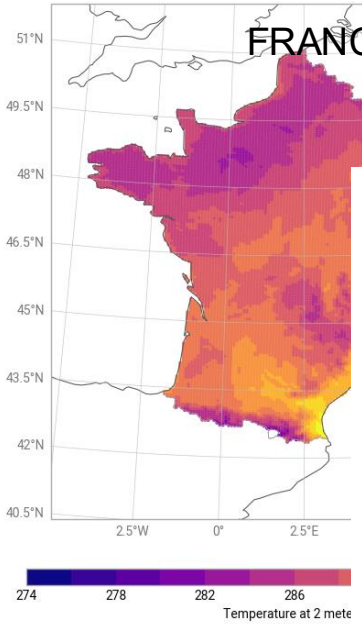
https://polytope-client.readthedocs.io/en/latest/

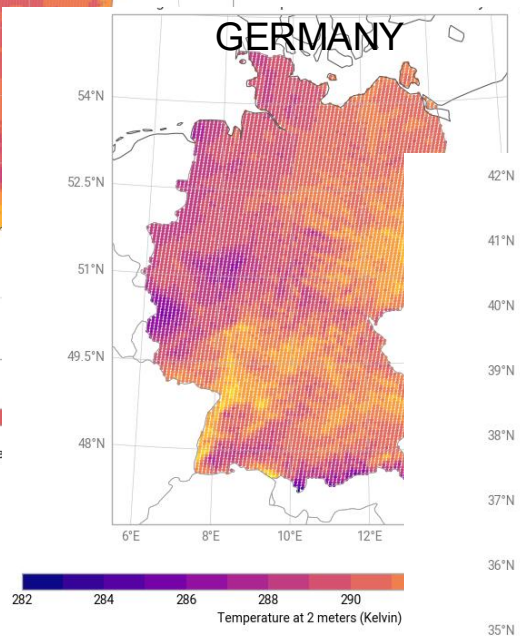
Interoperable Semantic Data Access

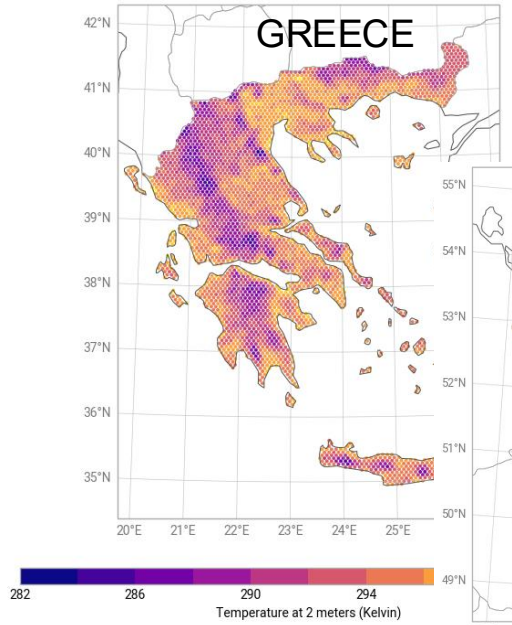


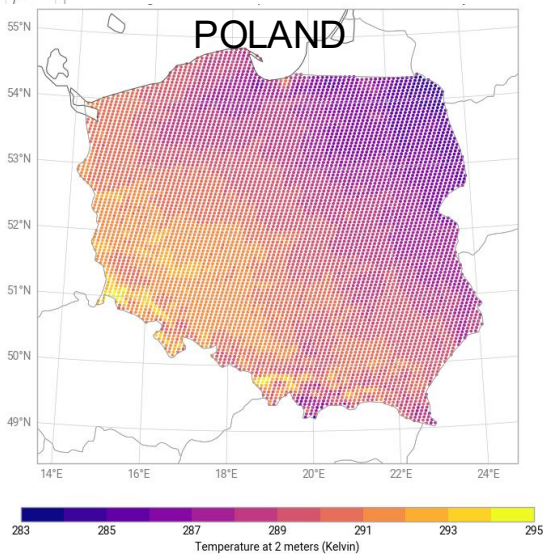
Polytope - service









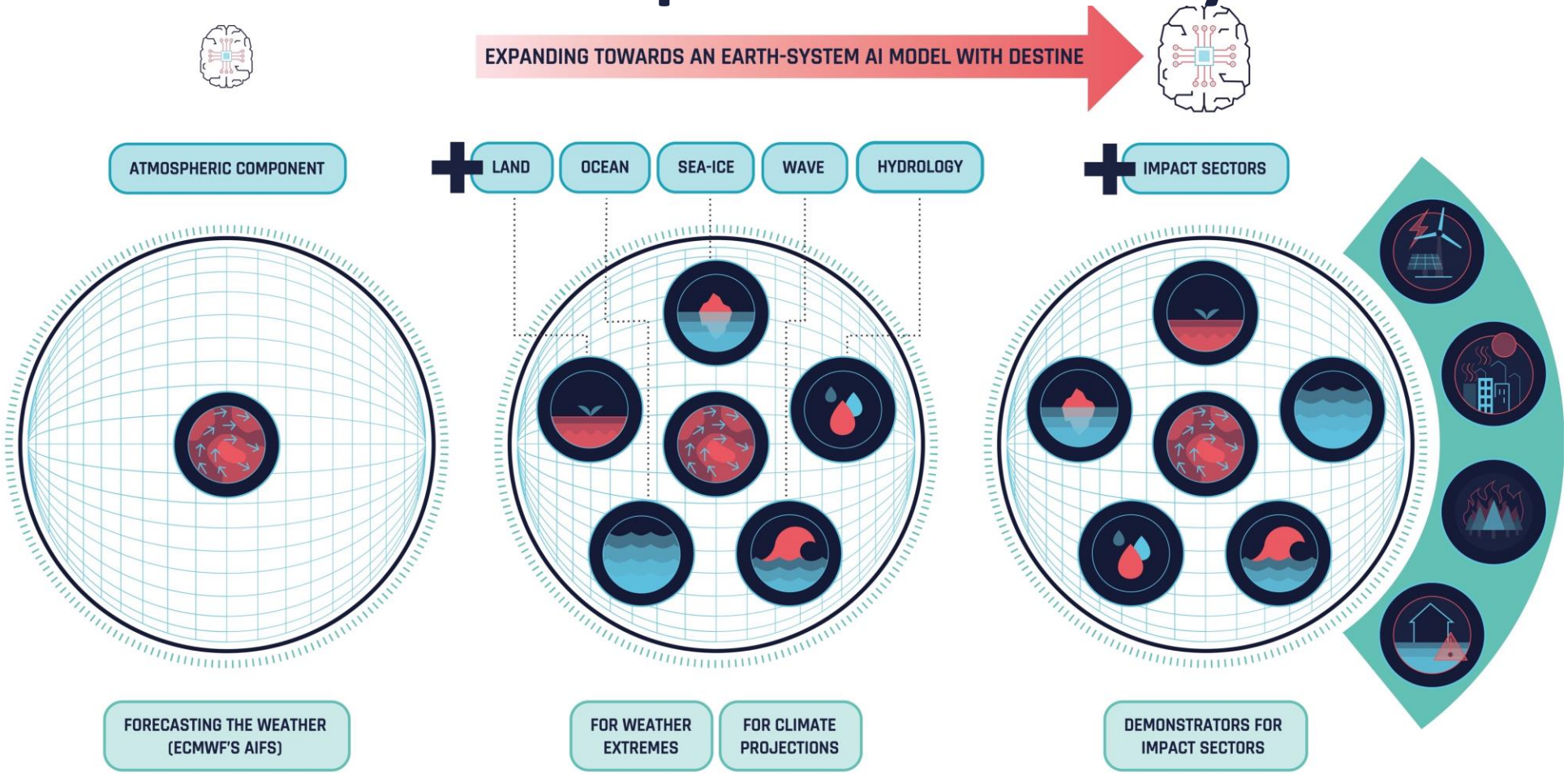


Swagger API; STAC catalogue; OGC/FAIR/INSPIRE compliant interfaces, AI-ready datasets, “truly harmonized” data access, hierarchical access, etc…

ECMWF

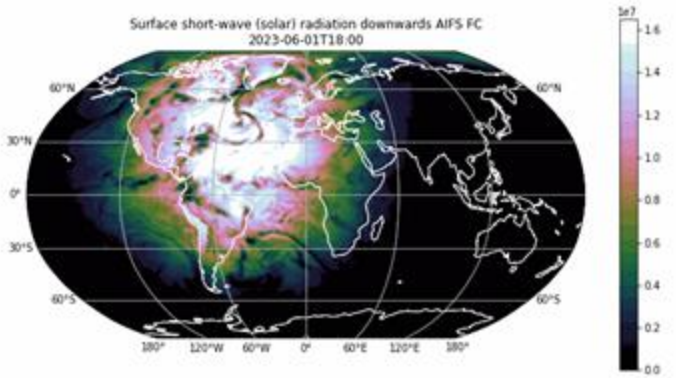
Examples:
https://github.com/destination-earth-digital-twins/polytope-examples

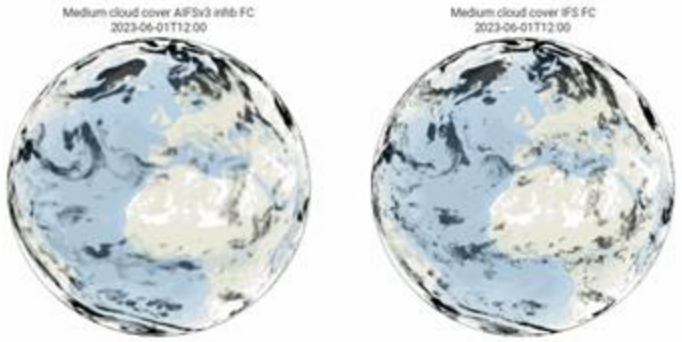
DestinE: toward a European AI earth system model



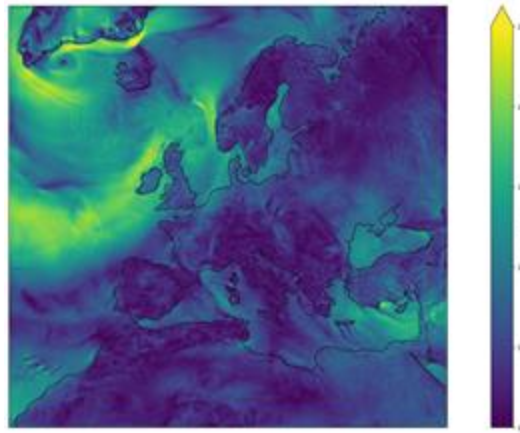
Anemoi: numerous operational AI applications in weather & climate

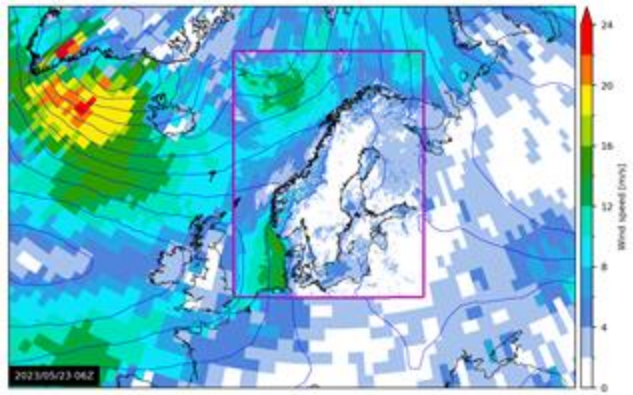
Global



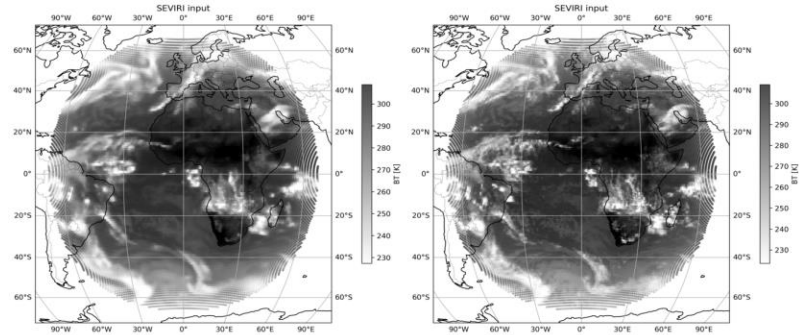


Limited area





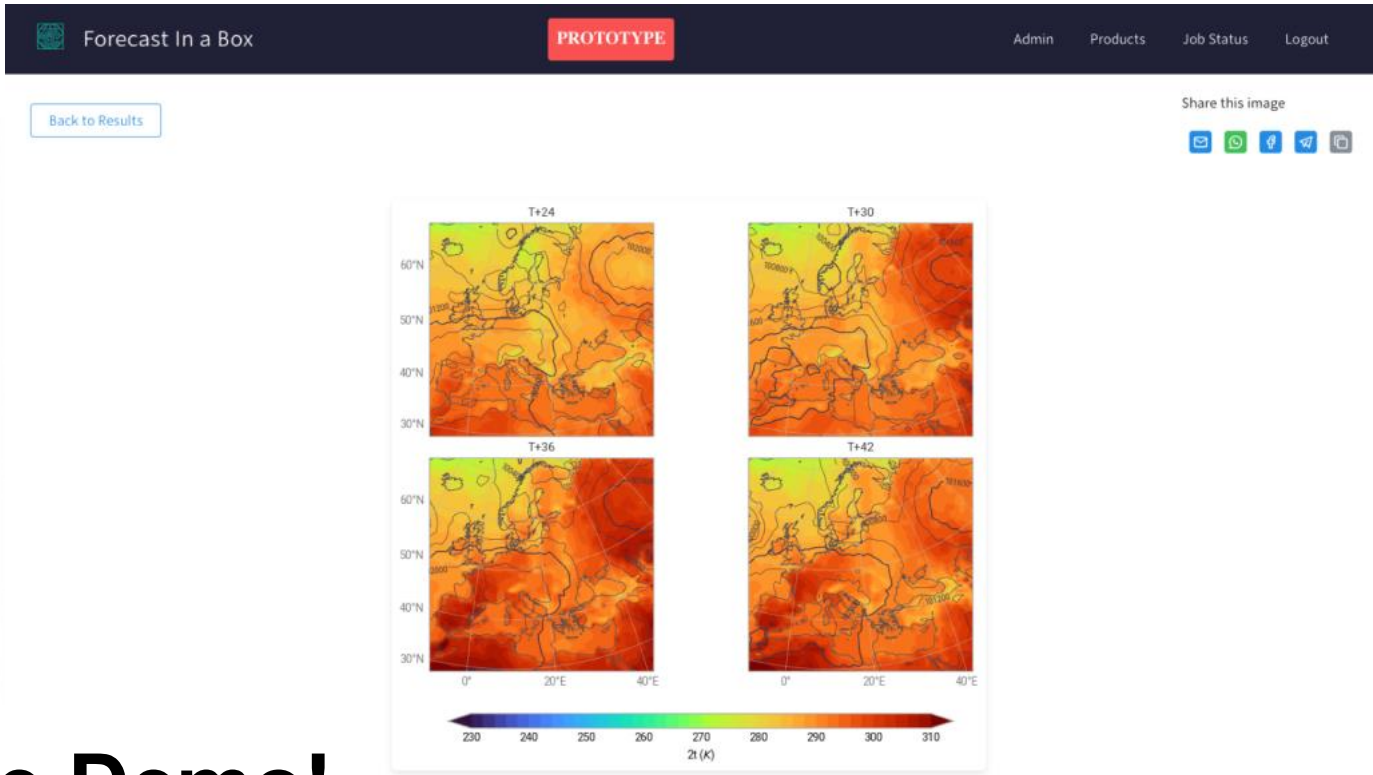
Direct observation prediction



ECMWF

anemoi

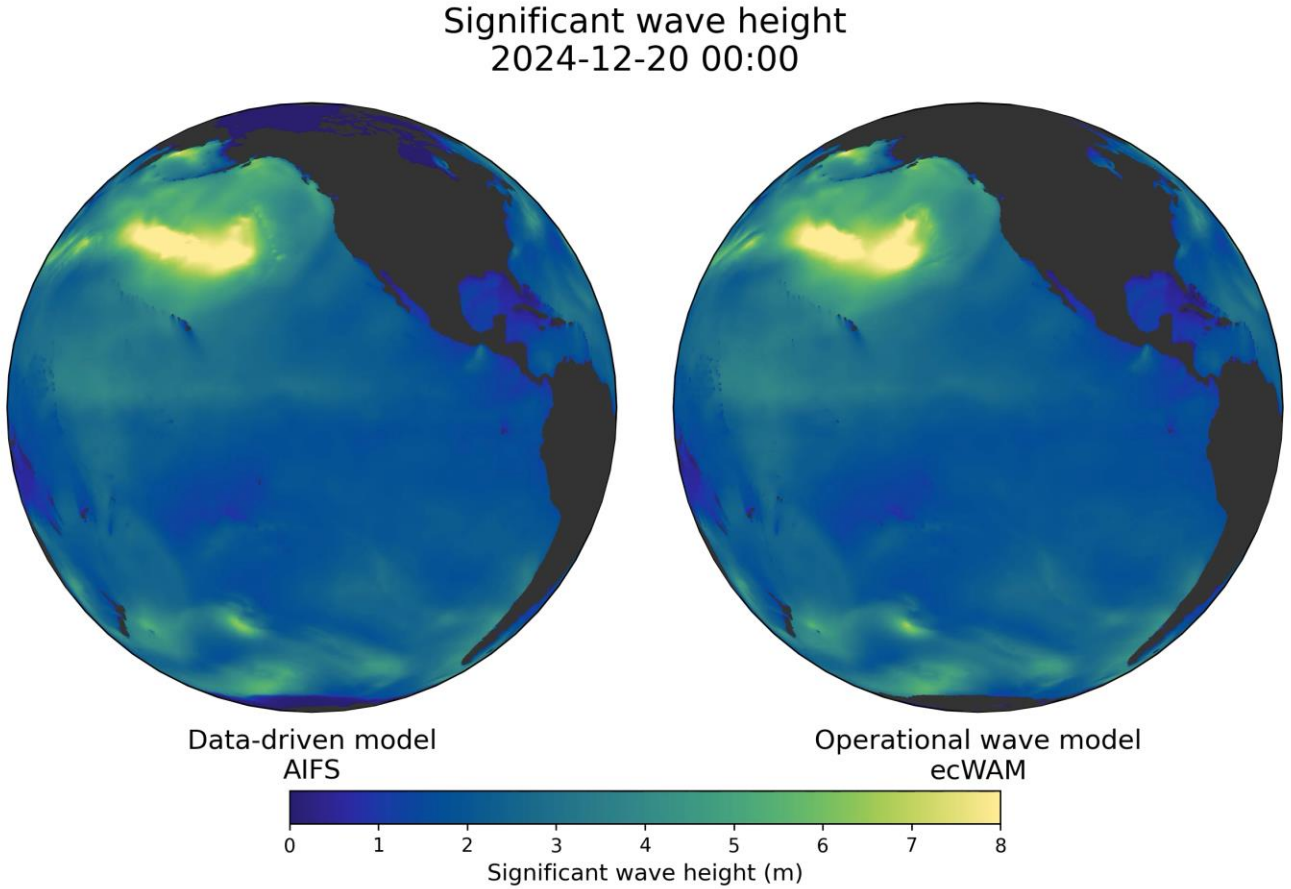
Forecast-In-A-Box



Come see the Demo!

https://destine.ecmwf.int/news/forecast-in-a-box-portable-ai-forecasting-workflows-within-the-destine-digital-twin-engine

AI – Earth system Components : Waves



For more on AI activities see https://destine.ecmwf.int/ai-in-destination-earth/