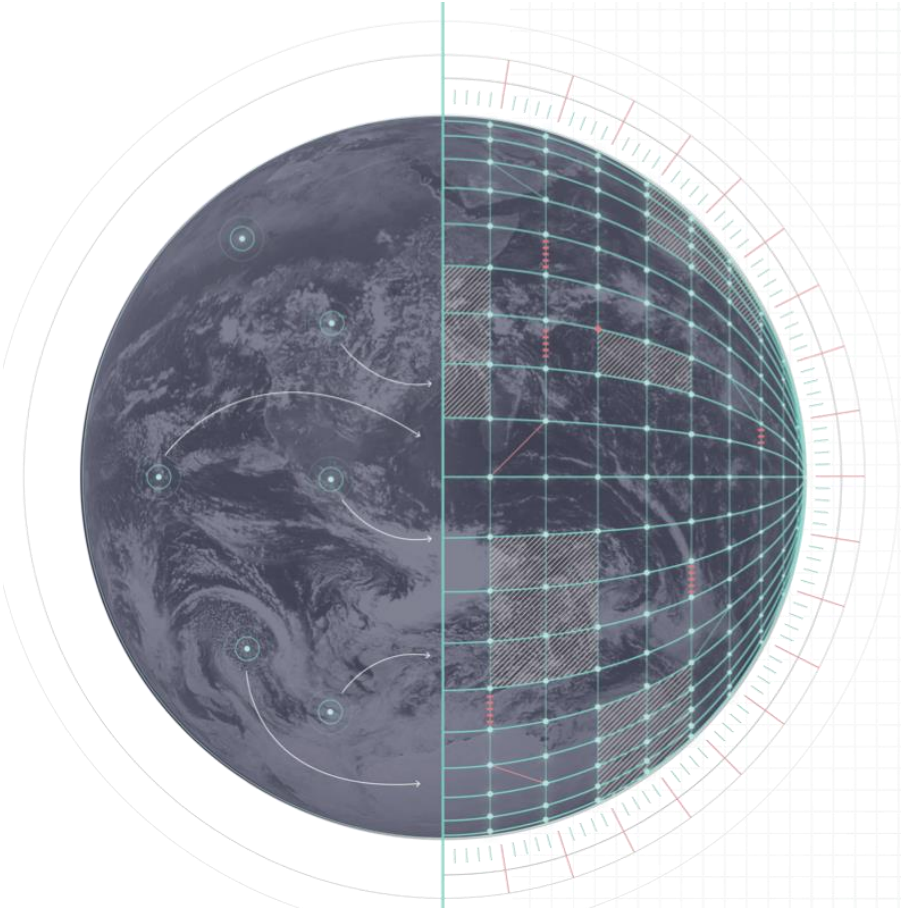


DESTINATION EARTH

ÜBERBLICK UND STATUS

Jörn Hoffmann, ECMWF

FFG Vernetzungsveranstaltung

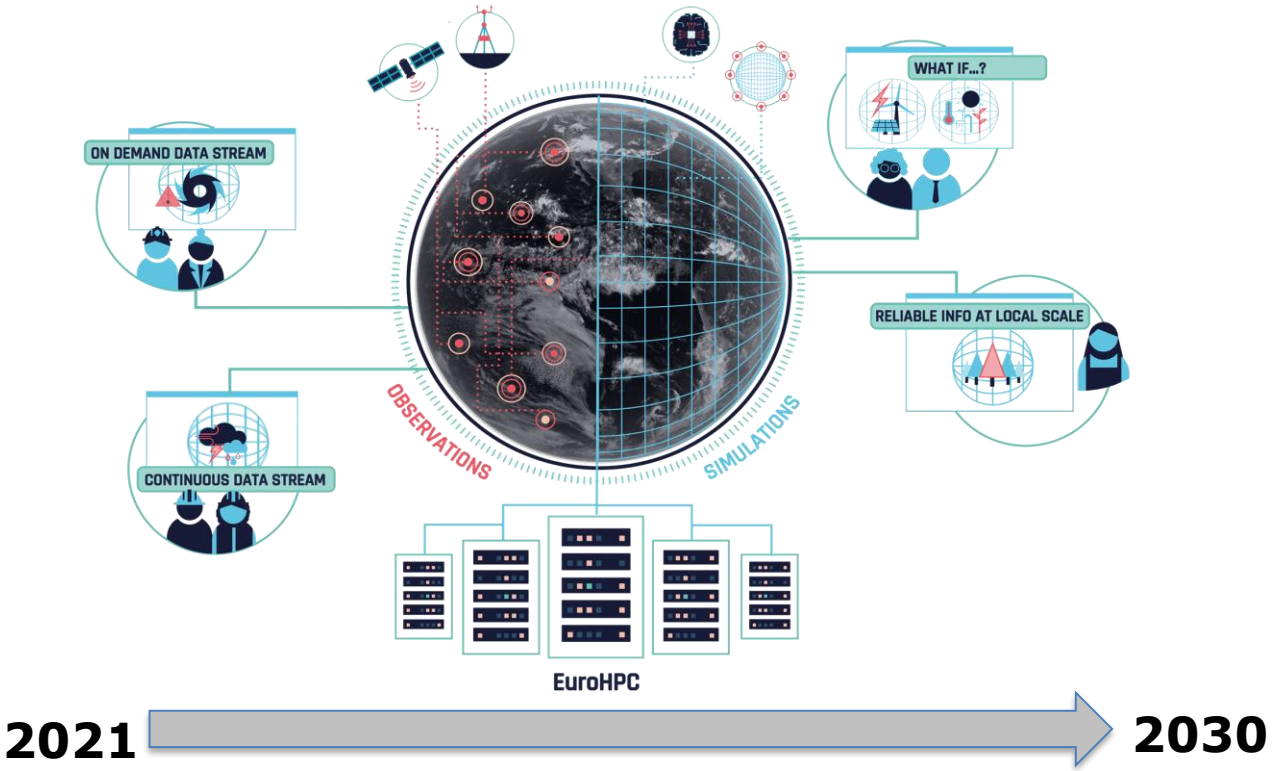
zur Ausschreibung “Digitaler Zwilling Österreich”

17. Januar 2024

Funded by the European Union

Destination Earth implemented by ECMWF esa EUMETSAT

The DestinE System

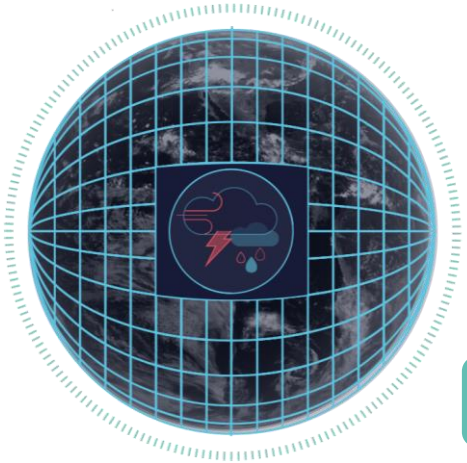


Two high-priority Digital Twins

To support decision making for real-time response to extreme events

Timescale of 2-5 days ahead (1h to sub-hourly output)

Km-scale resolution 1-4 km globally, 500-750m regionally



Run regularly & on demand & configurable

Decision-driven data analytics

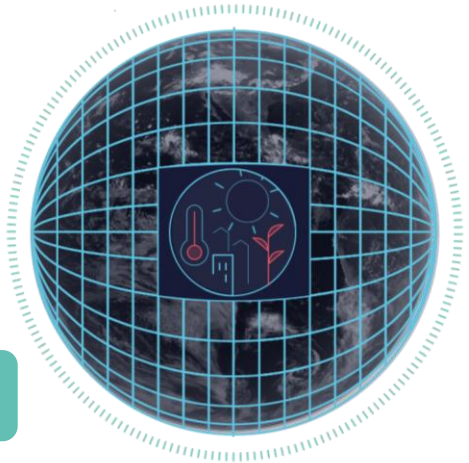
Weather-induced extremes

To support the efforts of defining and planning activities linked to climate change adaptation

Multi-decadal timescales (2020 to ~2050) (1h to 6 hours output)

Global multi-decadal projections operationalised

Km-scale resolution globally (5km)



Climate change adaptation

Exploiting the leading European HPC platforms

No 3 TOP500

LUMI

No 4 TOP500

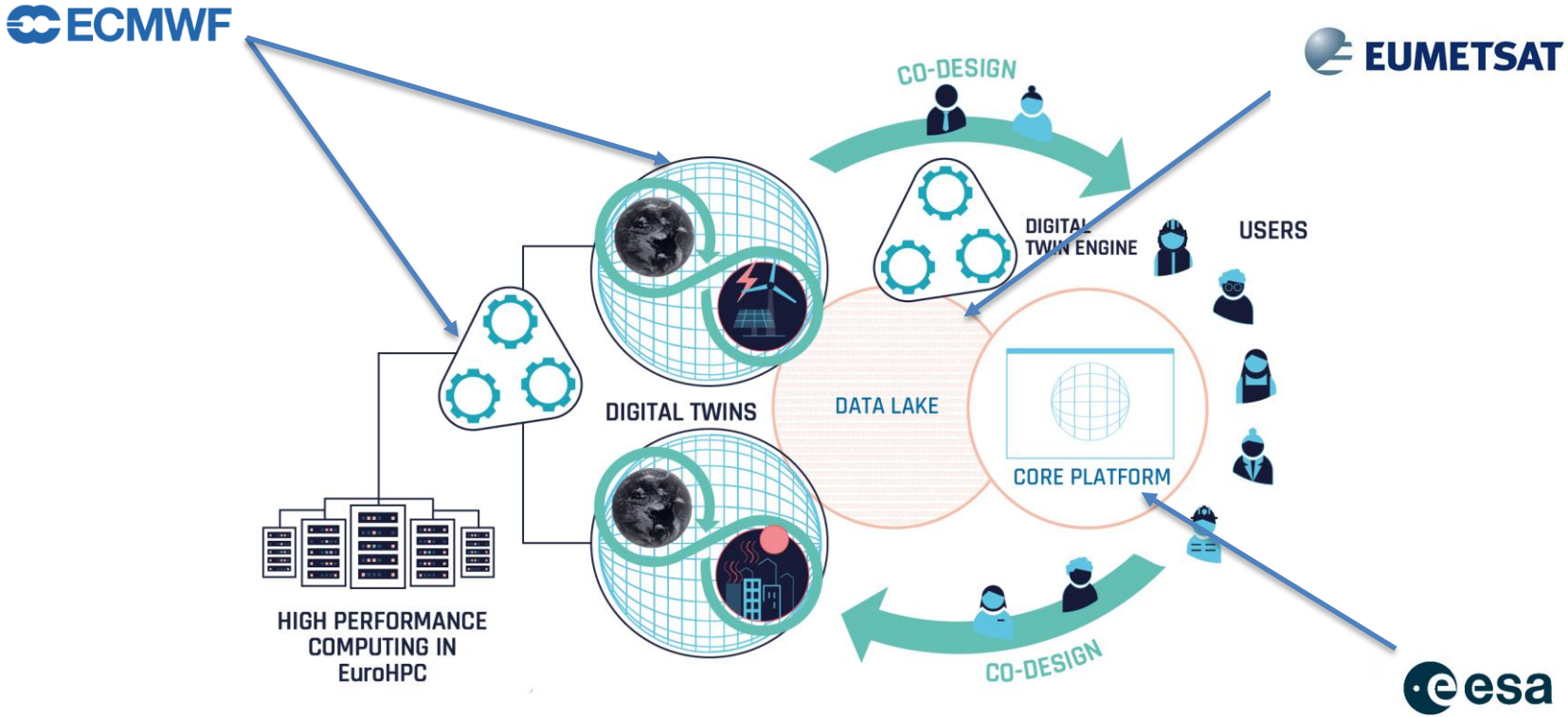
LEONARDO

MareNostrum

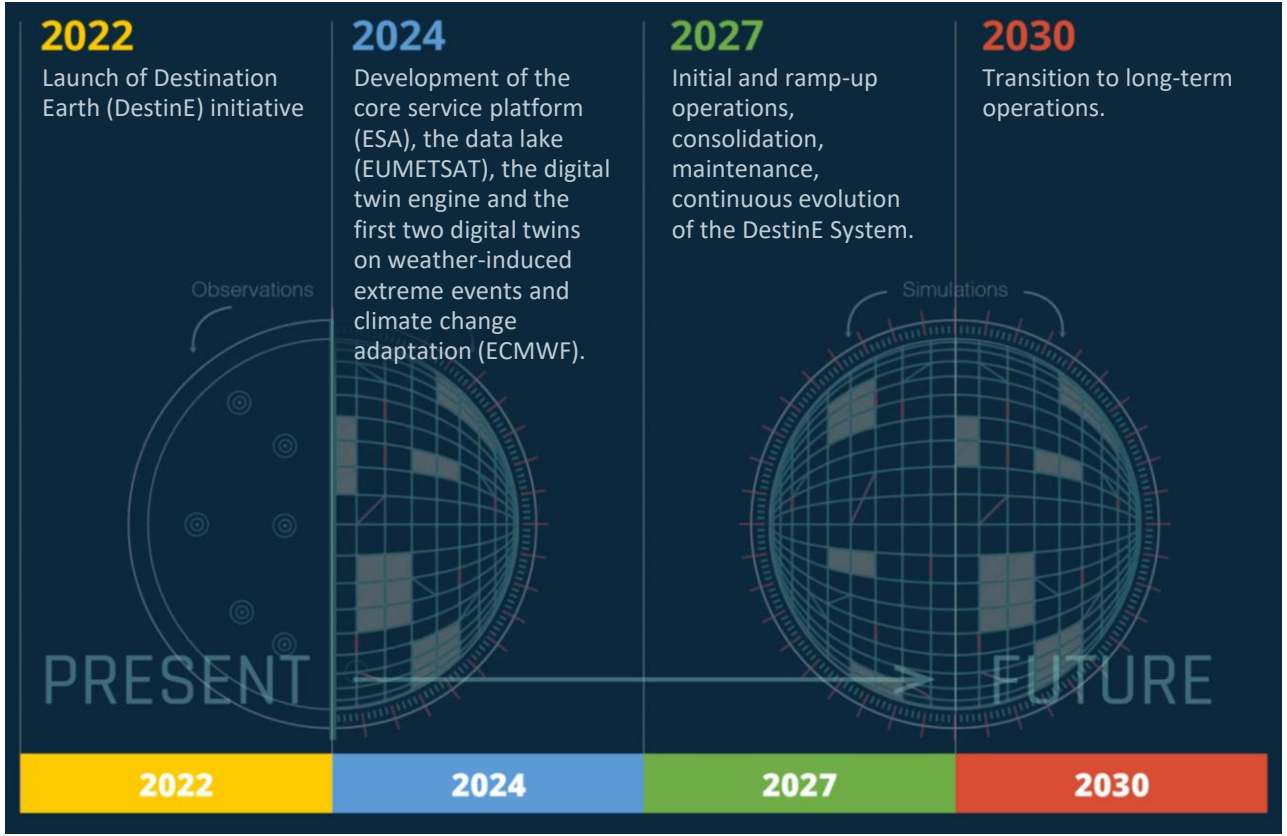
EuroHPC Joint Undertaking

ECMWF

DestinE System Components

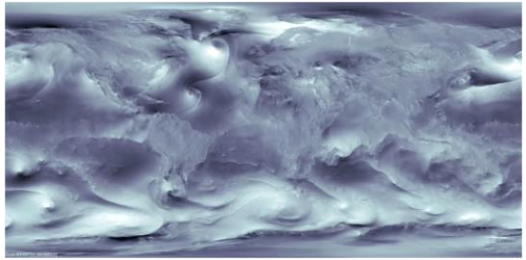


Implementation: Phasing

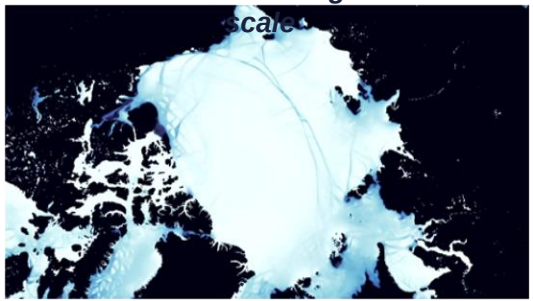


Digital Twin Features

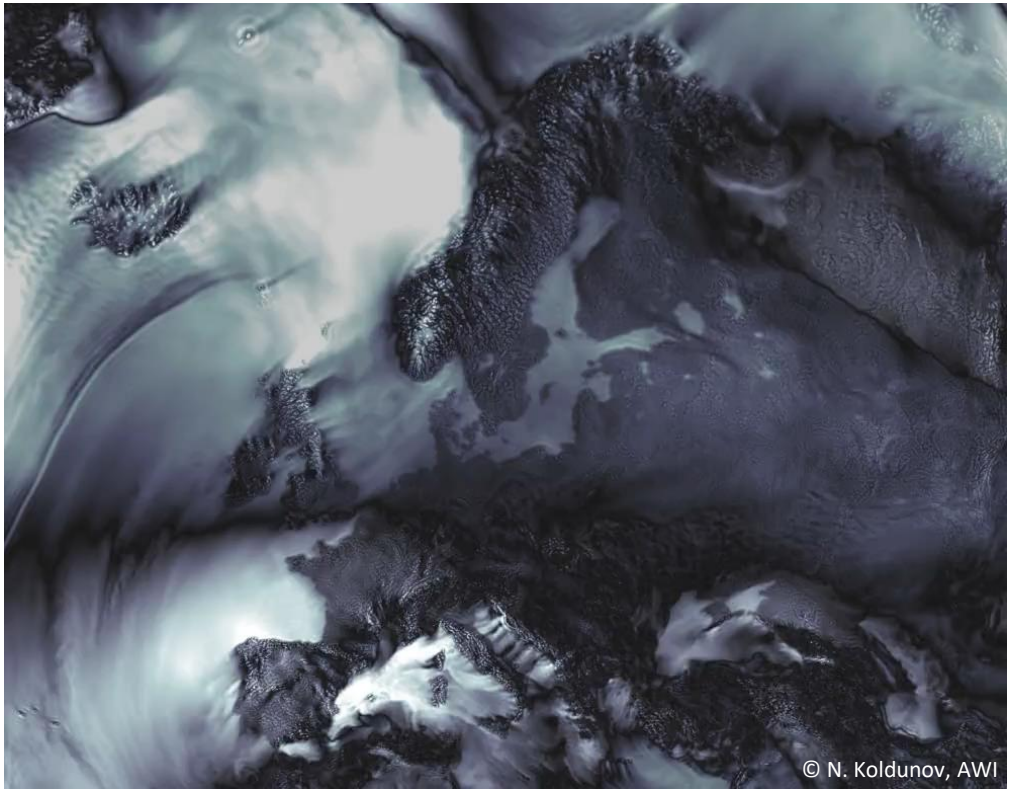
QUALITY



More realistic at global scale

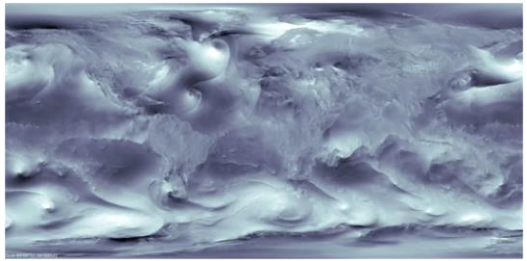


More realistic at local scale

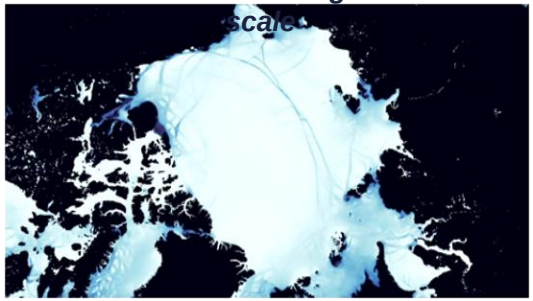


Digital Twin Features

QUALITY

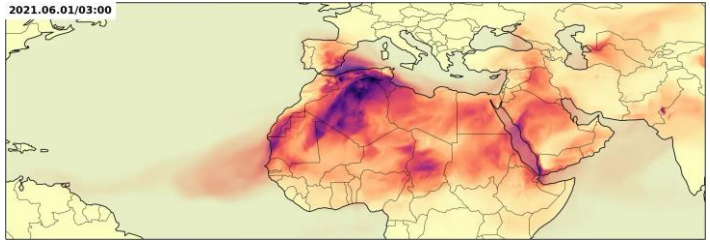


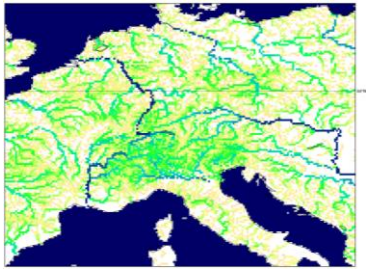
More realistic at global scale



More realistic at local scale

IMPACTS

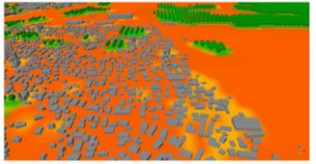




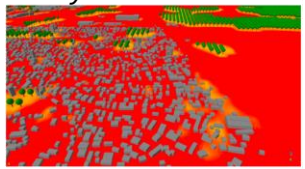
Include impacts where they matter

INTERACTIVITY

City A in a +2 world



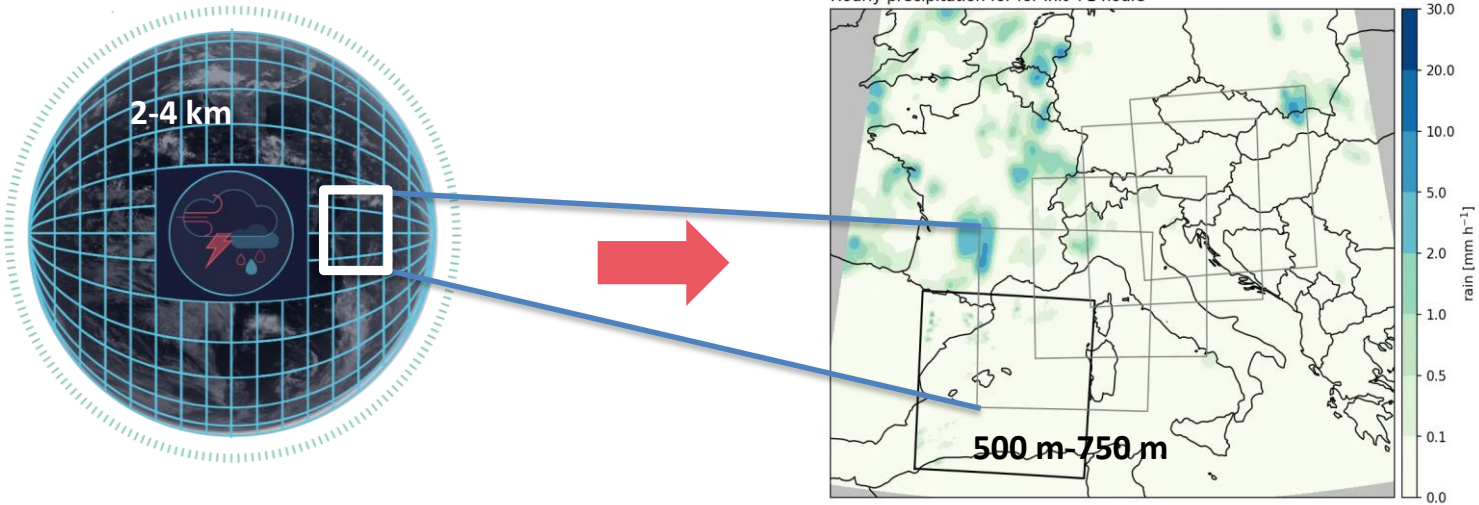
City A in a +4 world



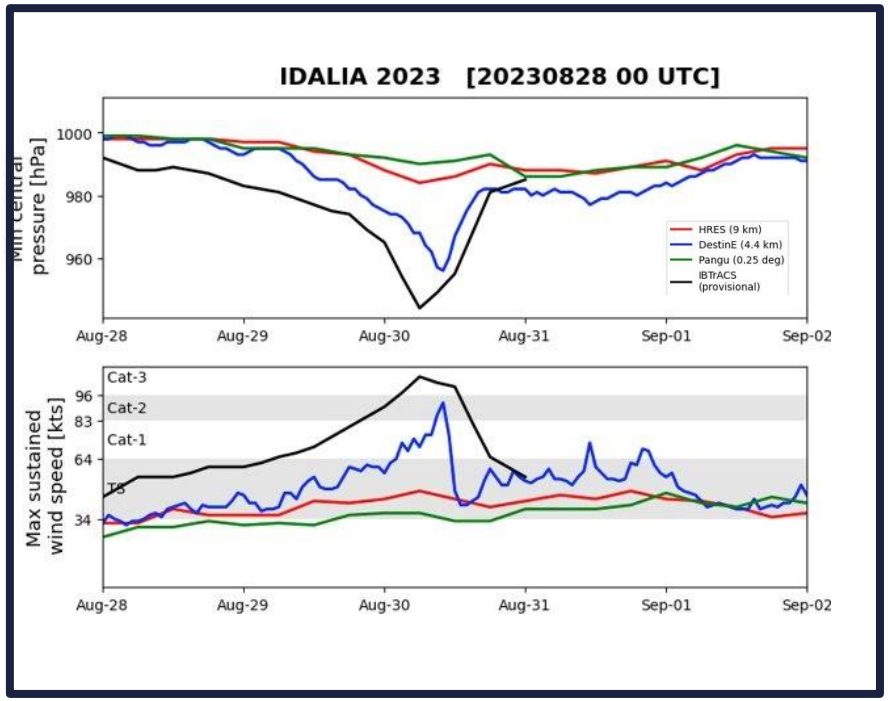
Extremes DT: Continuous and on demand

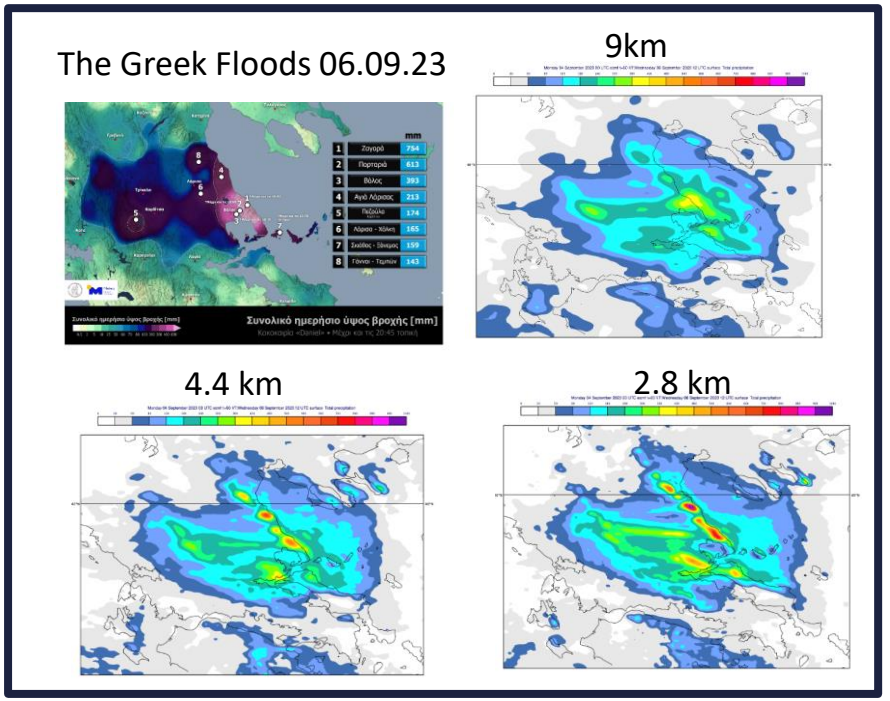
Continuous global component

On-demand regional component

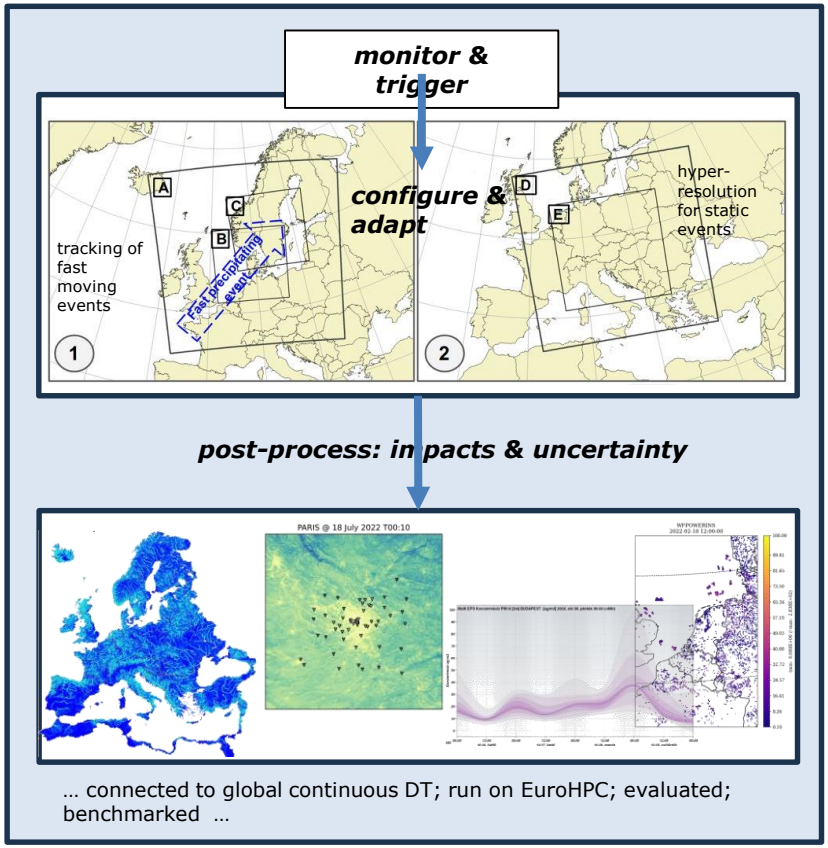


Global Extremes DT: examples





On-demand Extremes DT



Phase 1 delivery:

- Pilot DT launch for selected use cases with full on-demand DT workflow including triggering, configuring, input data, NWP and application runs, and output management.
- Demonstrate capacity to run on EuroHPC (specifically LUMI) targeting the GPU partition
- Demonstrate the capability of methods specifically designed for extreme event detection and subsequent triggering of hyper-resolution NWP and impact models
- Demonstrate various post-processing techniques specifically designed for extremes in an on-demand environment

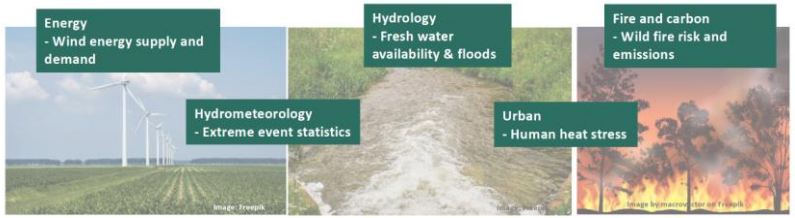
Climate DT – a novel workflow

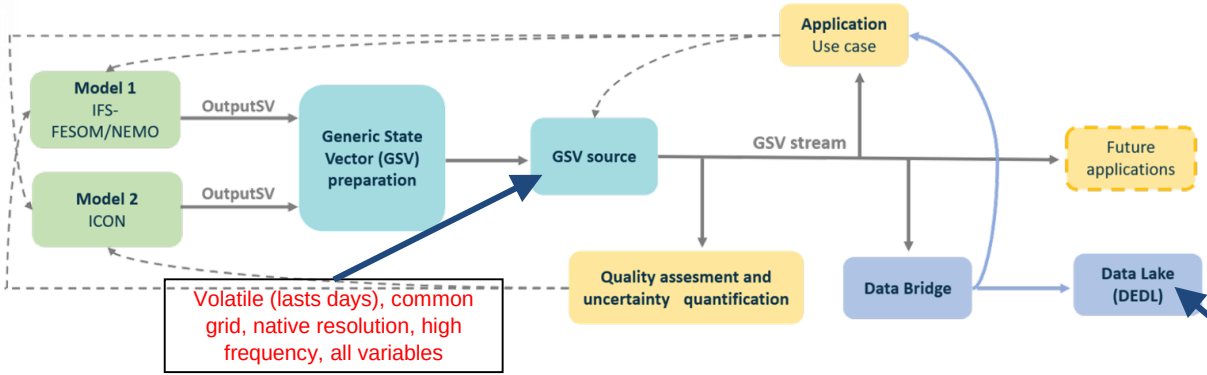
Phase 1 delivery:

- Multi-decadal climate simulations at production resolution (~5-10 km)
- Time slices & nudging capabilities, observation monitoring framework
- Model tuning t & improved climate readiness
- Deployment on EuroHPC & optimization
- Implementation of the end-to-end workflow
- All diagnostics implemented for monitoring purposes
- Active user interaction for building storylines

CSC

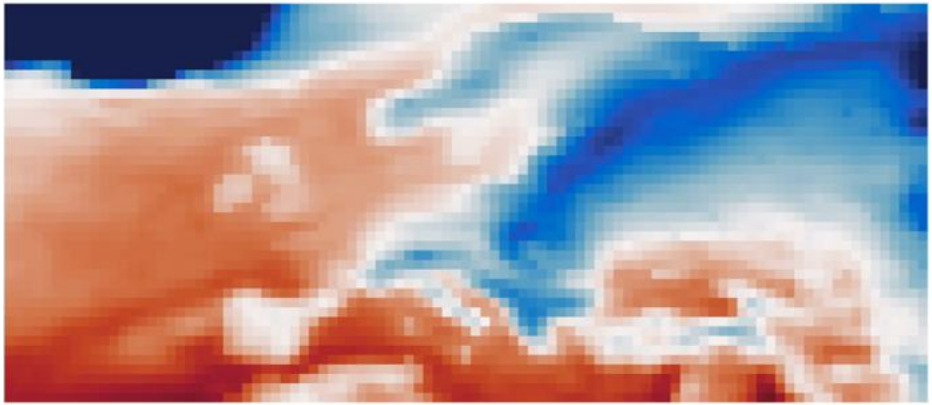
CSC	CSC – IT Center for Science	FI
BSC	Barcelona Supercomputing Center/Centro Nacional de Supercomputación	ES
MPI - M	Max Planck Institute for Meteorology	DE
UH	University of Helsinki	FI
AWI	Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research	DE
CNR-ISAC	Consiglio Nazionale delle Ricerche, Instituto di Scienze dell'Atmosfera e del Clima	IT
POLITO	Politecnico di Torino	IT
FMI	Finnish Meteorological Institute	FI
DWD	National Meteorological Service of Germany	DE
UFZ	Helmholtz Centre for Environmental Research	DE
UCLouvain	Université catholique de Louvain	BE
DKRZ	German Climate Computing Centre	DE
HPE	Hewlett Packard Enterprise	FR



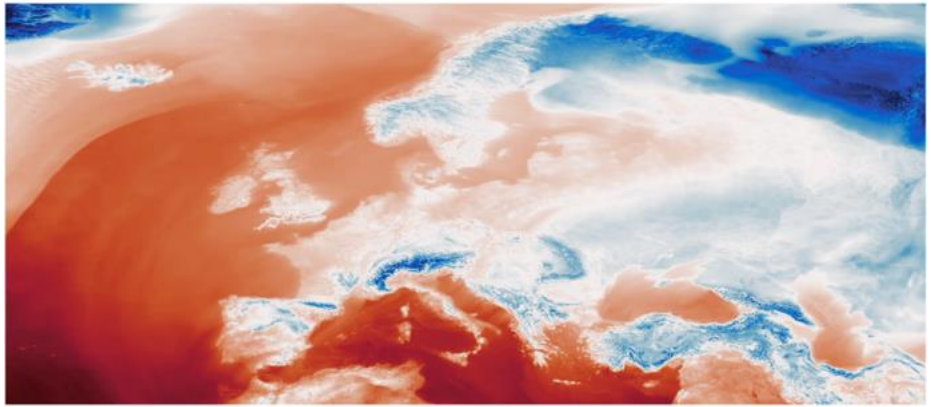


ECMWF

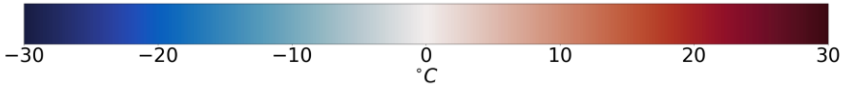
Global Information with Local Granularity



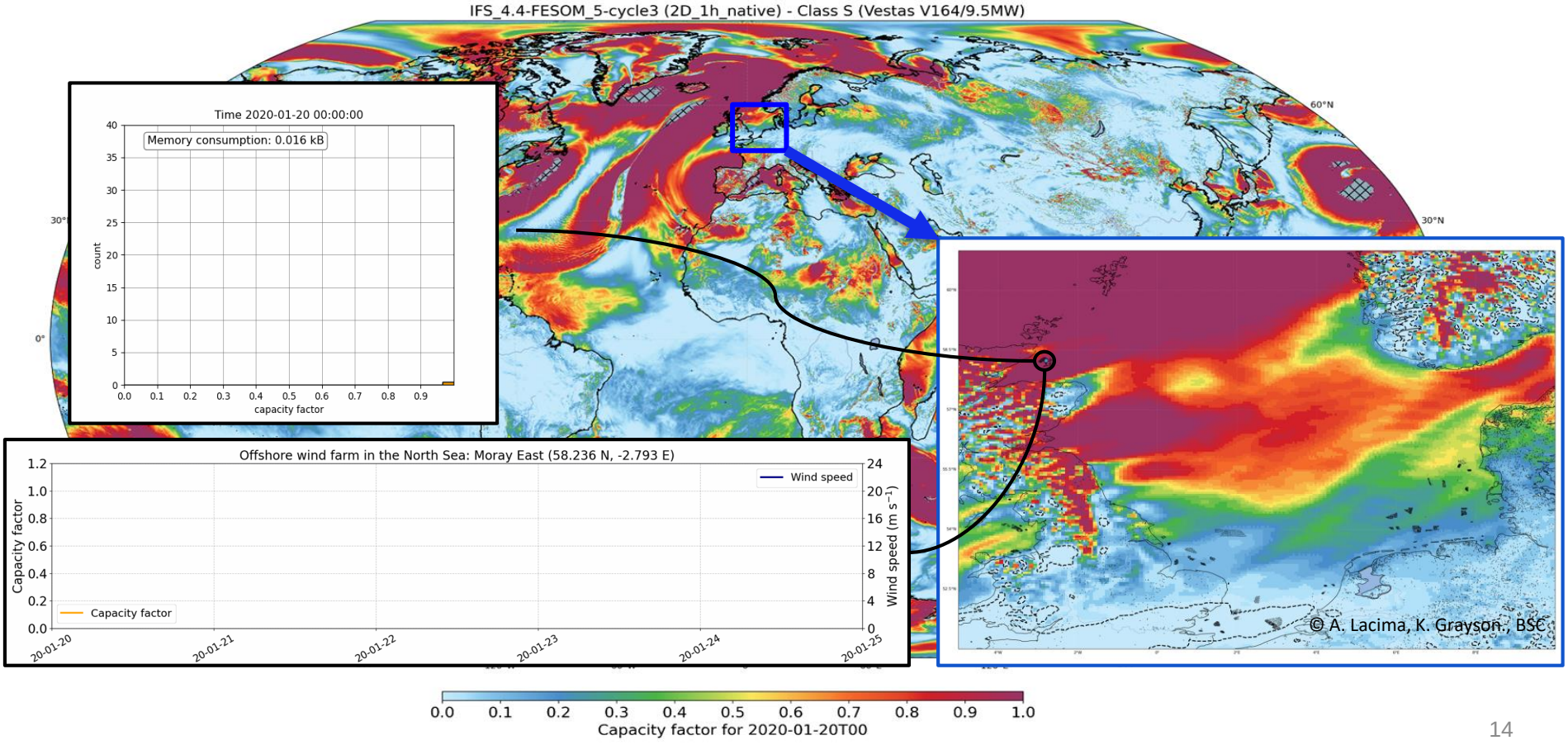
IPCC AR6 (2021), 100km



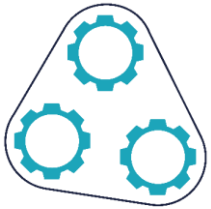
Digital Twin, 5km



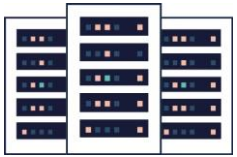
Tailoring the information to user needs



The Digital Twin Engine

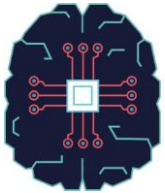


Software environment



Ensuring complex simulations are run efficiently on EuroHPC

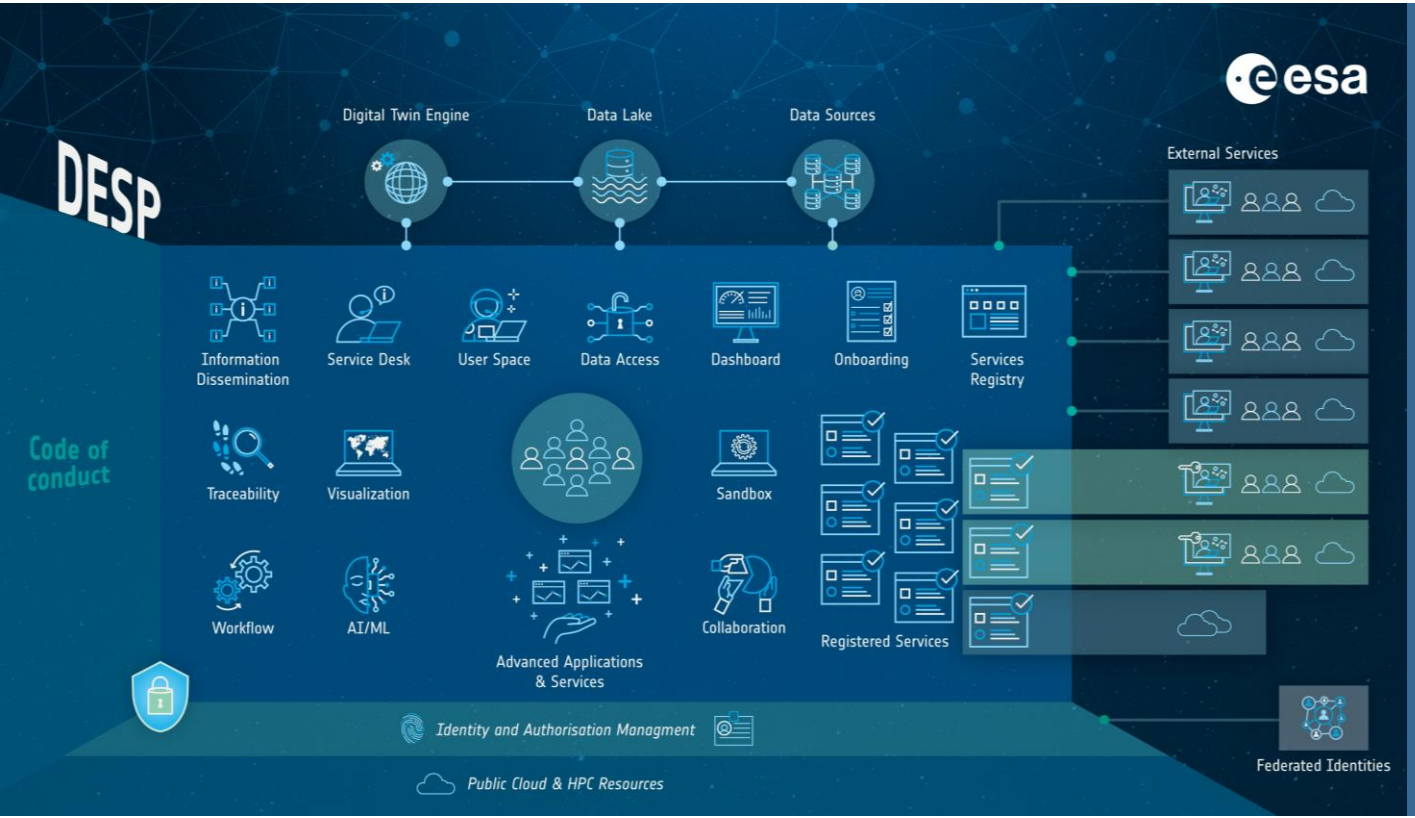
Powering the digital twins and managing big data



Using ML/AI to increase the efficiency of the digital twins and estimate uncertainty

Tailoring information to user's needs and interactivity

The DestinE Core Service Platform



An Ecosystem of services to :

- Access **infrastructure** services
- Access **Data** or **Information**
- Create new **workflows**
- Promote new **services**
- Streamline **collaboration**
- Offer cutting edge advantages to transfer new services in **operation**

DESP overview

Users landing on DESP can *discover the DestinE Ecosystem*, thanks to informative pages and engaging material on DestinE Activities and Services.

Registered Users will have access to:

- *Service Catalogue*
- *Community*
- *Specialized Service Desk*
- *Technical Resources and Trainings*

DestinE Data Lake

EUMETSAT

Design

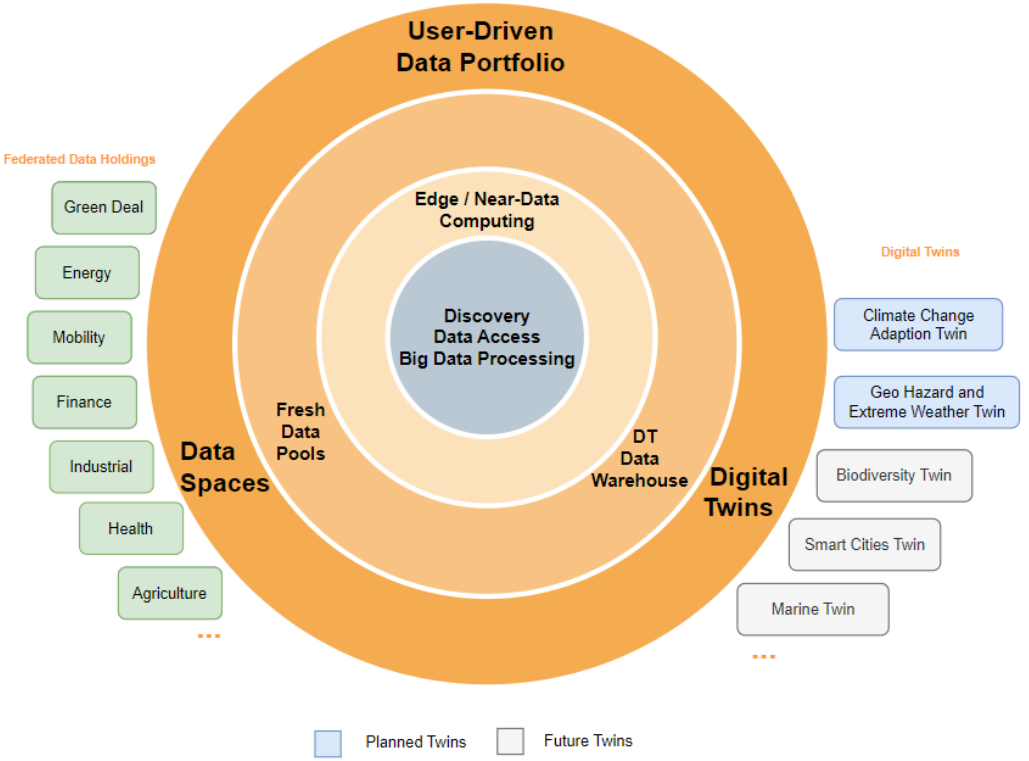
- Built from geographically distributed physical elements (central & edges)
- Distributed services – seamless access
- Implemented via European Industry

Discovery & Data Access

- Harmonised data access (HDA) to simplify data discovery & access
- External federated data spaces

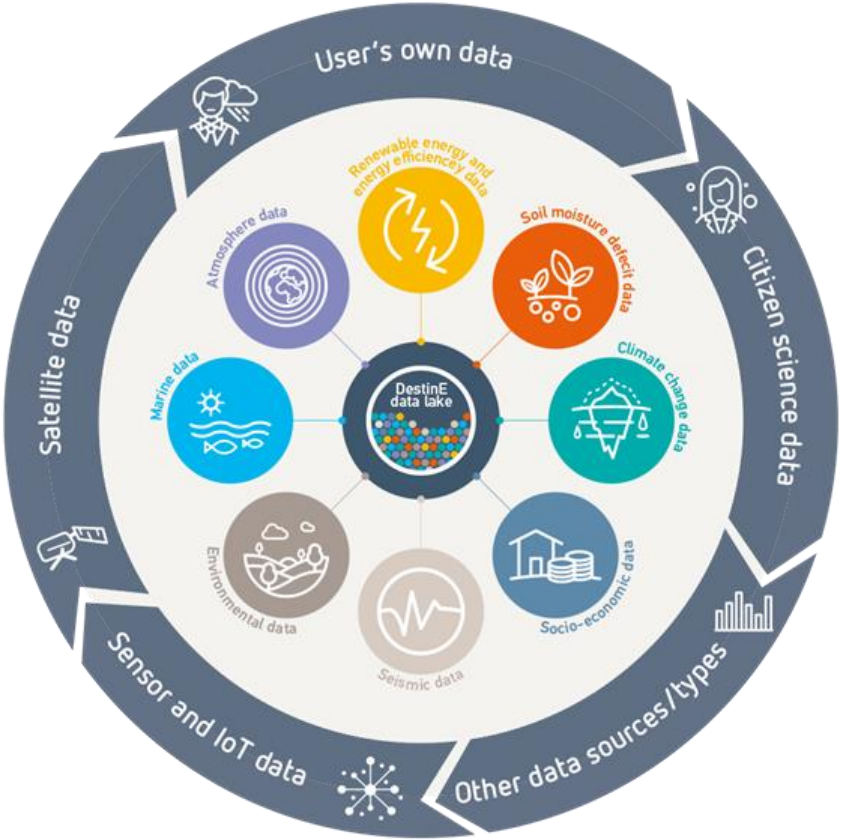
Big Data Processing

- Processing near data including distributed computing & workflows
- Supports & enables AI/ML applications



ECMWF

DestinE's Evolving Data Portfolio



Digital Twins Data

- Climate Change Adaptation
- Extreme Weather and Geo hazards

Federated datasets

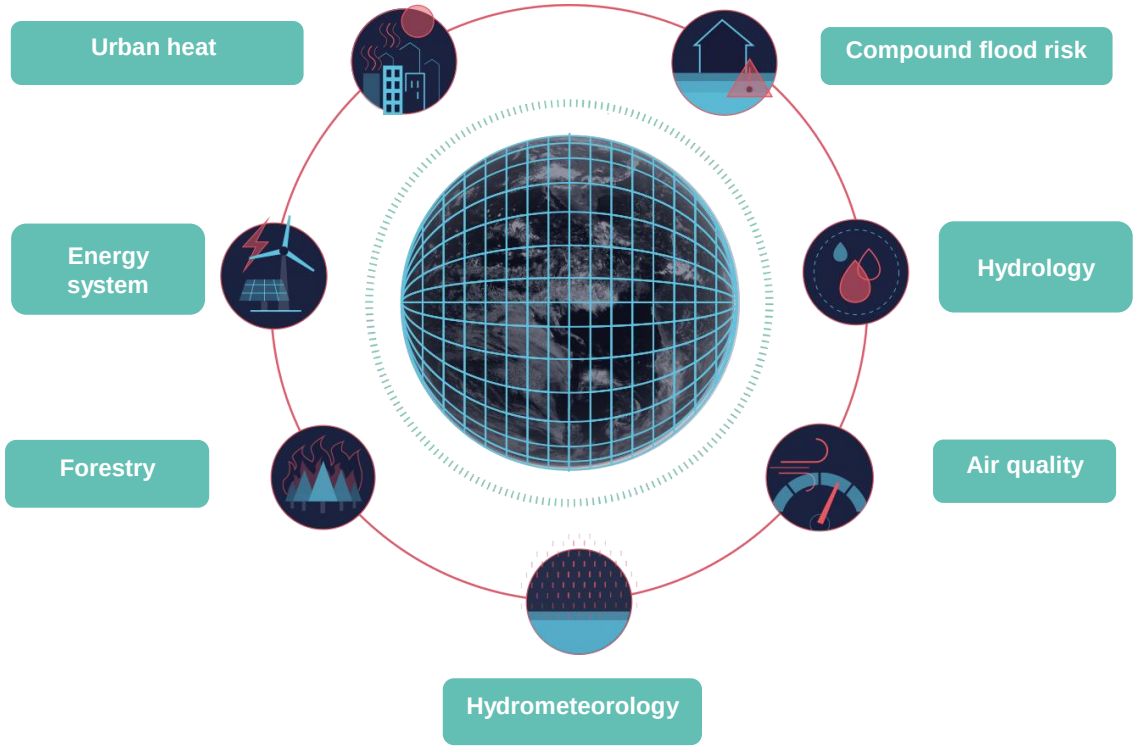
- Contributing missions (EUMETSAT, ESA, ECMWF)
- Copernicus Satellites & Services data
- Eurostat
- ISIMIP
- IAGOS

Governance

- User influenced and agreed with EC
- Managed and Controlled by DestinE Data Governance Board

Harmonized APIs: STAC compliant

Use Cases


Urban heat
Compound flood risk
Energy system
Hydrology
Forestry
Air quality
Hydrometeorology

Partnership roadmap

2022 | 2023 | 2024

Phase I | **Phase II** | **Phase III**

Open Stakeholder Dialogue
Wide community engagement

User eXchange

+ Conferences, workshops, …

Targeted User Partnerships
Supporting co-design

Use cases

Outreach and discussion with identified partners

Application and Technology Partnerships

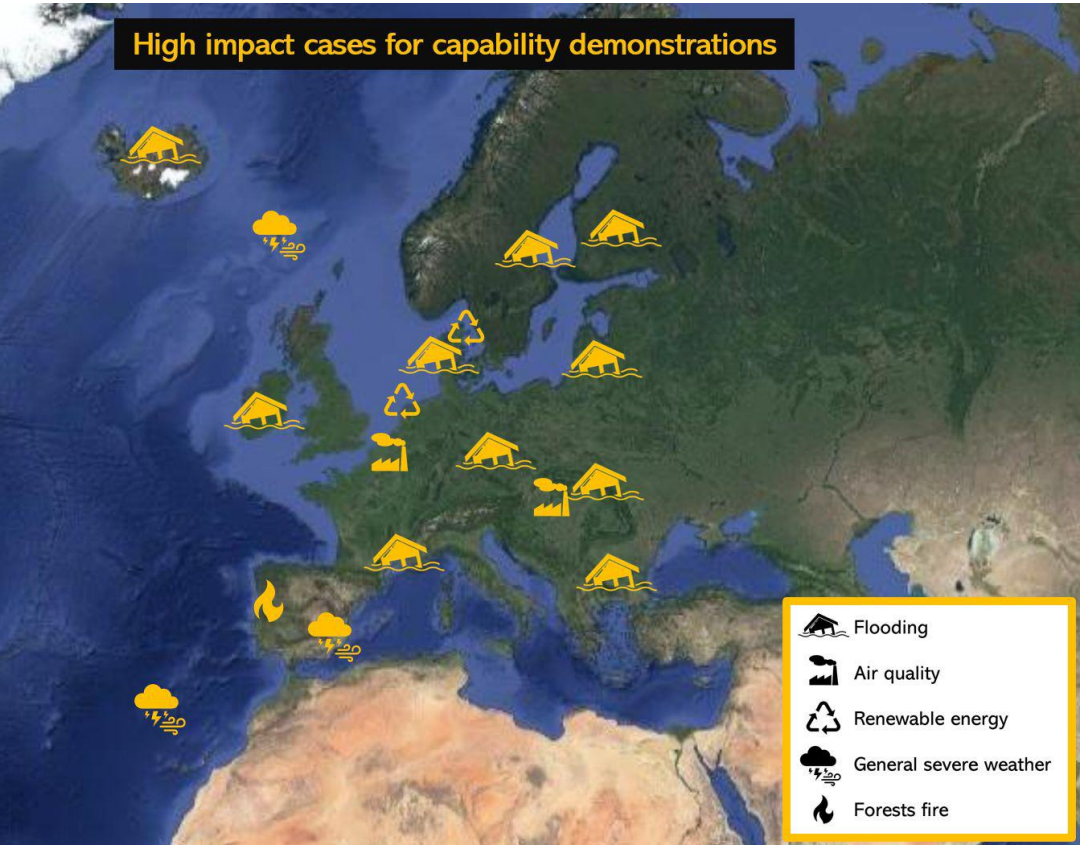
Use Cases

Use Cases demonstrate DestinE features, demonstrate improvement with DestinE, and involve domain users.

Implemented via contracts

1. DT Extremes contract
2. DT Climate contract
3. DestinE Use Cases contracts
4. Adaptation Modelling Framework
5. DestinE Use cases –DESP Use Cases (2 rounds: 04/23 & Q1/24)
6. Data Lake Use Cases (Q4/23)

Use Cases in DT Extremes



Hydrology / Extreme Flood Events

Workflows for flood modelling in BG, CZ, DK, FI, FR, IE, IS, SE, SK

SMHI

Air quality

Two air quality extremes:

- Cold inversion in Carpathian region, Jan 2017
- Ozone/heat in Benelux, Summer 2018

GeoSphere Austria

Renewable Energy

- North sea storms
- Ramping events (storms, fronts, …)
- Solar energy

KNMI

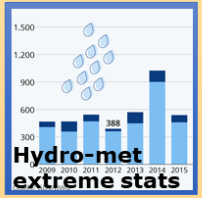
Use Cases in DT Climate

- Fire indices for Europe
- Fire spread models in Finland
- Burnt area, CO2 emissions (Finland)

ILMATIETEEN LAITOS

- Future freshwater resources
- Future flood/drought
- Focus: Germany

UFZ HELMHOLTZ Centre for Environmental Research



- Extreme event statistics
- Event catalogue

Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD

- Wind resources globally (onshore, offshore)
- Wind turbine vulnerability under extremes and icing

BSC Barcelona Supercomputing Center
Centro Nacional de Supercomputación

- Spatio-temporal variability of heat waves
- Human thermal comfort indicators

BSC Barcelona Supercomputing Center
Centro Nacional de Supercomputación

ECMWF

Further Use Cases

- Resource adequacy
- Grid planning
- Validation

DLR AARHUS UNIVERSITY Renewables Grid Initiative

- High-res regional AQ
- Coupled to DT Extremes
- Interactive immissions

JÜLICH Forschungszentrum

- Five regional/local hydro models
- Disaster risk and climate scales

Deltares tecnalia 510

- Coupled urban climate model
- Simulate heat stress/health impact

vito

- Wind damage risk predictions
- Harvesting conditions under climate scenarios

FMI Metsäteho Spatineo

ECMWF

Begleitung der ASAP-geförderten Projekte durch ECMWF

> Im Rahmen des Partnerschaftsprogramms begleitet das ECMWF die geförderten Projekte/Konsortien der FFG während der Projektdurchführung, sofern eine Kontaktaufnahme durch Fördernehmende bzw. Konsortien mit dem ECMWF erfolgt.

FFG Ausschreibungsleitfaden

Mögliche Begleitung sind, z.B.

- Beteiligung in ausgewählten Projekttreffen
- Verweise auf benötigte technische Dokumentation
- Vermittlung von technischen Ansprechpartnern zu technischen Fragen
- Beteiligung in Beratungsstrukturen der Projekte
- …

Beinhaltet keine bevorzugten Zugänge oder Bereitstellung exklusiver Ressourcen durch ECMWF.

Thank you

www.destination-earth.eu

https://digital-strategy.ec.europa.eu/en/policies/destination-earth
https://stories.ecmwf.int/destination-earth
https://www.esa.int/Applications/Observing_the_Earth/Destination_Earth
https://www.eumetsat.int/who-we-work/destine

Running DTs & Managing Big Data