Supercomputing and AI for high-resolution forecasts and scenarios simulations

📅 12 December 2023

📍 Palazzo Malvezzi - University of Bologna

Gabriella Scipione

The Scientific Cases for computing in Europe 2018-2026

We are witnessing a revolution in humankind's ability to solve complex problems by relying on the synergy of advanced **algorithms, data, and hardware**.

The US, China and Japan are making great strides in these frontiers, and we call attention to the urgent need for an expanded European advanced computing infrastructure …

Simulations are critical in Climate, Weather, and Earth Sciences. Exascale resources will enable sub-kilometre resolution instead of 10km

Data is driving a scientific revolution that relies heavily on computing to process, analyse, and translate information into knowledge and technological innovations.

Computing is undergoing a tectonic change ….for hardware and extensive deployment of accelerator technologies where traditional modelling is increasingly complemented by data-driven approaches and artificial intelligence.

By the PRACE Scientific Steering Committee

CINECA

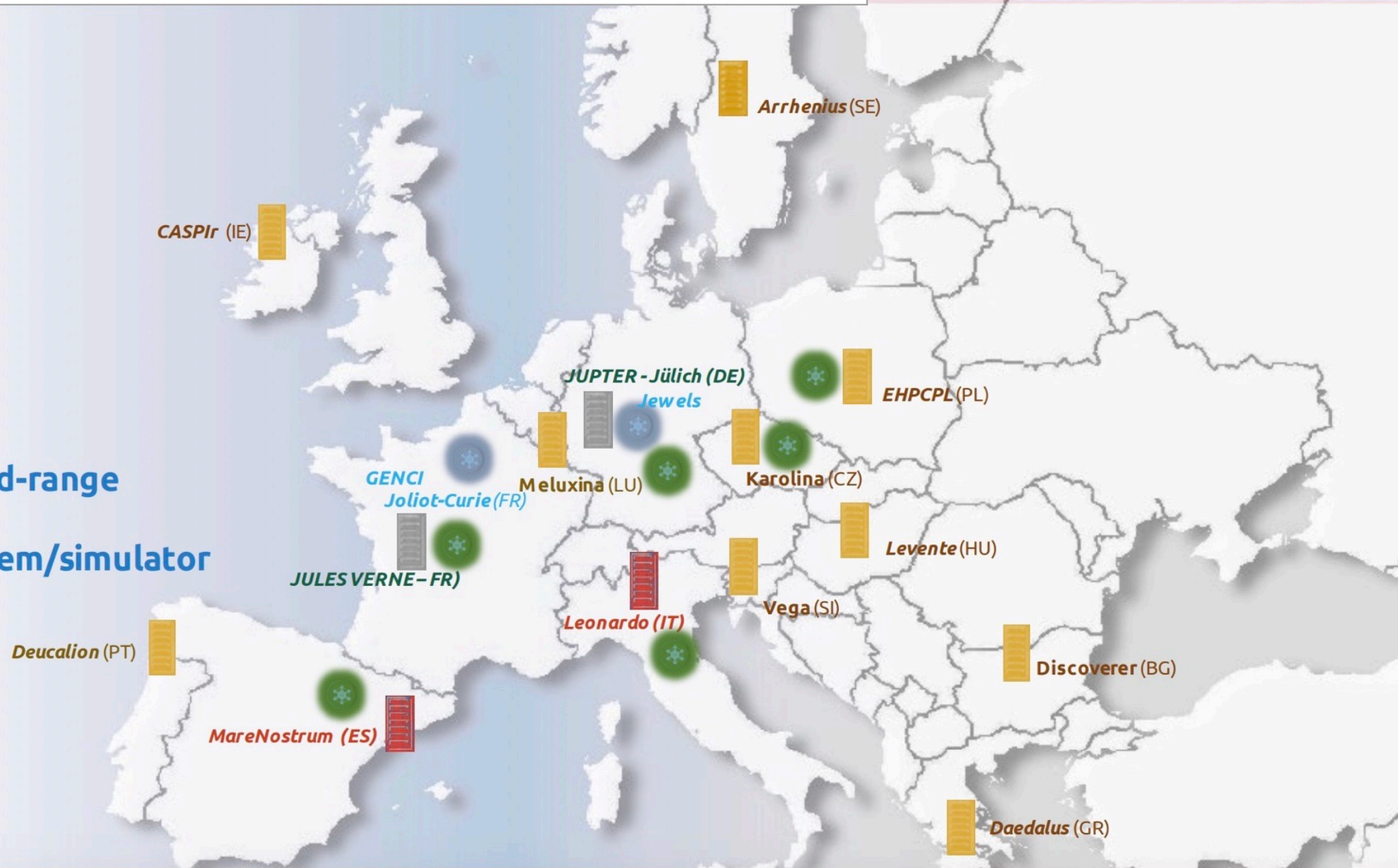# EuroHPC Systems

Lumi (FI)

EuroHPC
Joint Undertaking

Legend:
- Exascale
- Pre-exascale
- Petascale / mid-range
- Quantum system/simulator

Systems on map:
- Arrhenius (SE)
- CASPIr (IE)
- JUPTER – Jülich (DE)
- Jewels
- EHPCPL (PL)
- GENCI Joliot-Curie (FR)
- Meluxina (LU)
- Karolina (CZ)
- JULES VERNE – FR)
- Levente (HU)
- Leonardo (IT)
- Vega (SI)
- Deucalion (PT)
- Discoverer (BG)
- MareNostrum (ES)
- Daedalus (GR)

5

NOV 2023	TOP500	Green500
LUMI	#5	#7
LEONARDO	#6	#18
MARENOSTRUM 5	#8	#6
MELUXINA	#71	#27
KAROLINA	#113	#25
DISCOVERER	#166	#216
VEGA	#198	#253

LEONARDO

- **155**
- **4992** COMPUTING NODES
- **250** PETAFLOPS
- **6** MW IN OPERATIONS
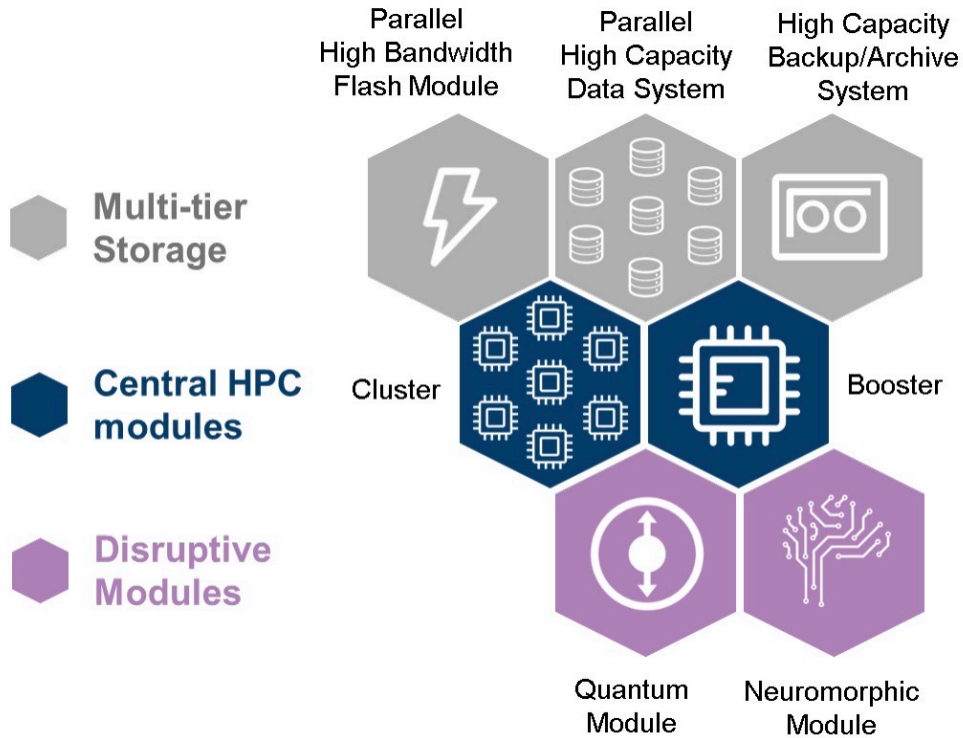- **2800** TB OF RAM
- **110** PB OF STORAGE
- **600** Mq FOOTPRINT
- **>95%** HEAT DISSIPATION VIA DLC

Modular Supercomputing

The most expensive global models will need last-generation HPC platforms to perform their simulations, leveraging both CPU and GPU resources, while AI based applications are more suitable for GPU architectures.

Parallel High Bandwidth Flash Module

Parallel High Capacity Data System

High Capacity Backup/Archive System

Multi-tier Storage

Central HPC modules

Cluster

Booster

Disruptive Modules

Quantum Module

Neuromorphic Module

1 - Modular Supercomputing Architecture (MSA)

adopted across Europe and world-wide

Several compute modules connected to create a single heterogeneous system

serving both HPC and AI applications

Heterogeneous computing using GPUs and CPUs

Integrating very diverse hardware technologies, including quantum computing

by Modular Supercomputing Architecture, ETP4HPC

Impact 1: Supercomputing in support of the ocean forecasting and modelling systems

Very high resolution simulations (< 1km) to obtain better simulations based on more realistic model.

starting point for any numerical representation of the ocean for offshore applications as well as for applications concerning biodiversity,..

for ocean downscaling capacities to reach the coastal scale

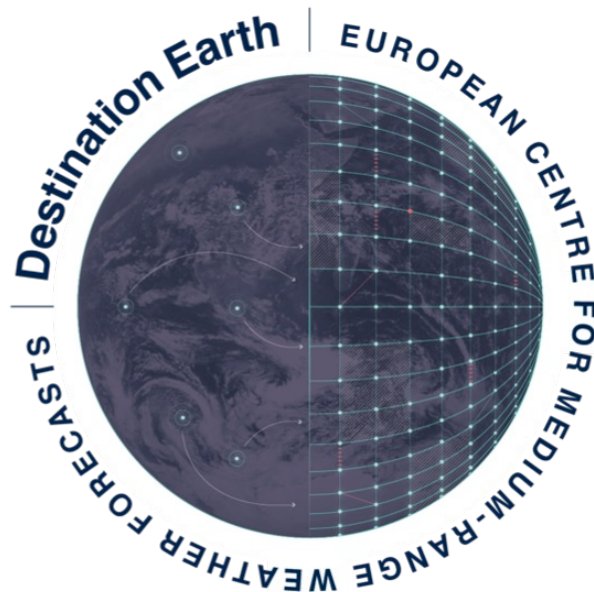# Impact 2: AI / Big Data analytics in support of the ocean forecasting and modelling systems

HPC necessary to implement state-of-the-art generative Machine Learning (ML) models aimed at providing ensemble generation
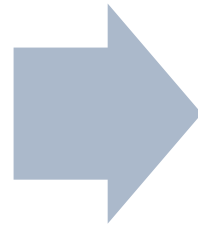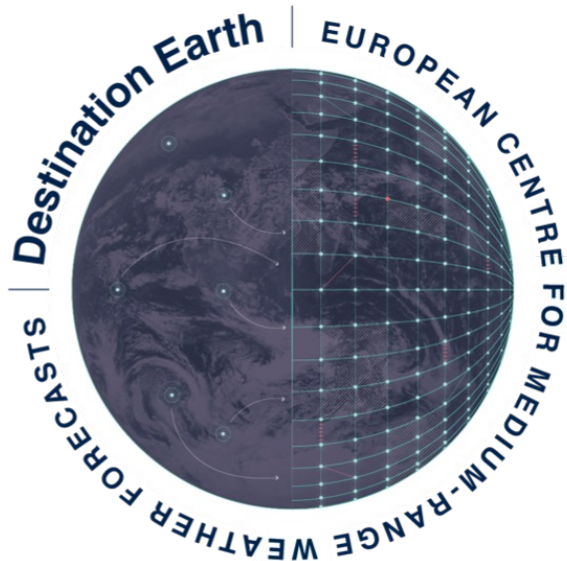
and temporal downscaling modules within the Digital Twin platforms.

Impact 3: Supercomputing in support of the environounment digital twins

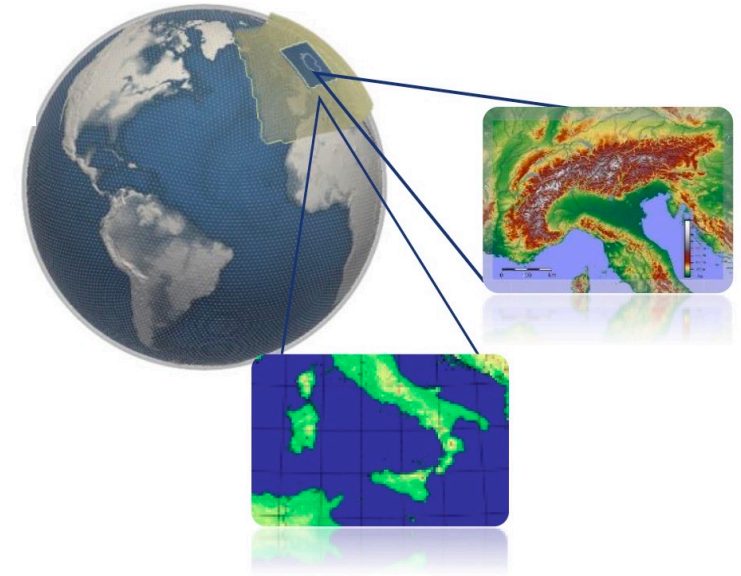# GLORI4DestinE

Global-to-Regional-ICON Digital Twin

ECMWF

LEONARDO

Cineca, ItaliaMeteo, Arpae, CMCC
+
GLORI consortium

The main aim:
- to **demonstrate** the possibility of interoperability between the Digital Twin Engine and GLORI Digital Twin.
- to **implementing interfaces** between GLORI and DestinE Digital Twins and architecture (Digital Twin Engine, data lake), **which are being run on the same EuroHPC platform (Leonardo).**

How to save Ravenna

Controlled breaking

The left embankment of one of the canals flowing north of the city of Ravenna has been broken by bulldozers to pour water into an area of about 200 hectares of fields and pine forest, so as to relieve the flood and reduce the pressure on the city

Thank you!

Gabriella Scipione
g.scipione@cineca.it