DESTINATION EARTH

INTRODUCING DESTINE, ITS HIGH-PRIORITY DIGITAL TWINS, AND THE DIGITAL TWIN ENGINE

Irina Sandu

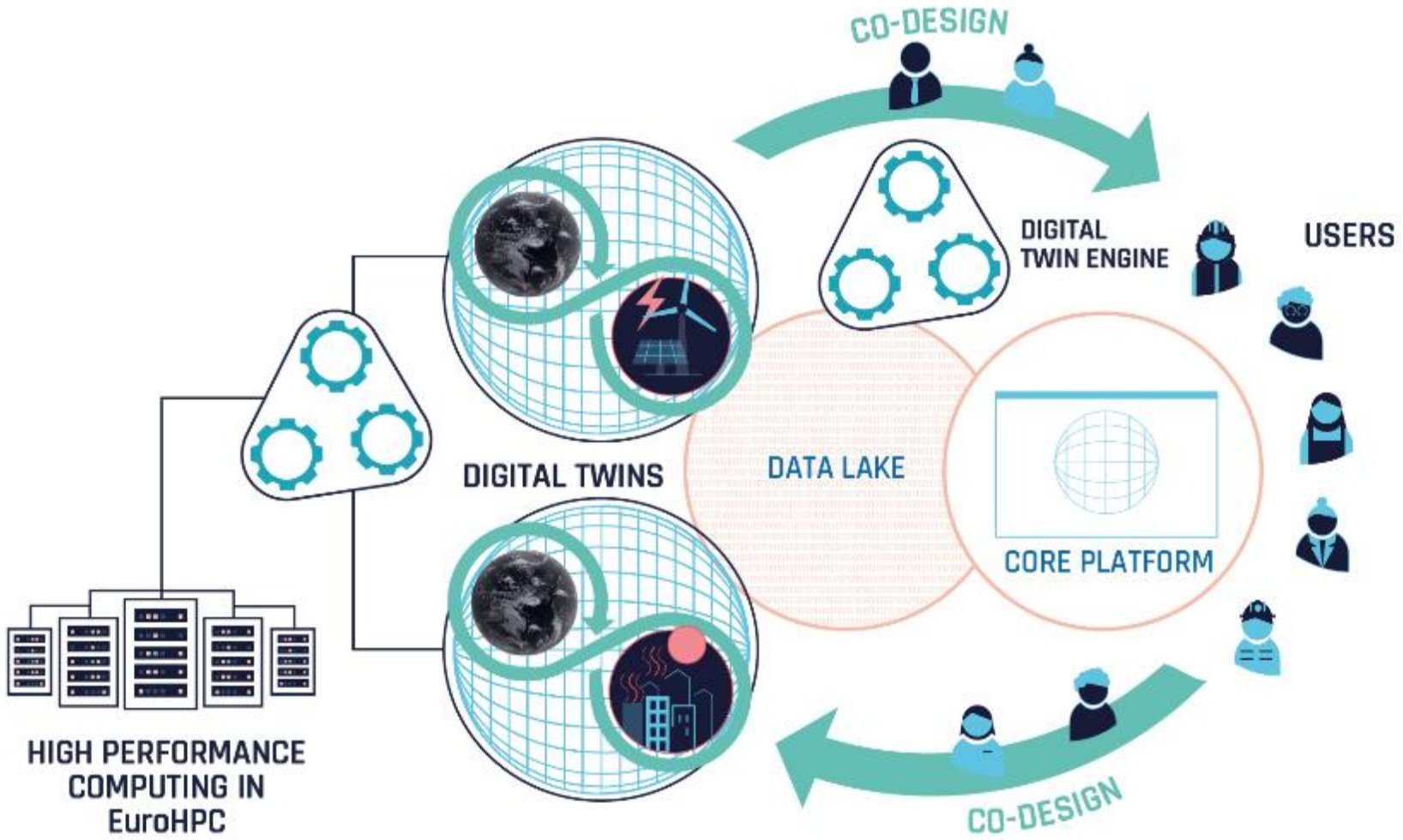
Funded by the European Union
Destination Earth
implemented by ECMWF esa EUMETSAT

CREATING A DIGITAL REPLICA OF OUR PLANET

A Digital Twin Earth, a 1 km simulation with ICON, MPI-M/DKZR/NVIDIA

HOW?

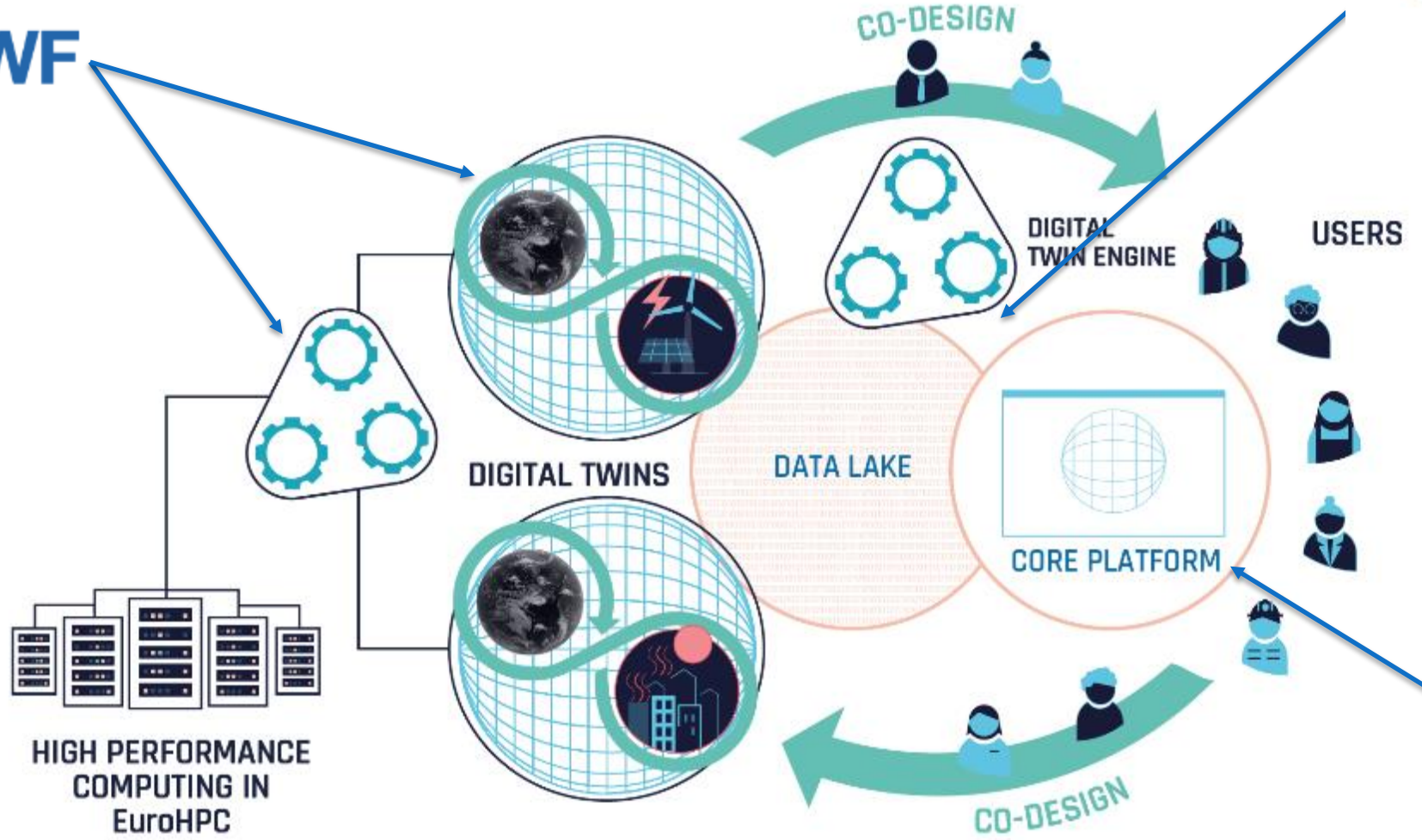
KEY COMPONENTS OF THE DESTINE SYSTEM



KEY COMPONENTS OF THE DESTINE SYSTEM

ECMWF

EUMETSAT



esa

EXPLOITING THE WORLD LEADING EUROPEAN HPC PLATFORMS

No 3 TOP500

LUMI

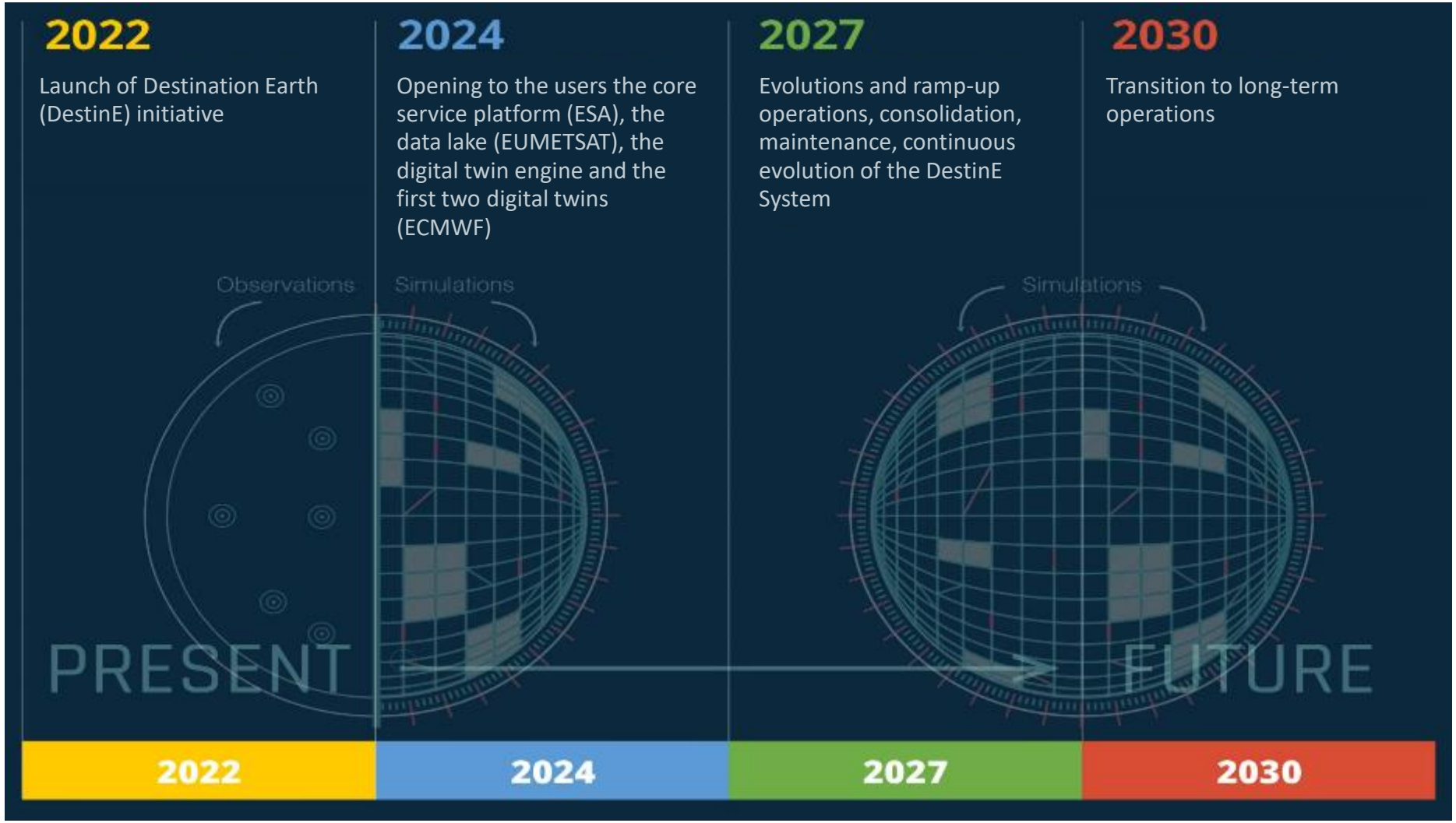
No 4 TOP500

LEONARDO

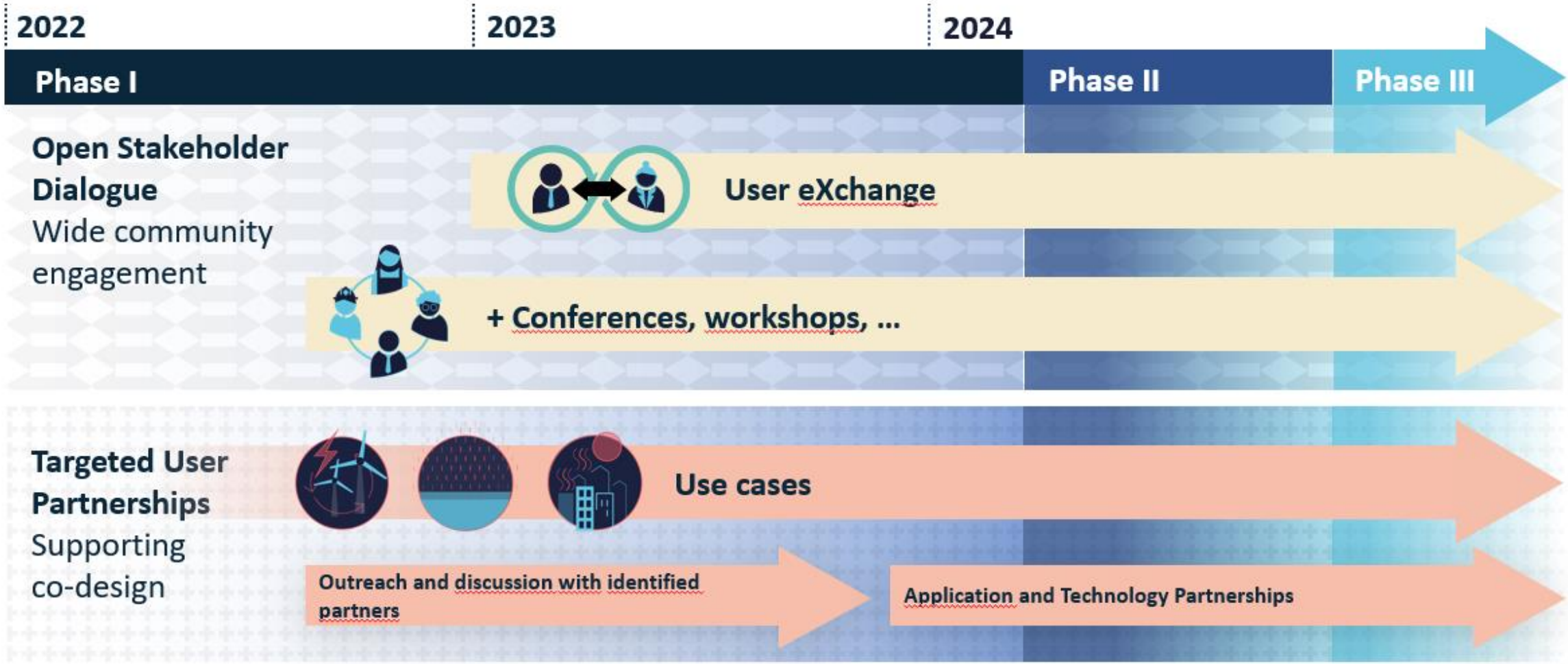
MareNostrum

EuroHPC Joint Undertaking

TIMELINE


2022
Launch of Destination Earth (DestinE) initiative
2024
Opening to the users the core service platform (ESA), the data lake (EUMETSAT), the digital twin engine and the first two digital twins (ECMWF)
2027
Evolutions and ramp-up operations, consolidation, maintenance, continuous evolution of the DestinE System
2030
Transition to long-term operations
Observations
Simulations
Simulations
PRESENT
FUTURE
2022
2024
2027
2030

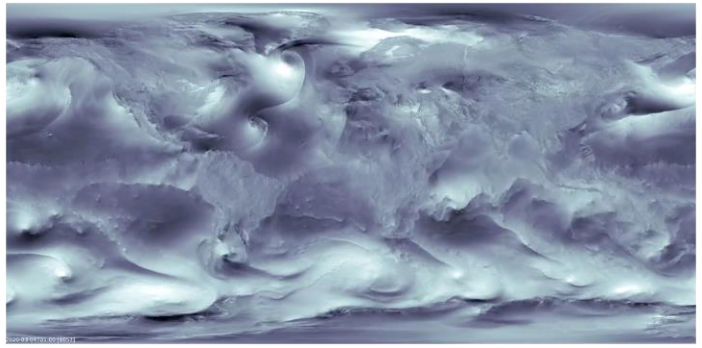
PARTNERSHIPS AND USER ENGAGEMENT IS KEY



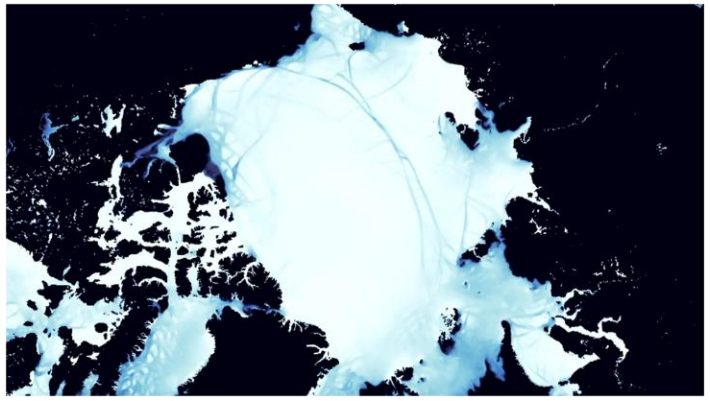
DIGITAL TWINS

DIGITAL TWIN FEATURES

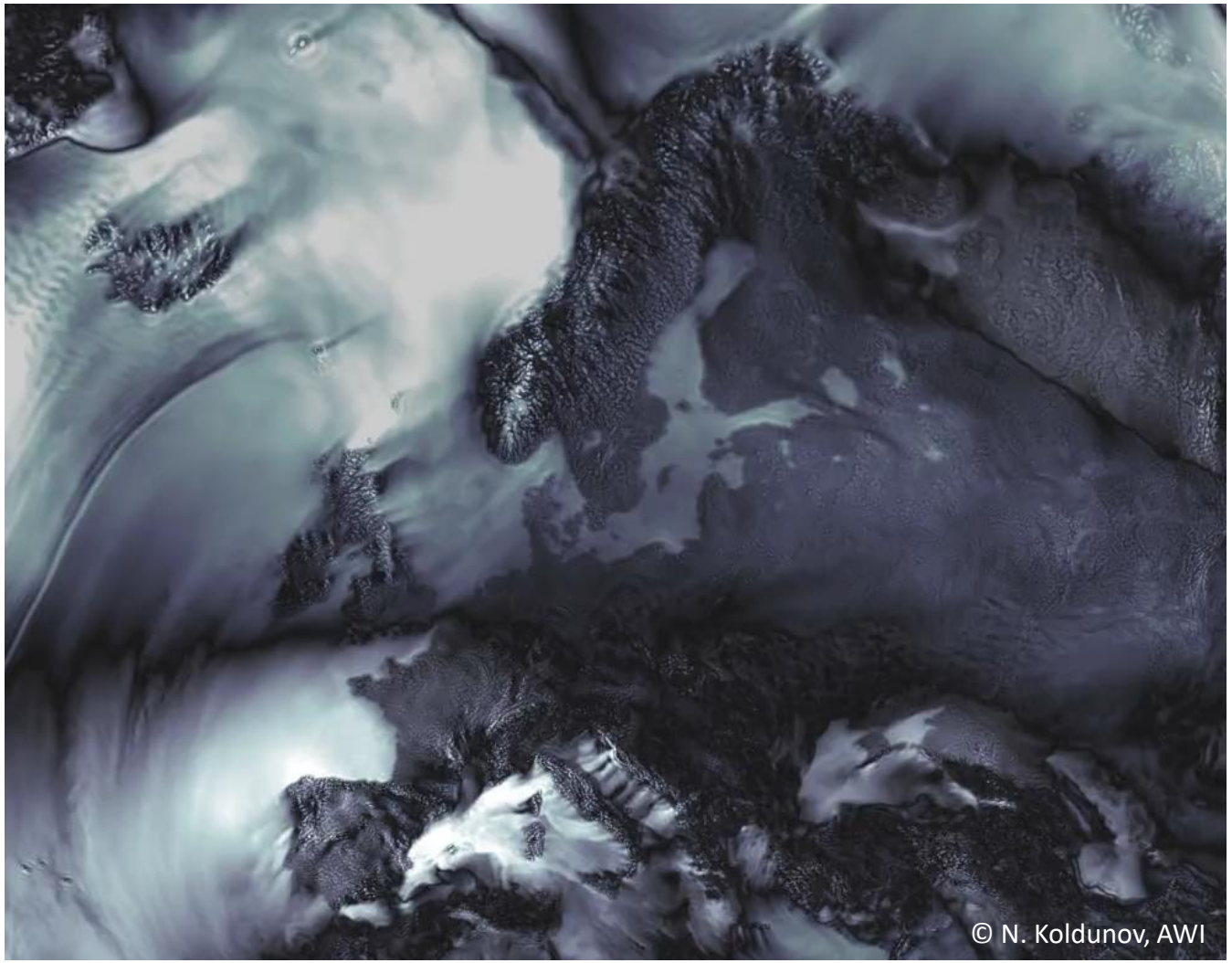
QUALITY



More realistic at global scale



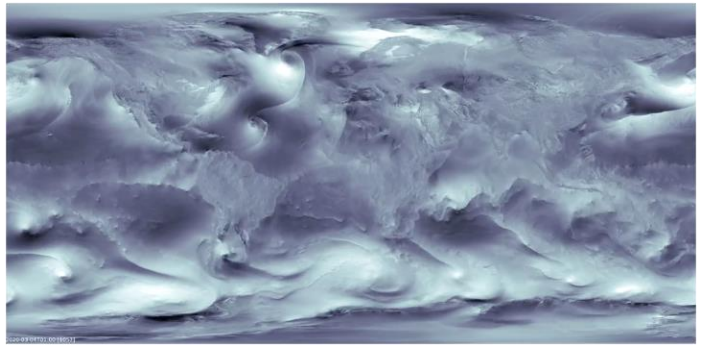
More realistic at local scale



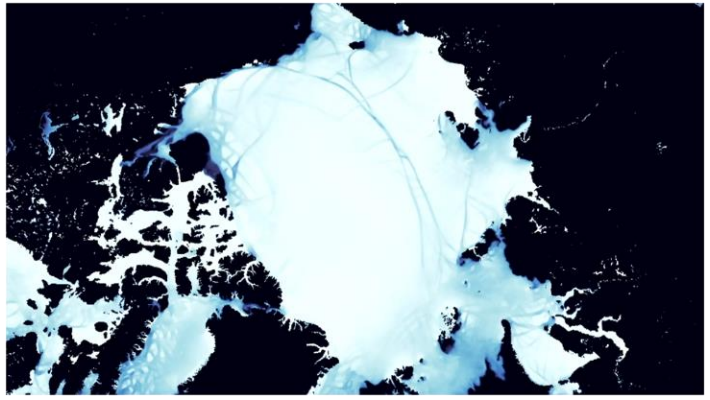
© N. Koldunov, AWI

DIGITAL TWIN FEATURES

QUALITY

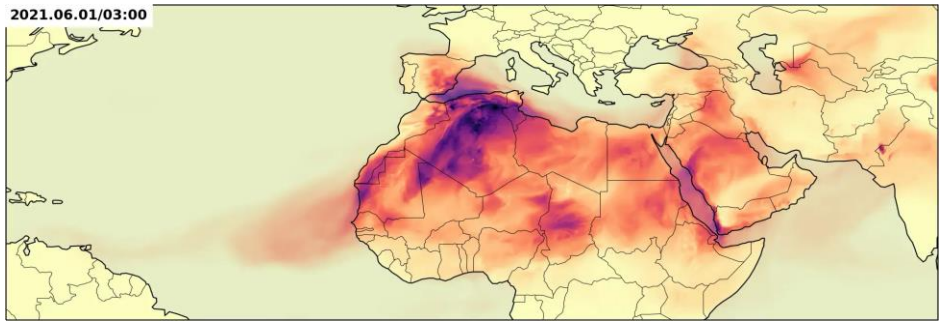


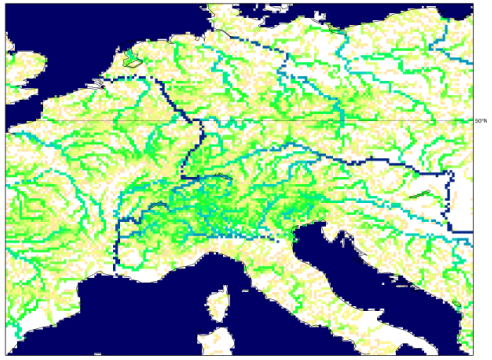
More realistic at global scale



More realistic at local scale

IMPACTS

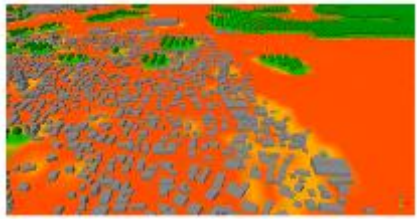




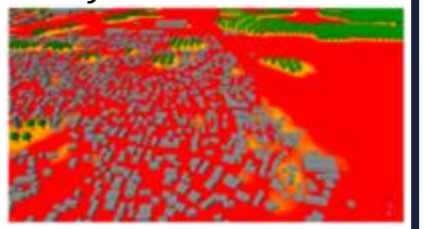
Include impacts where they matter

INTERACTIVITY

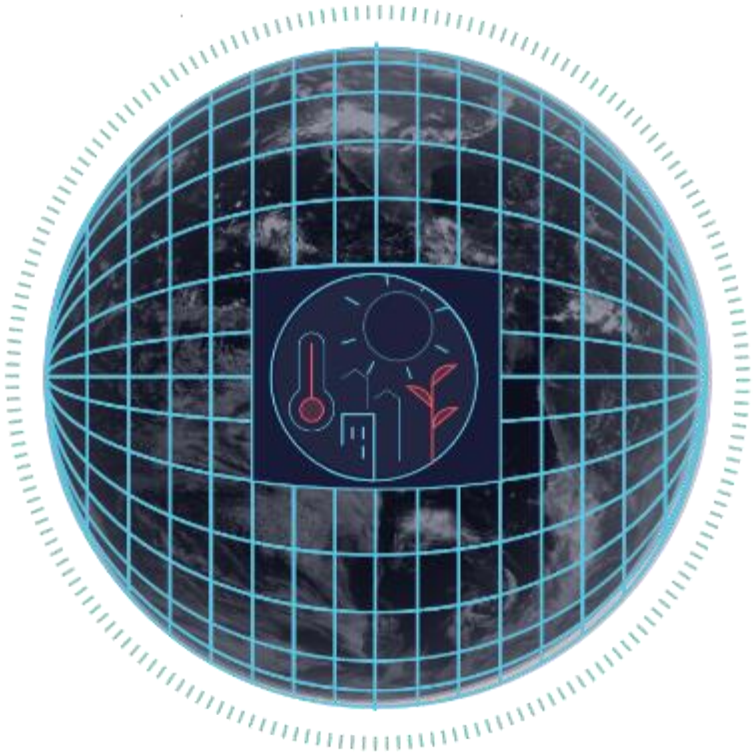
City A in a +2 world



City A in a +4 world



Trial different scenarios

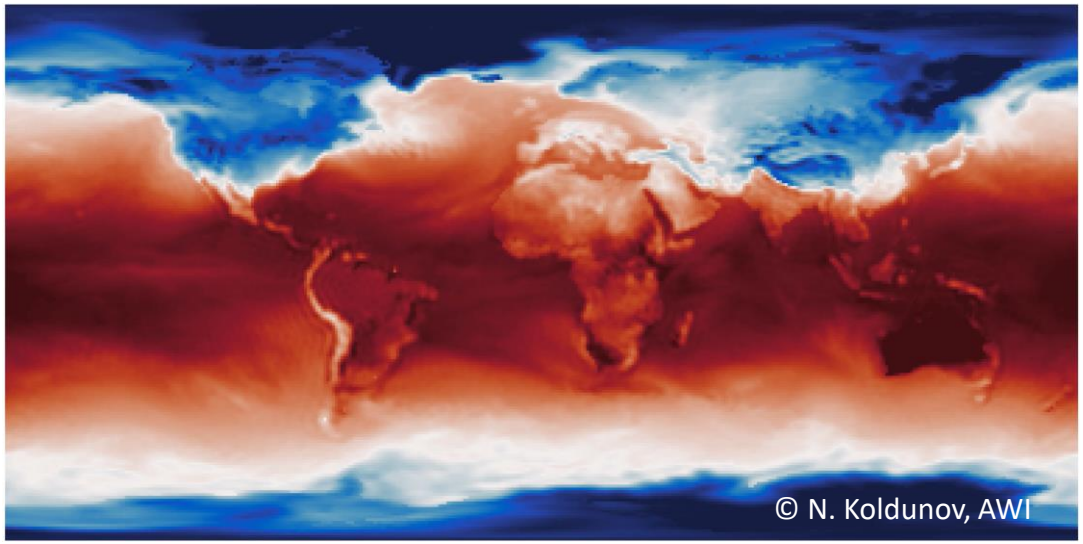


CLIMATE CHANGE ADAPTATION DIGITAL TWIN

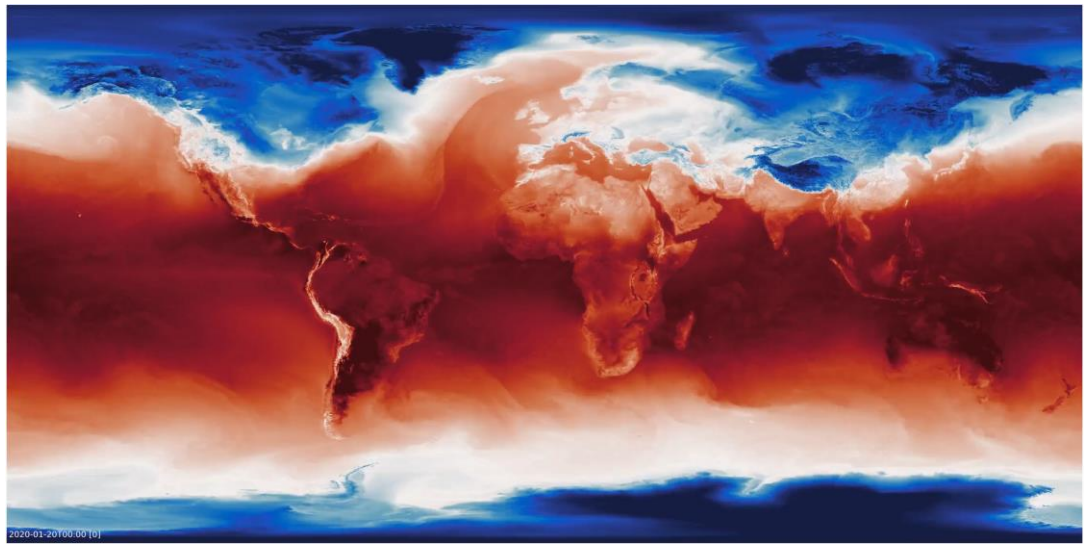
ECMWF

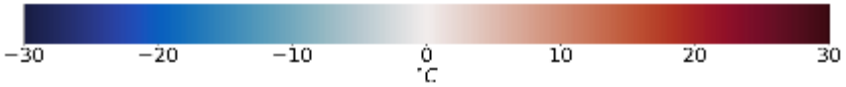
CLIMATE DT: MULTI-DECADAL CLIMATE PROJECTIONS AT KM-SCALE

IPCC AR6 (2021), 100km



Digital Twin, 5km





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

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, Istituto 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
UC Louvain	Université catholique de Louvain	BE
DKRZ	German Climate Computing Centre	DE
HPE	Hewlett Packard Enterprise	FR

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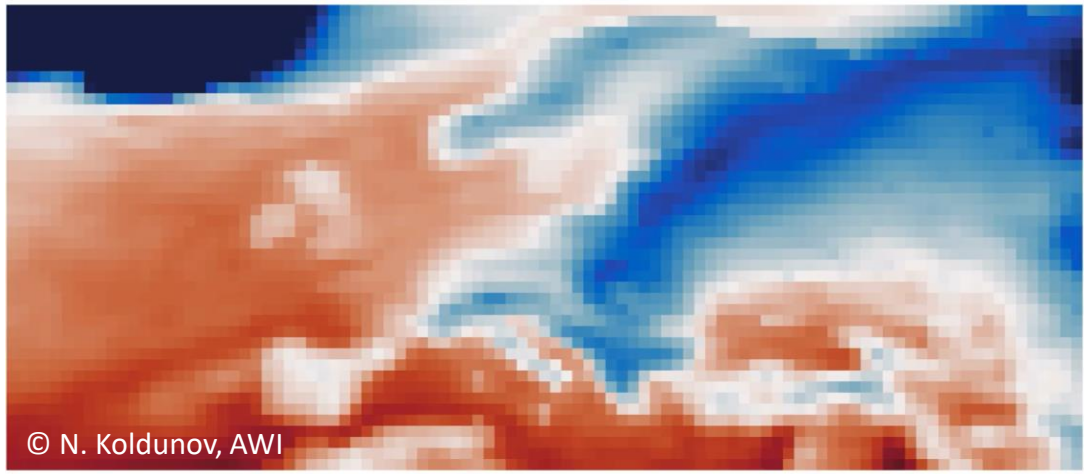
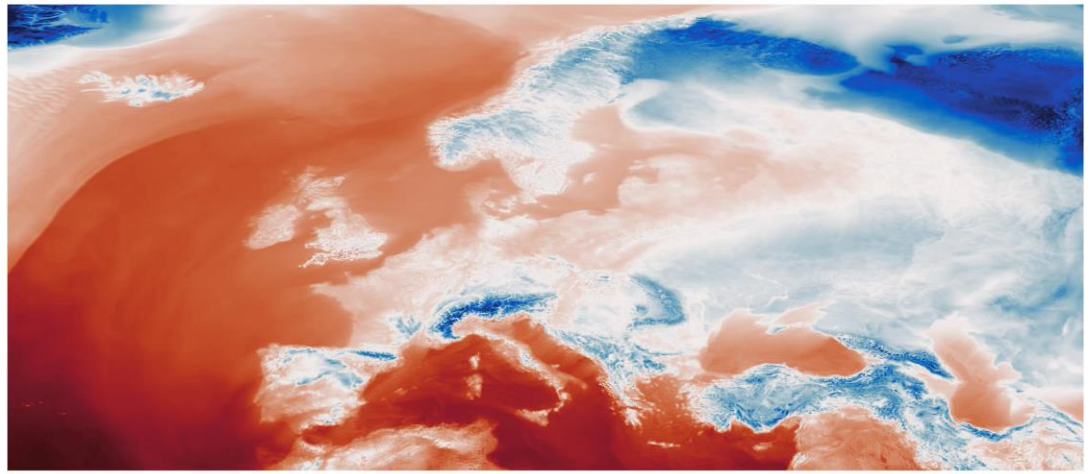
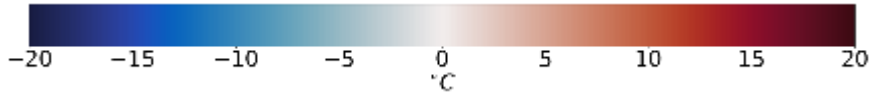


Digital Twin, 5km





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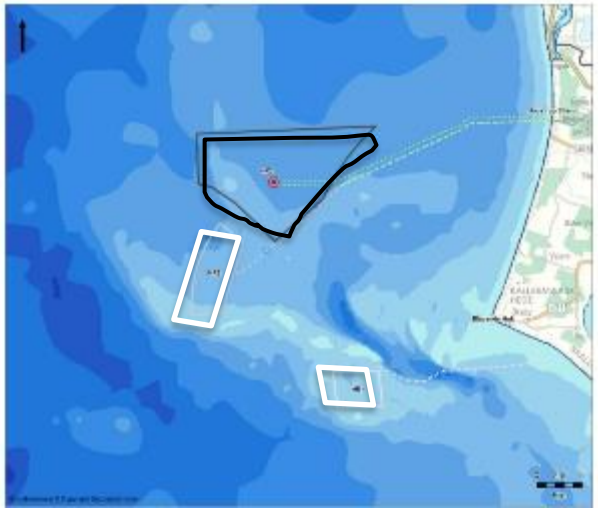
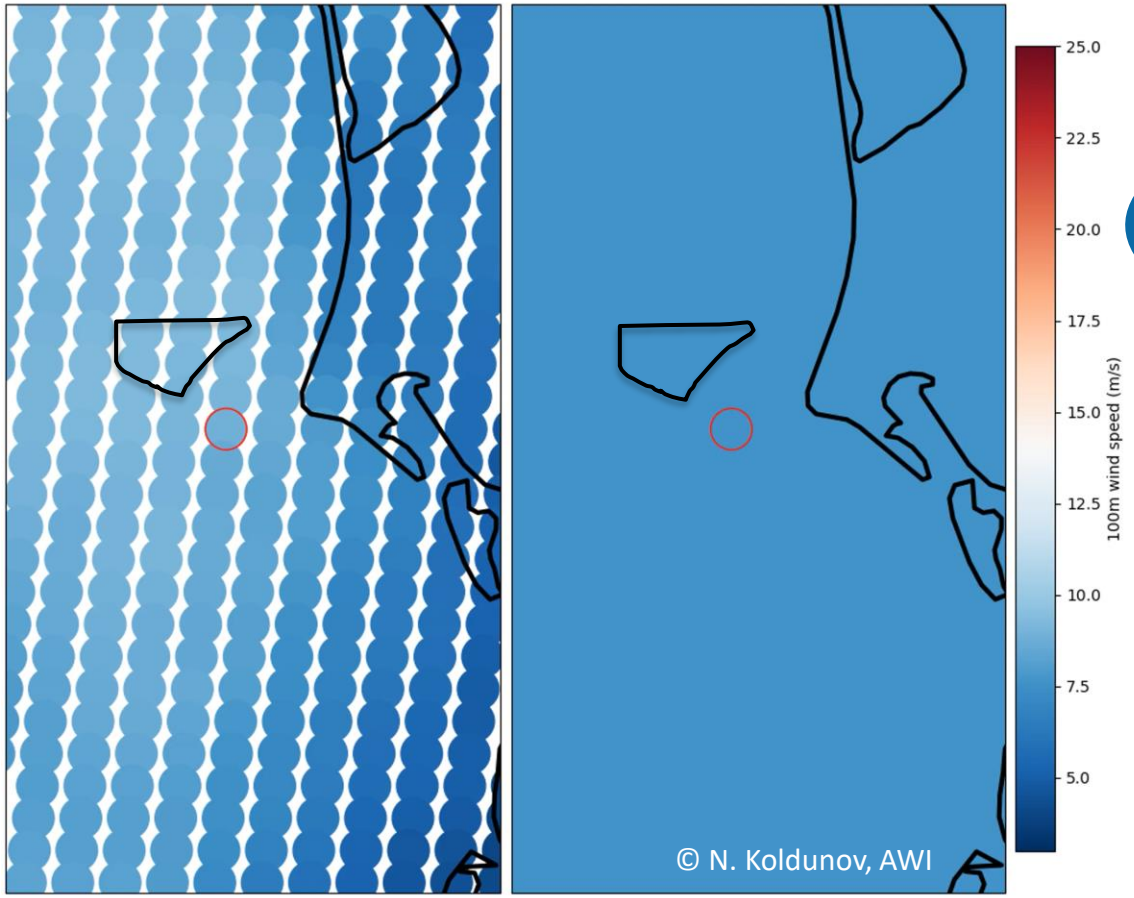
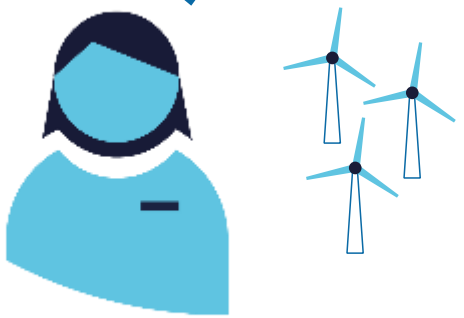
CSC

HARNESSING RENEWABLE ENERGY



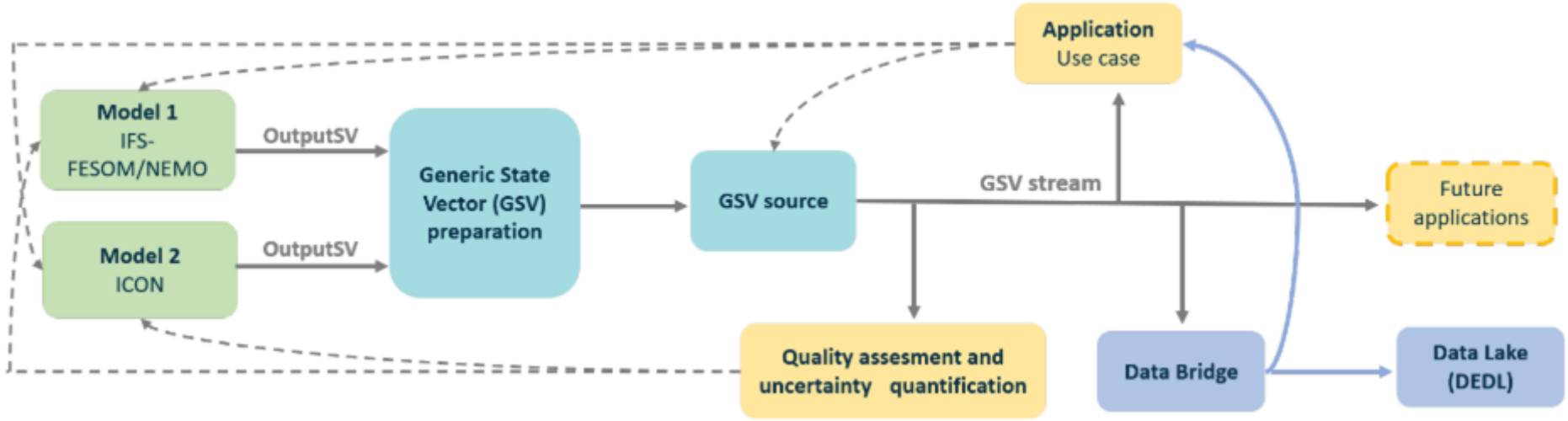


How to optimize a portfolio of windfarms to maximize energy yield ?



CLIMATE DT: PHASE 1 DELIVERY

- advanced high-resolution (5km and 10km) global Earth-system - impact-sector simulation configuration on LUMI
- a prototype contribution to the HighResMIP2 simulation protocol
- capabilities to monitor and assess the quality of the DT simulations
- capability to add selected impact models in the DT workflow & test capabilities with uses cases

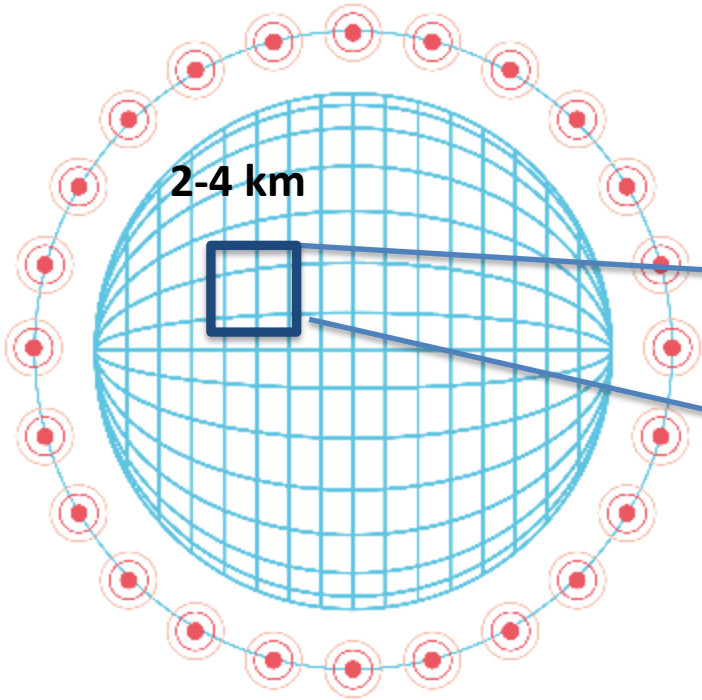


WEATHER-INDUCED EXTREMES DIGITAL TWIN

ECMWF

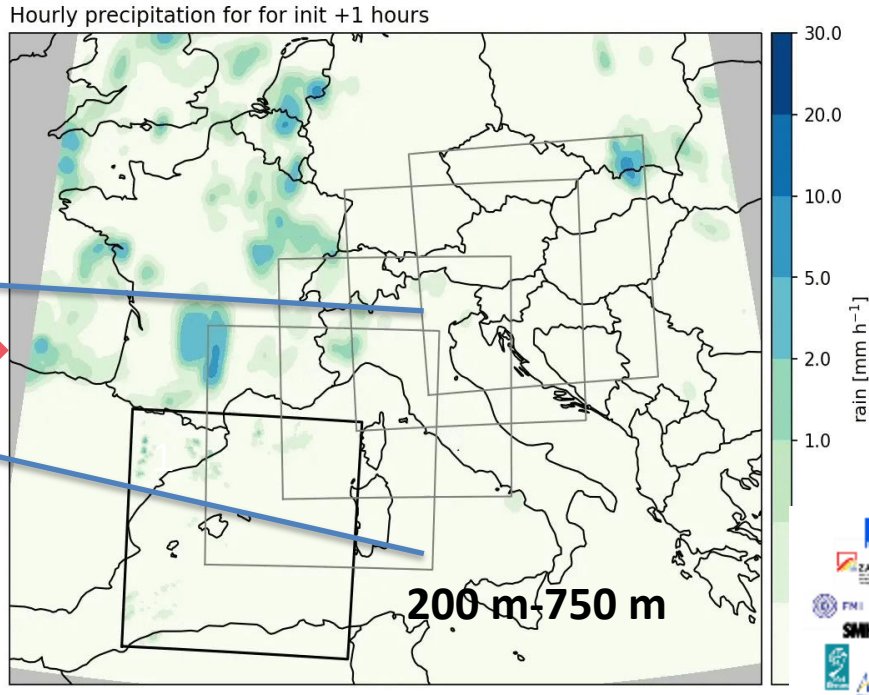
EXTREMES DT: CONTINUOUS AND ON DEMAND

Continuous global component



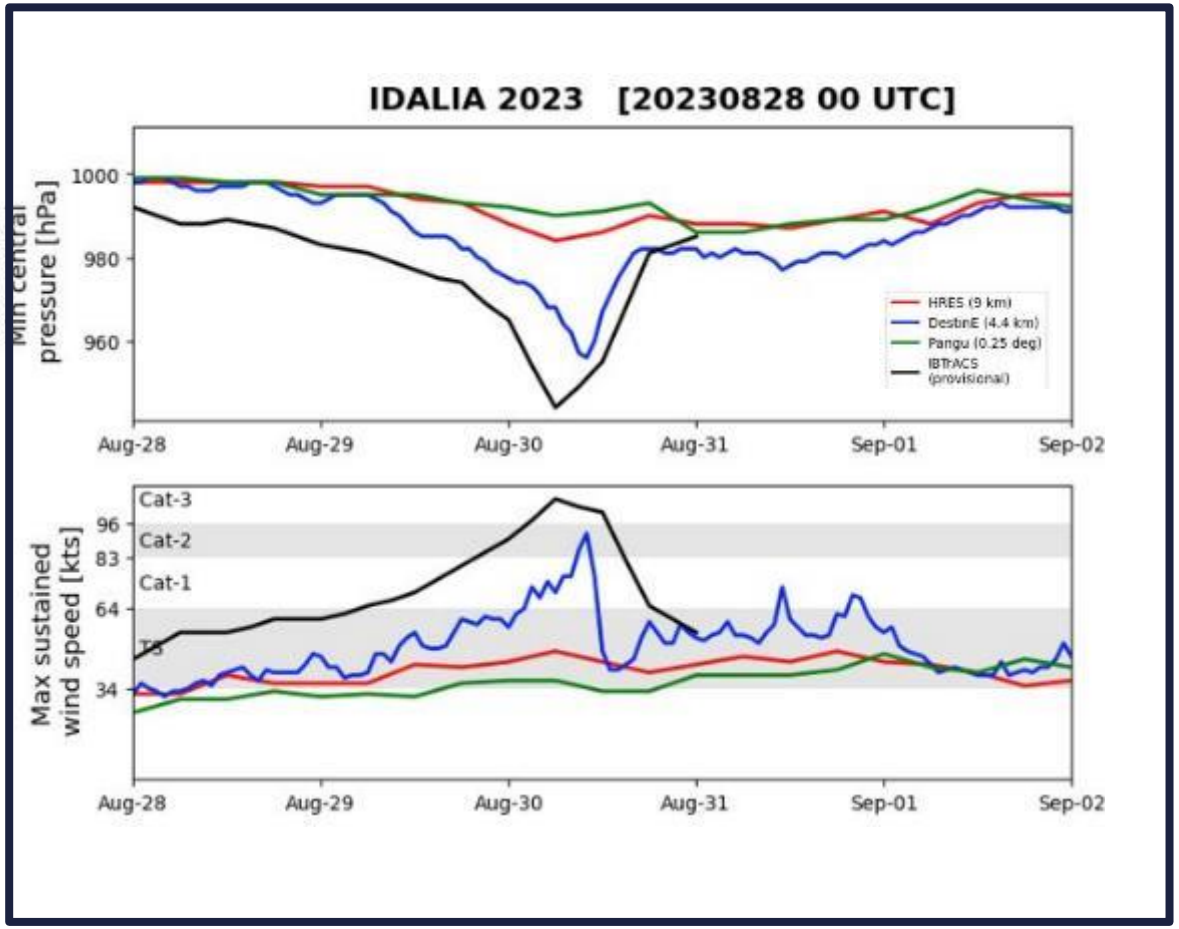
4 days

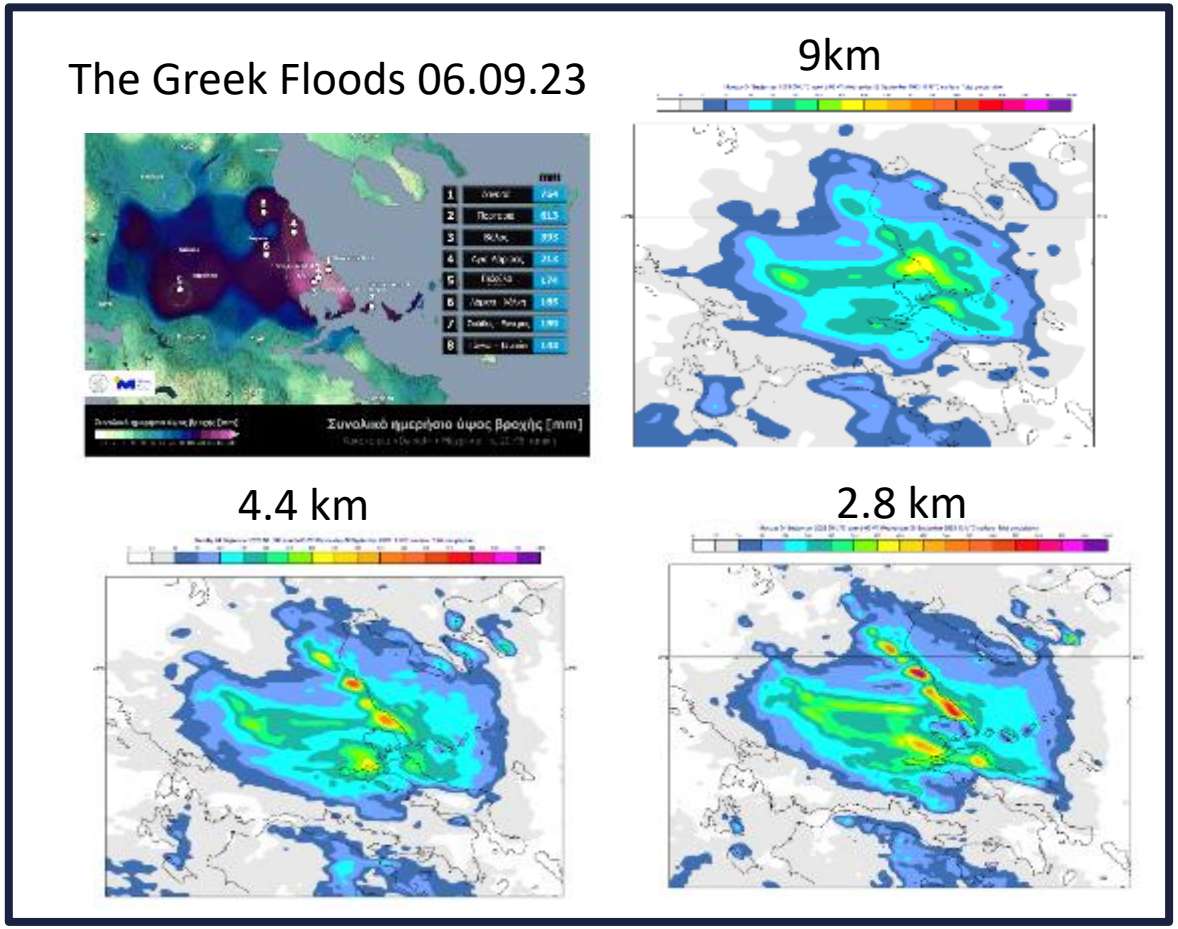
On-demand regional component



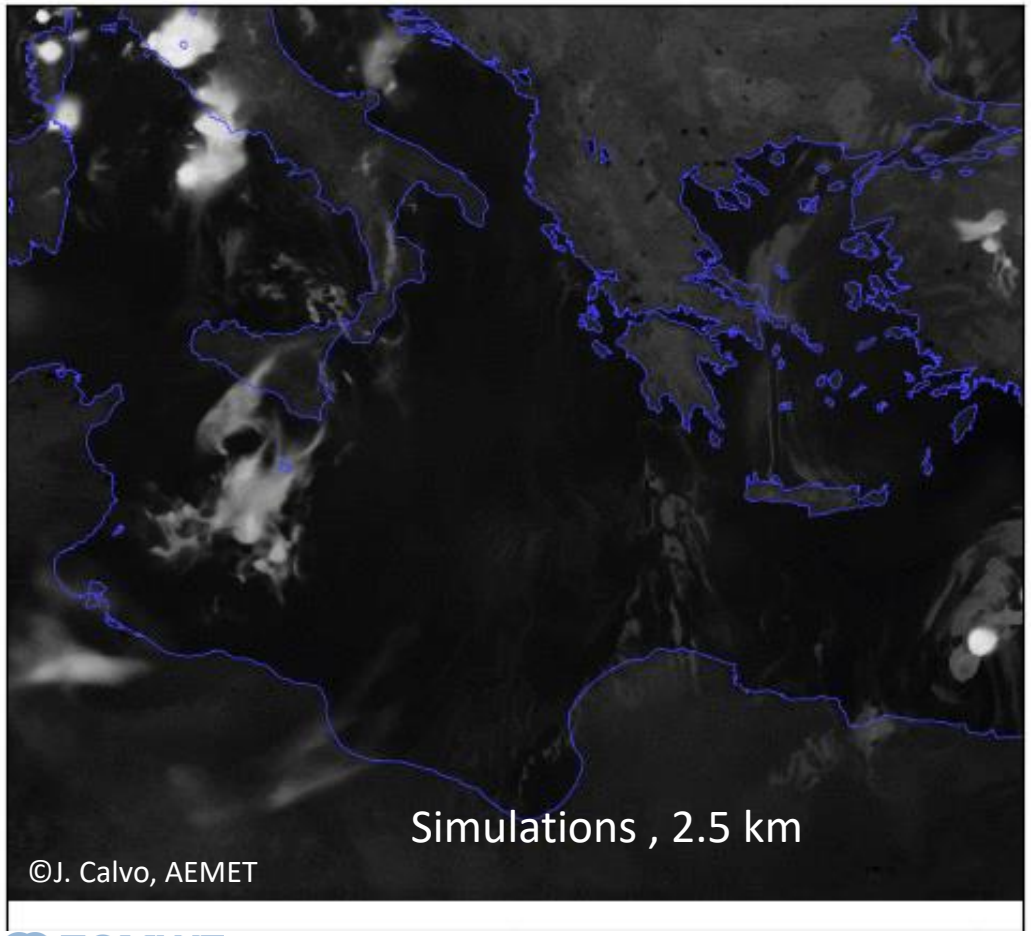
2 days

GLOBAL EXTREMES DT: RUNNING 4.4KM SIMULATIONS DAILY

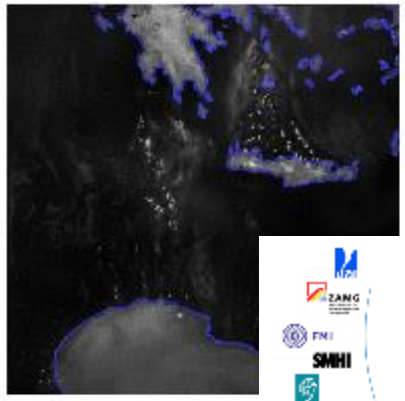




ON-DEMAND: ENHANCING DISASTER RESILIENCE



Can I get more insights about this extreme event to understand how it will impact my area?



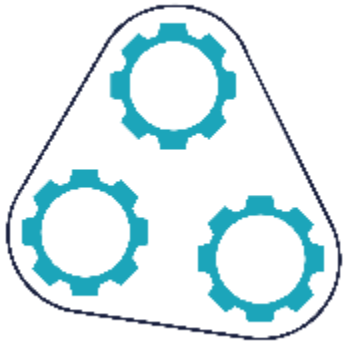
simulations, 500m

EXTREMES DT: PHASE 1 DELIVERY

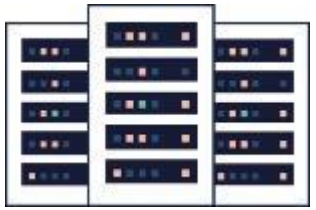
- configurable production on available EuroHPC JU systems, with the ability to provide information globally, in a continuous mode, and regionally, on-demand, for selected configurations
- enhanced simulation scales (2.8 to 4.4 km globally, 500-700 m regionally) at weather time scales
- an integration of weather, hydrology, air quality models in a unified simulation framework to provide Earth-system information selected impact-sectors & testing of capabilities with downstream use cases

THE DIGITAL TWIN ENGINE

THE DIGITAL TWIN ENGINE

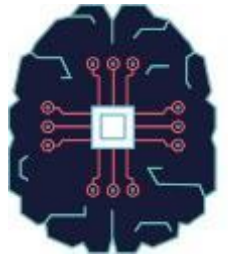


Software environment

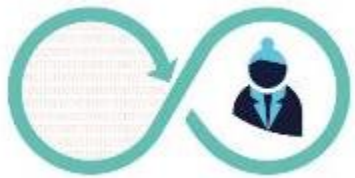


Ensuring complex simulations are run efficiently on EuroHPC

Powering the digital twins and managing big data

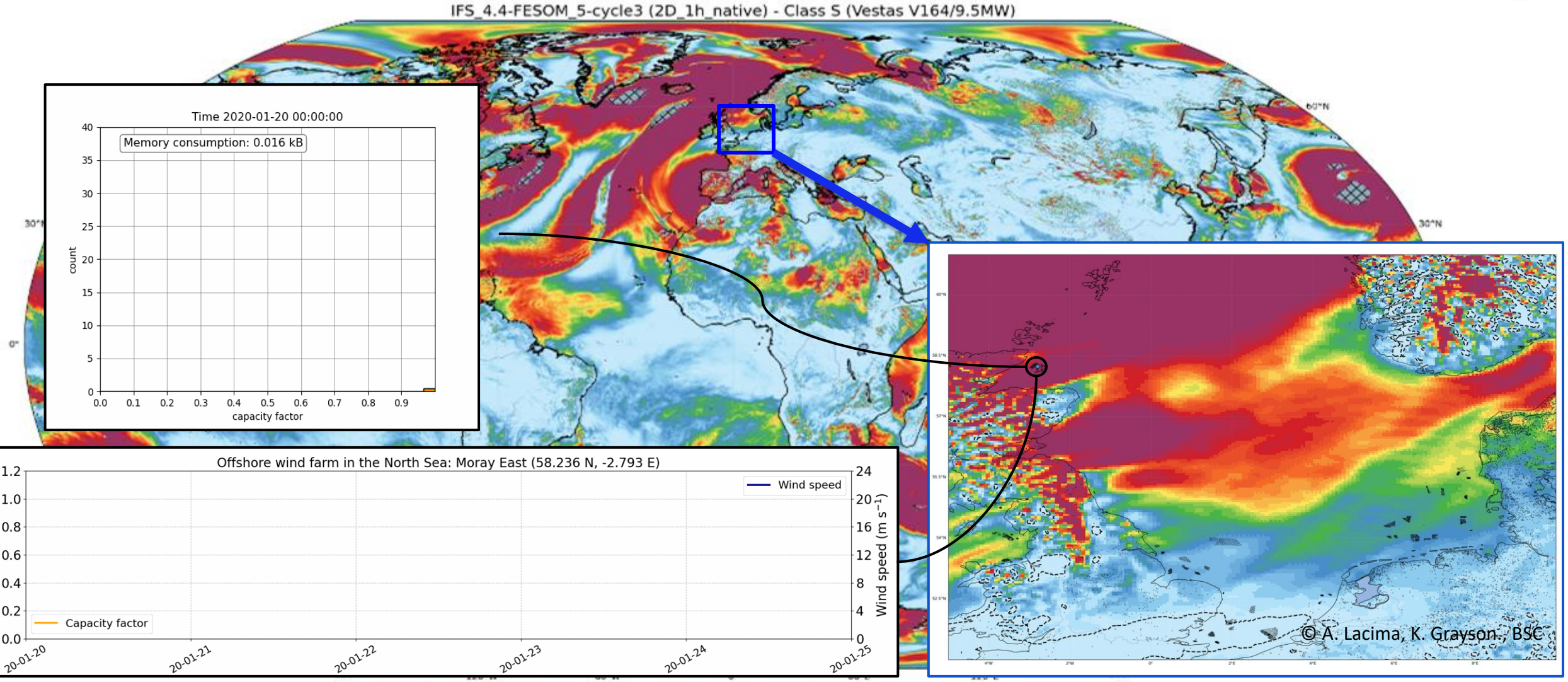


Using ML/AI to increase the efficiency of the digital twins and estimate uncertainty



Tailoring information to user's needs and interactivity

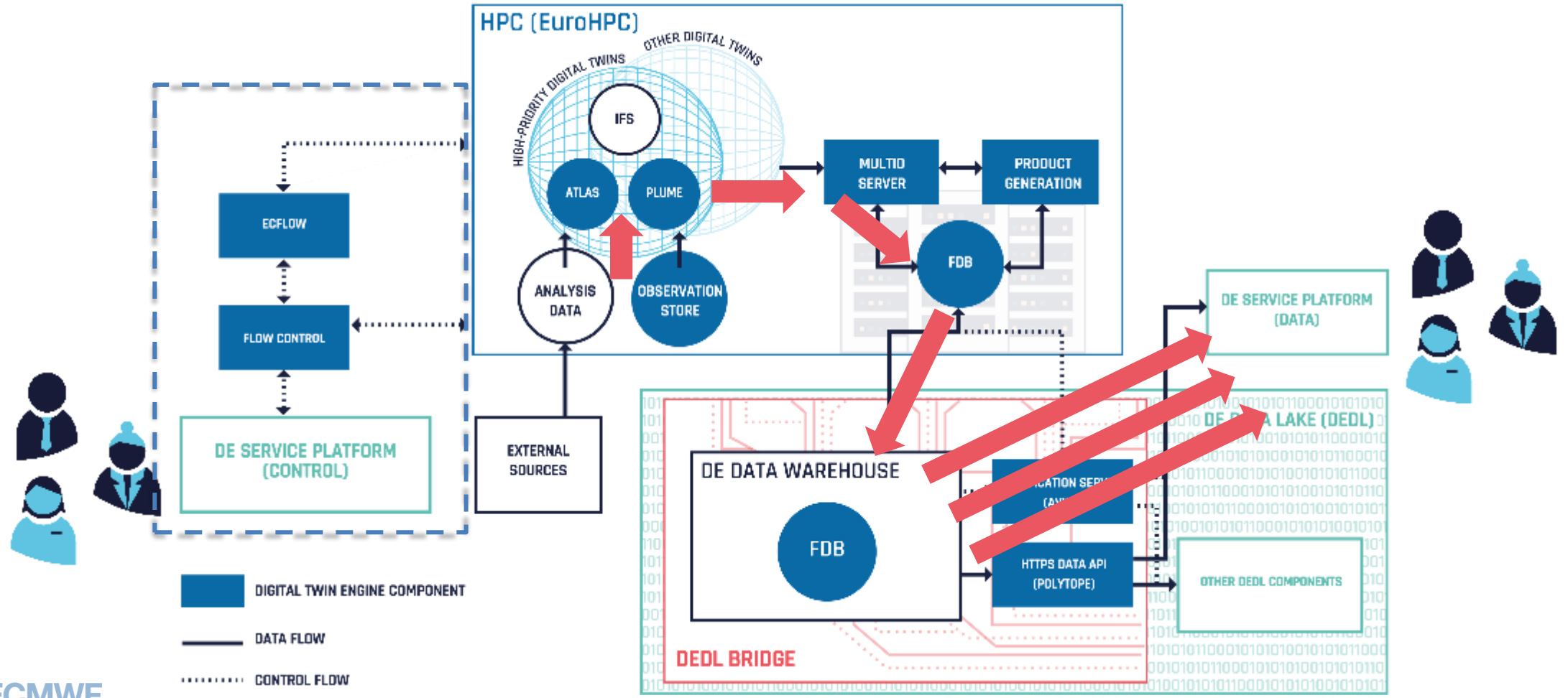
Tailoring the information to user needs: optimizing a wind farm portofolio



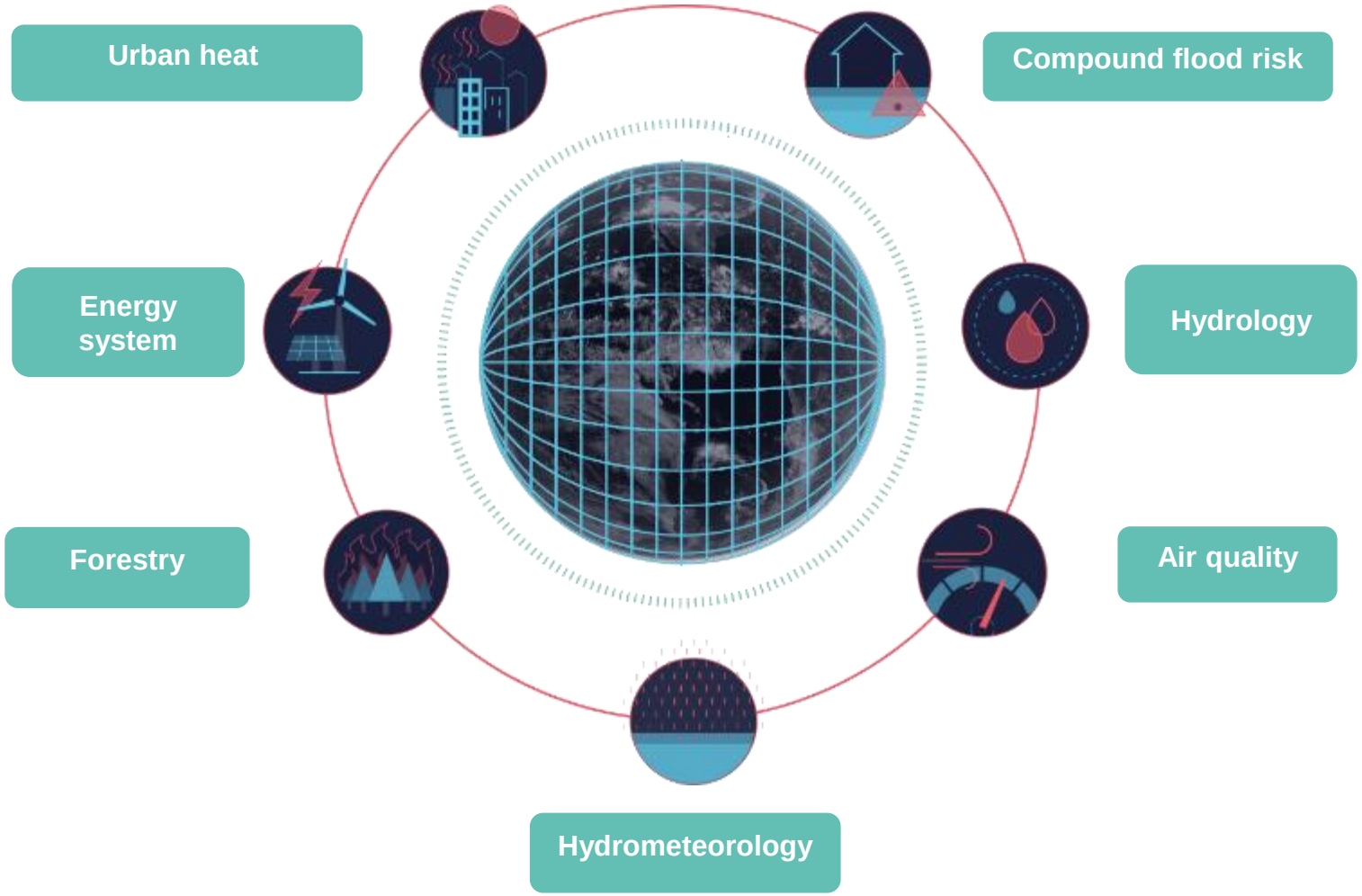
DIGITAL TWIN ENGINE: PHASE 1 DELIVERY

- established & deployed initial end-to-end workflows for the first two high-priority DTs on the available EuroHPC;
- supported the porting and adaptation, and tested the performance of the DT models on EuroHPC;
- developed an end-to-end Earth-system data handling software stack and deployed it across the available EuroHPC and DestinE reference architecture (involving the DTE and Data Warehouse);
- piloted new DT full data rate capabilities including scalable on-the-fly data processing, for selected cases;
- established WMO compatible data formats and FAIR compliant data standards;
- developed and piloted integrated interactive visualization/immersion capabilities, integrated with the reference architecture concept and associated DTE software infrastructure.

BRINGING THE KEY ELEMENTS OF DESTINE TOGETHER



USE CASES


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