CONNECT: Tagus river-to-ocean collaboratory for thematic digital twins and collaborative management

Marta Rodrigues, Anabela Oliveira, Gonçalo de Jesus, André Fortunato, Ricardo Martins, Zahra Mardani, Elsa Alves

EGI 2024, September 30, 2024 to October 4, 2024, Lecce, Italy

CONNECT - local COastal moNitoriNg sErviCe for PorTugal

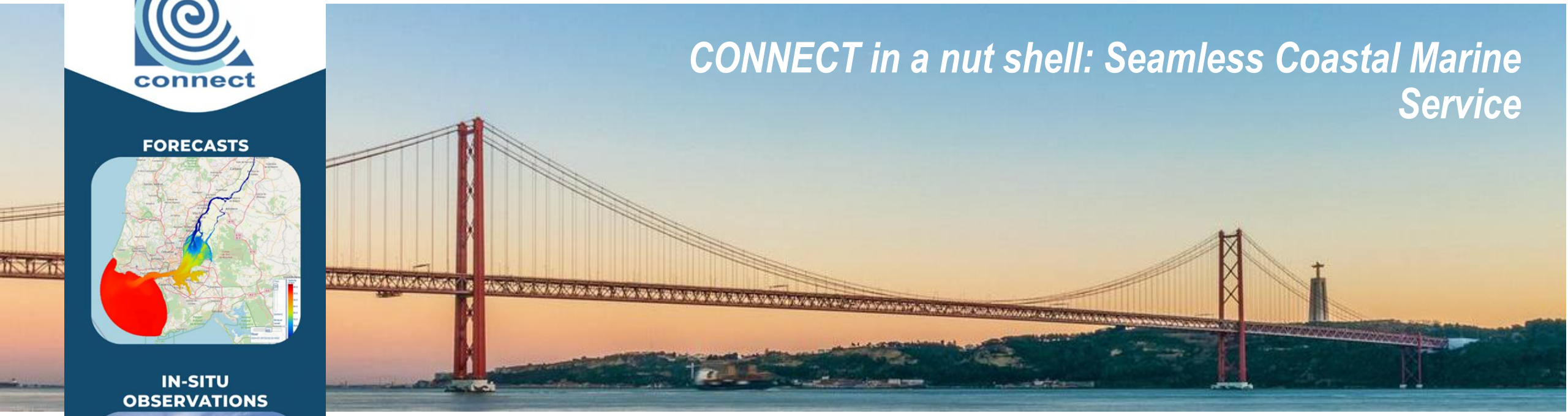
Copernicus Marine – User – EU Coastal Monitoring Pilot Demonstrations (22050-COP-INNO USER)

Goals CONNECT

Develop Digital Twins to:

- Support the evaluation of the ecological status of estuaries (WFD)
- Quantify land inputs to the adjacent coastal waters (MSFD)
- Anticipate inundation events (Floods Directive)
- Build tailor-made products and facilitate access to them

LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL



CONNECT in a nut shell: Seamless Coastal Marine Service

FORECASTS

IN-SITU OBSERVATIONS

SATELLITE

CONNECT delivers a local, high-resolution, coastal service that seamlessly integrates model-based forecasts and observations to provide blue (physical) and green (biogeochemical) data on Portuguese estuaries to CMEMS

DT Co-design with users

- Address user’s requirements and feedback on the coastal service through inquiries and interviews

- Dedicated actions with users for DT dissemination with detail improvement and future actions goals

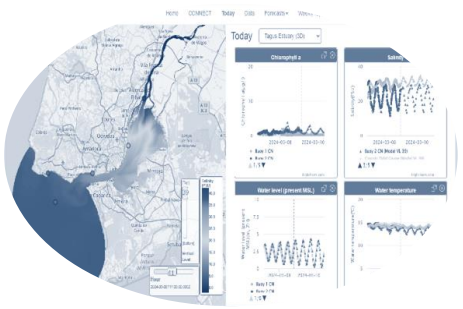
CONNECT DT building blocks

High-resolution operational modelling of estuarine - coastal circulation and water quality, forced by CMEMS regional models

Built using OPENCoastS

Near-real time *in-situ* data acquisition and Earth-observation data

From CoastNet



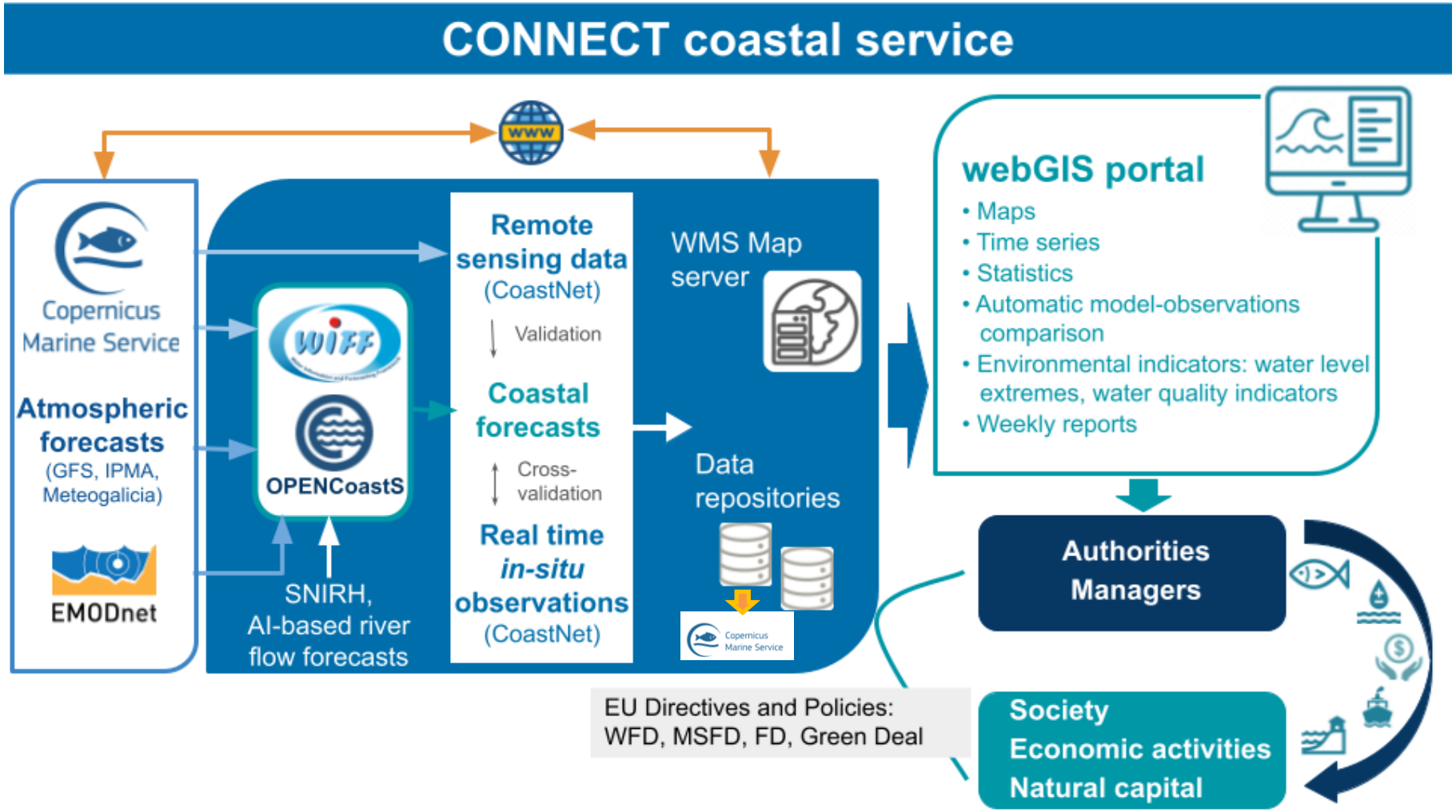
WebGIS portal to access physical and biogeochemical 2-day forecasts and observations

Using Collaboratory infrastruture for societal uptake

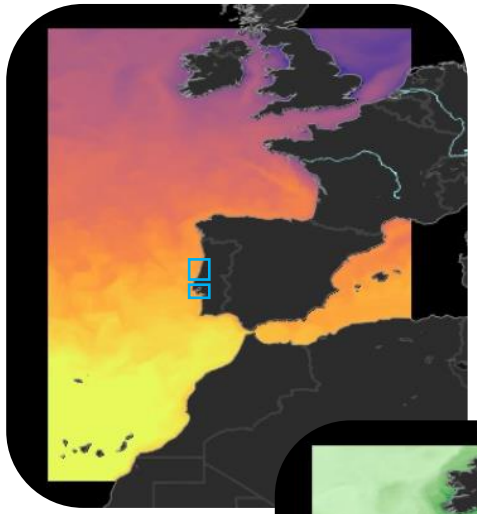
Seamless integration and provisioning of products to CMEMS

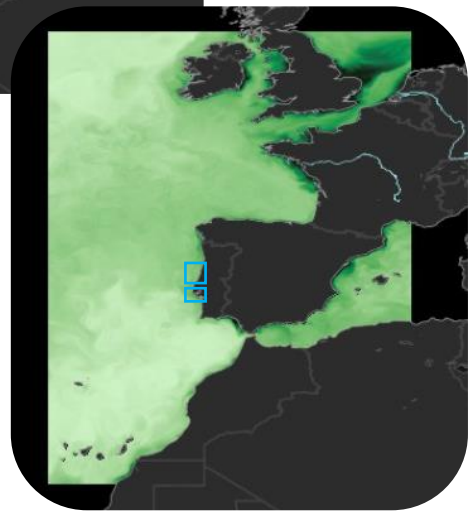
Copernicus Marine Service

CONNECT Digital Twin architecture



Building the model cascade in the DT





Horizontal resolution: 1/36º

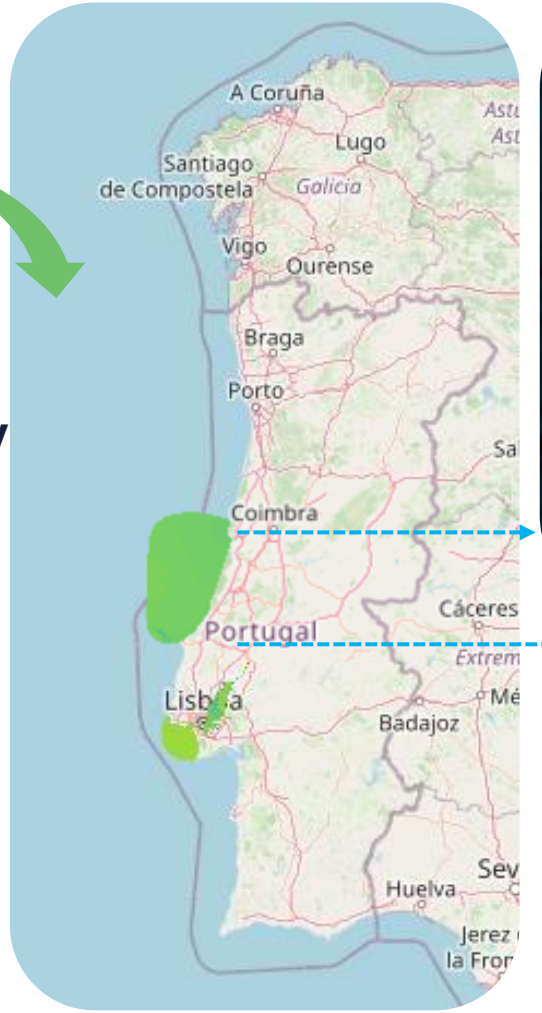
Vertical grid: 50 levels

Downscalling

SCHISM

IBI Physics

IBI Biogeochemistry



Mondego estuary

Horizontal resolution: 5-5000m

Vertical grid: 25 SZ levels

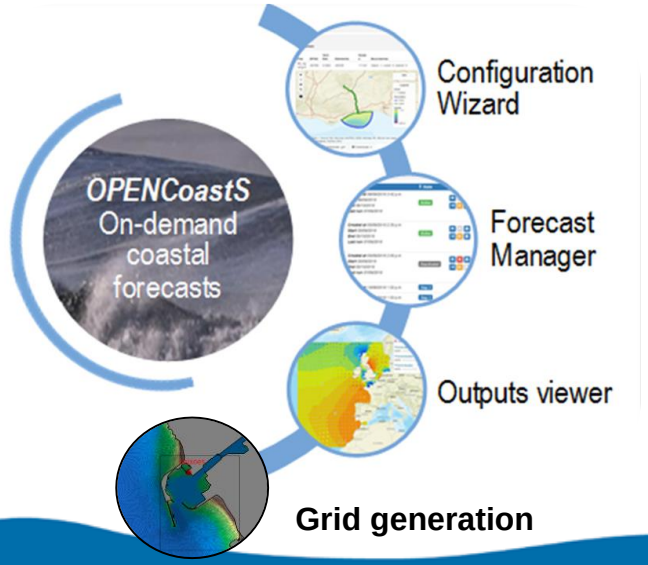
Tagus estuary

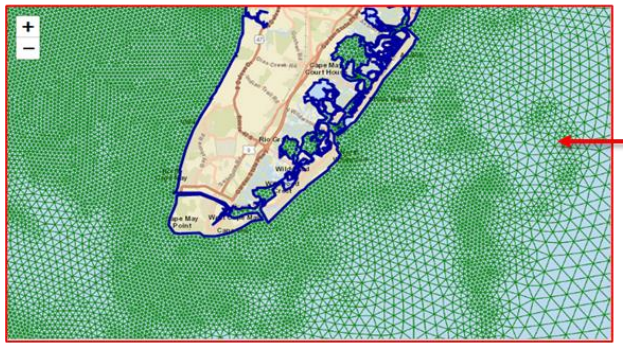
Horizontal resolution: 3/5-1600m

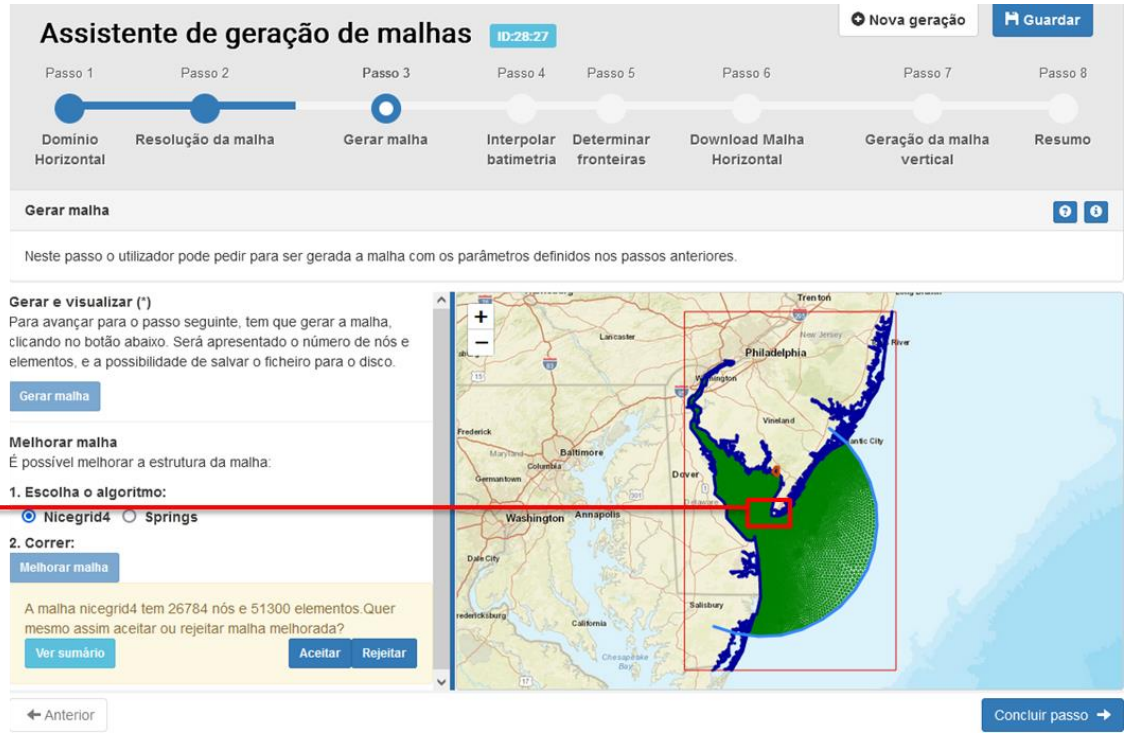
Vertical levels: 39 SZ levels

OPENCoastS: build the operational deployments

- Create and maintain an operational forecast for the user selected coastal area
  - Interaction with a simple Web interface
  - Allow choice of model, forcings, parameters and data sources
  - Integrate with external forecasts (AI model for the Tagus river)
  - Easy replication of deployments for fast calibration
- Whole forecast cycle: create grid, configure, manage, outputs viewer

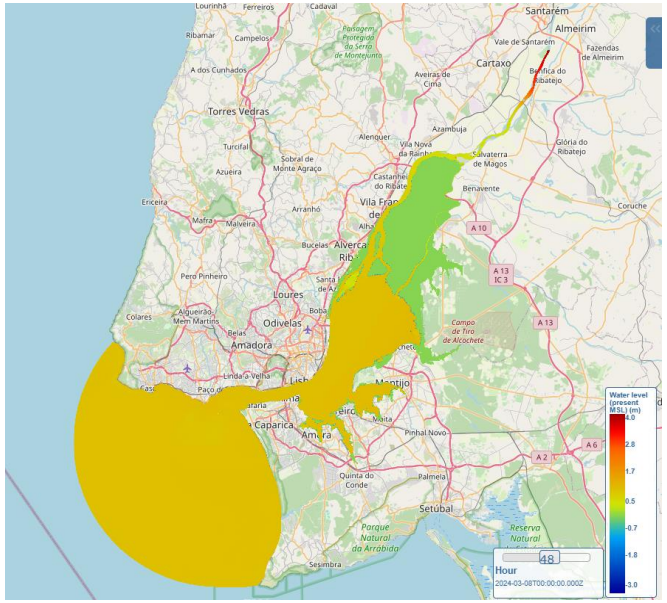






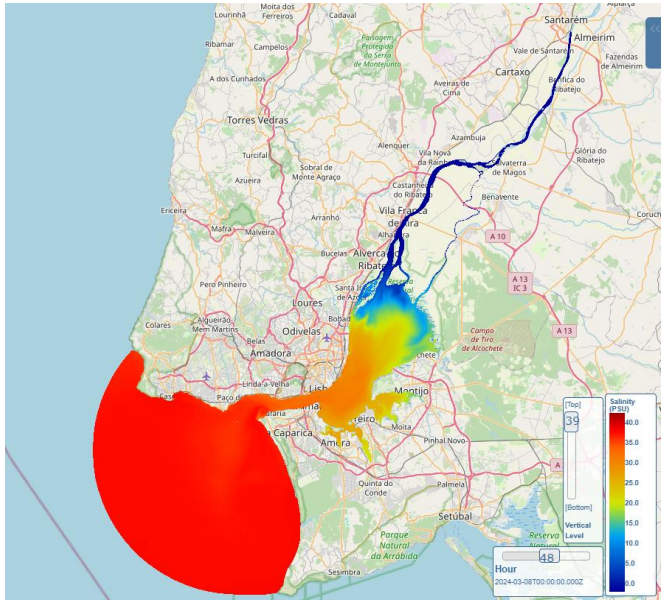
CONNECT DT Products designed for specific themes

Tagus estuary:
2D barotropic model, waves-currents interaction
- inundation



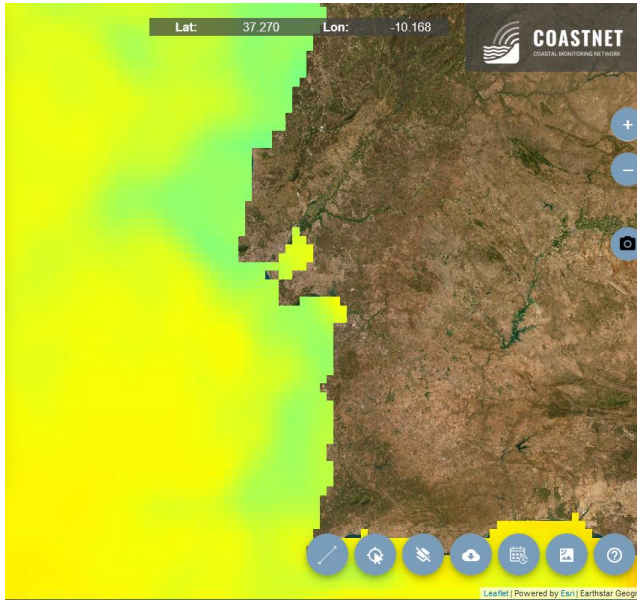
Water levels, Velocity,
Waves (Significant wave height, Mean period, Direction)

Tagus estuary: 3D baroclinic model, coupled circulation-biogeochemistry
– water quality



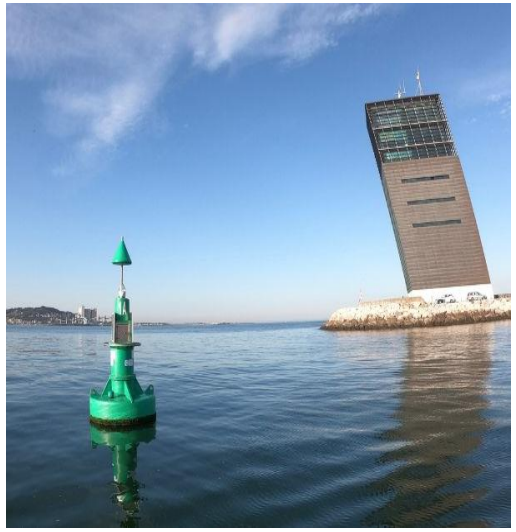
Water levels, Velocity, Salinity, Temperature, Ammonium, Nitrate, Phosphate, Silicate, Dissolved oxygen, Chlorophyll-a

Remote sensing:
Copernicus Marine Service



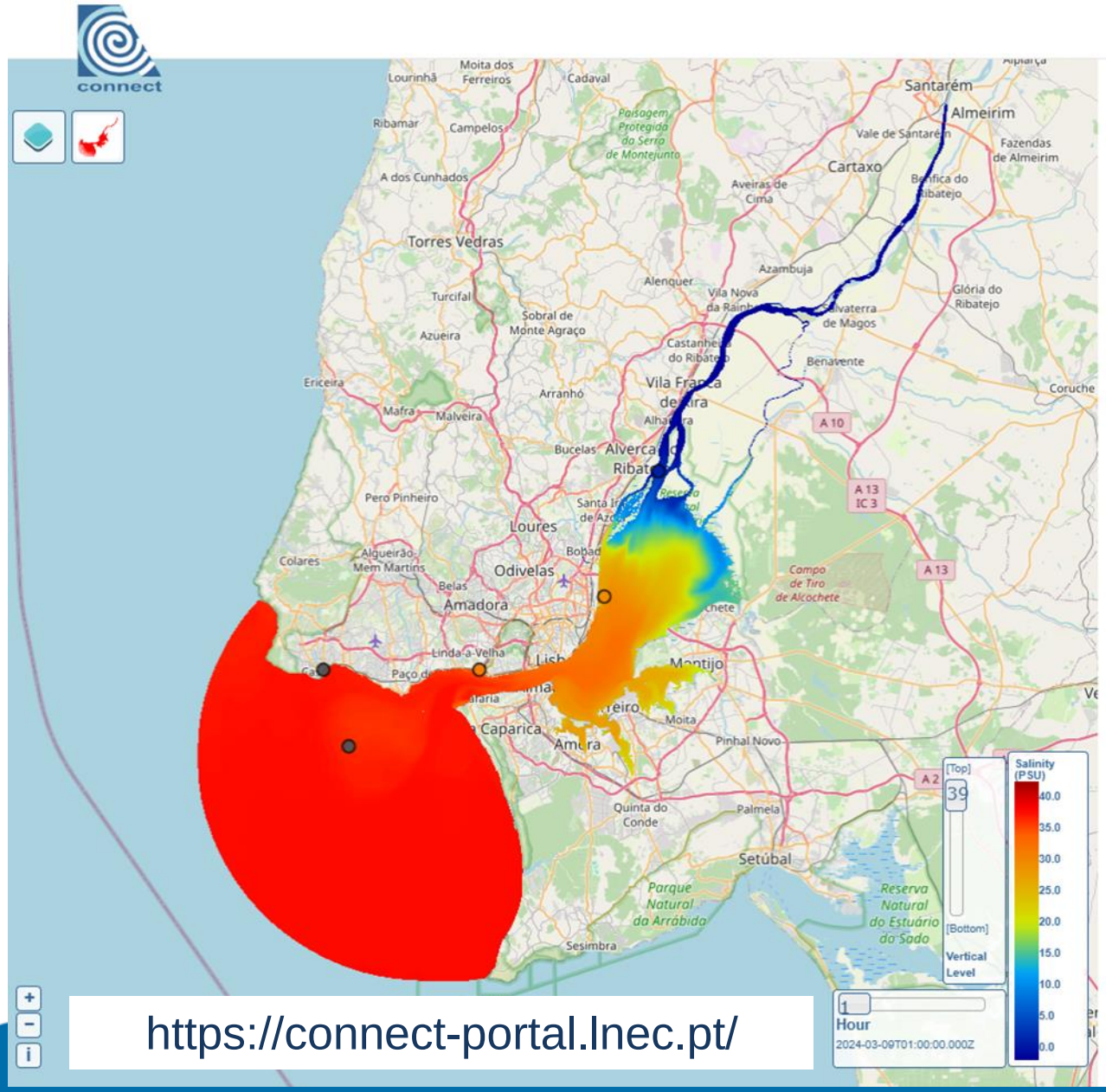
Water temperature, Chlorophyll-a

NRT in-situ monitoring network



Salinity, Temperature, pH, Dissolved oxygen, Chlorophyll-a, Turbidity

CONNECT DT WebGIS portal: Application of the Collaboratory infrastructure

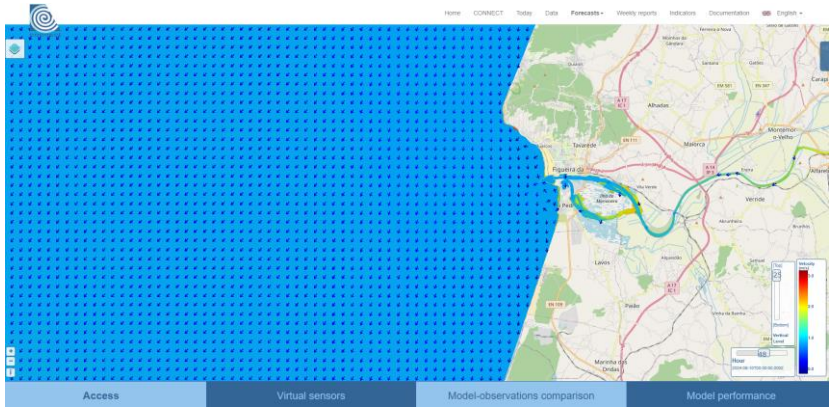


https://connect-portal.lnec.pt/

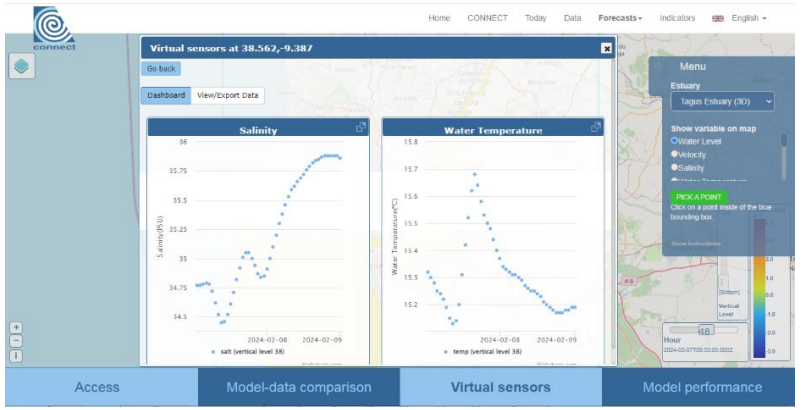
Collaboratory building

- Operational dashboard with a snapshot of the current state of the coastal system, built for the end-user requirements compliance
- Information quality: data/model comparison

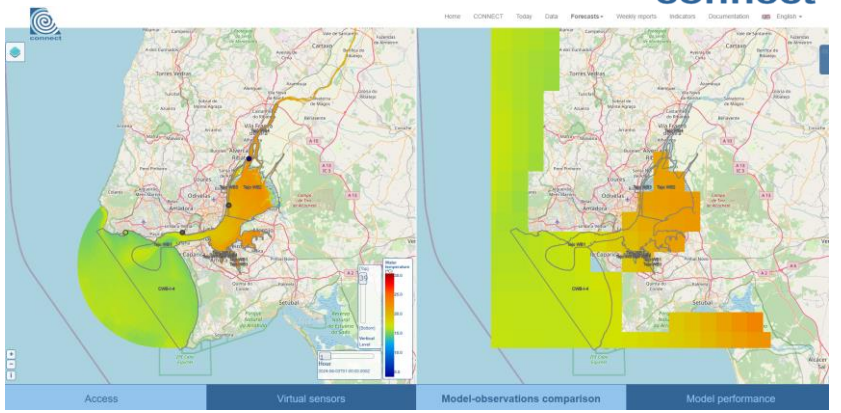
CONNECT webGIS portal: user-tailored services



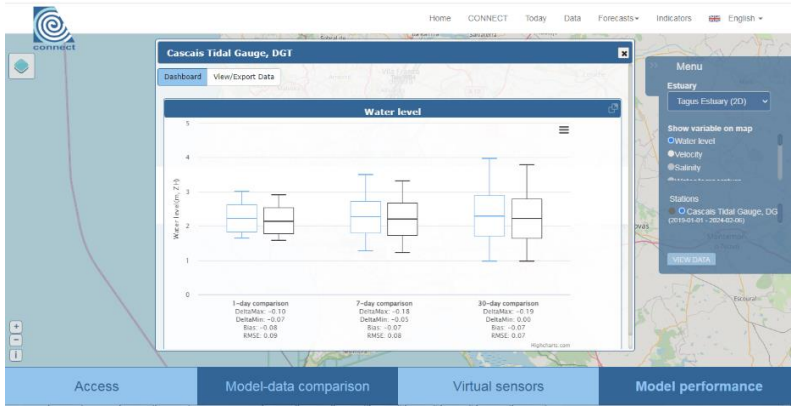
Circulation and water quality forecasts, next 48 hours



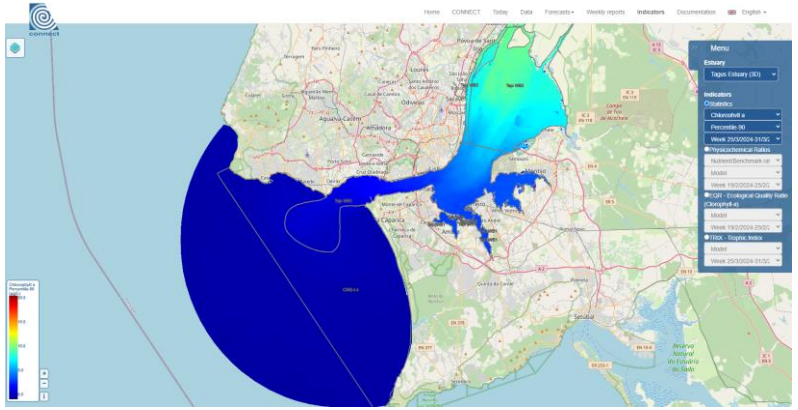
Virtual sensors



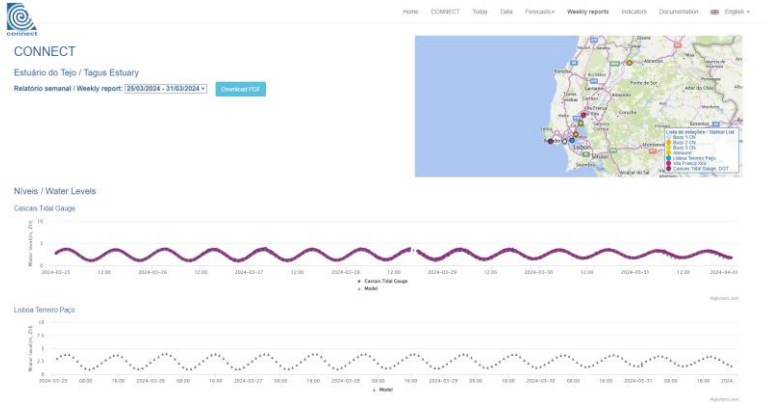
In-situ and satellite observations-model comparison



Model performance

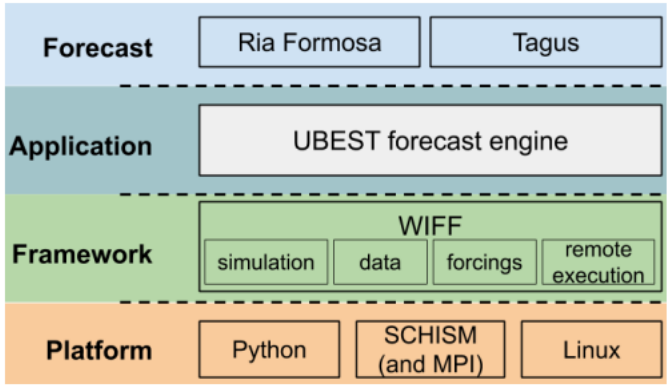


Indicators

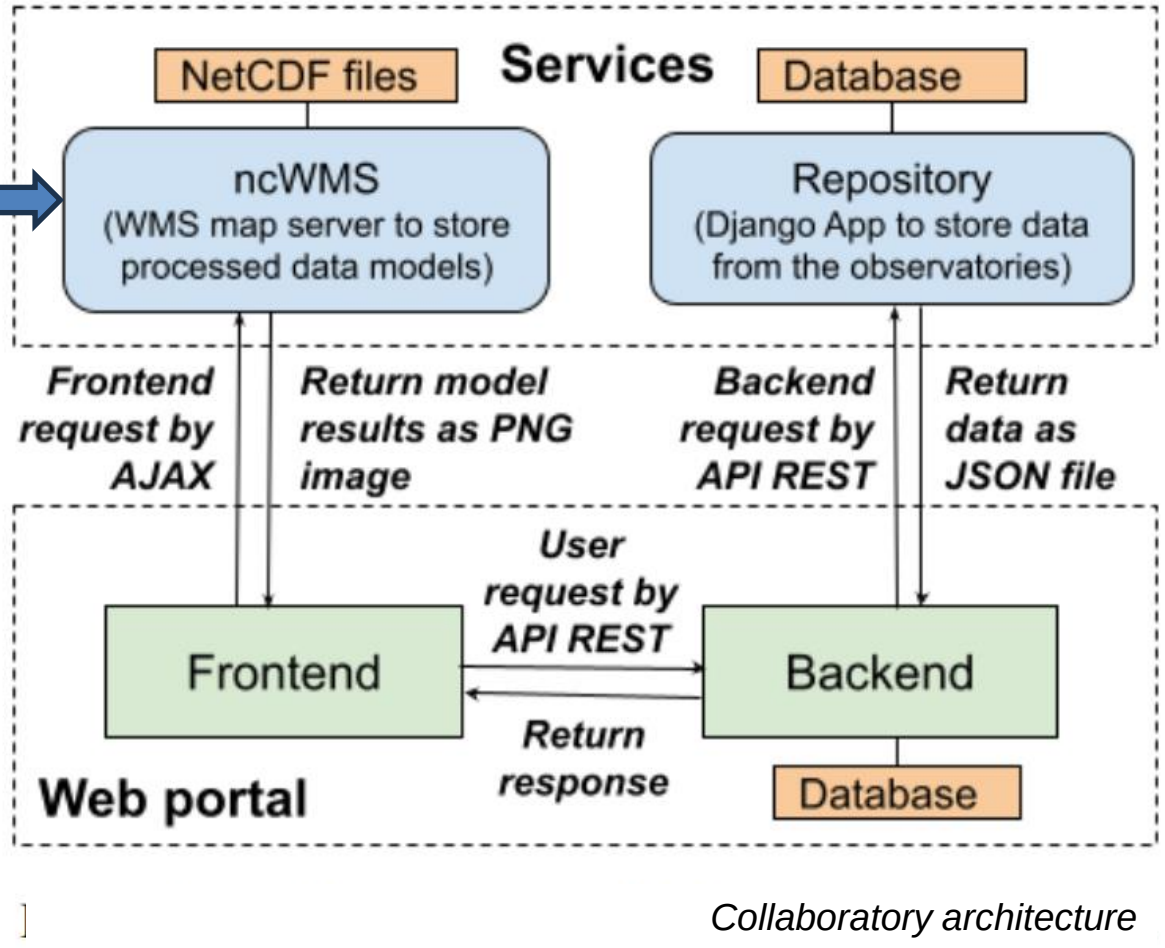


Automatic weekly reports

CONNECT webGIS collaboratory: behind the scenes



Forecast engine: software stack



Collaboratory architecture

- web portal: Django, a Python web framework for full-stack web development
- Frontend: provides the HTML pages for the user interactions
- Backend (with PostgreSQL Database): processes the user requests

Future developments in DT

Integrate “what-if” scenarios using the collaboratory infrastruture

- Climate change
- User-defined interventions

Enhance user interaction to build products and create sharable outputs

- Capacity to interact with data
- Capacity to build (simple) tools

Build consensus tools to support conflicting uses decisions

Implement the DT Collaboratory for distinct user requirements challenges:

WOLLF - Pilot Digital Twins for Water Pollution in Africa - UN Decade project

Duration: 2023-2026 (36 months)

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

WOLLF – Key expected outcomes

- The first Digital Twin for Africa focused on pollution and related areas, built through co-design
- The demonstration of this tool in two coastal regions of Africa (Nigeria and Cape Verde)
- An open source, relocatable tool that can be applied anywhere and be adapted to other challenges in the future
- An open platform for local communities' engagement through sharing knowledge and experience
- Training and learning materials regarding coastal dynamics, forecast systems and Digital Twins

Acknowledgements

Copernicus Marine Service
National Collaboration Programme 2022-2028

More info here:
connect.lnec.pt

Thank you for your attention!

mfrodrigues@lnec.pt
aoliveira@lnec.pt