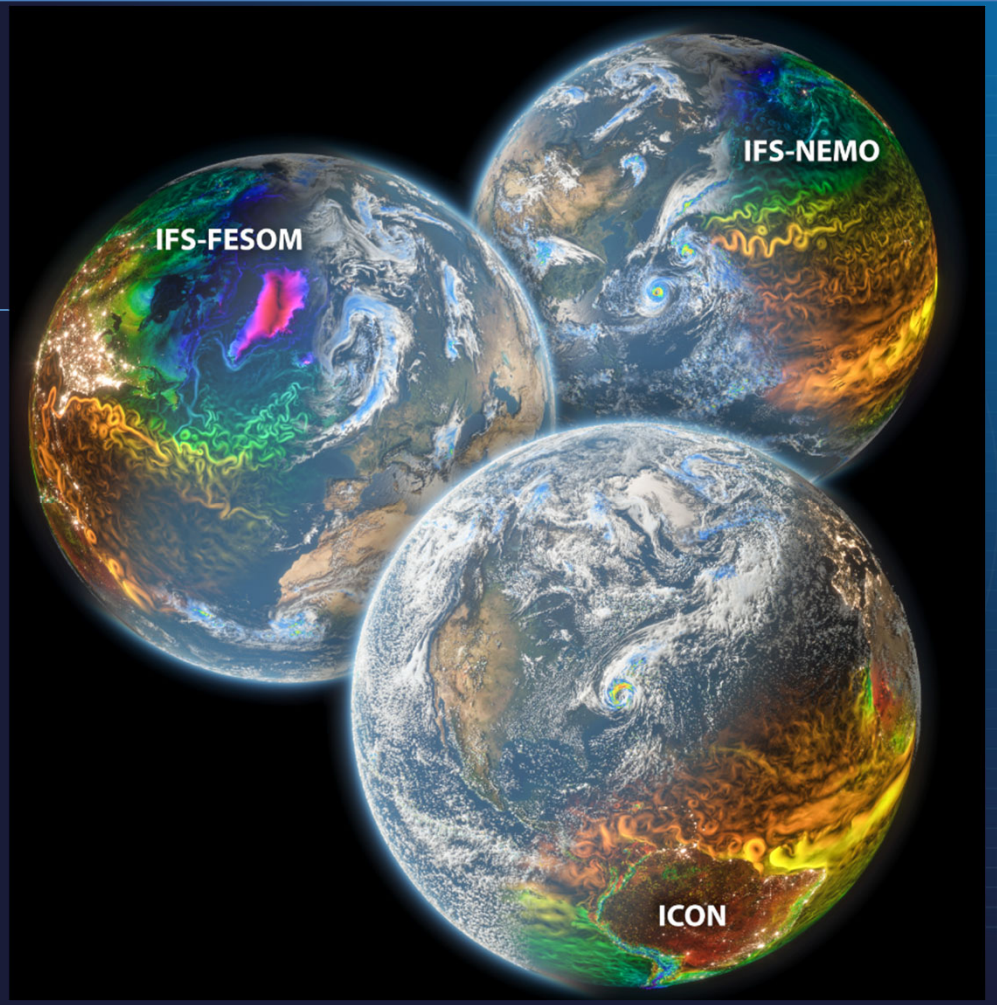
DESTINATION EARTH

STATUS – DIGITALE ZWILLINGE



Jörn Hoffmann

Für das Team am ECWMF
und >100 Partner-Organisationen

Funded by the European Union
Destination Earth
implemented by ECMWF esa EUMETSAT

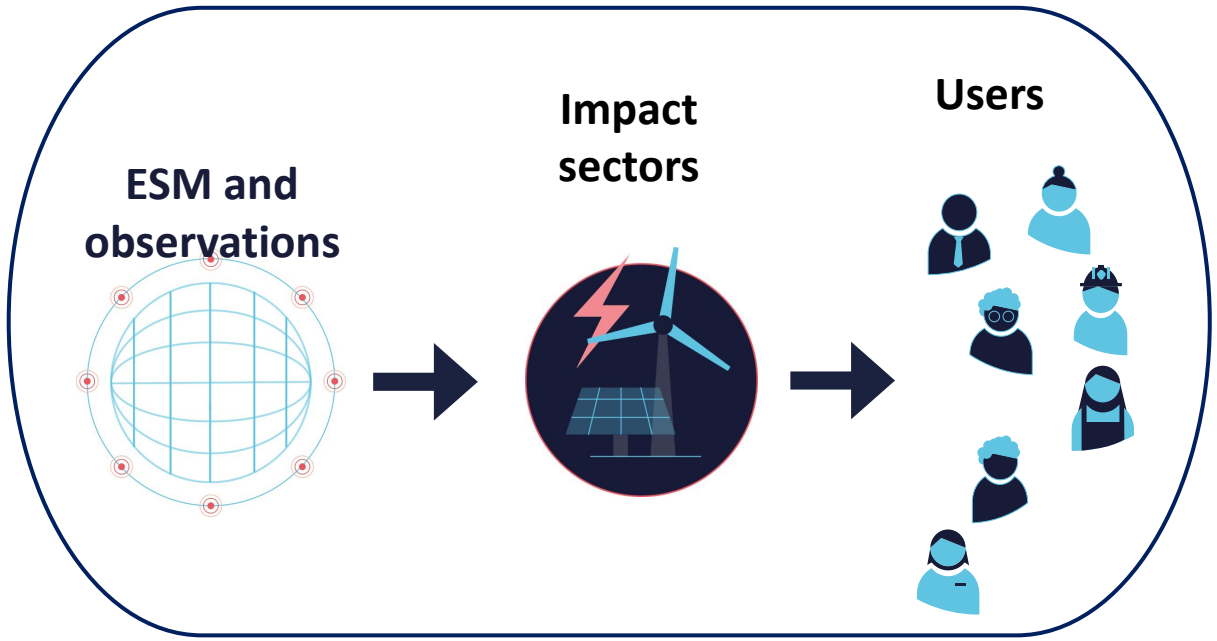
DESTINATION EARTH DIGITAL TWINS: BESPOKE SIMULATION CAPABILITY

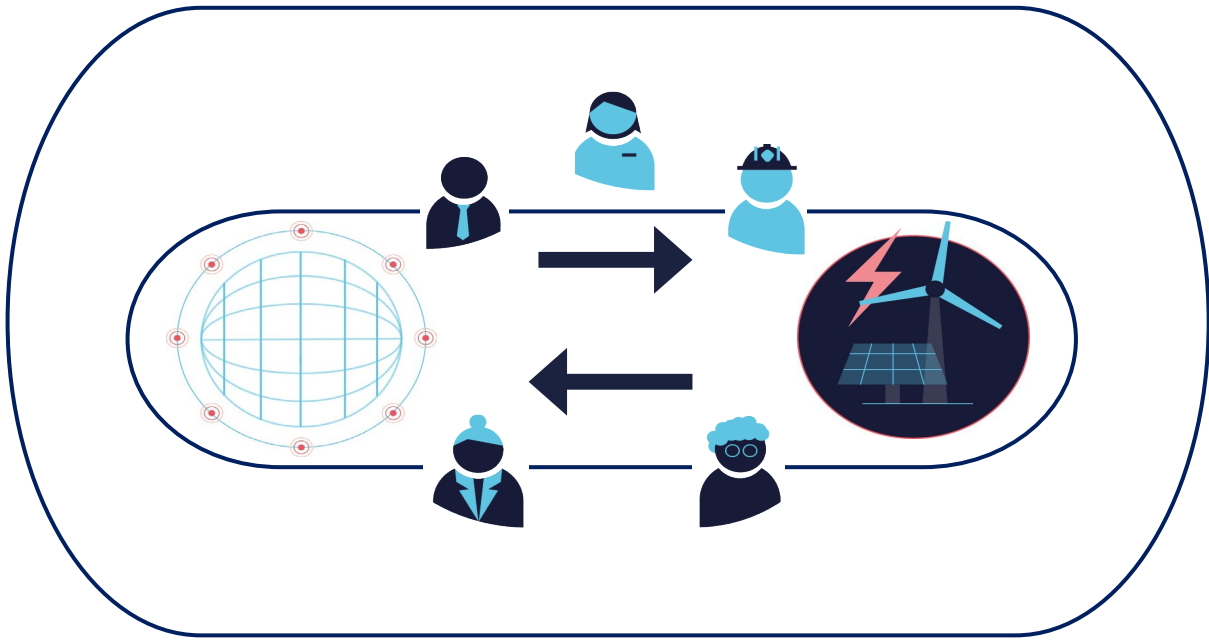
To assess the impact of “what-if” scenarios and questions on climate and extreme events, and provide globally consistent information at km-scale scales where these impacts are observed

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

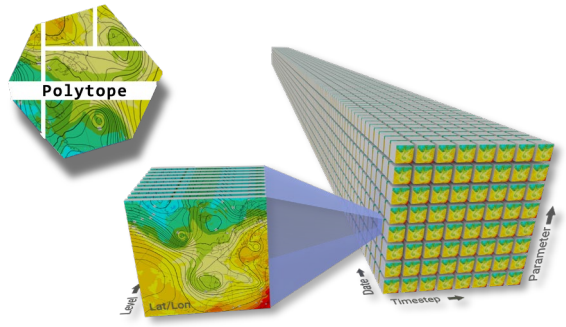
HPCwire 2024 READERS' CHOICE AWARDS
Best Use of HPC in Physical Sciences

From prediction systems to Digital twins of the Earth

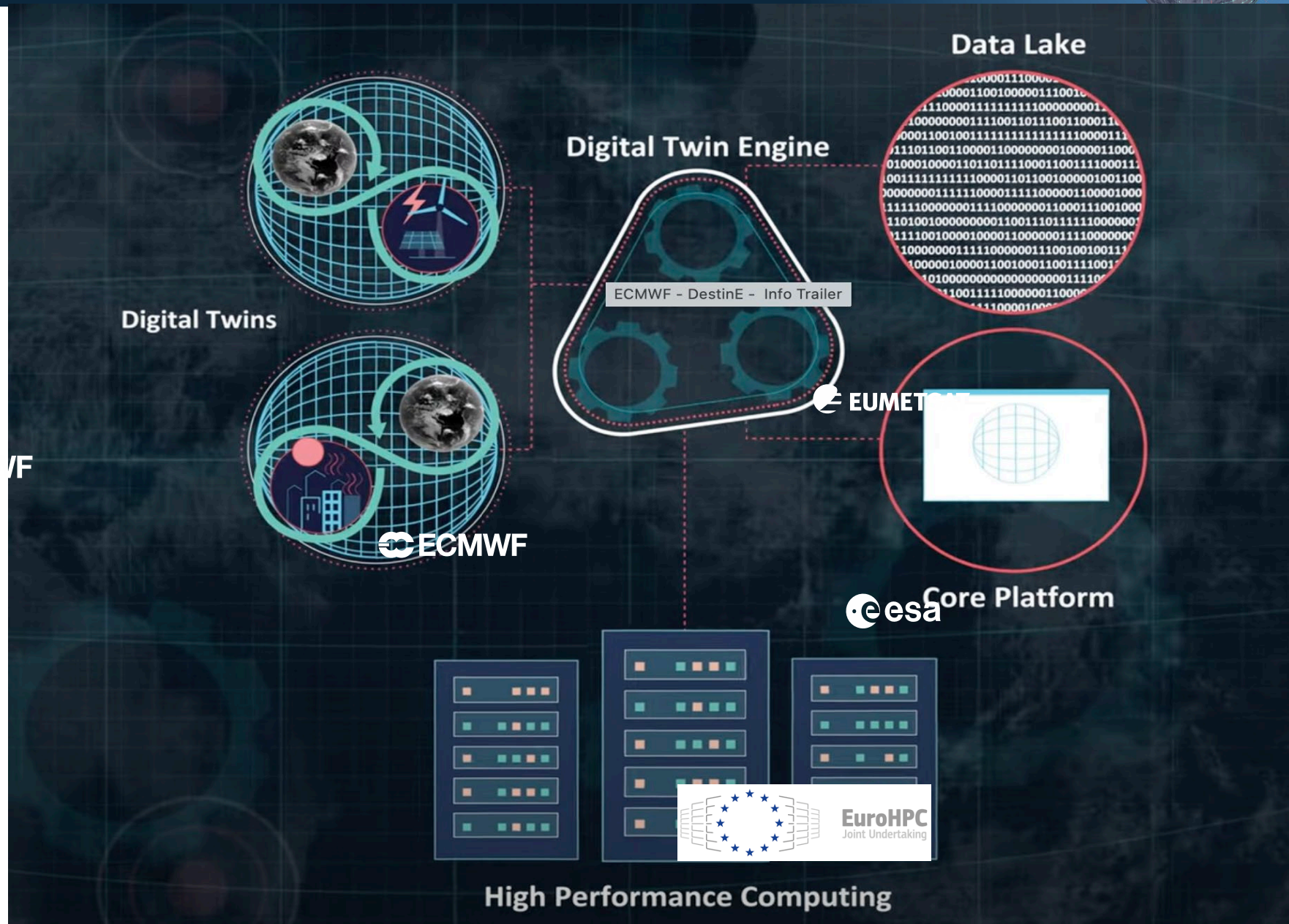




- ✓ Enhanced flexibility of simulations and output
- ✓ Flexible access to fields, time series, specific regions, …
- ✓ On-demand production, frequent updates
- ✓ Integration of sectoral models in the DTs workflow
- ✓ Enhanced spatial and temporal resolutions

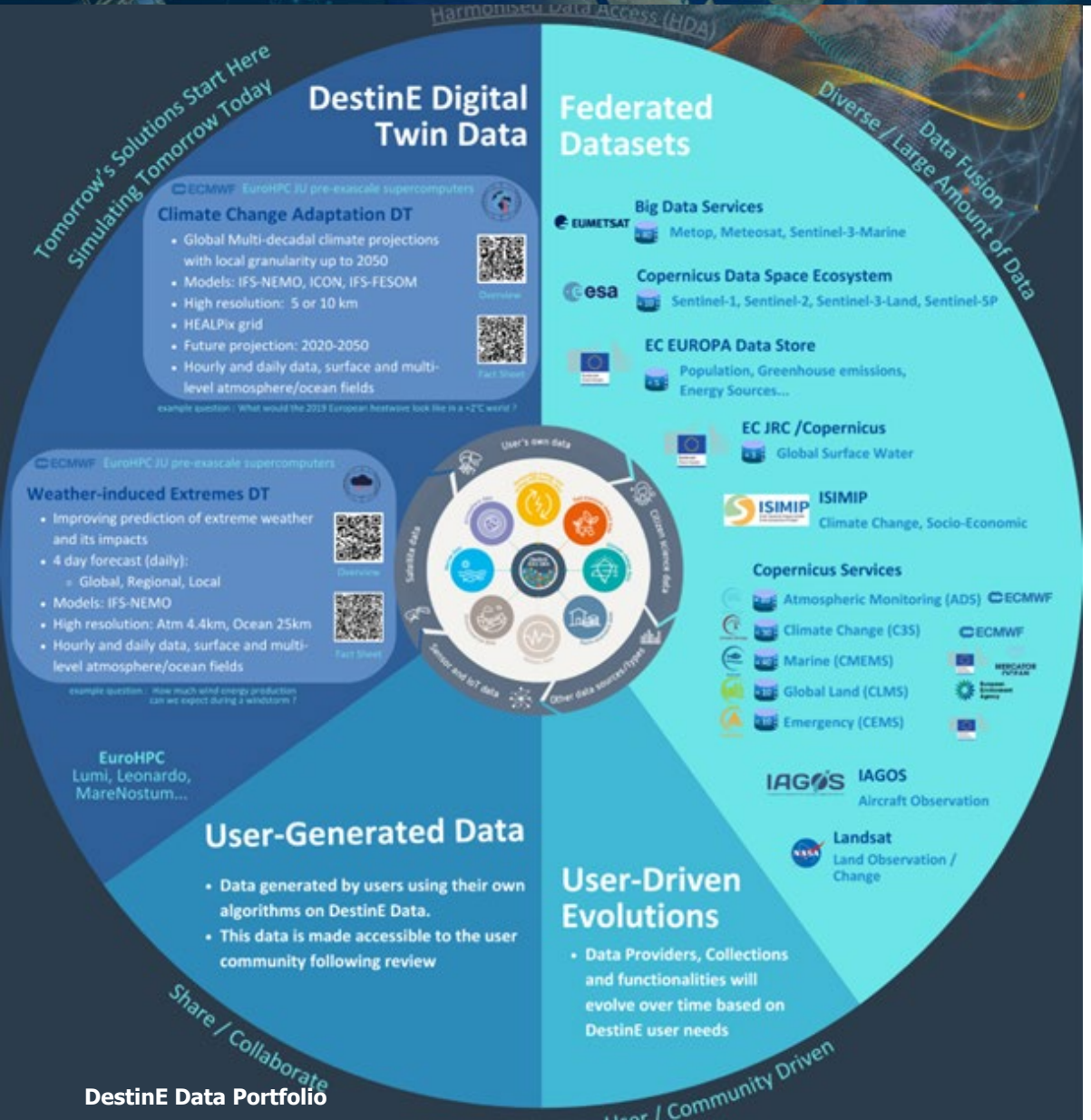


DestinE System



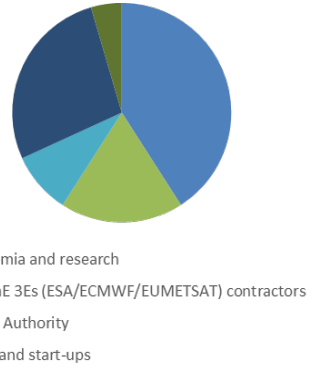
DestinE Data Portfolio & Edge services

Funded by the European Union



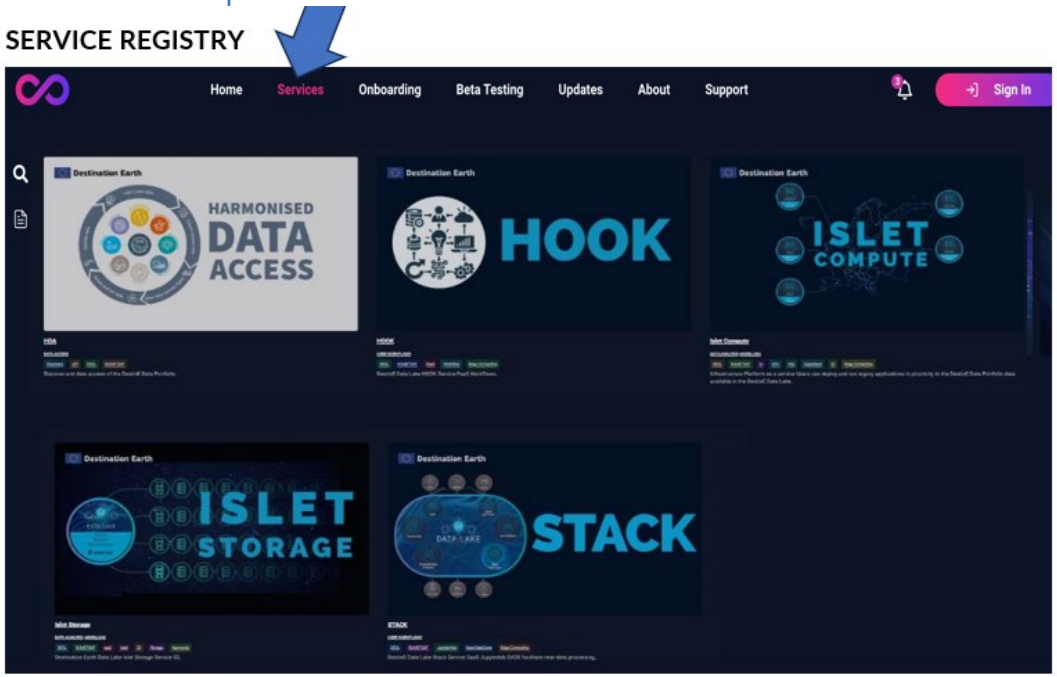
DestinE Data Portfolio

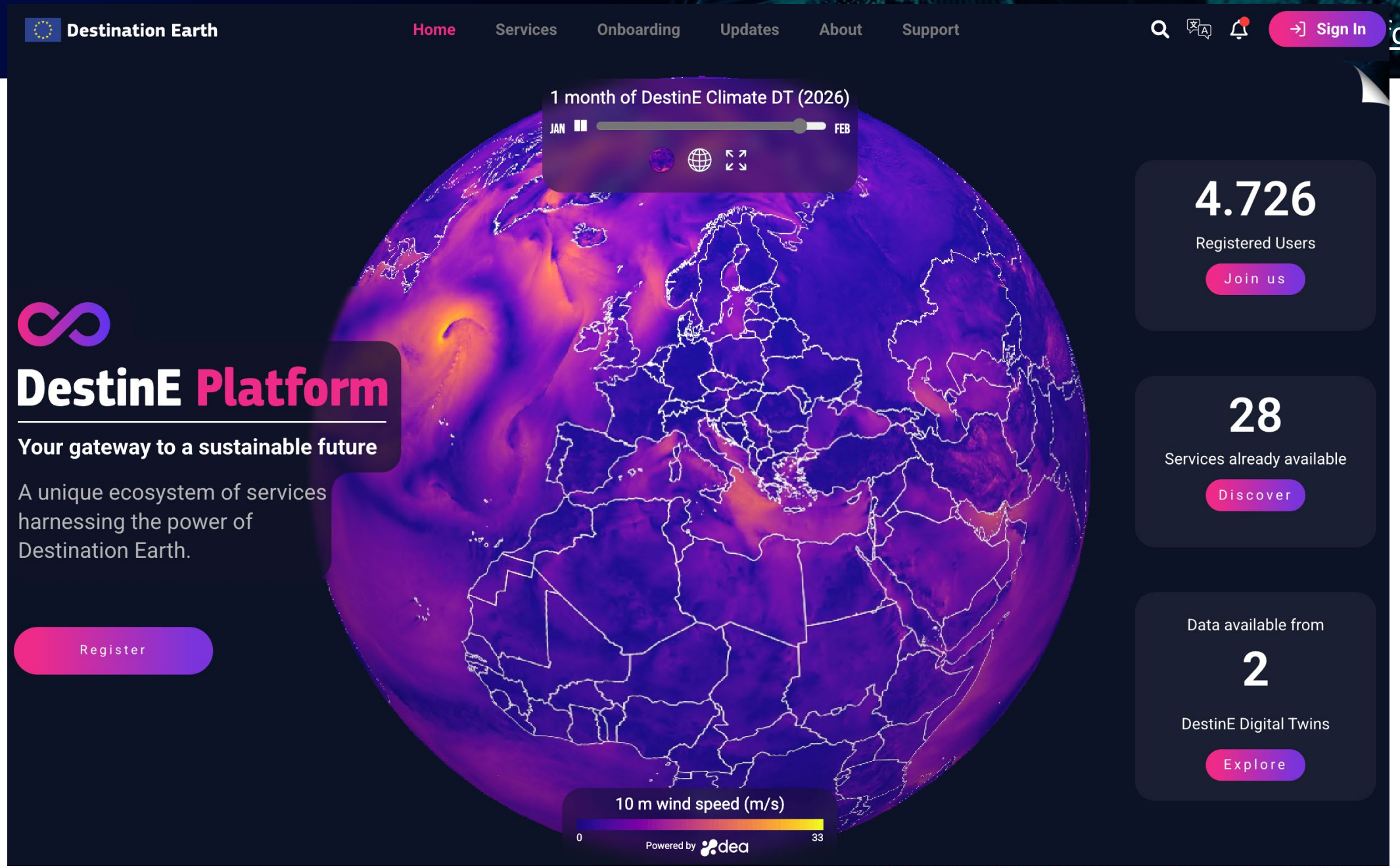
Number of EDGE requests per users categories



DestinE Edge services – on request

SERVICE REGISTRY

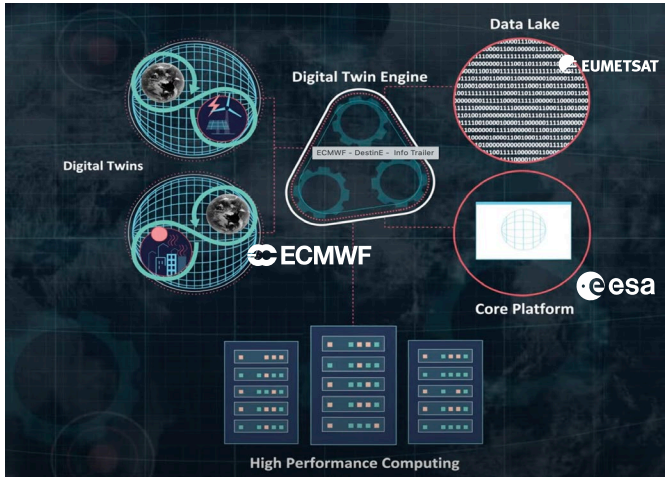



Destination Earth
Home
Services
Onboarding
Updates
About
Support
Sign In
orm.destine.eu/
1 month of DestinE Climate DT (2026)
JAN
FEB
DestinE Platform
Your gateway to a sustainable future
A unique ecosystem of services harnessing the power of Destination Earth.
Register
4.726
Registered Users
Join us
28
Services already available
Discover
Data available from
2
DestinE Digital Twins
Explore
10 m wind speed (m/s)
0
33
Powered by dea

DESTINE TIMELINE

2022 — June 2024 — June 2026

Phase 1: building the key components of DestinE



April 2023

EuroHPC access

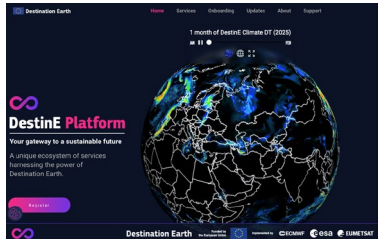
Phase 2: continuous evolution and transition DTs towards operations

June 2024

June 2024

Increased AI focus

October 2024



Continuous evolution and operational services

DIGITAL TWINS for exploring plausible what-if scenarios

WEATHER-INDUCED EXTREMES DIGITAL TWIN

A few days ahead

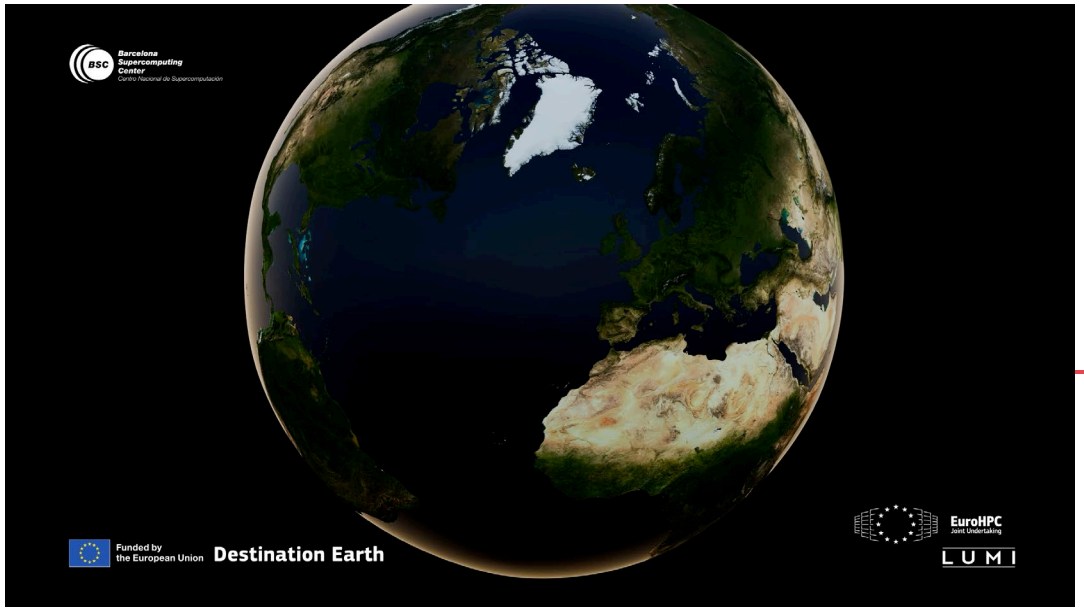
What specific adaption measure can limit the consequences of recent and future events?

CLIMATE CHANGE ADAPTATION DIGITAL TWIN

Multi-decadal timescales

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

Climate DT: 1st operational capability for climate projections



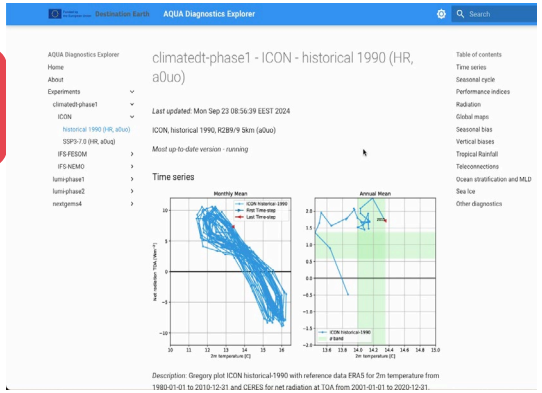
3 global climate models at ~5 km

IFS-NEMO
IFS-FESOM
ICON

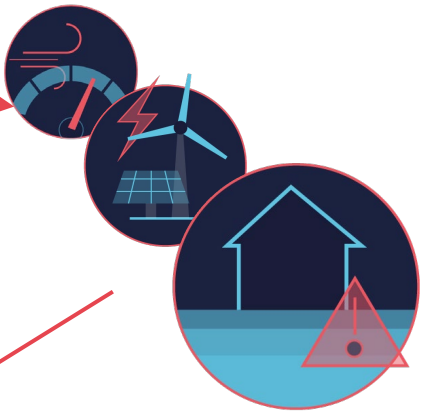
CSC

Common format and data governance

Monitoring & evaluation

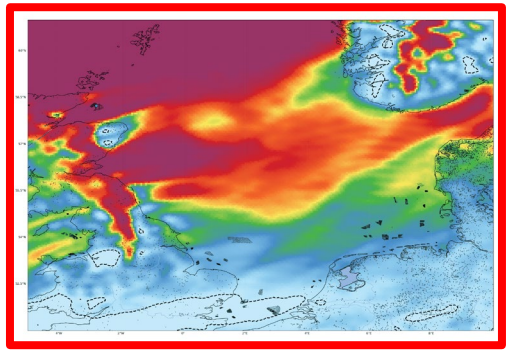


Statistics



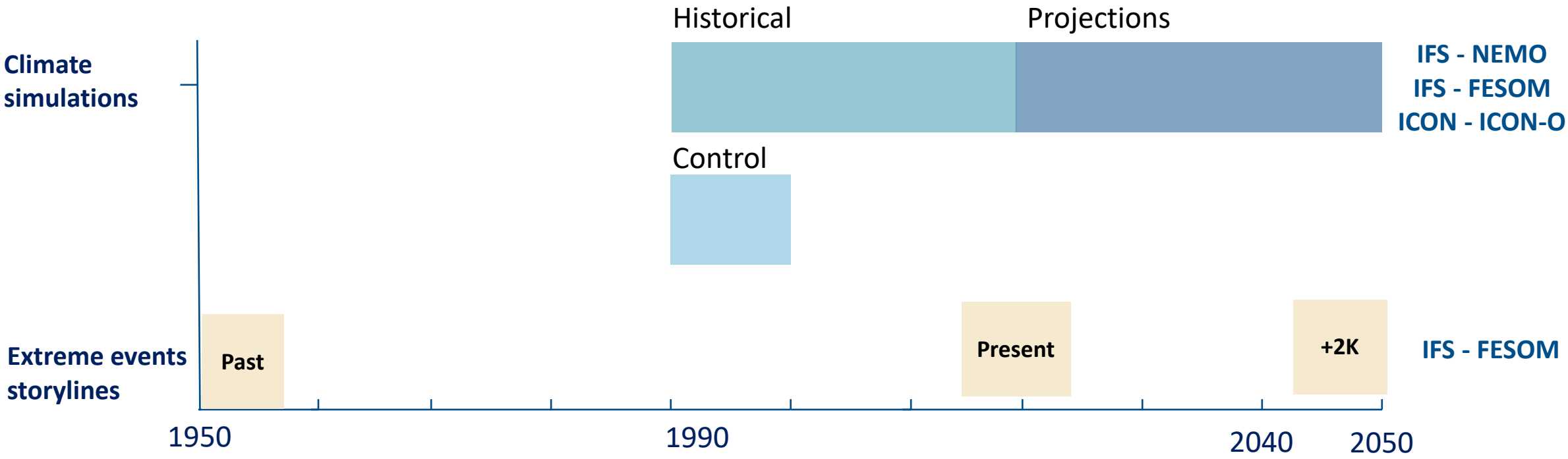
Impact-sector models

e.g Tailored information for wind energy

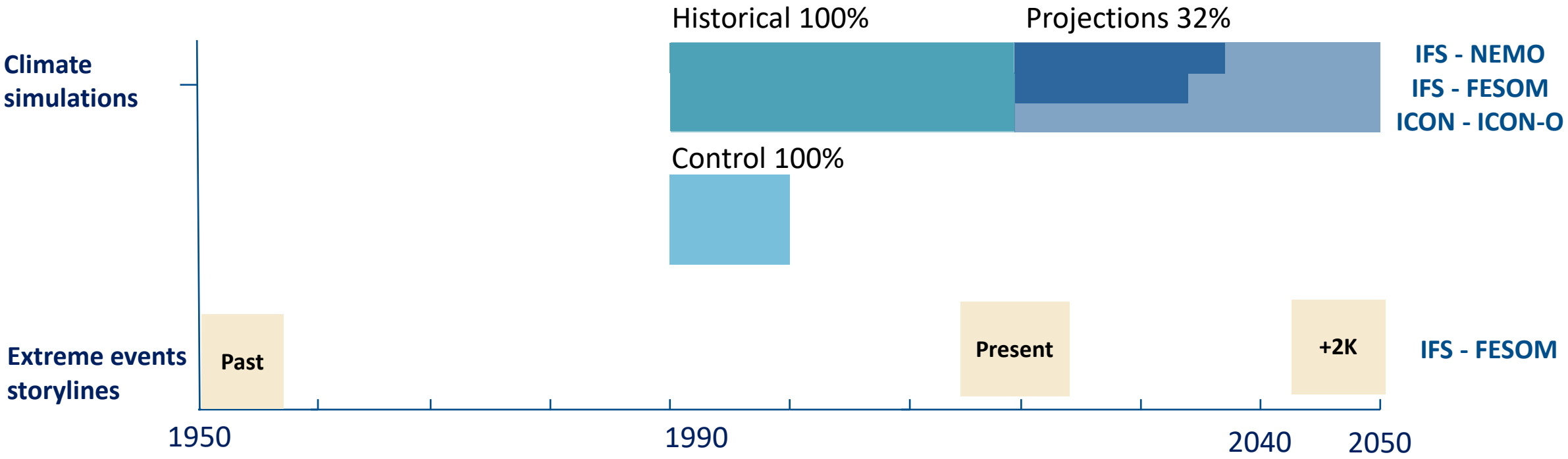


More info and full list of available simulations
https://destine.ecmwf.int/climate-change-adaptation-digital-twin-climate-dt/

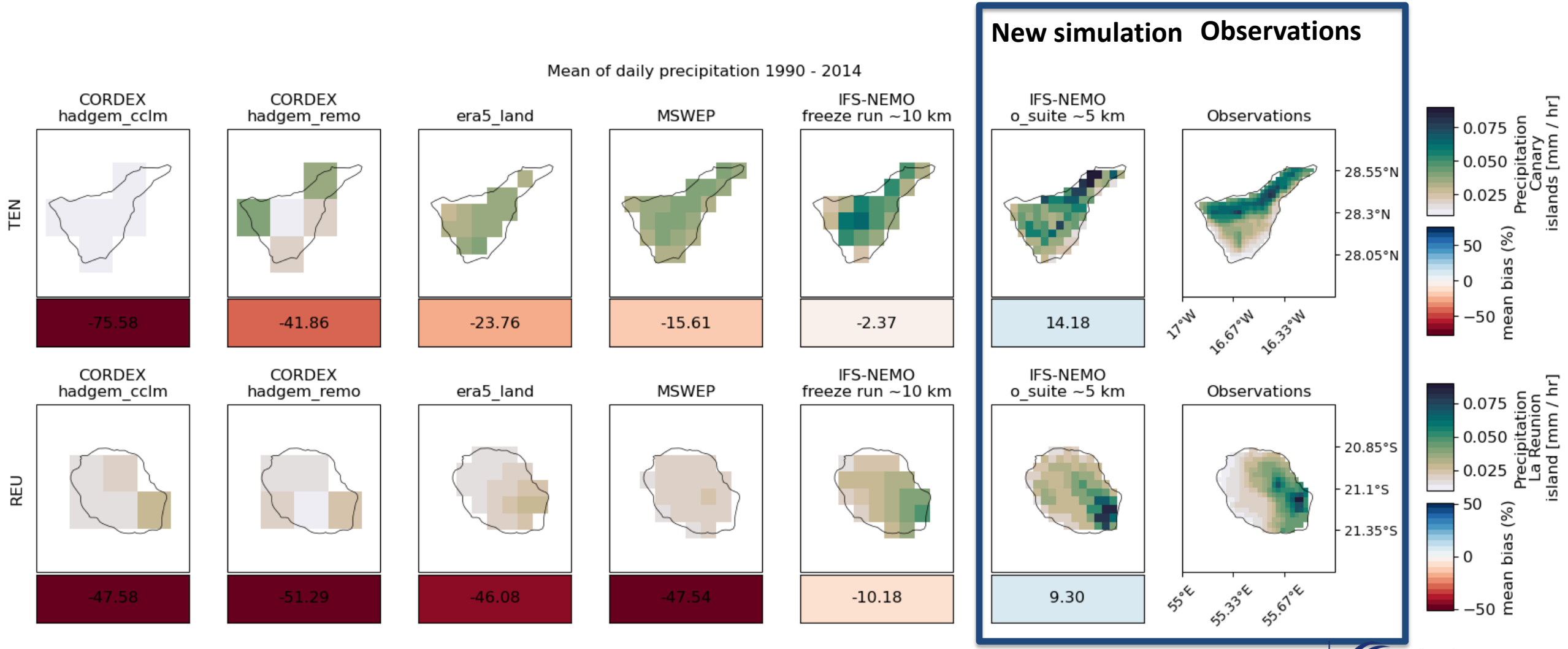
CLIMATE DT: SIMULATION STATUS



CLIMATE DT: SIMULATION STATUS



CLIMATE DT


New simulation
Observations
Mean of daily precipitation 1990 - 2014
TEN
REU
CORDEX hadgem_cclm
CORDEX hadgem_remo
era5_land
MSWEP
IFS-NEMO freeze run ~10 km
IFS-NEMO o_suite ~5 km
Observations
-75.58
-41.86
-23.76
-15.61
-2.37
14.18
-47.58
-51.29
-46.08
-47.54
-10.18
9.30
28.55°N
28.3°N
28.05°N
17°W
16.67°W
16.33°W
20.85°S
21.1°S
21.35°S
55°E
55.33°E
55.67°E
0.075
0.050
0.025
Precipitation Canary islands [mm / hr]
50
0
−50
mean bias (%)
Precipitation La Reunion island [mm / hr]

EXTREMES DT : A MAGNIFYING GLASS ON EXTREME WEATHER EVENTS

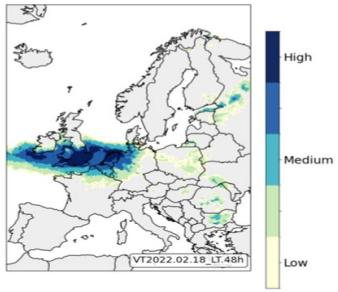
1 2 3 4 4

Global simulations

IFS-NEMO

- Initialized daily
- 4 days ahead
- Resolution: 4.4 km

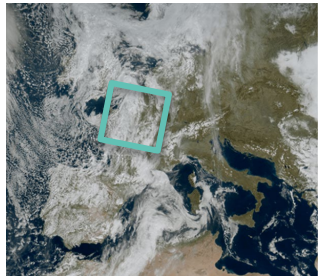
Detection/Configuration



IFS ensemble (9km)

- Detection of extreme weather (intensity and likelihood)
- Wind, precipitation, CAPE, surge…

Regional simulations



ALARO, AROME, HARMONIE-AROME

- On-demand
- Flexible domain
- 2 days ahead
- Resolution: 750-500m

Impact sector models

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

ECMWF METEO FRANCE À VOS CÔTÉS, DANS UN CLIMAT QUI CHANGE Norwegian Meteorological Institute METEO FRANCE Danmarks Meteorologiske Institut RMI DHMZ EMHI OMHI TAL TECH Republic of Estonia Environment Agency ARSO METEO Slovenia INRAE CSC Lietuvos hidrometeorologijos tarnyba RIVM AEMet FMI SMHI LVGMC IPMA ZAMG Koninklijk Nederlands Meteorologisch Instituut IMGW Icelandic Met Office bsc Barcelona Supercomputing Center SHMÚ ORSZÁGOS METEOROLÓGIAI SZOLGÁLAT GeoSphere Austria

REGIONAL EXTREMES DT

- About 130 sub-km simulations on ECMWF HPC from June to August
- Several test cases ran on LUMI, with improved performance and test data on the databridge

EDF | DTF | NWP | VERIF | GLOBAL | OBS | DCMDB

Deode triggering framework:

Event: flooding mask: no_mask

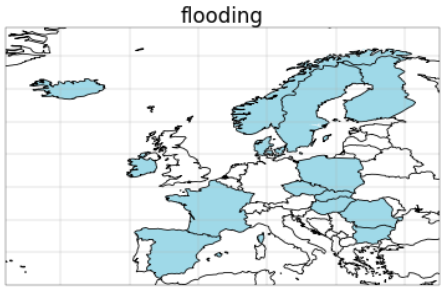
Lead time: D0+1

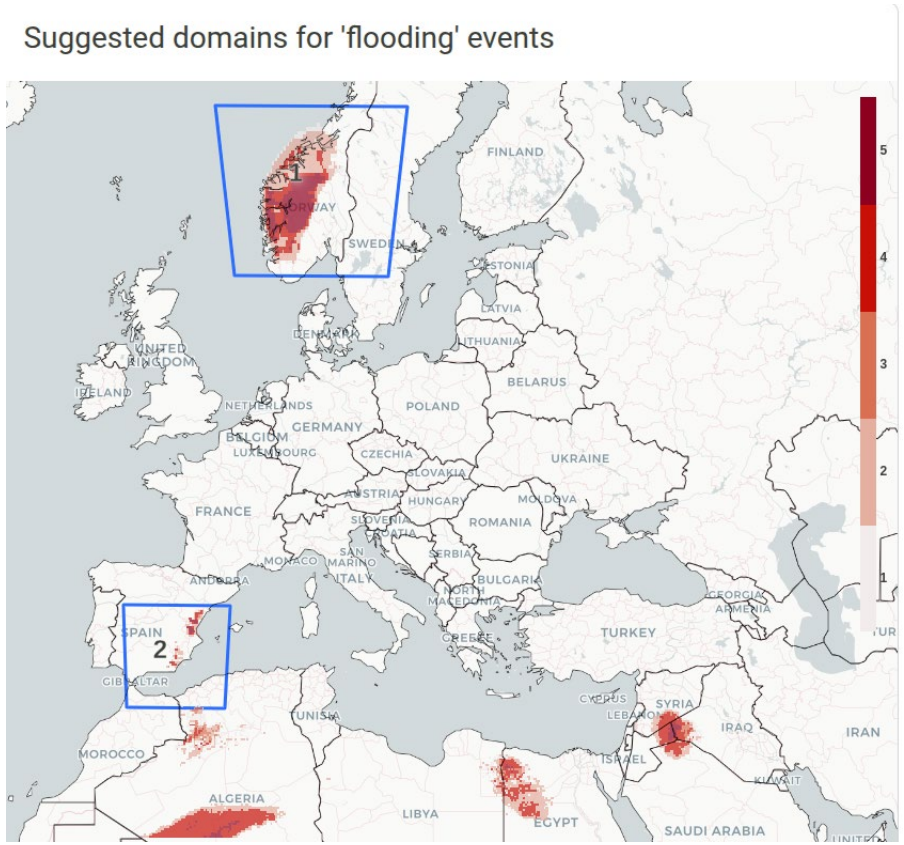
domain-1 | domain-2 | domain-3 | domain-4 | domain-5

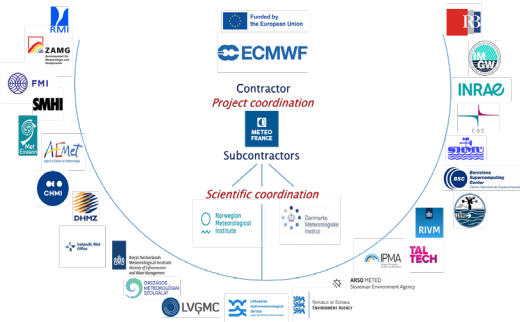
```
[general]
event_type = "flooding"

[domain]
xloncen = 9.140206378986894
xlatcen = 61.78054633144476
number = 1

[general.times]
start = "2025-03-04T00:00:00Z"
forecast_range = "P2D"
```



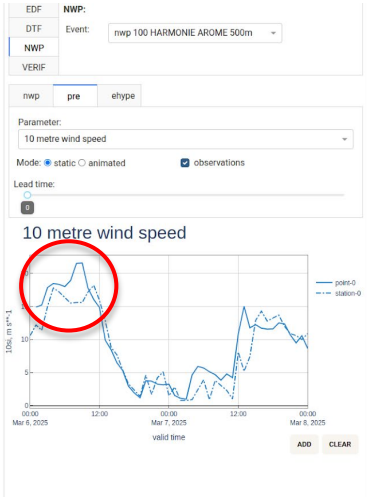


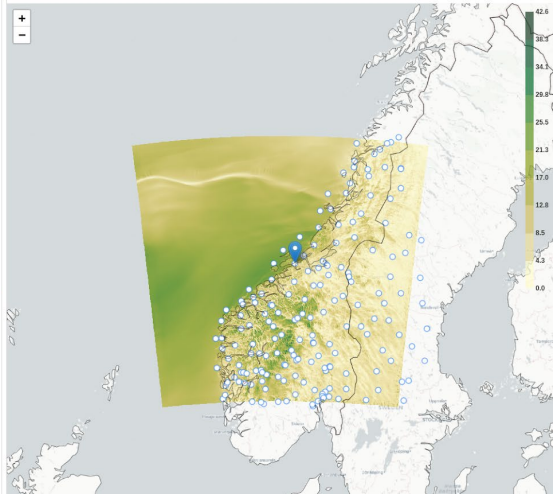


SUB-KM SCALE INFORMATION COMPLEMENTS EXISTING PREDICTION SYSTEMS

Supporting events

FIS Nordic World Ski Championships 2025

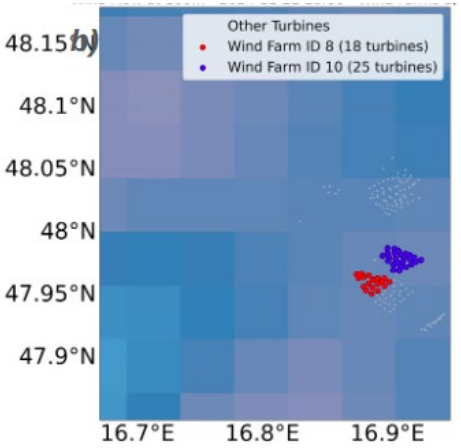




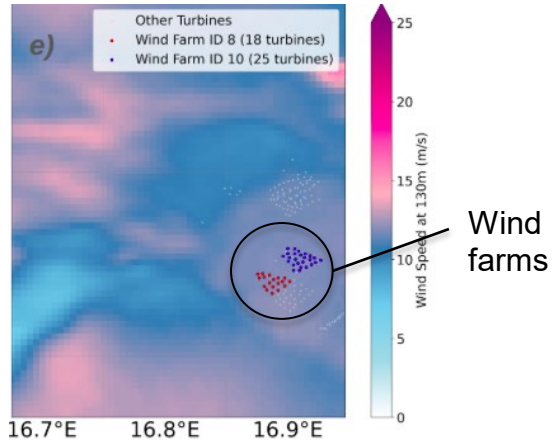
Wind energy

Wind energy production in Austria

DT 4.4 km



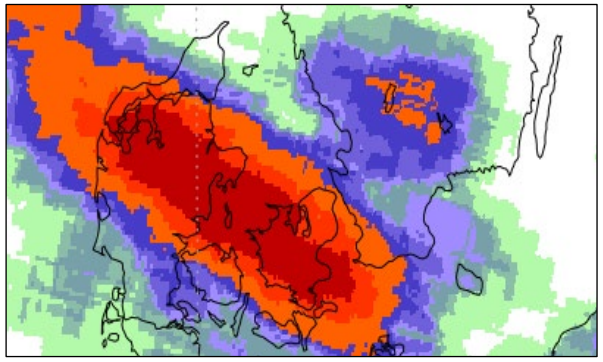
HARMONIE-AROME 500 m



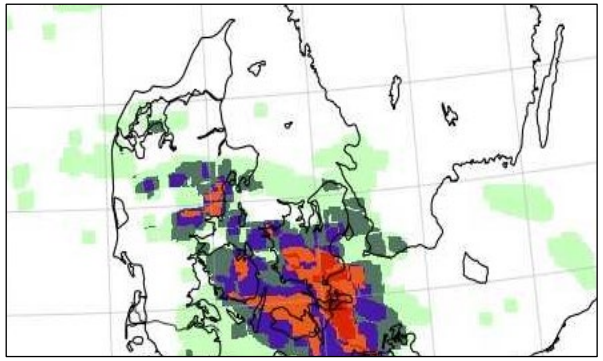
Likelihood of extremes

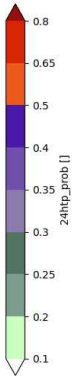
Probability of exceedance of 50 mm/day over 24h in the ensemble forecast (6 members)

Harmonie-Arome 2 km

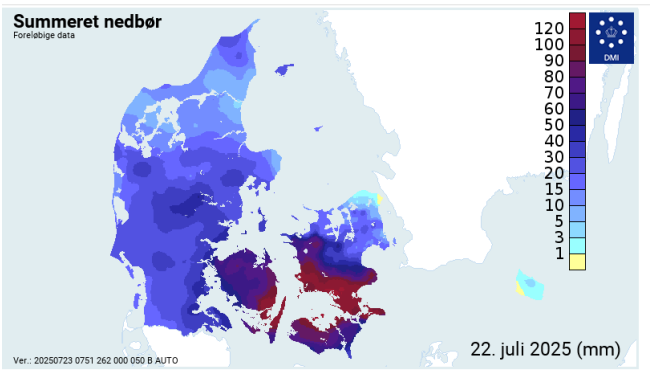


Harmonie-Arome 750 m



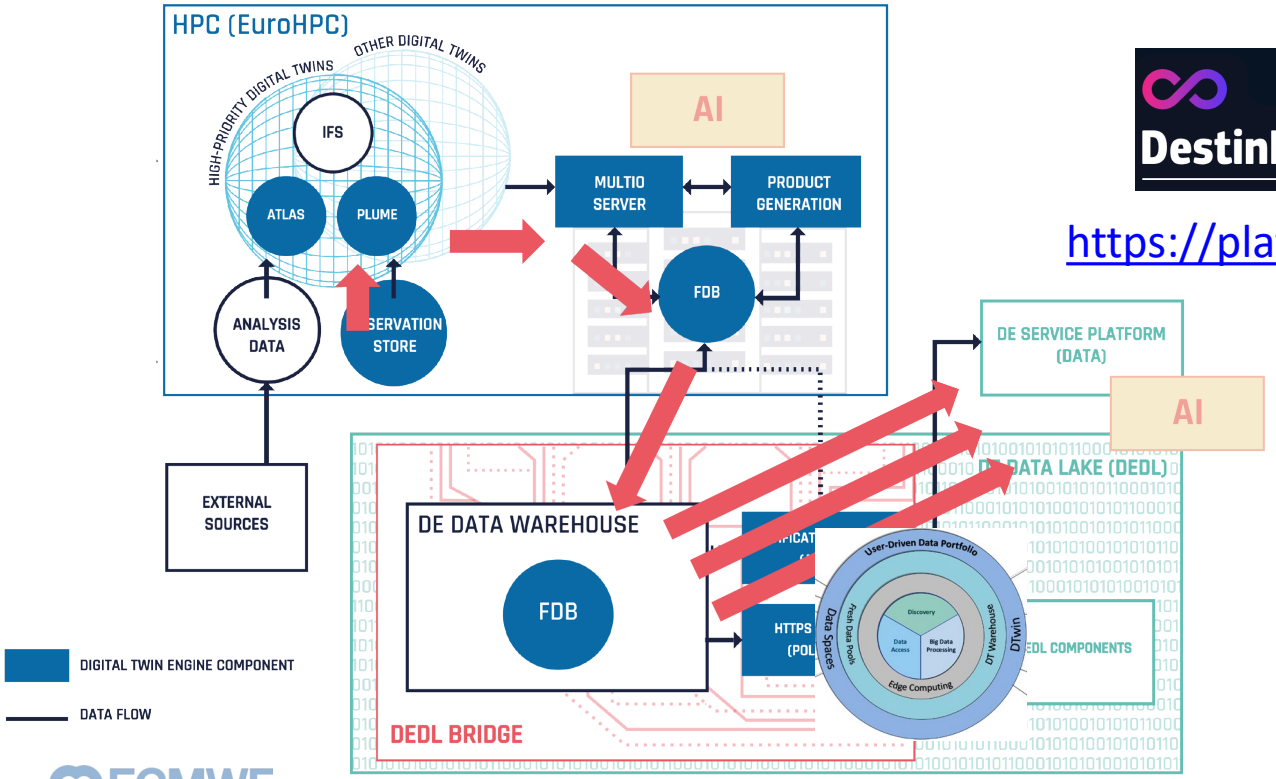


Observations



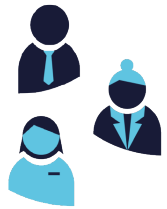
DIGITAL TWIN ENGINE

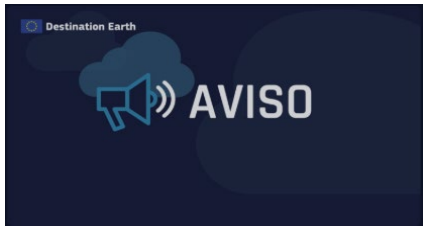
Routinely used to operate complex Earth-system and impact-sector workflows on EuroHPC, and provide software solutions and services for accessing, handling and interacting with the digital twin data on distributed infrastructures

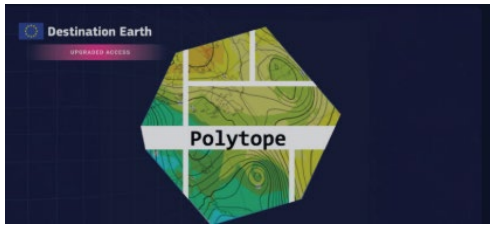


DestinE Platform

https://platform.destine.eu/







WMO WIS2.0 compatible data access

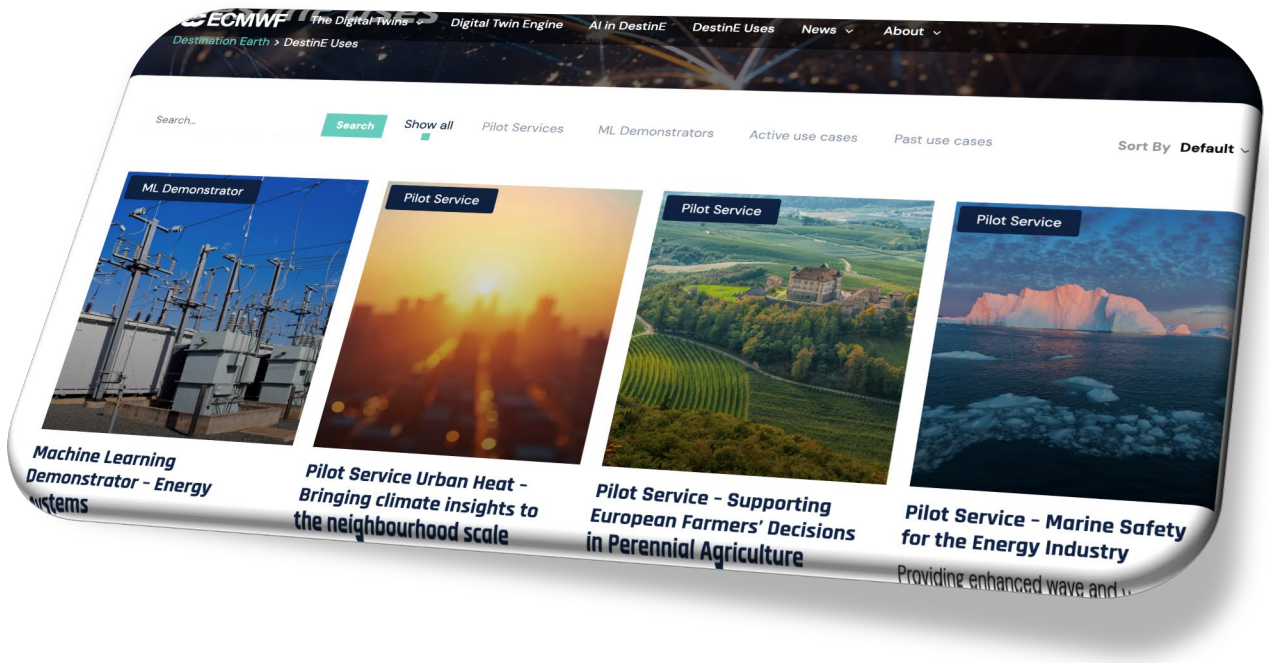
https://pygeoapi.io/

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

ECMWF

PILOT SERVICES & PARTNERSHIPS

- **6 pilot services** in energy, flood, maritime, urban heat, agriculture
- **3 ML Demonstrators**: energy systems, data fusion, flood nowcasting (+ 3 upcoming)
- **Applications in DT workflows**
- **Strategic Partnerships**: ECB, EIB, EEA, DGs, ENTSO-E, UNICEF, WFP
- Technology Readiness Assessment with geophysical and biodiversity digital twins



See https://destine.ecmwf.int/destine-uses/

Funded by the European Union **Destination Earth** implemented by ECMWF esa EUMETSAT

5th DestinE User eXchange

*The Royal Meteorological Institute of Belgium (RMI) will act as **local partner** to **connect the event to Benelux communities**.*

Objectives

- Showcase progress across DestinE components (end of Phase 2)
- Collect user input on priorities & expectations for Phase 3
- Demonstrate emerging value for practical applications
- Strengthen visibility, including among Brussels-based actors
- Expand and strengthen the DestinE stakeholder community

Participants

Implementers
ECMWF, ESA, EUMETSAT, Commission, and contractors building the system

Partners
Academic, research, and public institutions shaping the system

Users
Public and private actors applying DestinE systems

Media
Journalists and institutional comm. teams