Destination Earth and Data Lake

powering Europe's high precision climate and environmental modelling

Michael Schick (EUMETSAT)
OGC iDAYS 2025 – Session #5
10th of December 2025

An intergovernmental organisation with 30 member states

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BELGIUM
BULGARIA
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FINLAND
FRANCE
GERMANY
GREECE
HUNGARY
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IRELAND
ITALY
LATVIA
LITHUANIA
LUXEMBOURG
THE NETHERLANDS
NORWAY
POLAND
PORTUGAL
ROMANIA
SLOVAK REPUBLIC
SLOVENIA
SPAIN
SWEDEN
SWITZERLAND
TURKEY
UNITED KINGDOM

EUMETSAT mission

Primary objective:

Establish, maintain and exploit European systems of meteorological satellites.

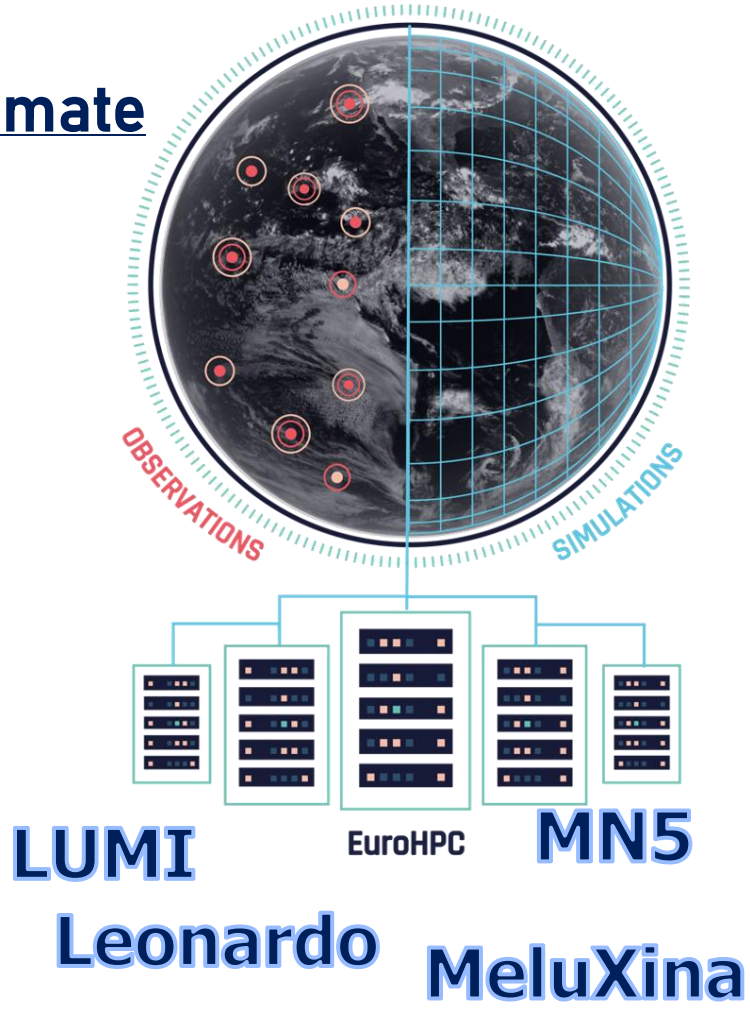
Further objective:

Contribute to the operational monitoring of the climate and the detection of global climatic changes.

Destination Earth

Flagship initiative of the European Commission to develop

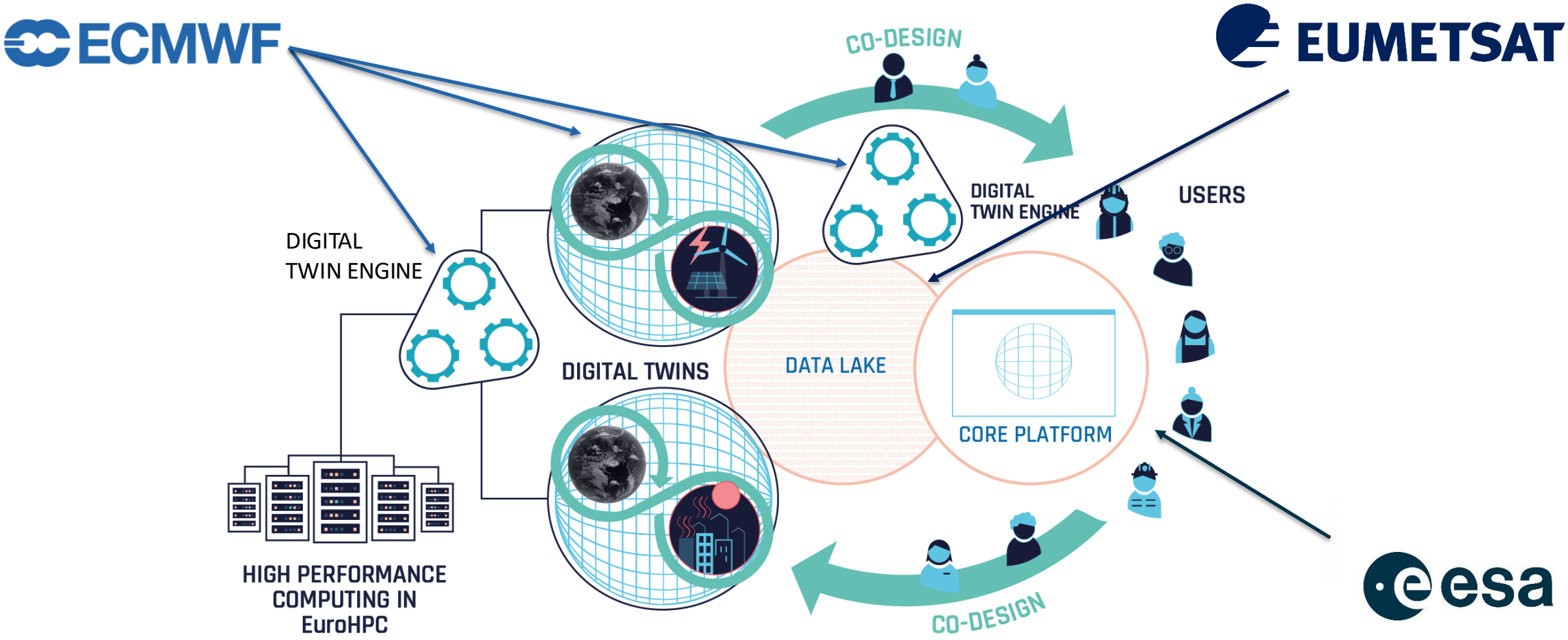
a digital replica of our planet to respond and adapt to climate change and extreme events



DestinE is a joint undertaking in strategic partnership with **EuroHPC**

- Establishes bespoke cutting-edge simulation capabilities
- Provides Earth-system information at scales where the impacts of **extreme** events and **climate change** are felt
- Fosters an innovative and thriving AI-enabled digital ecosystem
- DestinE Data is part of European Green Deal Data Spaces

A novel information system – implemented by the 3EEs



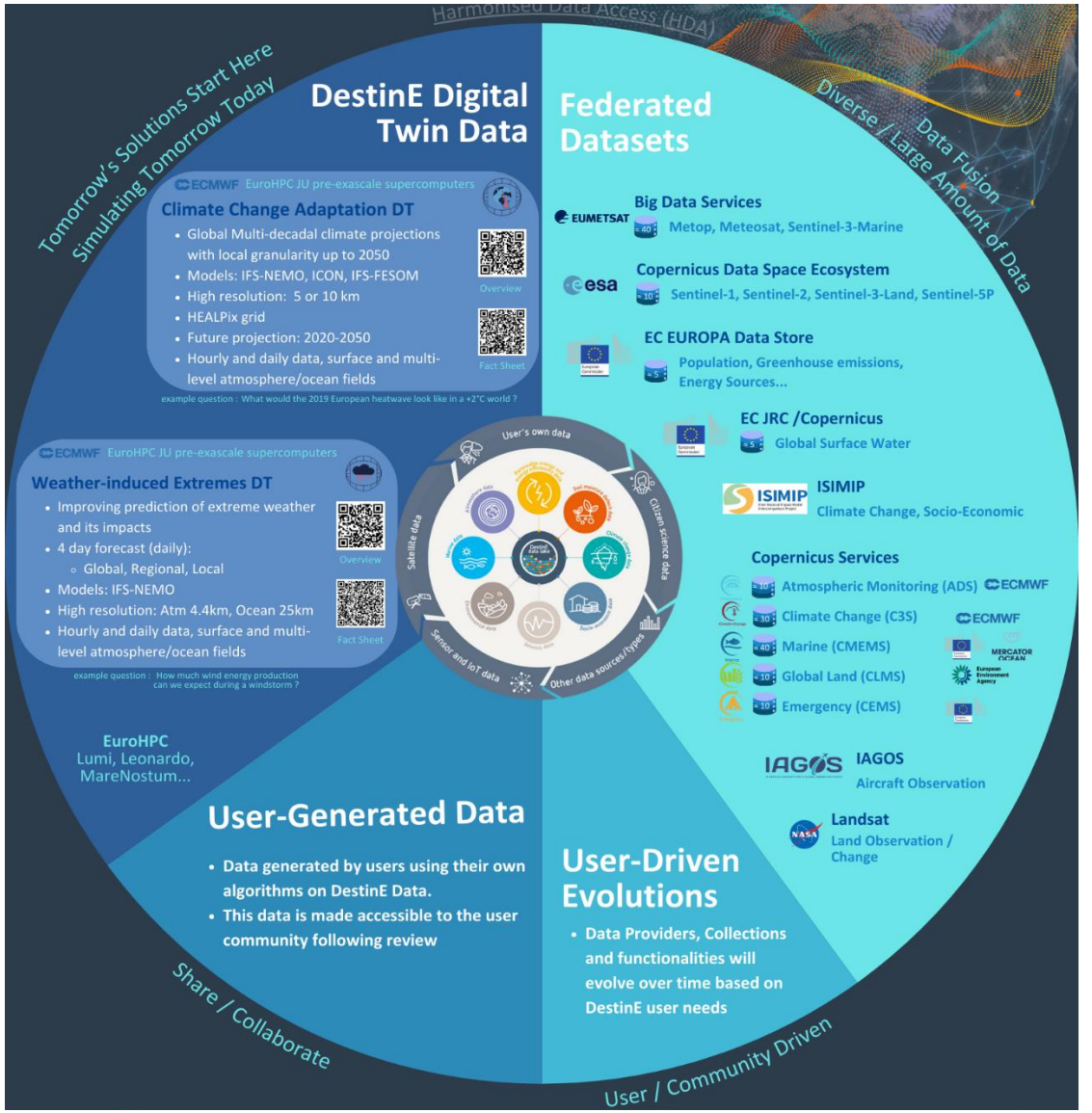
DestinE Data Portfolio

DestinE Data Lake offers a wide variety of data.

- Digital Twin Data
- Federated datasets from various data spaces, also beyond traditional Earth Observation
- User generated data
- User-driven datasets, based on DestinE user needs

This data portfolio is enabled by a harmonized data access solution (HDA) that abstracts away the heterogeneity and complexity of the underlying data sources

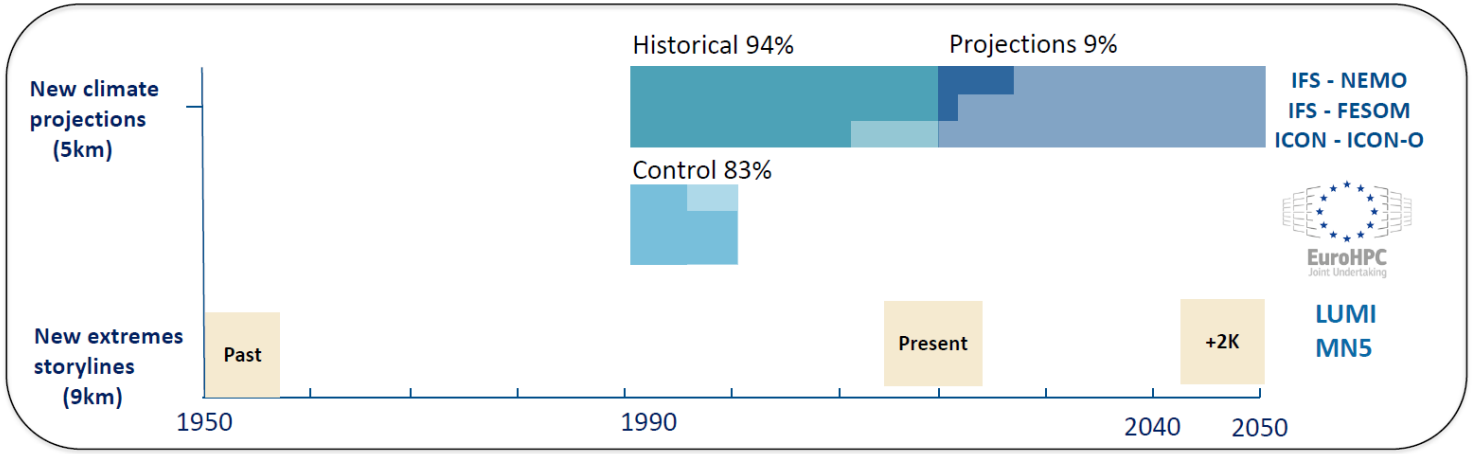
https://data.destination-earth.eu/data-portfolio



DestinE – Climate Change Adaption DT

CLIMATE DT

Defined development / evaluation / operational - suites: production started with o-suites



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

ECMWF | DestinE Platform | CSC

KEY FEATURES

Km-scale Earth system models
Uses km-scale Earth system models, at 5 to 10 km resolution, to better represent critical processes like storms and ocean eddies.

Global multi-decadal projections with local granularity
Produces global multi-decadal climate projections with local granularity, up to 2050, by exploiting the EuroHPC pre-exascale supercomputers.

Tailored climate information
Tailors the climate information to match the needs of users from relevant impact sectors, through co-design and innovative data streaming and data handling techniques.

Routine and on-demand operational production of climate simulations
Establishes an operational infrastructure to produce climate simulations in support of adaptation activities, both routinely (yearly or less) and on-demand.

DestinE – Weather-Induced Extremes DT

EXTREMES DT : A MAGNIFYING GLASS ON EXTREME WEATHER EVENTS

Global and **daily** simulations of extreme weather **4 days** ahead at **4.4km**

On-Demand regional simulations **2 days** ahead at **750m** to **500m**

Impact-sector models: user-relevant information for societal impacts

- First comprehensive evaluation of global medium-range forecasts at 4.4 km in near real-time – demonstrating clear benefits at local scale (TC, orographic precipitation)
- End-to-end workflows for the regional, on-demand, component for selected configurations set up; including impact sector models for selected use cases

KEY FEATURES

Km-scale Earth system models

Uses "km-scale" models to better represent extreme weather events and deliver information at scales where their impacts are felt.

Routine production of global simulations

Produces global simulations at 4.4 km resolution for 4 days ahead to predict extreme weather events worldwide.

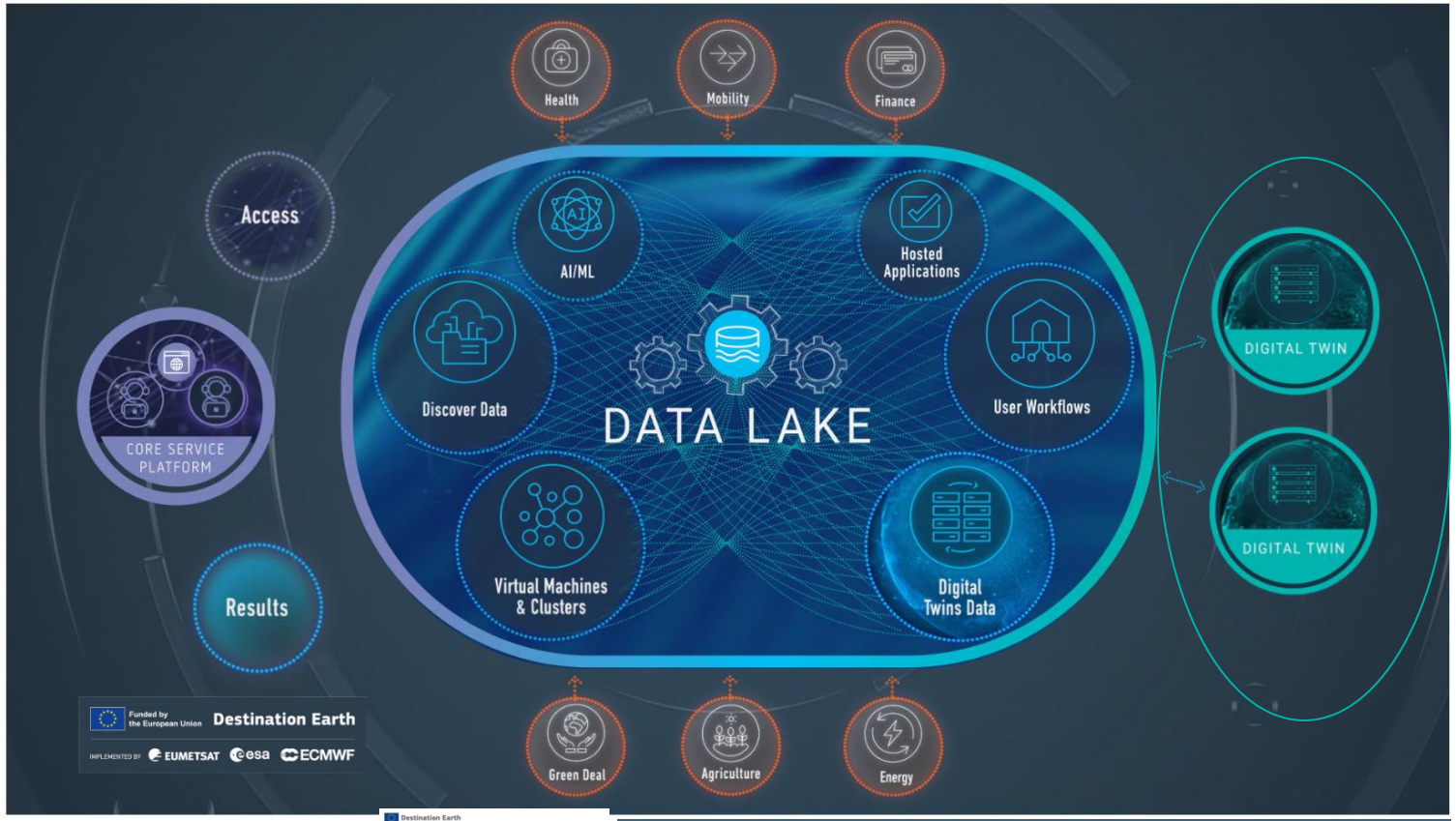
On-Demand refinement over Europe

Produces on-demand regional simulations at 750 to 500 m resolution for 2 days ahead to refine the representation of extreme events occurring over Europe.

From weather to impact-sector information

Integrates impact sector models in the Digital Twin workflows, to transform meteorological data into user-relevant information.

DestinE Data Lake in a nutshell



DEDL is central component with three essential pillars

Distributed infrastructure

- Implementing near-data processing
- Data Bridges close to EuroHPC sites that host the ECMWF Digital Twins and big data providers such as EUMETSAT
- Storage of DestinE data

Discovery & Data Access

- Harmonisation of data access (HDA) to simplify data discovery & access
- External federated data spaces
- Digital Twin data (ECMWF):
- DestinE User generated data

Big Data Processing Services and Tools

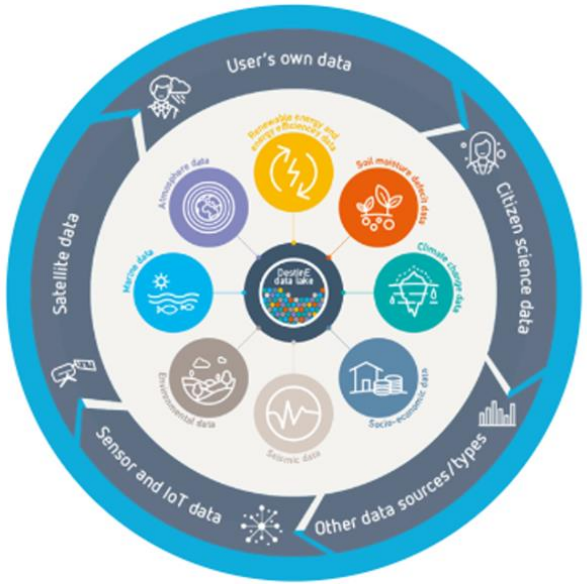
- Processing near data including distributed computing & workflows tools and services (i.e. ISLET)
- Supports & enables AI/ML applications

Harmonised Data Access

Around **200** collections

One credentials

Various data providers



HARMONISED DATA ACCESS

DT collections

Discovery and access data

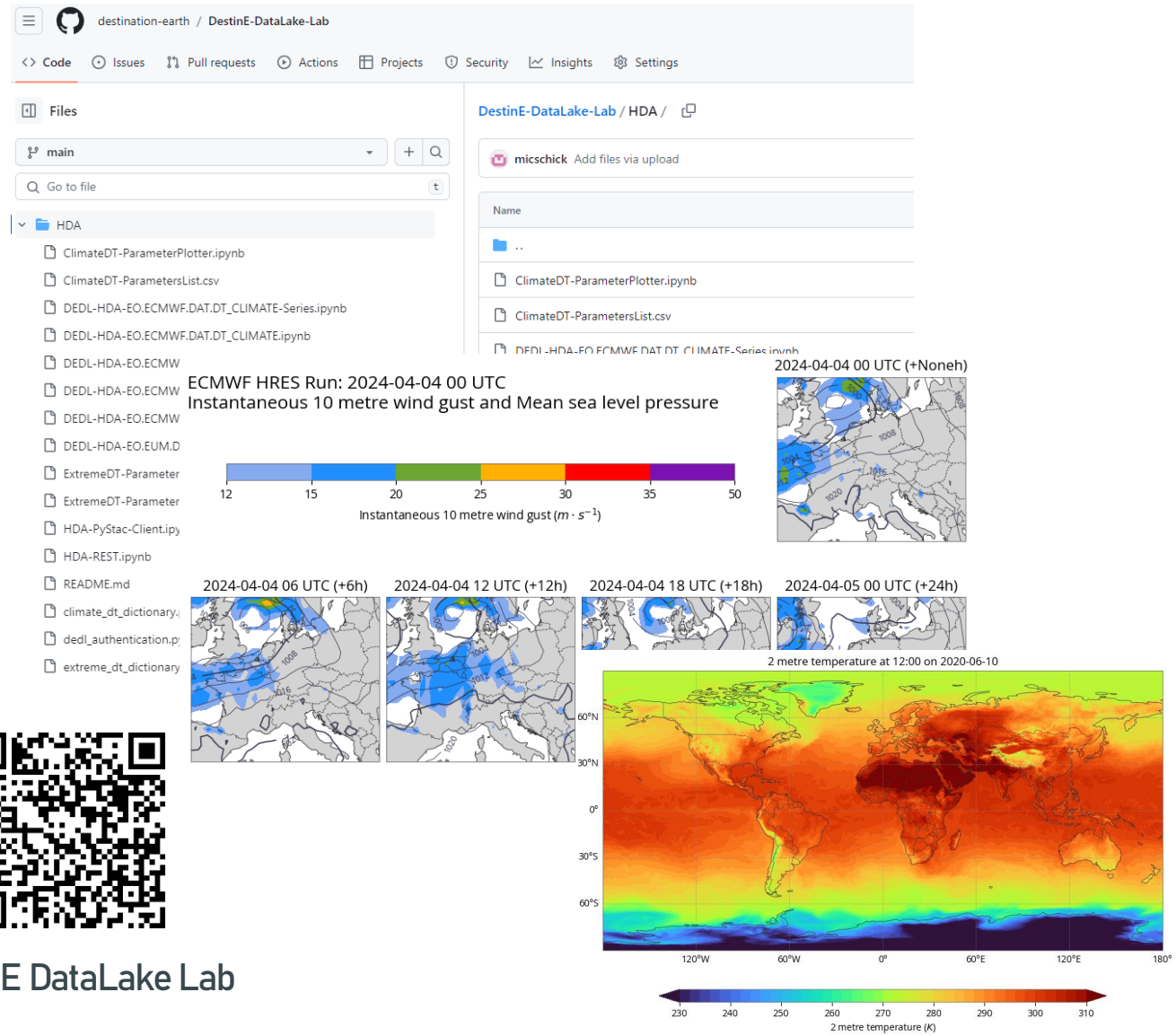
STAC

https://github.com/destination-earth/DestinE-DataLake-Lab

Harmonised Data Access

- Harmonised Data Access (STAC)
  - REST API client
  - PyStac-Client
  - EODAG (simple python API)
- Access DestinE Data Portfolio
- Datasets from multiple provider
- Protected datasets **(DT Data)**
- Quotas Group **based**

- Notebooks DestinE-DataLakeLab
  - From Insula, STACK
    - Climate DT plotter
    - Extreme DT plotter
    - HDA-PySTAC-Client
    - ....



DestinE DataLake Lab

DestinE Data Lake Cube

- Design and development of a new service exposing EUMETSAT and Copernicus datasets via a Cube interface (compliant to **OGC GeoDataCube** SWG recommendations)
- MVP supporting a subset of datasets to be delivered in June 2026
- Mixed approach: conversion of some datasets to Zarr + virtualized Zarr-like access to others
- Near-data processing capabilities: system and user-defined workflows
- Streaming API for efficient data loading in ML applications
- Service deployed and operated on EUMETSAT Data Bridge

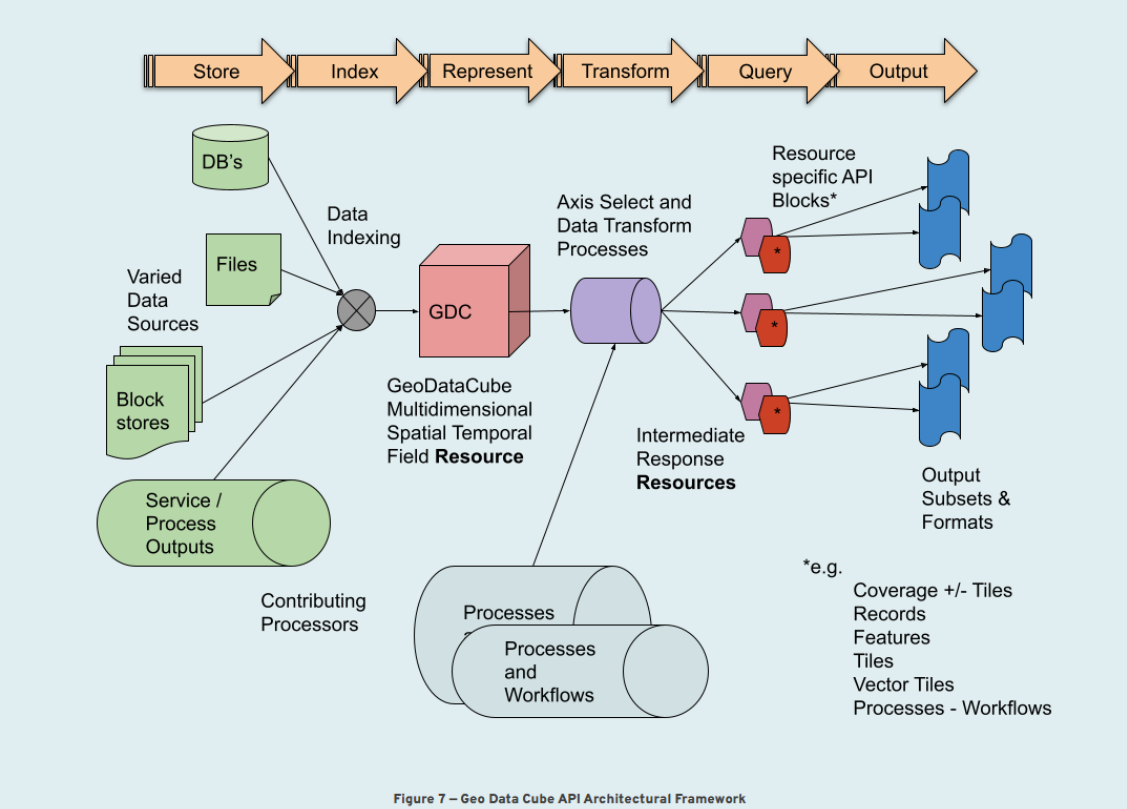
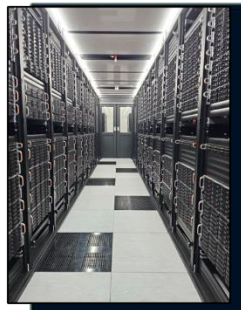


Figure 7 – Geo Data Cube API Architectural Framework



Data Lake distributed infrastructure

LUMI HPC — FINLAND, Kajaani — June 2023 — Nominal

Leonardo HPC — ITALY, Bologna — January 2024

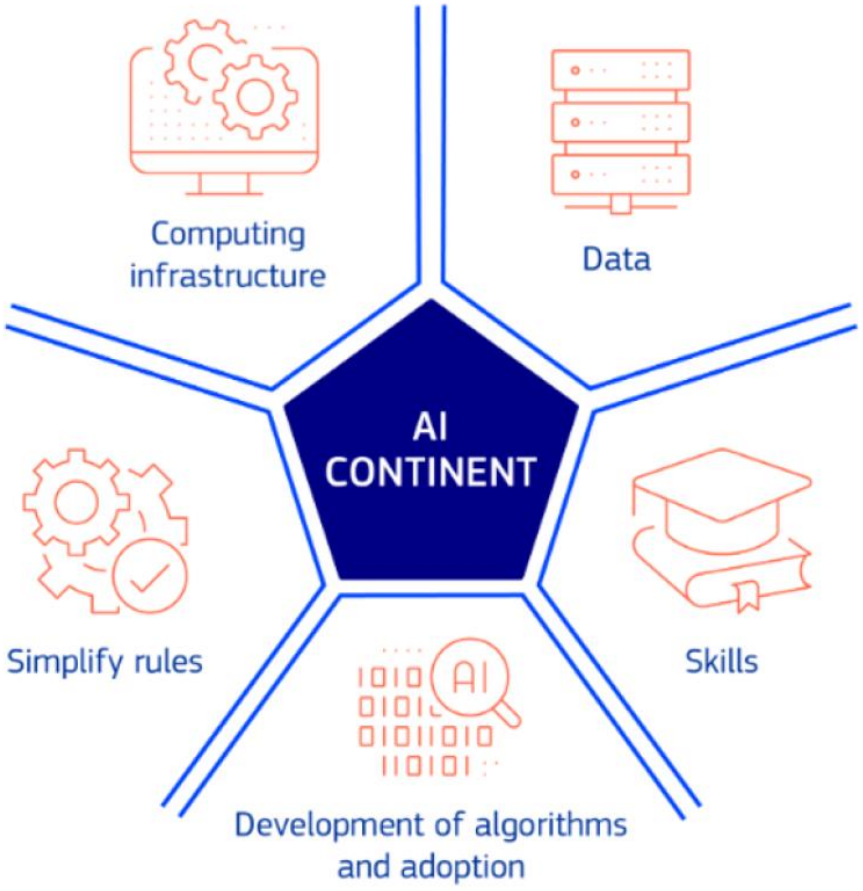
Mare Nostrum HPC — SPAIN, Barcelona — March 2025

EUMETSAT Data Center — GERMANY, Darmstadt — Dec 2024

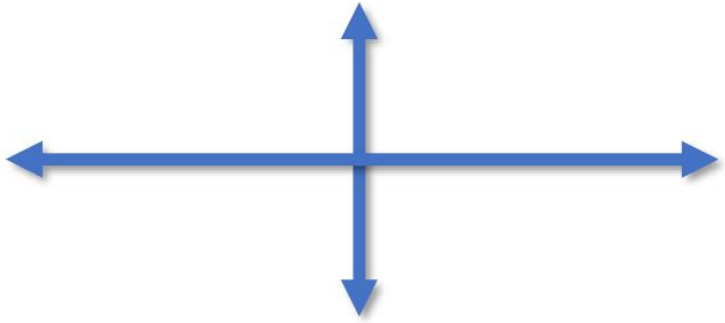
CloudFerro Data Center — POLAND, Warsaw — September 2022

Totals	
Storage (PB):	120
CPUs:	20450
GPUs:	66
Datasets:	+200

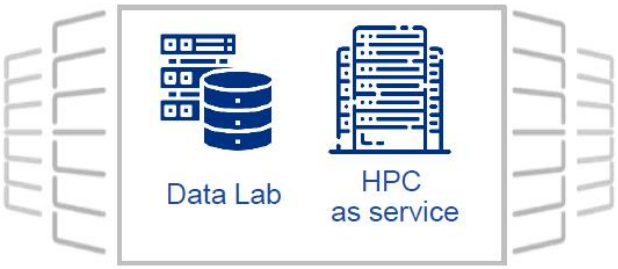
DestinE + AI Factories + DataSpaces



Destination Earth



AI Factory



Data Spaces

Data Spaces Considerations in Context of DestinE

Several initiatives on connecting Data Spaces

- DestinE, EOSC, CDSE, WEkEO ...
- SIMPL => Smart Middleware Platform

from “FAIR/O”

- Finable, Accessible, Interoperable, and Reusable /open license

towards “FIRST”

- Findable, Interoperable, Reusable, **Streamable**, **Transformable**

Harmonise/ Standardise

AI requires

- Analysis Ready Data => AI Ready Data
- Model Context Protocol Server (MCP)

Loosely coupled Data Spaces (federated vs monolithic)

Process near data and Transform & Stream
only what is needed !

Pangeo

DASK

xarray

Open Geospatial Consortium

STAC SpatioTemporal Asset Catalog

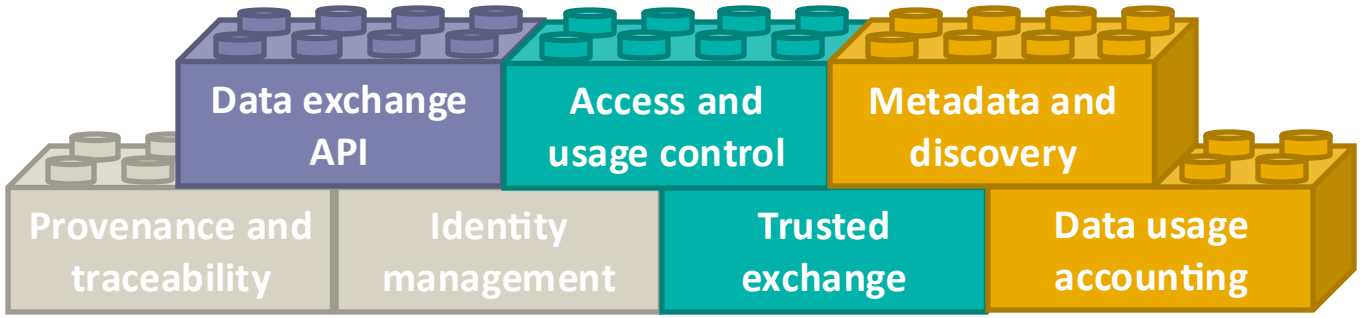
Zarr

python

Destination Earth

SIMPL is the smart middleware that will enable cloud-to-edge federations and **support all major data initiatives** funded by the European Commission, such as the **common European data spaces and DestinE**

SIMPL - Smart Middleware Platform
- Simpl-Open – middleware itself
- Simpl-Labs – Infrastructure & test beds
- Simpl-Live – Deployments of Simpl-Open




SAVE THE DATE!
Fifth Destination Earth
User eXchange
9-10 June 2026
Brussels, Belgium
Funded by
the European Union
Destination Earth
implemented by
ECMWF
esa
EUMETSAT
in partnership with
RMI