

# GLORI4DE GLObal to Regional Icon for Destination Earth

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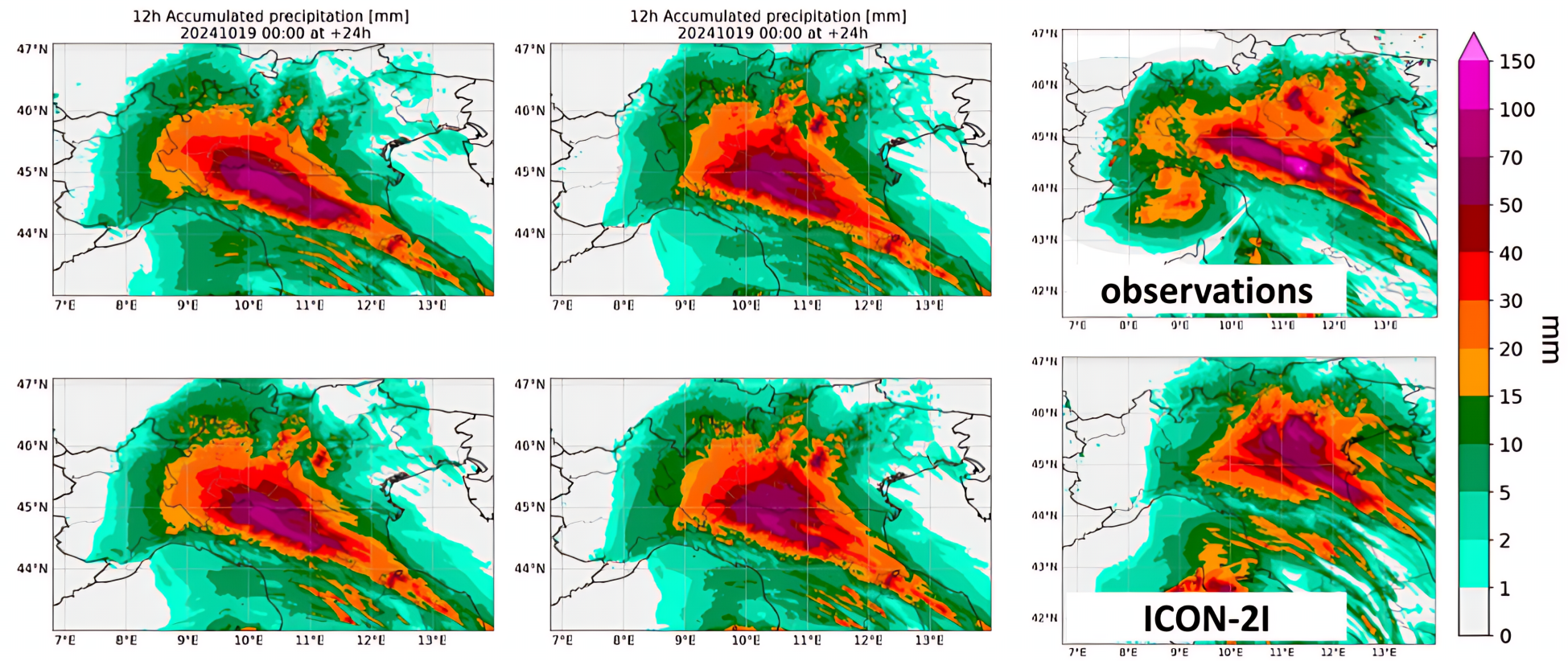
## GLORI4DE: Overview and Implementation

The **goal of the project** has been to enhance the interoperability between the DestinE and GLORI digital twins:

- On the weather model side, we use *high-resolution* output from the IFS model to trigger a high-resolution ICON-LAM model (Limited Area Model)
- On the components side, we integrate DestinE tools with the ICON workflow, ultimately deploying the project on the *LEONARDO* cluster

## Use case scenario: October 2024 Emilia-Romagna flood event (Arpae)

On 19 October 2024, intense precipitation affected north and central Italy, with the Emilia-Romagna region severely hit by flood events.

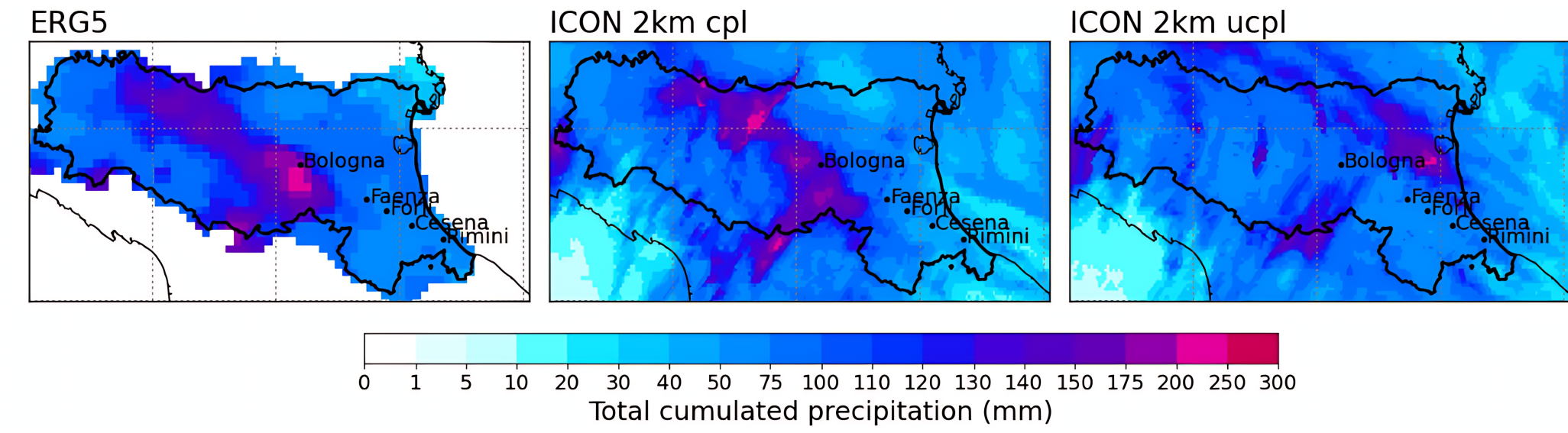


- The top-right panel displays the observed precipitation
- ICON-2I, the weather model in use at the time, strongly underestimated the intensity and location of the precipitations (bottom right panel)
- The left and center panels show 4 out of the 20 GLORI4DE ensemble members (12-hour accumulation starting at 12 UTC, 19/10/2024)

Although not fully matching observations, GLORI4DE simulations show a clear improvement over ICON-2I in both intensity and location of precipitation.

## GLORI4DE with added ocean component (CMCC)

A *coupled ocean-atmosphere* simulation using ICON-LAM was run over a Mediterranean grid as part of the GLORI4DE workflow.



- The left panel shows the observed precipitation from the ERG5 dataset.
- The central panel displays the result of a coupled ICON-A-LAM + ICON-O-LAM simulation (atmosphere + ocean), using online coupling via the YAC coupler (frequency: 400 s).
- The right panel shows the same setup in uncoupled mode (ICON-A-LAM only) using the same grid and boundary conditions.

| Component                  | Grid                         | Initial & Boundary Conditions | DE Experiment |
|----------------------------|------------------------------|-------------------------------|---------------|
| ICON-A-LAM<br>(Atmosphere) | ICON R2B10 grid<br>at 2.5 km | IFS analysis                  | i4q1          |
| ICON-O-LAM<br>(Ocean)      |                              | CMEMS analysis                | inq9          |

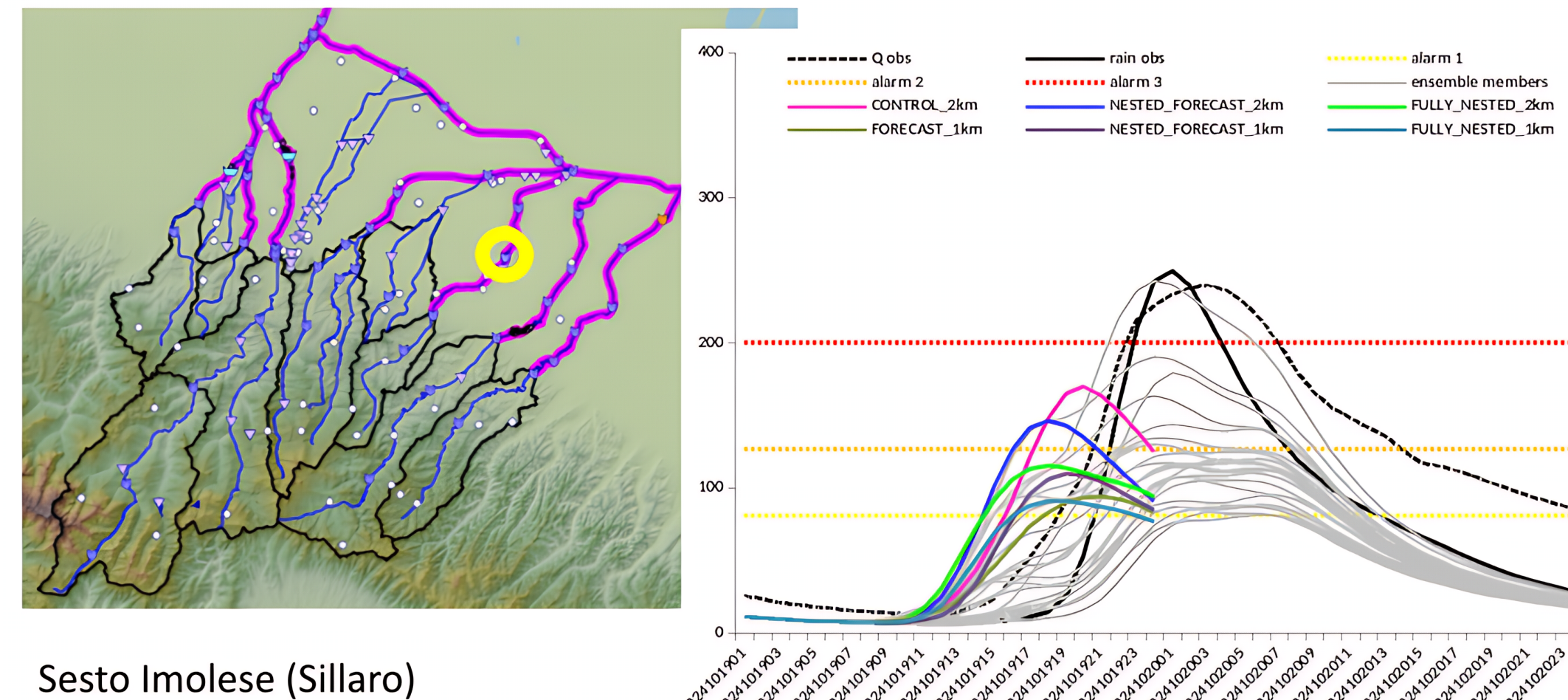
The coupled configuration provides a visibly improved spatial match with observations, especially over the Apennine foothills and central plains of Emilia-Romagna.

## Deployment of Destination Earth tools

- Definition of an ad-hoc suite in *ecFlow* to handle the overall workflow
- Deployment of and *FDB endpoint* on LEONARDO, adaptation of FDB metadata to the ICON-model/GLORI4DE-project via the Yaco software
- Use of *polytope* to retrieve high-resolution initial/boundary conditions from the Destination Earth catalogue

The precipitation forecasted by the GLORI ensemble has been used as input for the *Topkapi* rainfall-runoff model, operational at Arpae

- Left*: the yellow circle indicates the section of the Sillaro river where the discharge is computed by Topkapi and measured.
- Right*: Discharge measured at the Sillaro section (black dashed line) and calculated by the Topkapi model for the observed precipitation (solid black line) and for the twenty members of the Scenario 3 ensemble (grey lines).

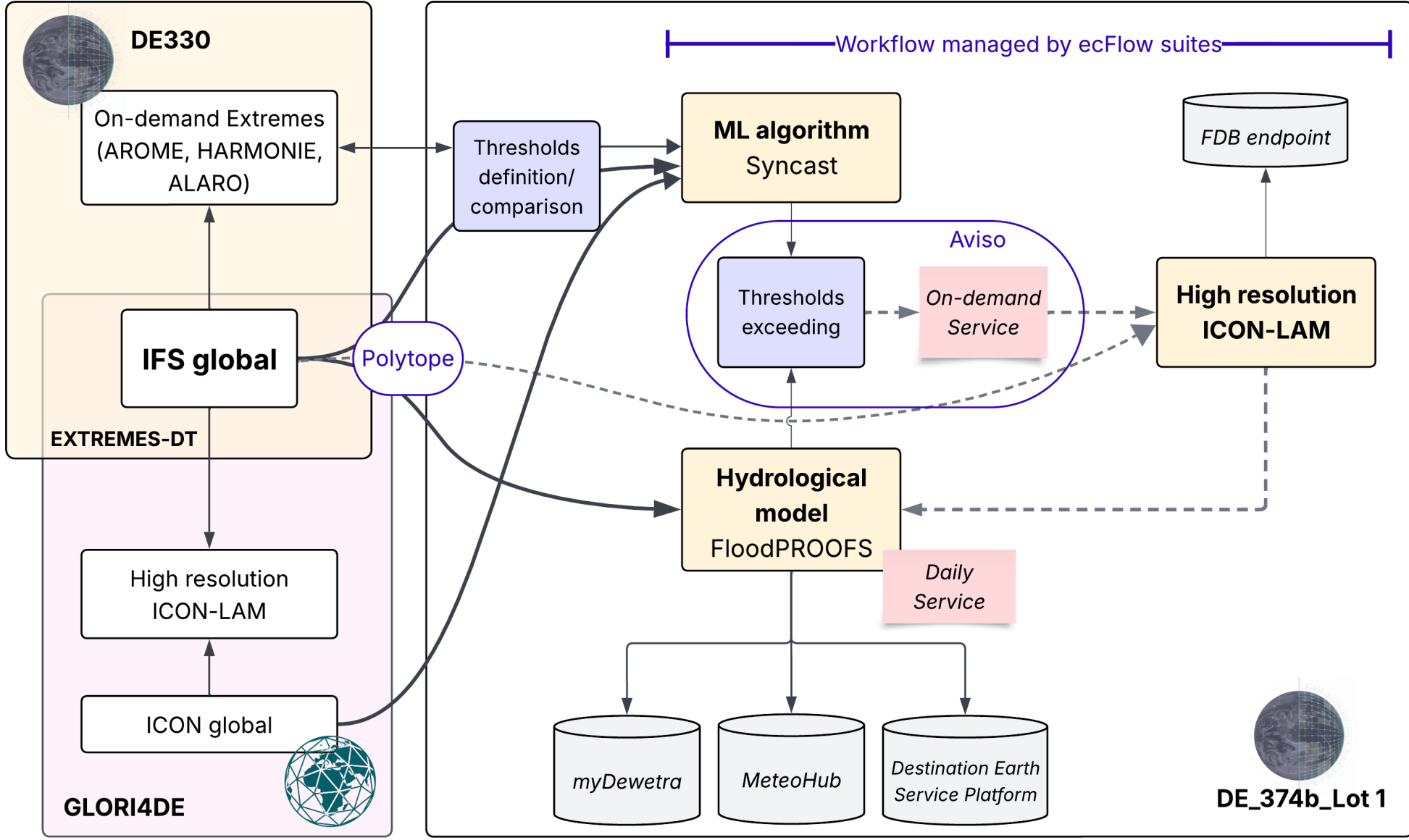


## GLORI4DE outcomes: DE374b, high-res precipitation-to-flood signals

The DE374b project advances integration of high-resolution regional forecasting into operational flood risk management, in collaboration with Italian Civil Protection and regional authorities.

- High-resolution IFS data trigger the *FloodPROOFS* hydrological model.
- Workflows are managed via *ecFlow* suites adapted from GLORI4DE; input is fetched through Polytope from the DestinE catalogue.
- On-demand high-resolution ICON regional forecasts extend the GLORI4DE setup to provide localized hydrological triggers.
- Machine learning algorithms are being developed to dynamically define event-triggering thresholds.

DE374b will deliver streamflow forecasts for over 500 river sections, accessible through DestinE, MyDewetra, and MeteoHub.



## Partners & People



People: Gabriella Scipione, Gian Franco Marras, Massimo Gisonni, Fabio Di Sante, Matteo Ippoliti, Alfonso Ferrone (CINECA), Virginia Poli, Chiara Marsigli, Davide Cesari, Thomas Gastaldo (Arpae), Gabriella Ceci, Angelo Campanale, Mario Raffa, Pasquale Schiano, Paola Mercogliano (CMCC), Roland Potthast, Michael Kray, Thorsten Steinert, Xu Xu (DWD), Thomas Geenen, Emanuele Danovaro, Matthew Griffith (ECMWF), Renata Pelosini, Giulia Pietrollini (AIM), Simone Gabellani, Elena Oberti, Luca Monaco (CIMA foundation, DE374b project)