

# Using on-demand services to build reliable coastal forecasts

## The CONNECT service as a demo

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*Ocean Circulation Predictions from Global to Coastal scale. Session 1, OBPS Workshop VIII, 17 October 2024*

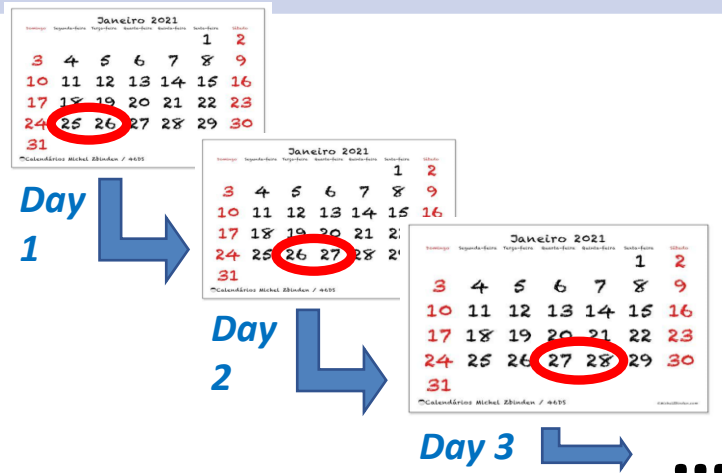
# Forecast systems: predicting coastal zones dynamics for the next (few) days

Forcings

Prediction simulations

Post-processing, archiving and visualization

Comparison with real time data



- High-resolution information in space and time
- Ability to address “what-if”, CC and management scenarios
- Very accurate and reliable tools

# Societal value of forecast systems

- Anticipate contamination events and support emergency actions
- Support water economy daily tasks and leisure & recreation
- Guide management to minimize risks and address conflicting uses in coastal areas

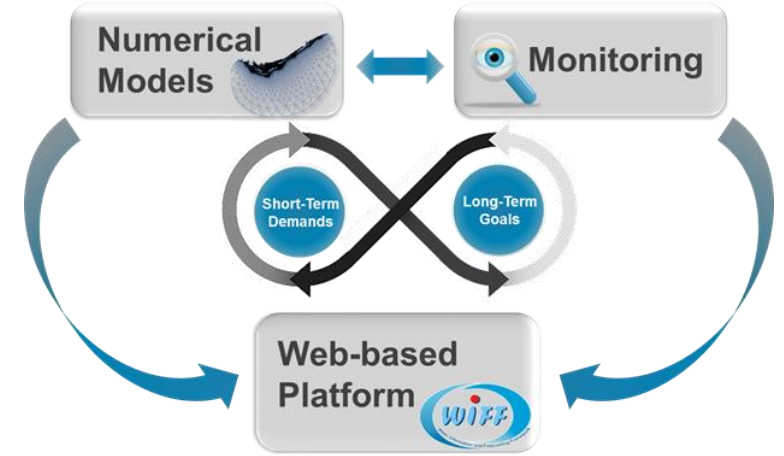
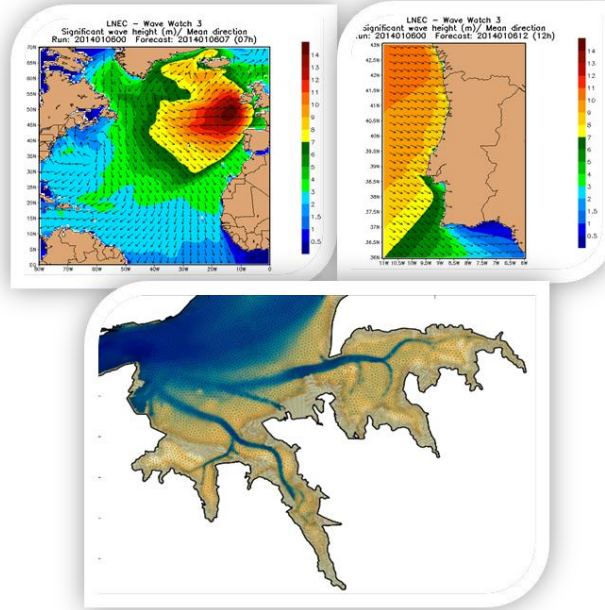
## Coastal Digital Twins:

user-centered, on-demand framework for decentralized ocean-to-coast knowledge creation through modeling, **forecasting**, data analysis and **service provisioning**



# Methodology to create and operate a coastal forecast system

waves tides flow storm  
 precipitation river floods urban  
 surge drainage floods urban



- Identified the relevant physical processes
- Evolution to more complex stages (water quality,...) built on accurate physics

- Identify the adequate spatial and temporal scales
- Implement models that solve processes and handle scales.
- Validate with (historical) data across environmental conditions

- Implement robust and accurate forecast system that runs automatically everyday
- Make results available in friendly and tailored way

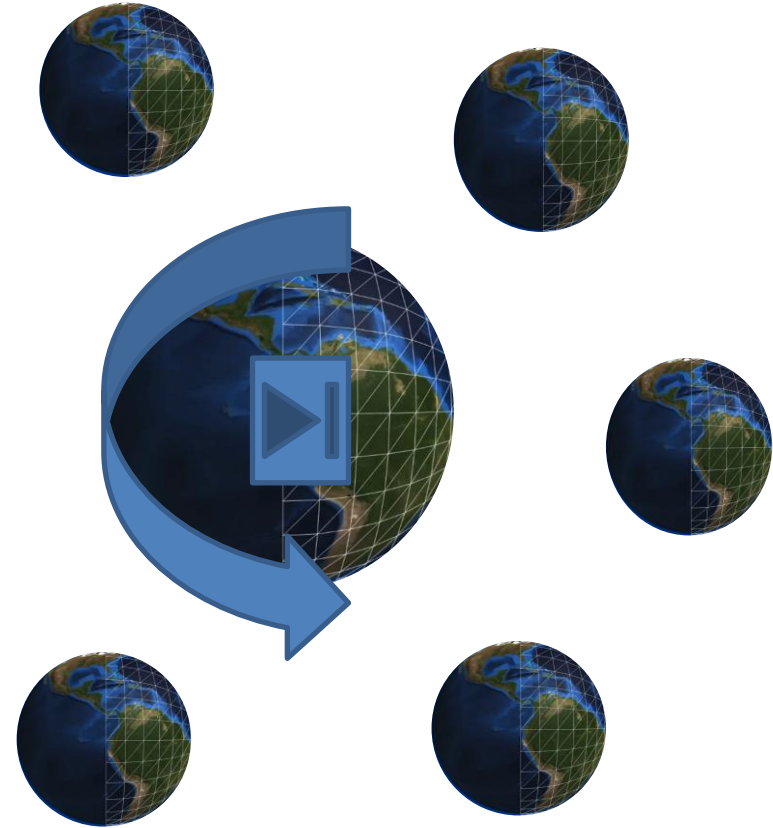
# Limitations and challenges in forecast systems

- Traditionally built individually – difficult to replicate and evolve with better tools
- Requires huge IT resources to build and maintain
- Quality control difficult: different models, different inputs, seldom automatic performance assessment
- *Build forecast frameworks through building blocks*



# Relocatable on-demand forecast tools

- 
- 
- Modeling and prediction for all systems
- Flexibility, replicability and high accuracy
- Facilitate good quality deployment and help non-experts to build their systems
- Provide replicability for reliability and trustwordiness
- 
- 
- Forecast systems as services
- 
- 



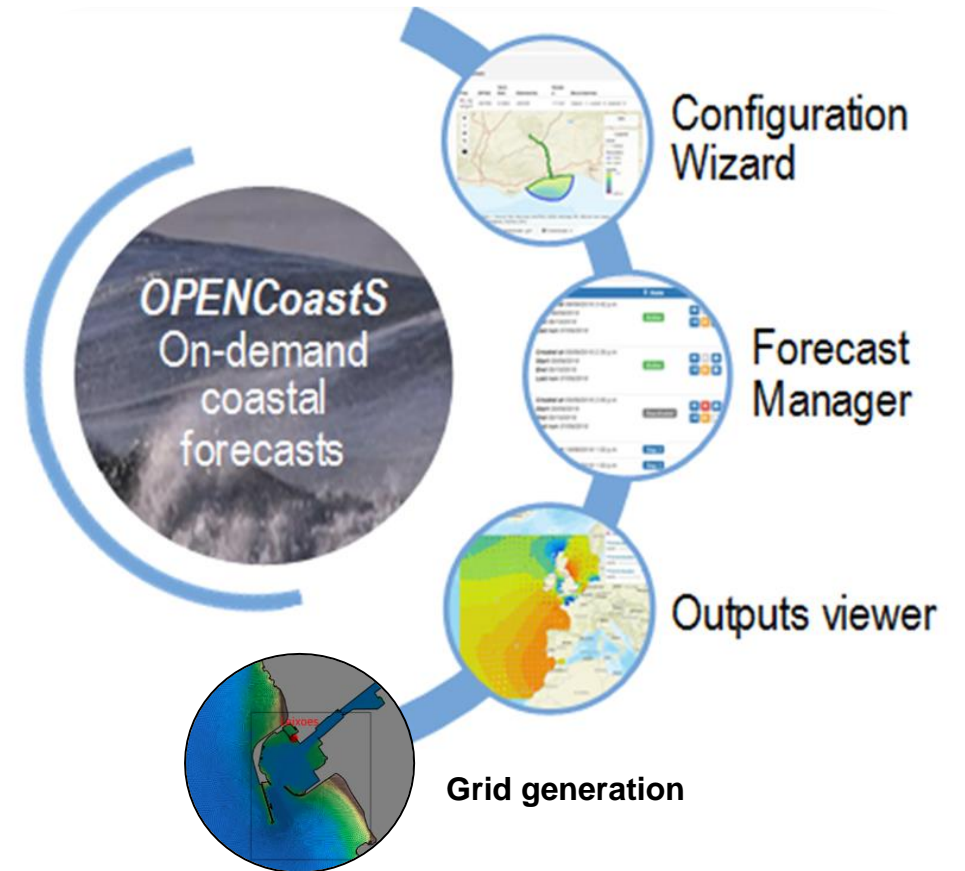
# Generic model and prediction tools

- Forecast systems quickly
- Create and share good practices
- OPENCoastS stands out for simple usage and hiding computational complexity and need for computer resources

Platform	Country	Access	Not available	Applicable	Web Platform	Notes
Delft-FEWS (GLOSSIS/GLOFFIS)	Netherlands	Free	Not available	Generic	Yes	New models
Saturn	USA	Free	Partially open	Several generic tools	Yes	Scenarios + predictions
SOCIB	Spain	Free	Partially open	Several generic tools	Yes	FAIR data, assimilation
Web MARine Virtual Laboratory	Australia	Closed	Open	Generic	Yes	Modeling and pre-operational
RELOCatable ocean nowcast/forecast system	USA	Closed	Not available	Generic	Yes	Ocean scale + ADCIRC at the coast
SURF: Structured and unstructured infrastructure	Italy	Free	Open	Generic	On-going	Downscaling automatic from regional to local scales
OPENCoastS	Portugal (Spain+ France)	Free	Open	Generic	Sim	Friendly interface for on-demand. Hydrodynamics + WQ

# OPENCoastS computational service

- Create and maintain an operational forecast for the user selected coastal area
  - Interaction with a simple Web interface
  - Allow choice of forcings, parameters and data sources
  - Integrate with external forecasts (e.g., AI river flow)
  - Easy replication of deployments for fast calibration
- Whole forecast cycle: create grid, configure, manage, outputs viewer
- Flexible IT architecture that can grow to additional processes
- Take advantage of the EOSC infrastructure





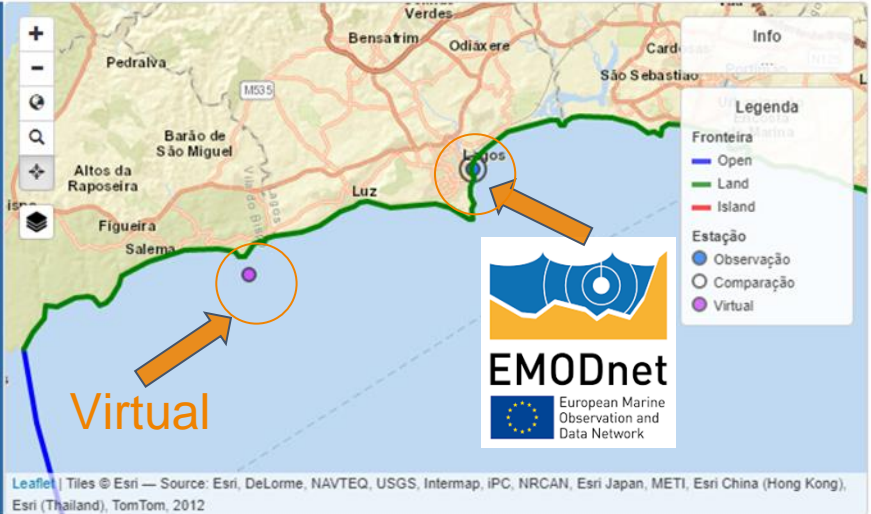
# Build a forecast system on demand

**Configuration Assistant** ID:26:19 New System

Step 1 Model    Step 2 Domain    Step 3 Boundaries    **Step 4 Stations**    Step 5 Hydrodynamic Parameters    Step 6 Additional Data    Step 7 Water Quality

Nome	Latitude	Longitude	Comparação
<input checked="" type="checkbox"/> LagosTG	37.10000	-8.66670	LagosTG (37.10000, -8.66670)
<input checked="" type="checkbox"/> teste	37.055254	-8.786659	

**Nova Estação**



**Virtual**

Leaflet | Tiles © Esri — Source: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

Automatic  
(EMODNET)



Virtual  
sensor  
(user)



# Fast management of deployments and visualization of results

OPENCoastS User Manual | anabela.pacheco.oliveira@gmail.com | PT EN

## Forecast Systems

Extension requests | New System

Forecasts management

ID	Model	Name	Dates	State
79	SCHISM, v5.4.0 (48h)	my youtube forecast	Created at 06/09/2018 3:42 p.m. Start 06/09/2018 End 06/10/2018 Last run 07/09/2018	Active
77	SCHISM, v5.4.0 (48h)	teste_prep_imum2	Created at 05/09/2018 2:35 p.m. Start 05/09/2018 End 05/10/2018 Last run 07/09/2018	Active
76	SCHISM, v5.4.0 (48h)	teste_prep_imum	Created at 05/09/2018 2:00 p.m. Start 05/09/2018 End 05/10/2018 Last run 07/09/2018	Deactivated
68	SCHISM, v5.4.0 (48h)	teste de carga2	Created at 10/08/2018 1:53 p.m.	Step 3
57	SCHISM, v5.4.0 (48h)	teste de carga1	Created at 10/08/2018 1:58 p.m.	Step 3

Annotations:

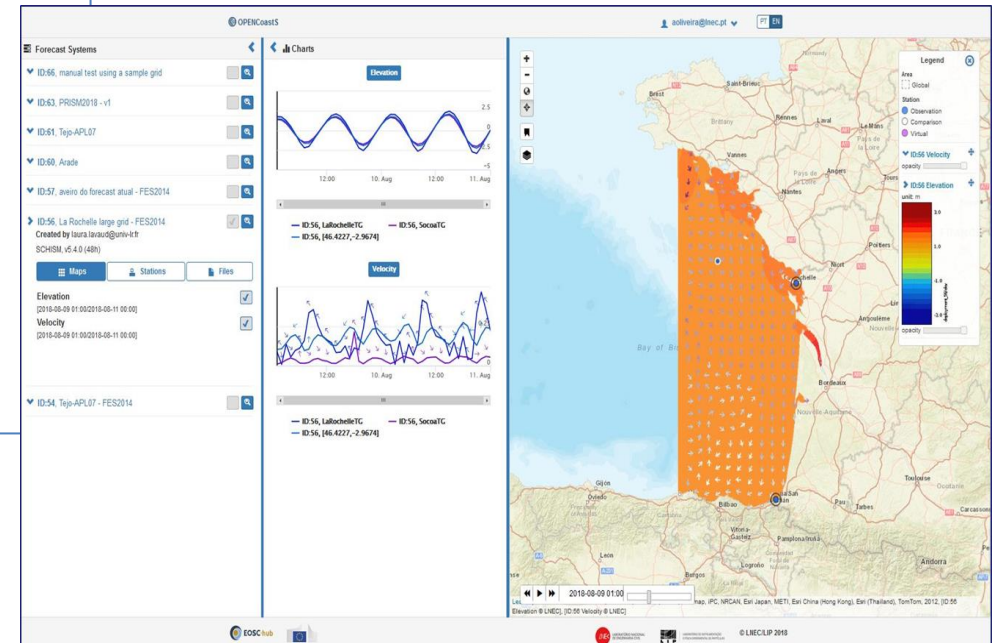
- Checking the status and the settings of my runs
- Clone it – duplicate to change: b.c., parameters, outputs
- Re-activate a deactivated system or eliminate it
- Return to Conf. Assist. to continue to setup my forecast

Many states are possible:

- “step k” – in construction, we can continue later or just eliminate it
- Active – we can deactivate, clone it, check it,...
- Deactivated – we can activate it again or eliminate it

Manager

Viewer



Coastal observatories: Dedicated web portals  
Example: the **CONNECT** project

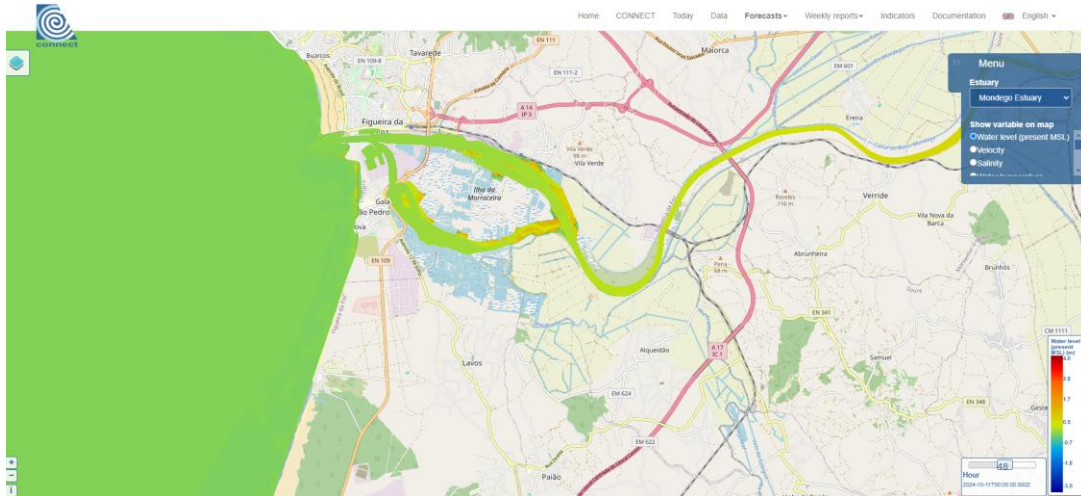
# CONNECT project: Observatory co-designed with users

- Address user's requirements and feedback on the coastal service through inquiries and interviews
- Dedicated actions with users for portal dissemination with improvement and future actions goals



# CONNECT forecast system: baroclinic circulation with wave and current interaction forecast at the Mondego estuary

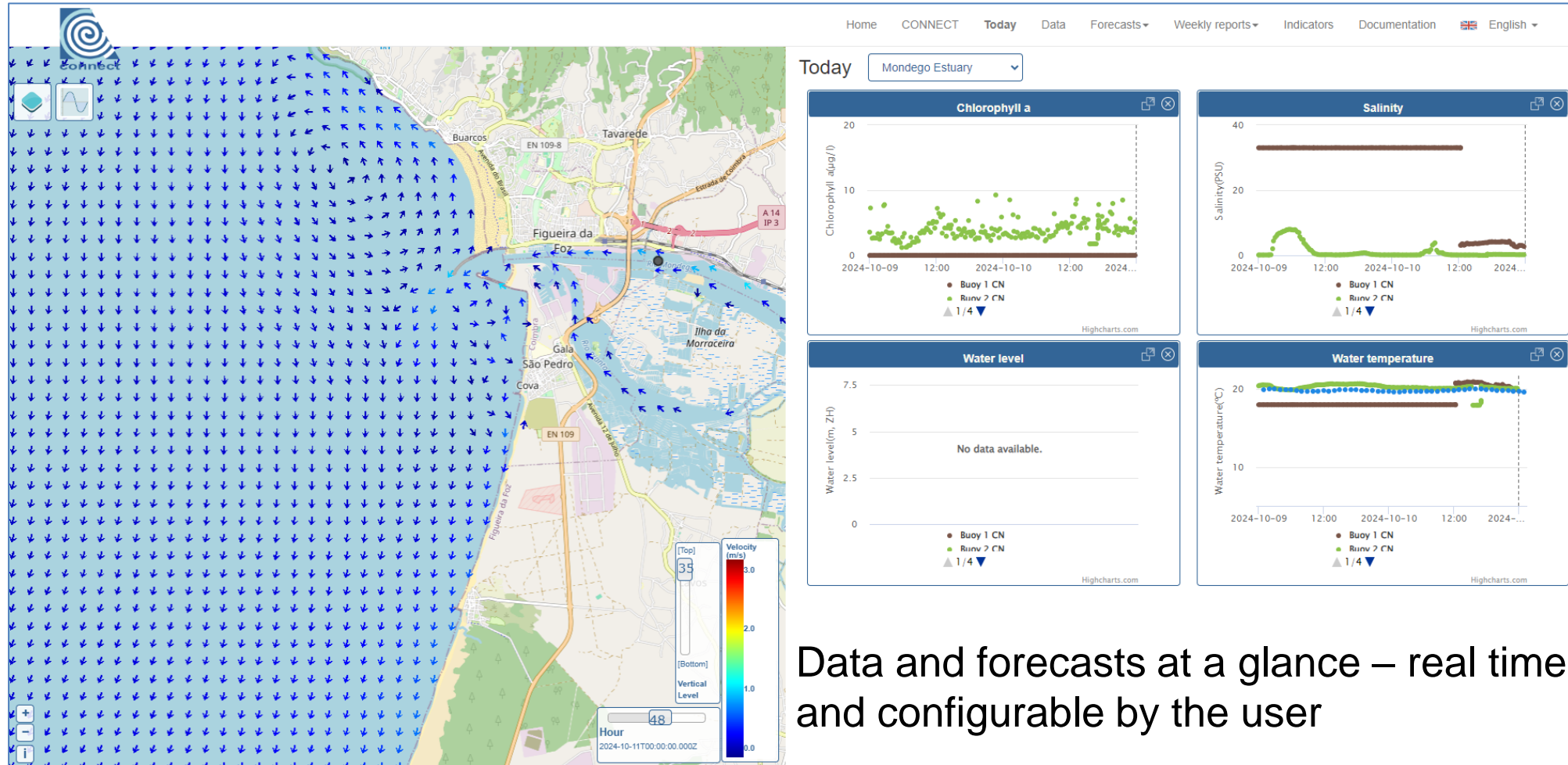
## 3D forecast



- For navigation, estuarine inundation and water mass characterization
- Developed using OPENCoastS
- Simulates water levels, velocity, waves, salinity and temperature
- forcings: water levels, velocity, salinity and temperature (CMEMS-IBI), waves (WW3-LNEC for spectra), wind, pressure, temperature, solar radiation (MeteoGalicia), river flow (national water resources database SNIRH)
- Horizontal resolution: 5 – 2000 m (10-40 m inside the estuary)
- In the vertical: 11 S levels plus 24 Z levels

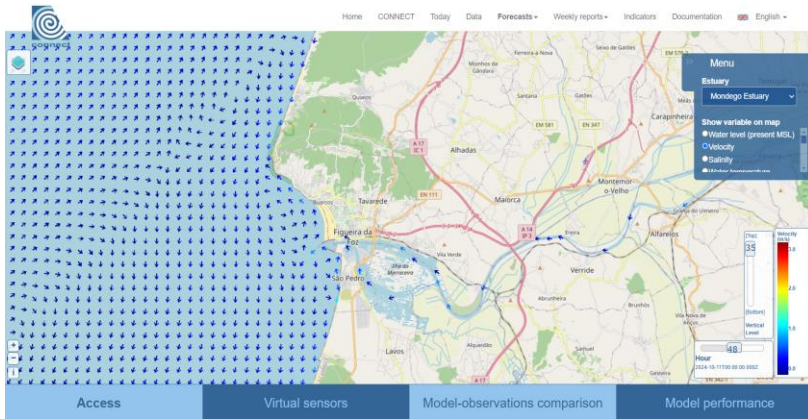
# CONNECT project: tailored platforms for users

Dedicated WebGIS portal - [connect-portal.lnec.pt/connect/](https://connect-portal.lnec.pt/connect/)

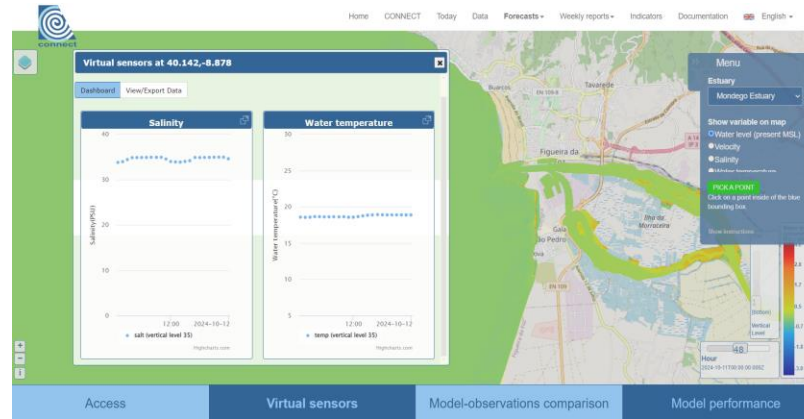


Data and forecasts at a glance – real time and configurable by the user

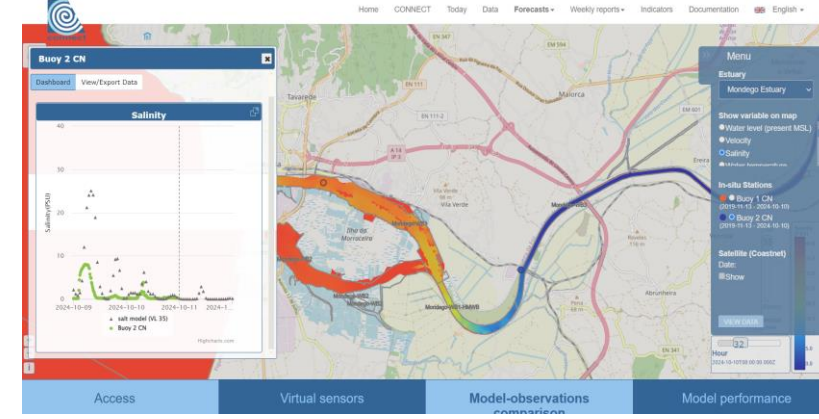
# CONNECT observatory: selected products



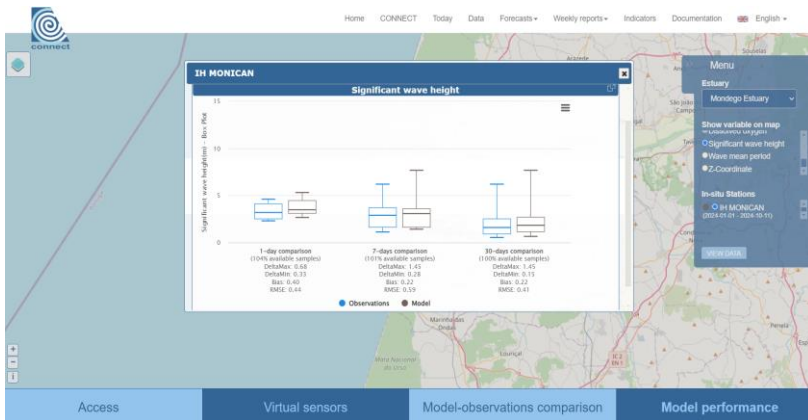
48-hour forecasts



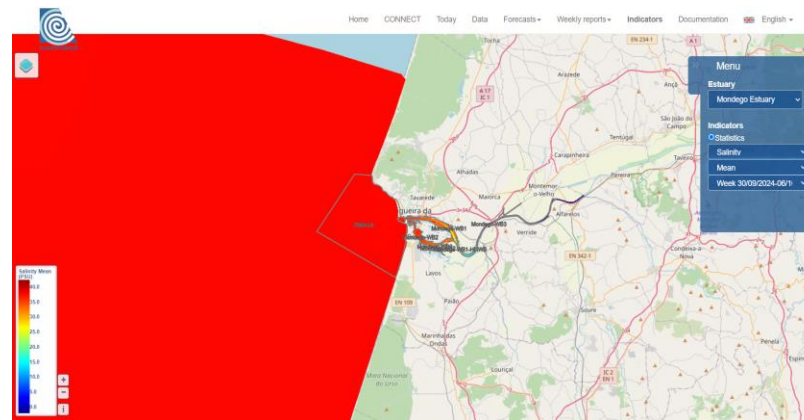
Virtual sensors



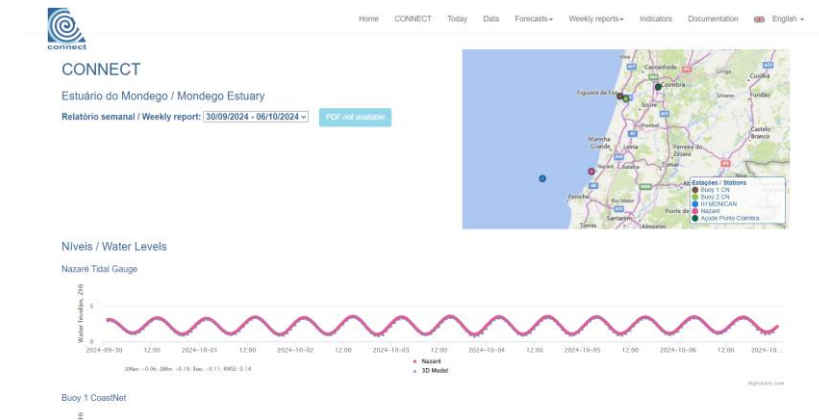
Data / model comparison (in-situ & satellite)



Model performance & quality



Indicators for EU Directives



Weekly reports

# Conclusions and take-home messages

- The complexity of coastal dynamics, the multiple tools available for modeling and the need for computational resources are challenging for users to setup good quality forecast systems
- High resolution models are freely available along with (near) real time data sources to support good quality forecasts, but IT implementation brings additional challenges
- Reliable and accurate forcing conditions providers (such as CMEMs) contribute to good quality of coastal forecasts
- OPENCoastS computational service - example of helpful tools to build reliable and robust forecast systems for the coast
- AI will play a major role at coastal scale: to handle land inputs (rivers, city) and to build faster predictors based on process-based simulations
- The human-in-the-loop: forecast systems (in DT) need to address end-users needs

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