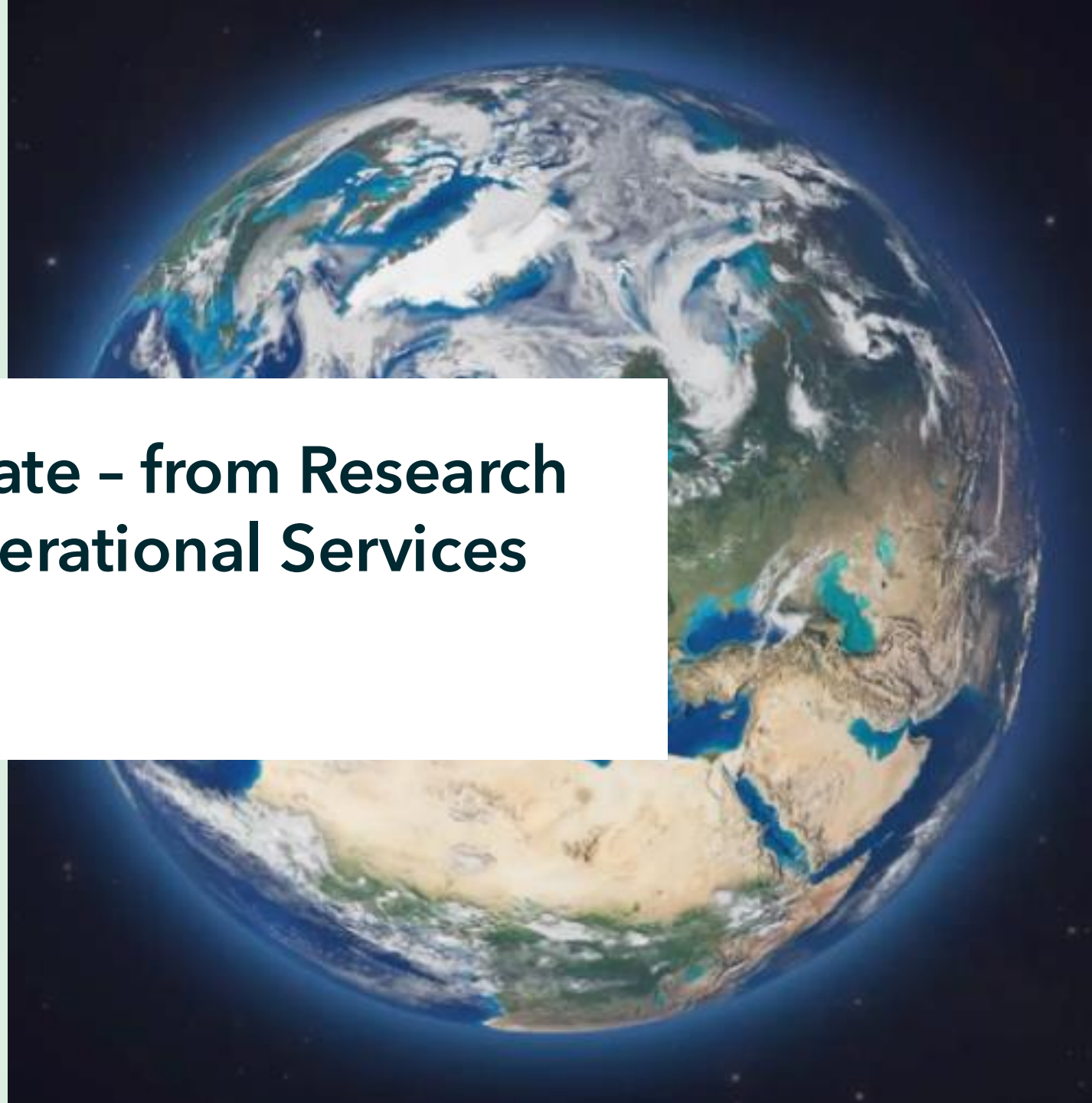
Digital Twins for Climate – from Research and Innovation to Operational Services

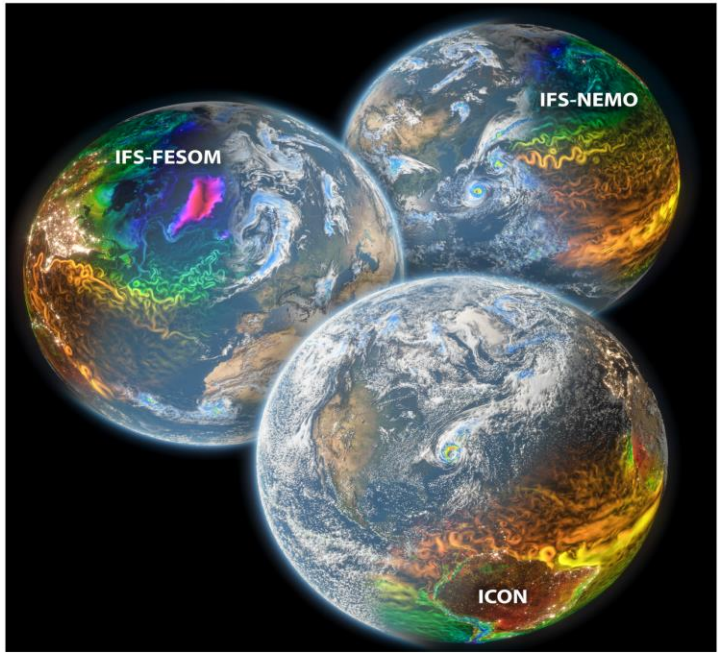
Jenni Kontkanen

CSC – IT Center for Science



Why Digital Twins?

- **Digital Twins (DT)** of Earth provide capabilities beyond traditional models or EO data:
  - Provision of consistent information of environmental change and their impacts at **high spatial and temporal resolution**
  - **Enhanced interactivity** – users can access the results near real time and explore what-if scenarios
  - Combination of **physics- and AI-based models and EO data**



- **Destination Earth** develops DTs to support decision making
  - two high priority DTs: Climate DT and Extremes DT

- Digital Twins and their components also developed in other **EU and nationally funded projects**

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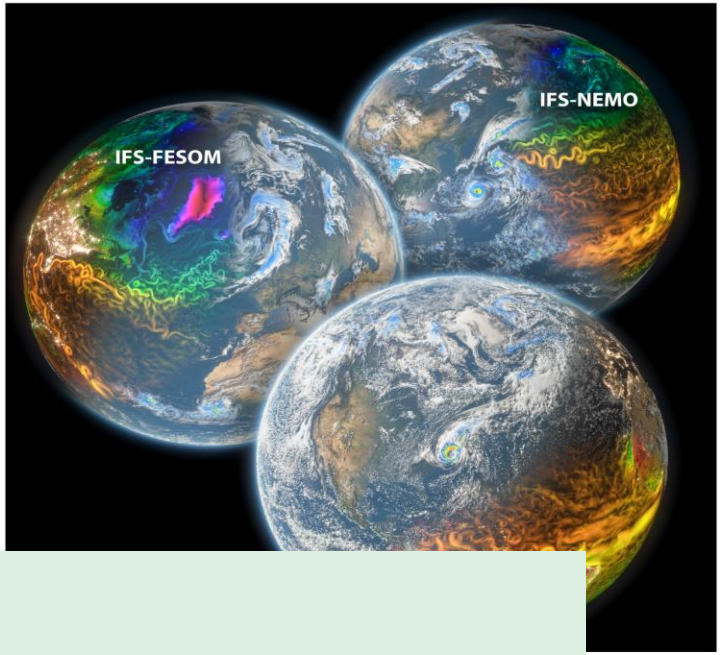
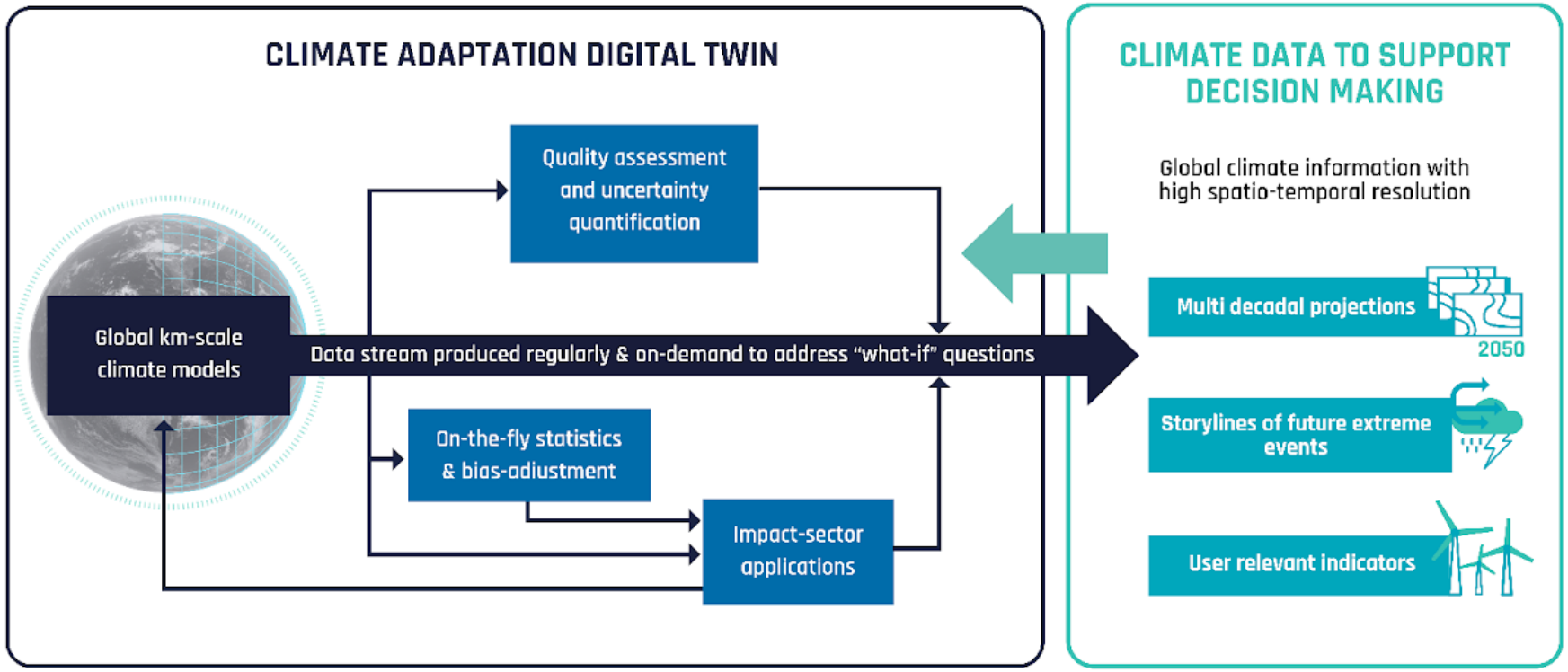


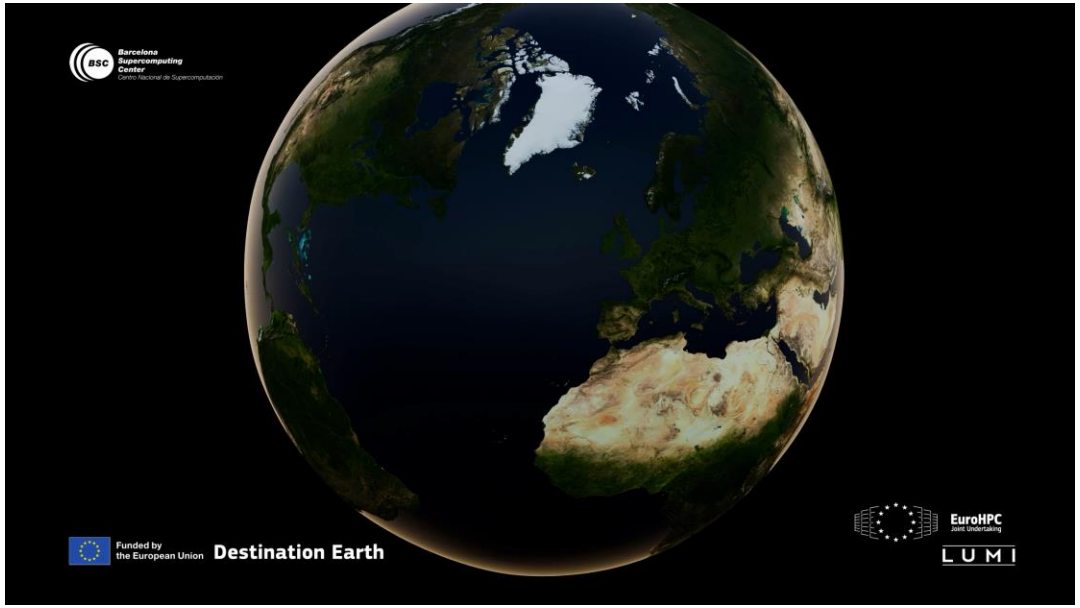
Digital Twins can transform the provision of climate information due to their novel capabilities

DestinE Climate DT - Operational climate information system integrating km-scale global climate models with impact-sector applications to produce actionable information



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

DestinE Climate DT - km-scale global simulations provide globally consistent information on climate change impacts at high spatial and temporal resolution



Three global models (IFS-NEMO, IFS-FESOM and ICON) at 5-10 km resolution

We acknowledge the EuroHPC Joint Undertaking (JU) for awarding this project access to the EuroHPC supercomputer LUMI and MareNostrum5 through a EuroHPC JU Special Access call

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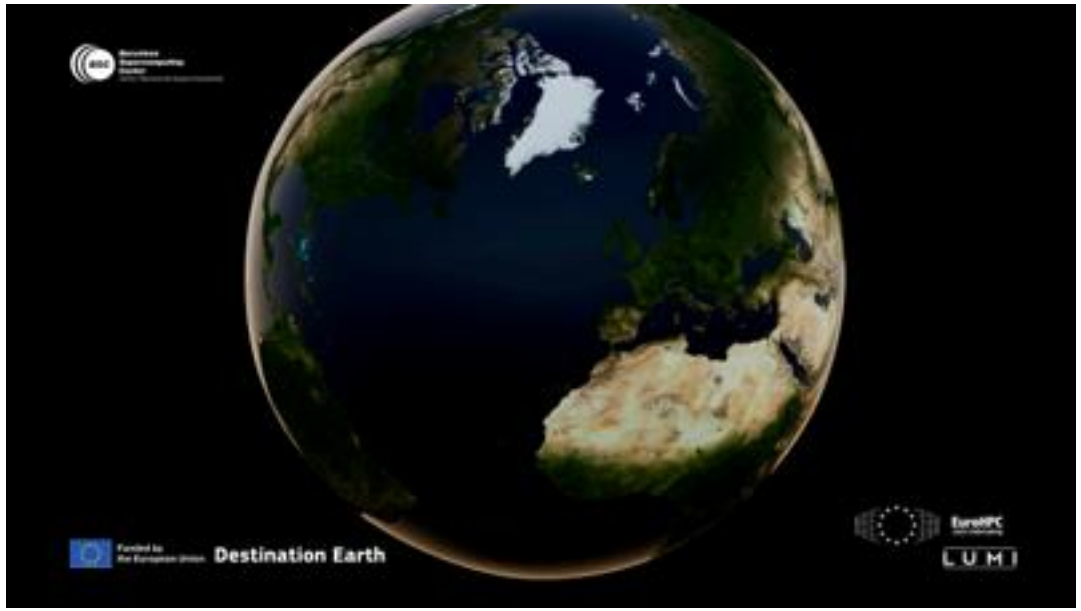

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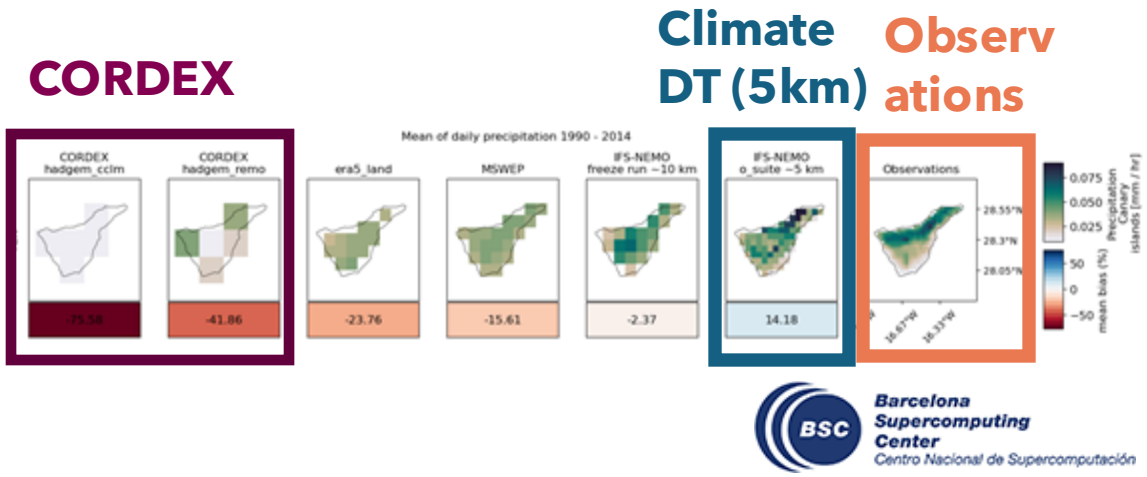
Analysis of precipitation over small islands demonstrates the added value of global km-scale data



Barcelona Supercomputing Center
Centro Nacional de Supercomputación

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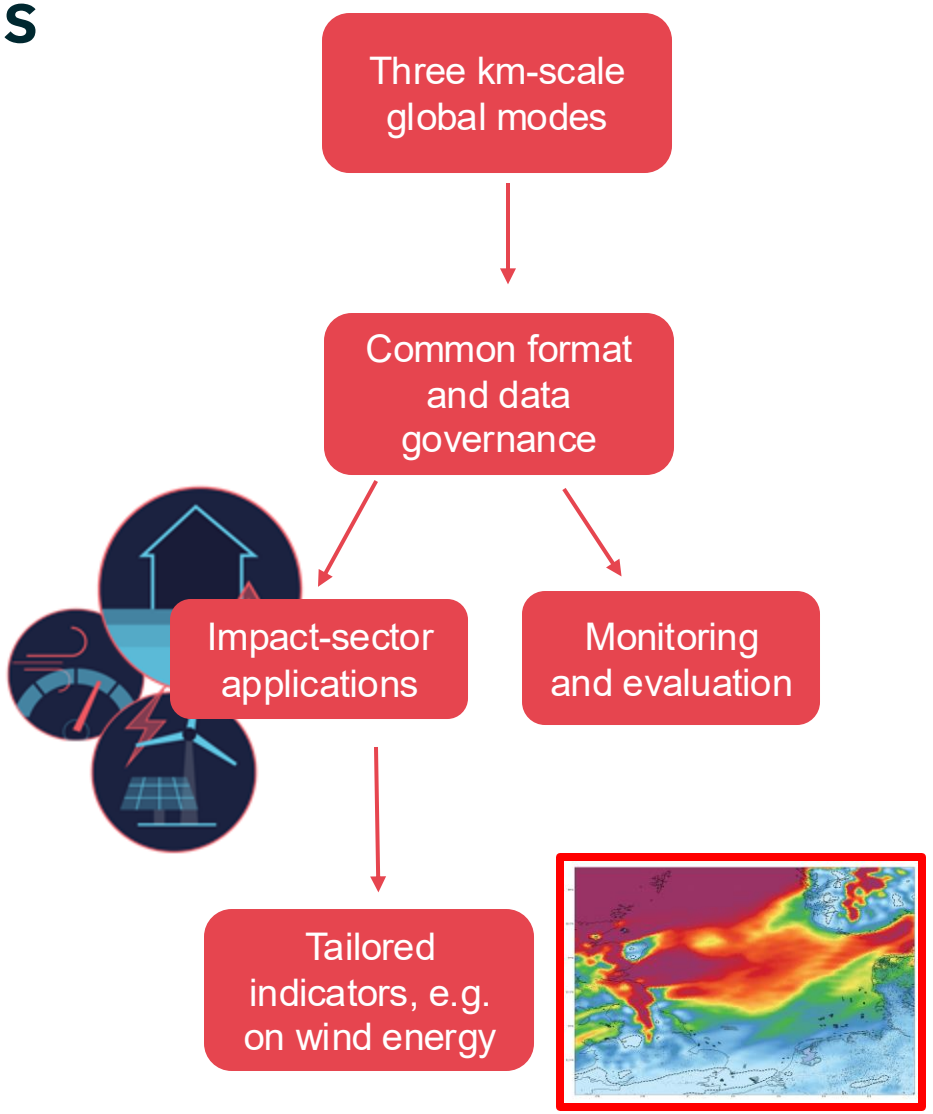
DestinE Climate DT - Applications for impact sectors and for monitoring & evaluation integrated in the same workflow with climate models

- **Common format and data governance** for three climate models
- Impact-sector applications produce **tailored user-relevant indicators** on the fly
- **Monitoring, evaluation** and **bias adjustment** on the fly
- Possibility to also access (reduced) data via DestinE Platform for **offline processing**



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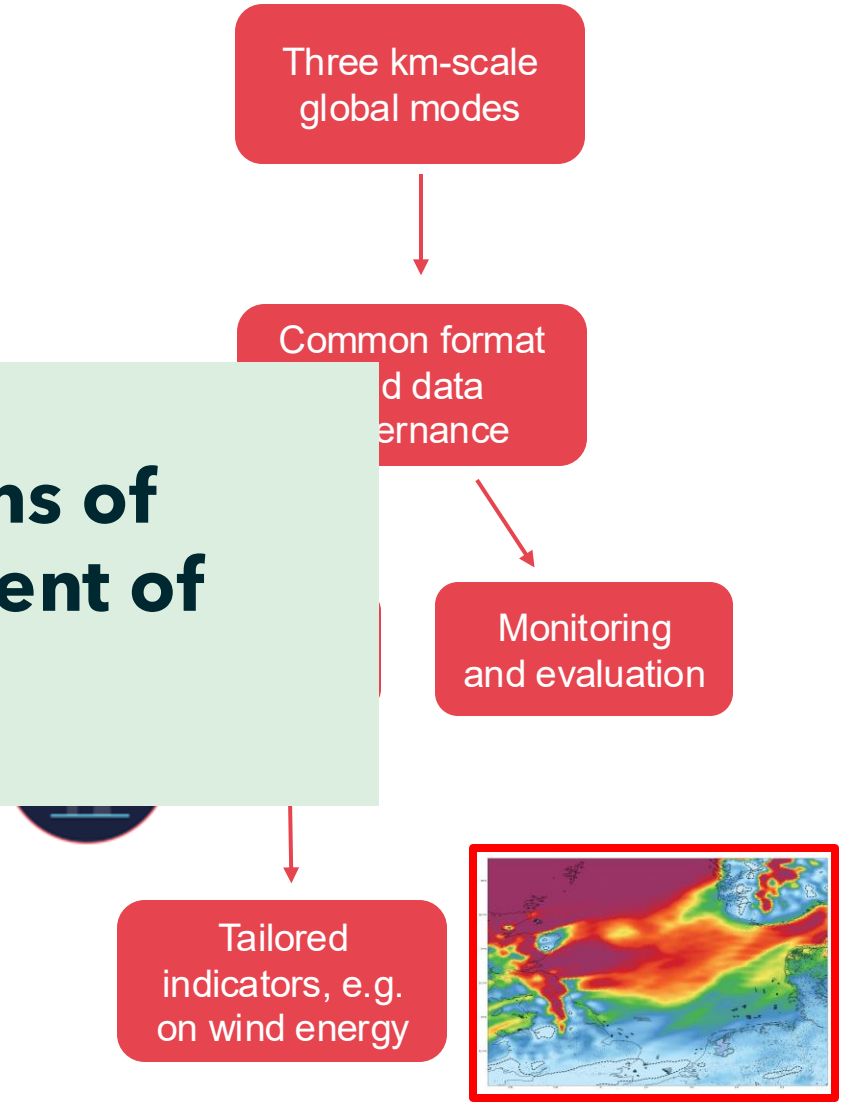
DestinE Climate DT - Applications for impact sectors and for monitoring & evaluation integrated in the same workflow with climate models

- **Common format and data governance** for three climate models

Novel concepts and technological solutions of DestinE Climate DT can benefit development of other climate and environmental services

- Possibility to also access (reduced) data via DestinE Platform for **offline processing**



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Research projects feeding into DestinE – TerraDT developments improve Climate DT capabilities

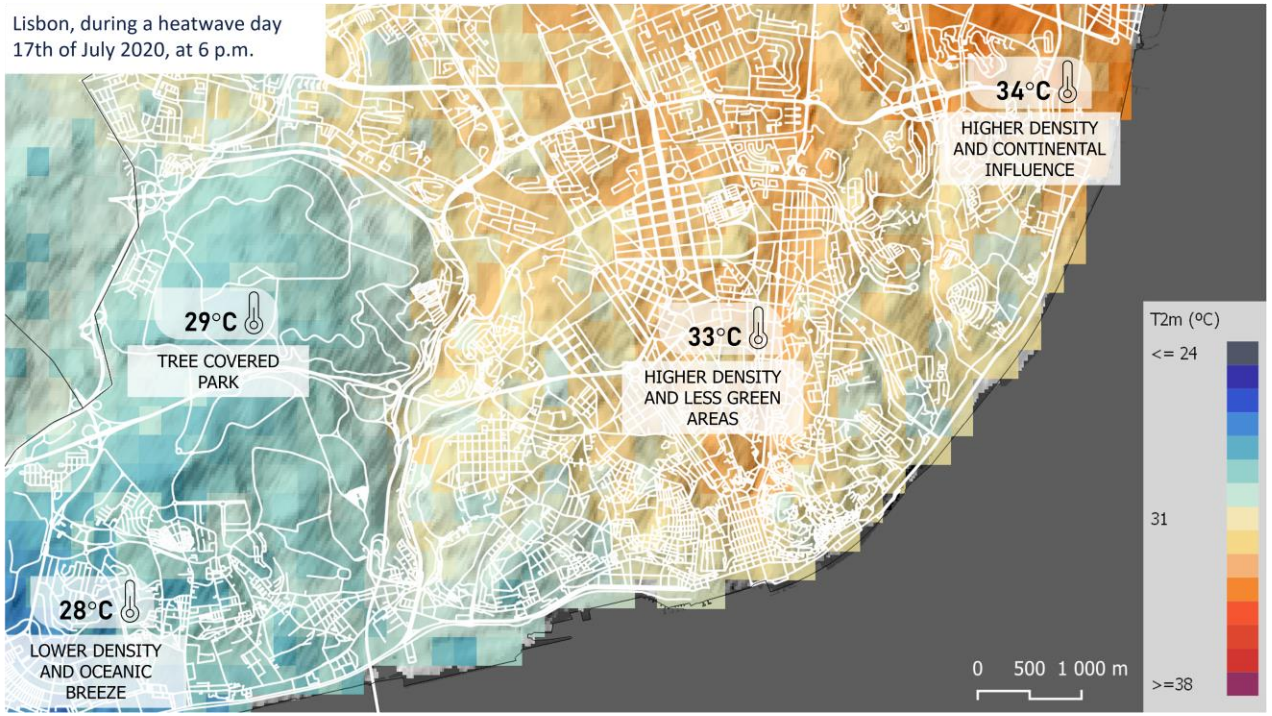
- **Horizon Europe funded TerraDT** project develops new components to be integrated as part of DestinE Climate DT

- Focus on **development of AI/ML approaches** for:
  - **Replacing** or **improving components** of km-scale Earth system models (sea ice, aerosols, land surface, ice sheets)
  - **Developing impact models** that provide user-relevant information by **combining EO data and models** (forests, urban heat extremes, urban carbon sequestration)

Funded by the European Union

TerraDT – Urban extremes impact model can support climate adaptation in cities

- **ML model for urban extremes** is developed using observational data from citizen-owned stations and different sources
- **City-scale information** on future temperature extremes will be generated using km-scale climate projections downscaled to ~200x200m
- **Interactive user interface** will enable users to explore different options for urban climate adaptation



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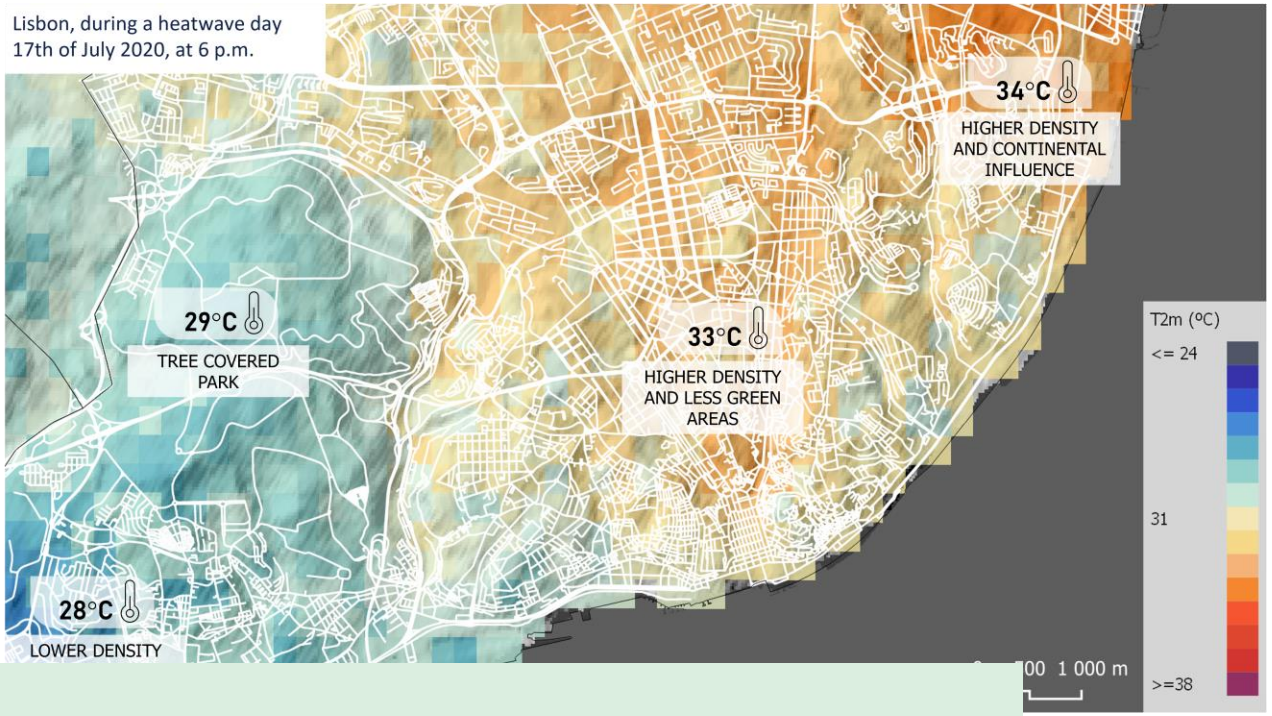


Research projects are critical for developing DestinE system and other services further and keeping them state-of-the art

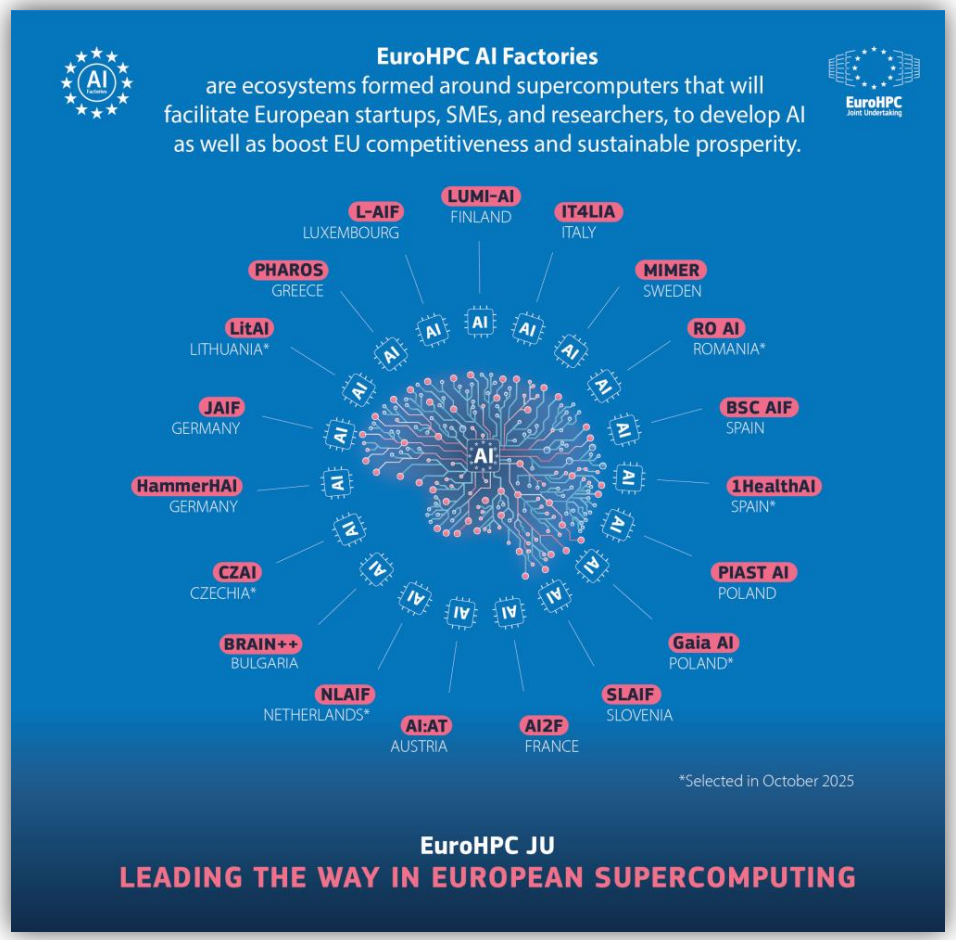
EuroHPC AI factories can facilitate using AI for development of climate and EO services

EuroHPC AI Factories

- Ecosystems formed around supercomputers to foster AI development in Europe
- Targeted at European startups, SMEs and researchers
- 19 AI Factories + 13 AI Factory Antennas

AI factory services

- Computing capacity
- Expert support
- Data sets and related services
  - LUMI AI factory's Dataset-as-a-Service provides curated datasets close to HPC resources
  - Upcoming thematic Data Labs will provide data sets and tools to different communities



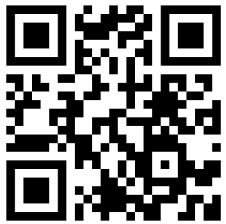
Conclusions

- Digital twins combining physics-based models, ML approaches and EO data can transform the provision of climate information
- Innovations from Destination Earth can benefit the development of other services
- Research projects are essential for keeping operational services cutting-edge
- EuroHPC AI factories can boost AI use in climate and EO services

More information:

Climate DT

TerraDT



Contact:
jenni.kontkanen@csc.fi