Destination Earth: first high-priority Digital Twins

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Funded by the European Union

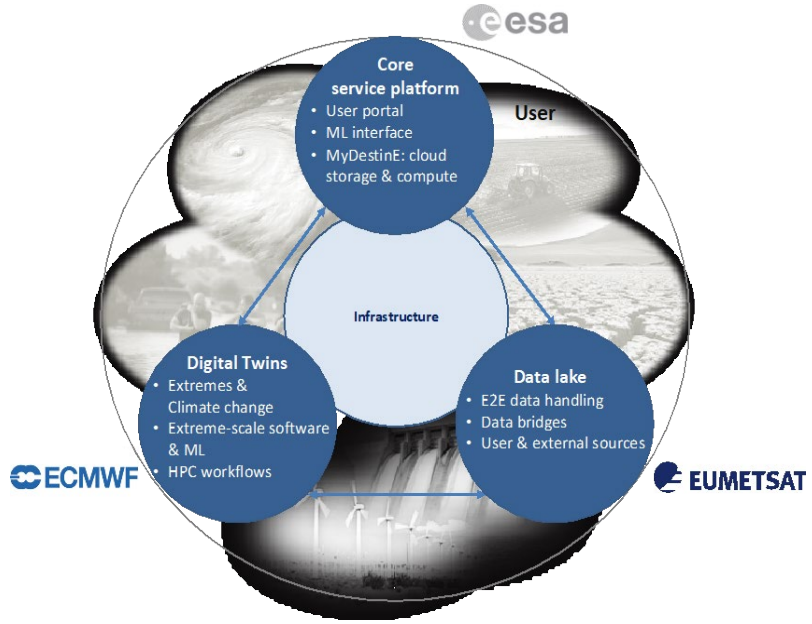
European's Commission Destination Earth (DestinE) initiative

Key initiative, announced in:

- A European Green Deal (2019)
- A European strategy for data (2020)
- Shaping Europe's digital future (2020)

Towards a Digital Twin Earth

DestinE entrusted entities



2021-2023

- Operational cloud-based platform
- First two digital twins

2023-2025

Platform integrates the next operational digital twins and offers services to public sector users

2025-2027+

Towards a full "digital twin of the Earth" through a convergence of multiple digital twins on the platform

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Courtesy Grazyna Piesiewicz, DG-CNECT

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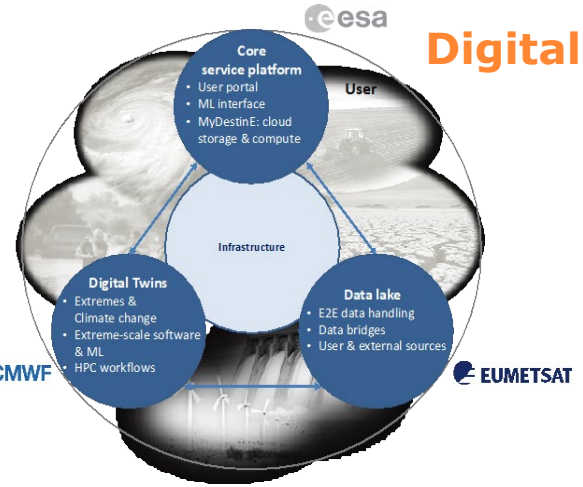
Partnerships across programmes



Digital twins/Platform/Lake

Services

Technology & infrastructures

Earth-system & impact science

European Environment Agency

Destination Earth | EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

opernicus
Europe's eyes on Earth

GAIA-X

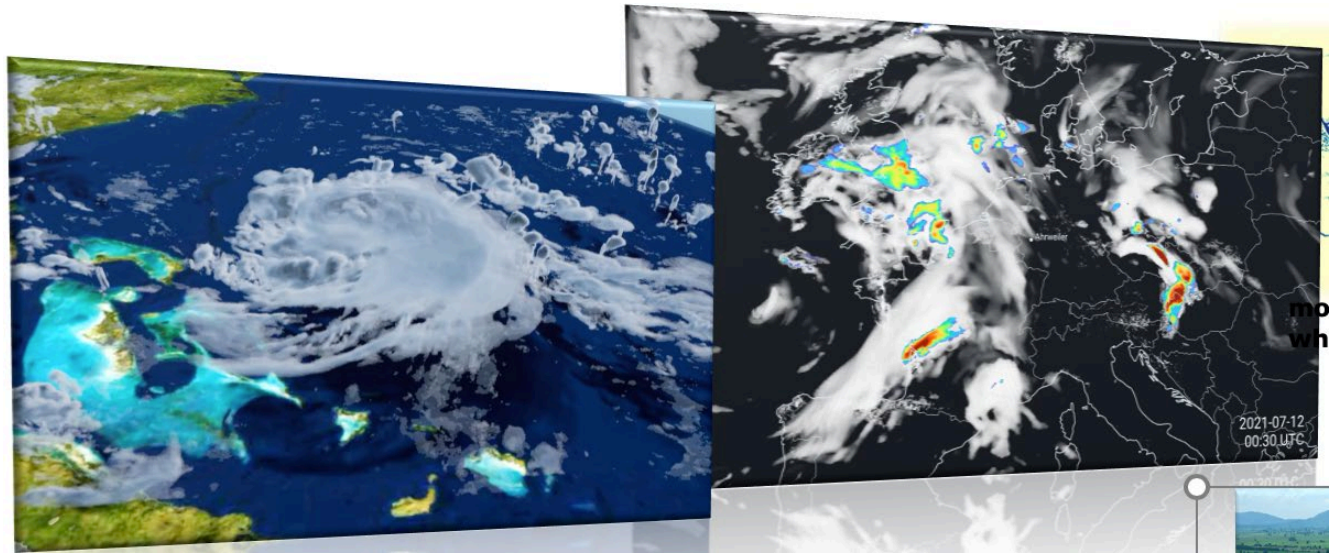
EuroHPC Joint Undertaking

FENIX RESEARCH INFRASTRUCTURE

EUROPEAN OPEN SCIENCE CLOUD

Expected break-throughs: Quality, Impacts, Interaction

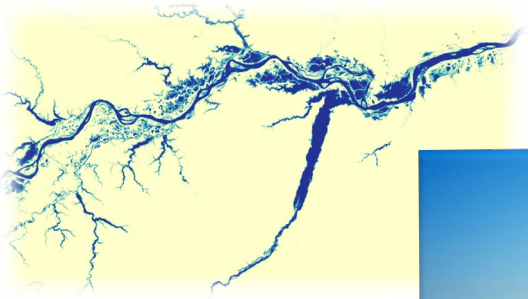
1. **Better simulations** based on **higher-resolution, more realistic, models**
2. **Better ways of combining all observed and simulated information** from entire Earth system: physical + food/water/energy/health + action
3. **Interactive and configurable access to all data, models and workflows**



more reliable *global* simulations

more reliable *local* simulations

effective adaptation and mitigation, scenarios



model *impacts* where they matter

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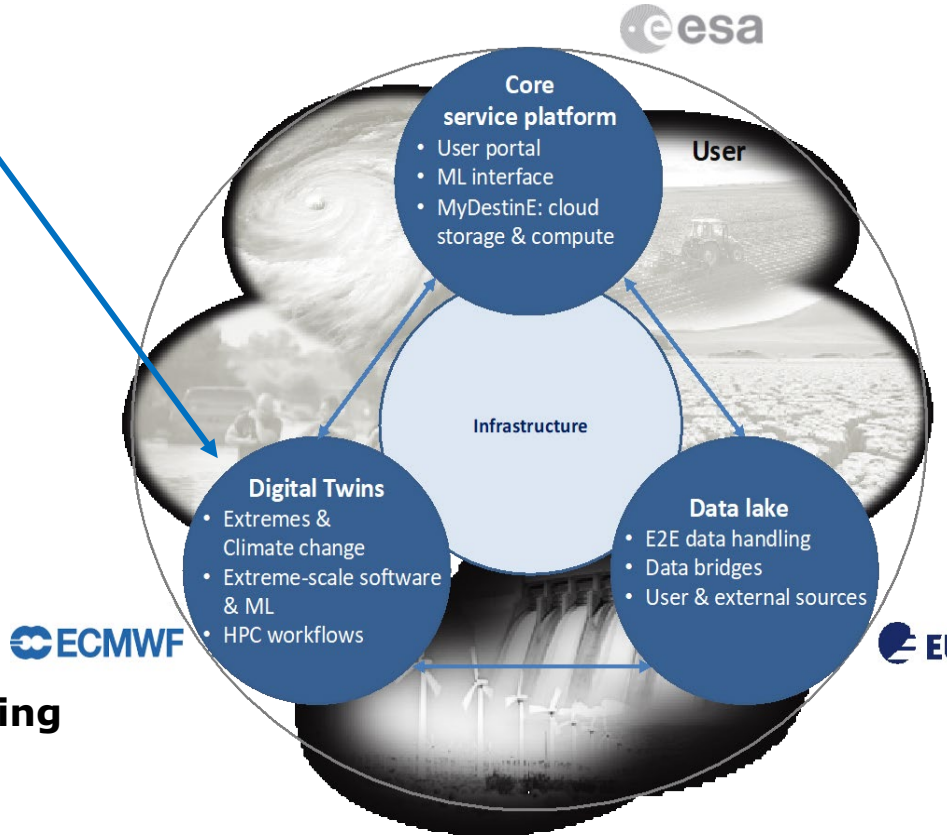
ECMWF's role in DestinE : Digital Twin Engine & Digital Twins

The DestinE **Digital Twin Engine** (DTE):
- common approach for a unified orchestration of Earth-system simulations and their fusion with observations, requiring **large-scale HPC** resources

Weather-induced and Geophysical **Extremes Digital Twin**:
- capabilities and services for the assessment and prediction of **environmental extremes**

Climate Change Adaptation **Digital Twin**:
- capabilities and services in support of climate change **adaptation policies and mitigation scenario** testing



ECMWF:
- Acknowledged **world-leader** in medium-range **weather prediction**
- Decades of experience in **extreme-scale computing and data handling**
- **Delegated authority** for **C3S** and **CAMS**; supports CEMS

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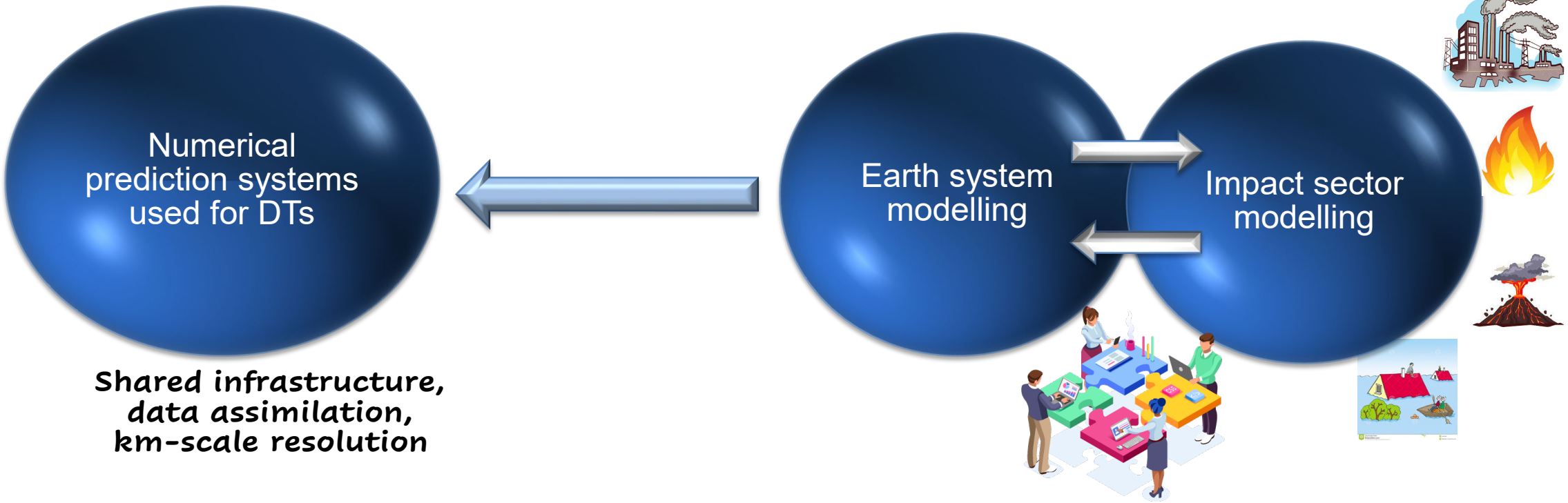
The first two Digital Twins: scientific vision

Stronger convergence of weather & climate prediction systems

Integrated Earth-system & impact-sector modelling



Shared infrastructure, data assimilation, km-scale resolution

Codesign with users

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The first two Digital Twins: production modes

Continuous production mode

time

extreme event

on-demand, USER driven:
- regional, hyper-resolution
- more frequent updates
- added data
- impact sector specific extensions
- adaptation/mitigation scenarios

on-demand, EVENT driven:
- regional, hyper-resolution
- more frequent updates
- added data
- impact sector specific extensions
- adaptation/mitigation scenarios

Lists not exhaustive;
not all capabilities fully developed in phase 1

The first two Digital Twins: content

ECMWF:

Extremes Digital Twin (global, continuous)

- Earth-system observation fusion/assimilation and initialization
- Earth-system modelling and simulations **at storm-resolving scale, a few days ahead**
- Evaluation and uncertainty quantification
- Workflow set-up and monitoring
- End-to-end demonstration at scale with timely delivery

Procured (March 2022)
Extremes Digital Twin (on-demand):

- **(as above)**
- Earth-system modelling and simulations **at sub-km-scale, a few days ahead**
- Configurability for geographical and extremes types, spatial resolution, coverage, temporal refresh, ensembles
- Use cases for selected impact-sectors

Procured (March 2022)
Climate Digital Twin (continuous and on-demand):

- **(as above)**
- Earth-system modelling and simulations **at storm/eddy-resolving scale, multi-model, multi-decadal timescales**
- Use cases for selected impact-sectors

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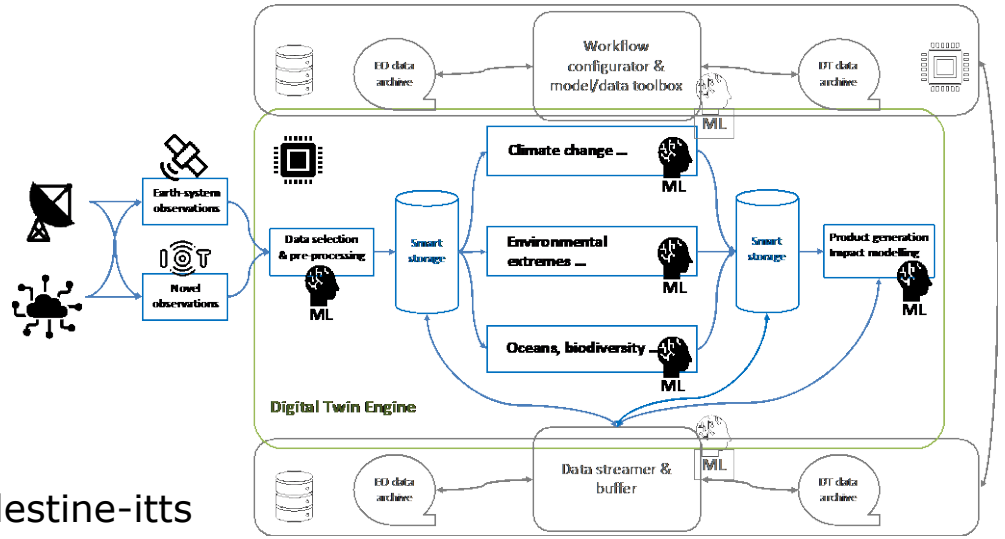
Phase 1 (2021-2024): Delivery of 1st digital twin generation; demonstration of new capabilities at scale

Outcomes:

- Establish *Digital Twin Engine* – demonstrate at scale on EuroHPC
- Implement *Extremes DT*: science, technology, impacts, use cases – demonstrate
- Implement *Climate DT*: science, technology, impacts, use cases – demonstrate
- Develop near-DT *interactive tools* and future *digital technology agenda*
- Co-develop *partnership programme*

Status:

- Extremes & Climate DT tenders now closed*
- visualization tools and technology agenda tenders, use cases open or upcoming
- EuroHPC access to be confirmed



* https://www.ecmwf.int/en/about/suppliers/destine-procurement/update-destine-itts

Phase 2+ (2024-): Further develop the weather and climate DTs, fully integrate impact-sector elements; widen DTE scope, include other DTs

DestinE will contribute to revolutionising the European capability to monitor and predict our changing planet, complementing existing national and European efforts such as those provided by the national meteorological services and the Copernicus Services

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