

Digital twins for global to regional weather systems

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GLORI
GLObal to Regional | ICON Digital Twin

Global-to-regional digital twin based on ICON

A computational model close to reality which provides

- configurable
- on-demand
- portable
- high resolution

digital twins for weather forecasts.

Use cases include health applications (pollen, air quality, urban heat islands), energy applications (photovoltaics) and extreme events (floods, droughts), agriculture, ...

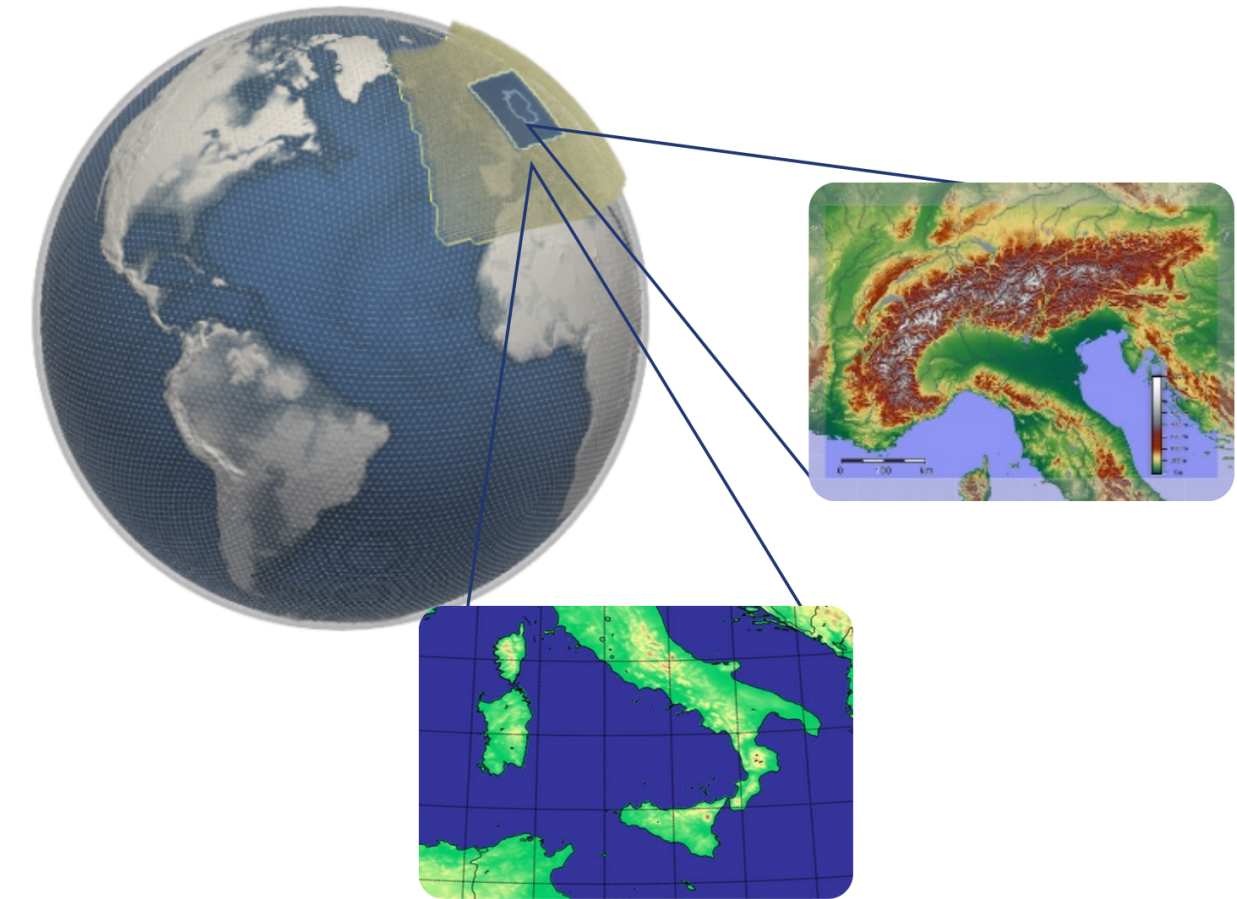


Figure 1: GLORI combines global simulations at 6.5 km resolution with regional simulations at down to 500 m resolution in the Alpine and Mediterranean regions.

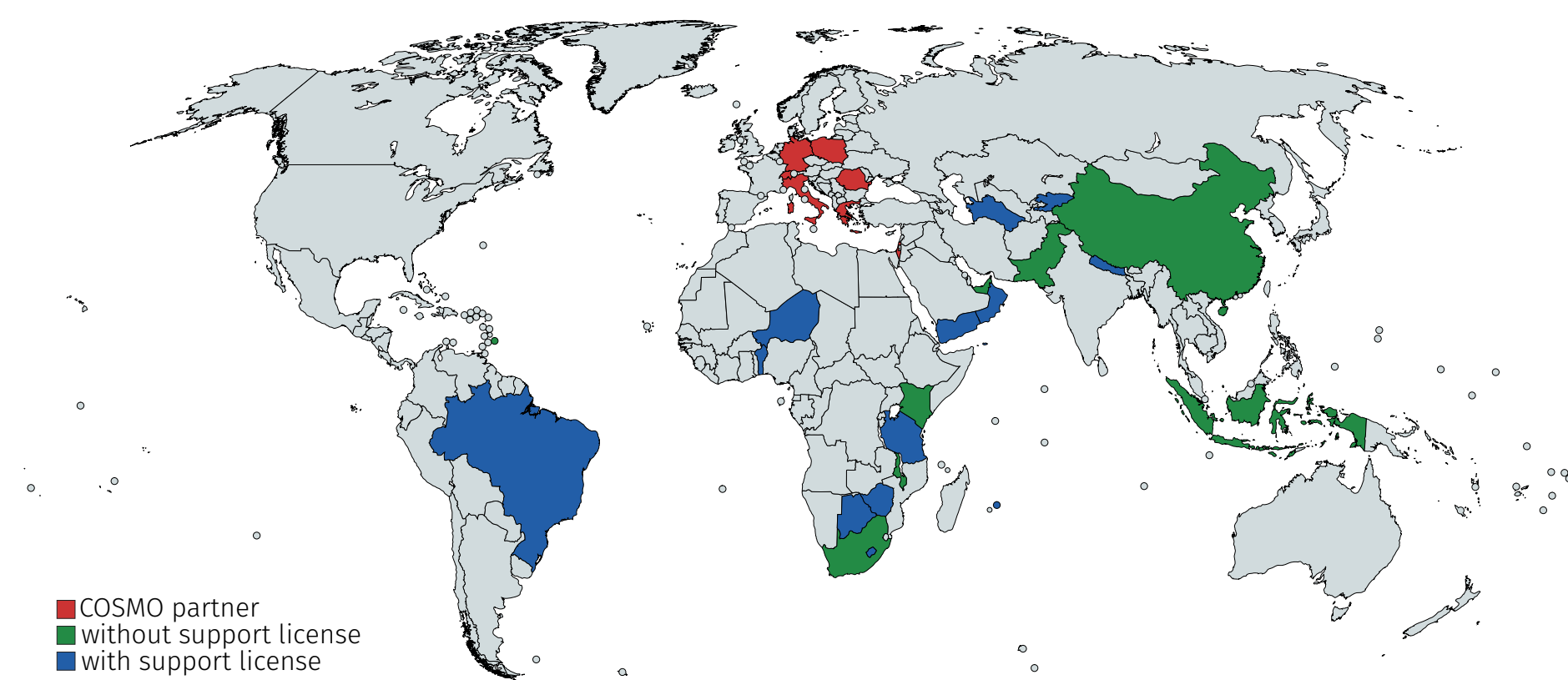


Figure 2: Countries whose meteorological service uses ICON.

ICON

ICON is a flexible, scalable, high-performance, open-source modelling framework for weather and climate prediction

- (compressible) non-hydrostatic model dynamics
- FV discretization on icosahedron-based triangular grid
- enables simulations of the atmosphere, oceans or a coupled earth system model
- predominantly written in Fortran
- supports various parallelization paradigms (MPI, OpenMP, NEC vector engines, OpenACC)

www.icon-model.org

developed by

Deutscher Wetterdienst

Wetter und Klima aus einer Hand

DWD

MAX-PLANCK-INSTITUT

FÜR METEOROLOGIE

DKRZ

KIT

Center for Climate Research

ALFA ROMEO

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HPC systems within GLORI

These machines serve as prototype implementations of the twins: (Top500, Rmax)

- Alps @ CSCS, Switzerland (#6, 270 Pflop/s)
HPE, NVIDIA GH200 Superchip
2688 nodes, Slingshot-11 200 Gbit/s
- Leonardo @ CINECA, Italy (#7, 241 Pflop/s)
EVIDEN, Intel Xeon 8358 + NVIDIA A100 64 GB
3456 nodes, Infiniband HDR 200 GBit/s
- Horeka Green @ KIT, Germany (#118, 8 Pflop/s)
Lenovo, Intel Xeon 8368 + NVIDIA A100 40 GB
167 nodes, Infiniband HDR 200 GBit/s

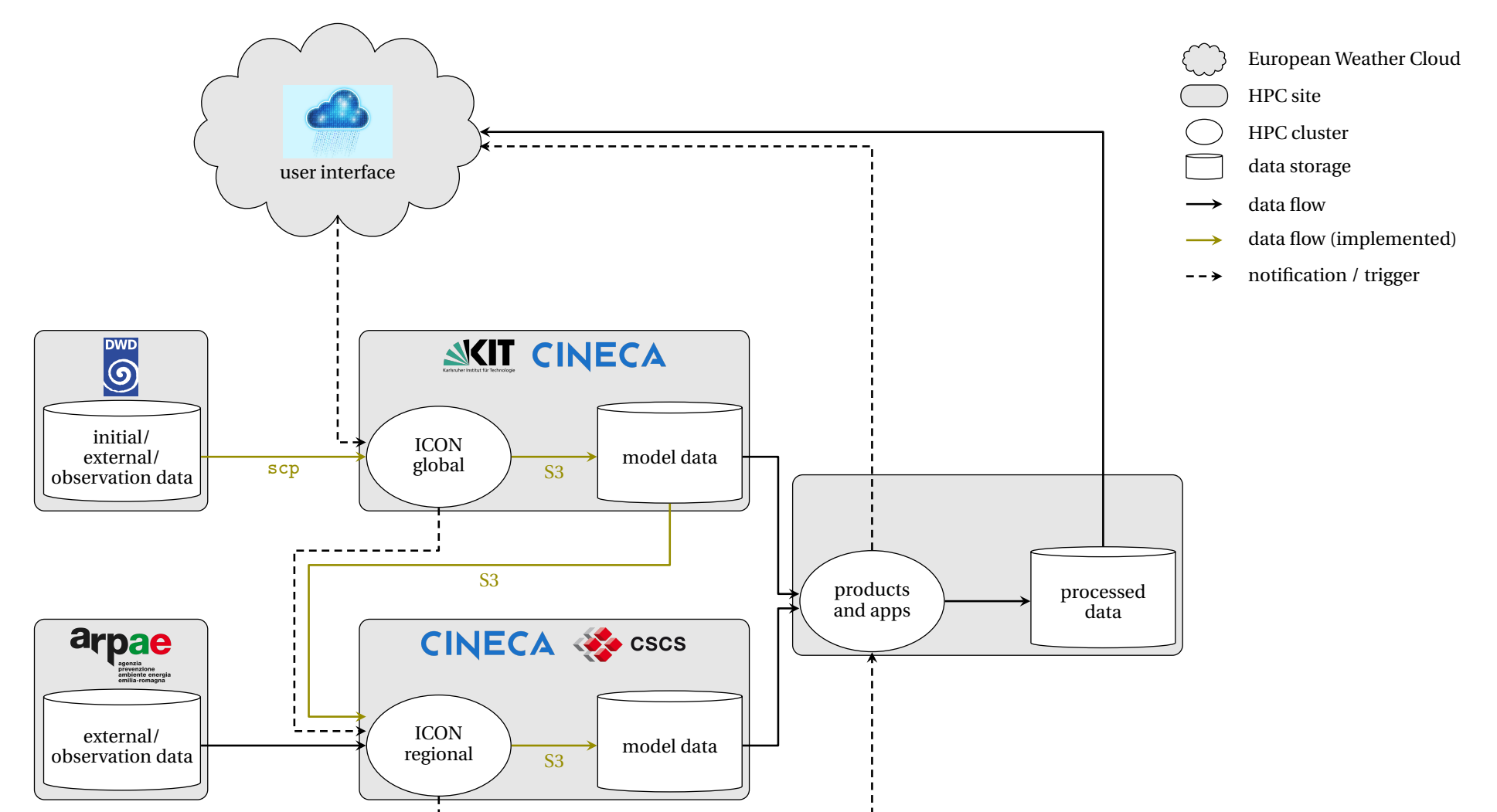


Figure 3: Dataflow between meteorological services and various HPC sites which run the digital twins.

Open challenges:

- High-resolution physics: Atmospheric simulations at sub-kilometer scale partially resolve convective cloud processes. The parametrization at these scales is an active topic in atmospheric research.
- Performance portability: The digital twins will run on various heterogeneous architectures and consistent performance is crucial due to the time-critical nature of forecasts.
- Infrastructure and data flow: HPC sites require recent observational data from meteorological services and model data needs to be transferred between various HPC sites. The GLORI-DT will be integrated into *Destination Earth*—a flagship initiative of the European Commission.