Framework for improving land boundary conditions in ocean regional products

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8th International Coordination Meeting of the Coastal and Shelf Seas Task Team (COSS-TT)
12 & 13 April 2022

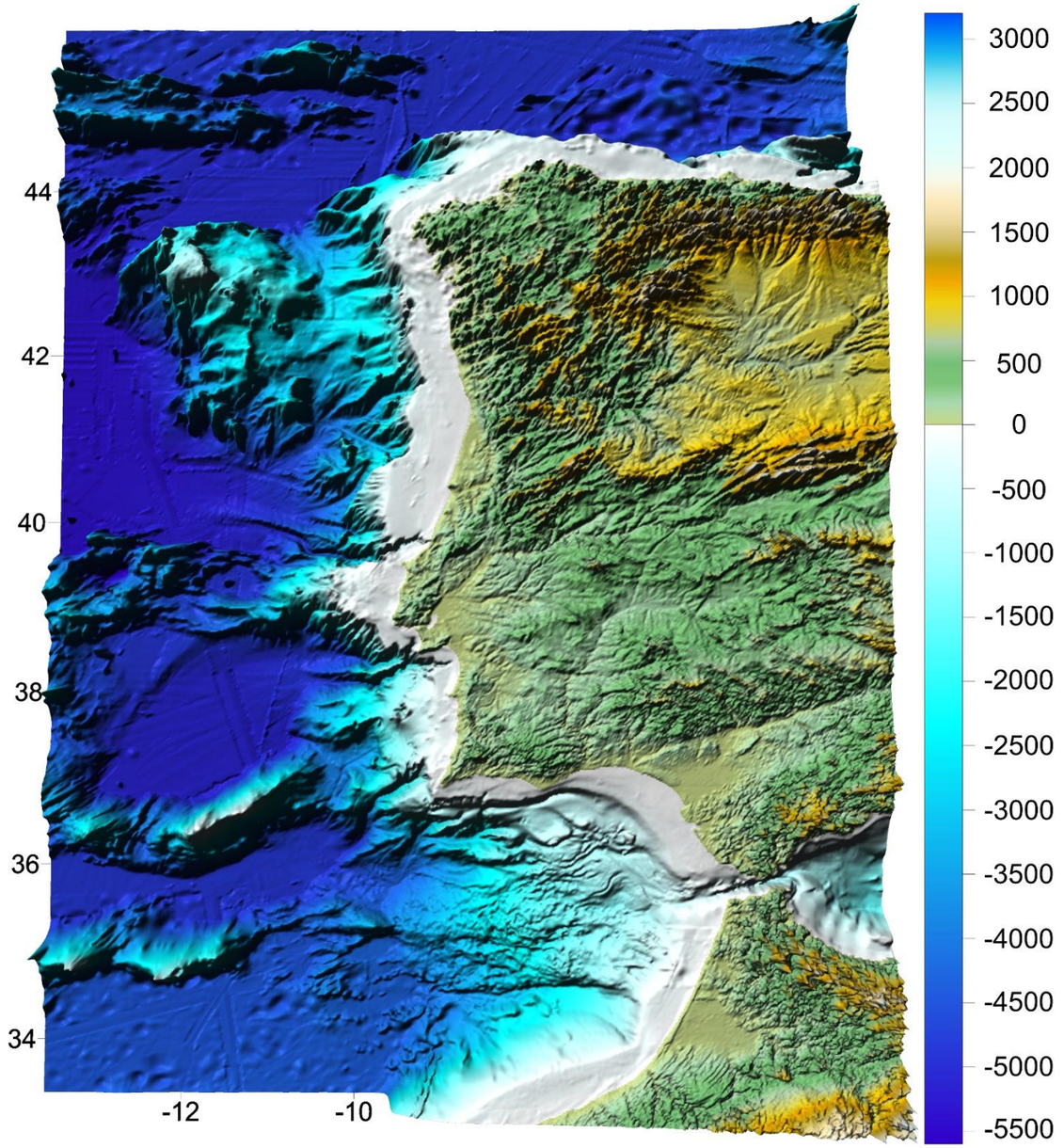
+ A paradigm shift

Integrated water cycle approach

The main objective of the present research was to **develop a methodology** and to explore the capacity to **improve** the thermohaline circulation in regional ocean model applications by a better characterisation of the **land-ocean boundary conditions** able to represent the salinity features described for the Western Iberia region.

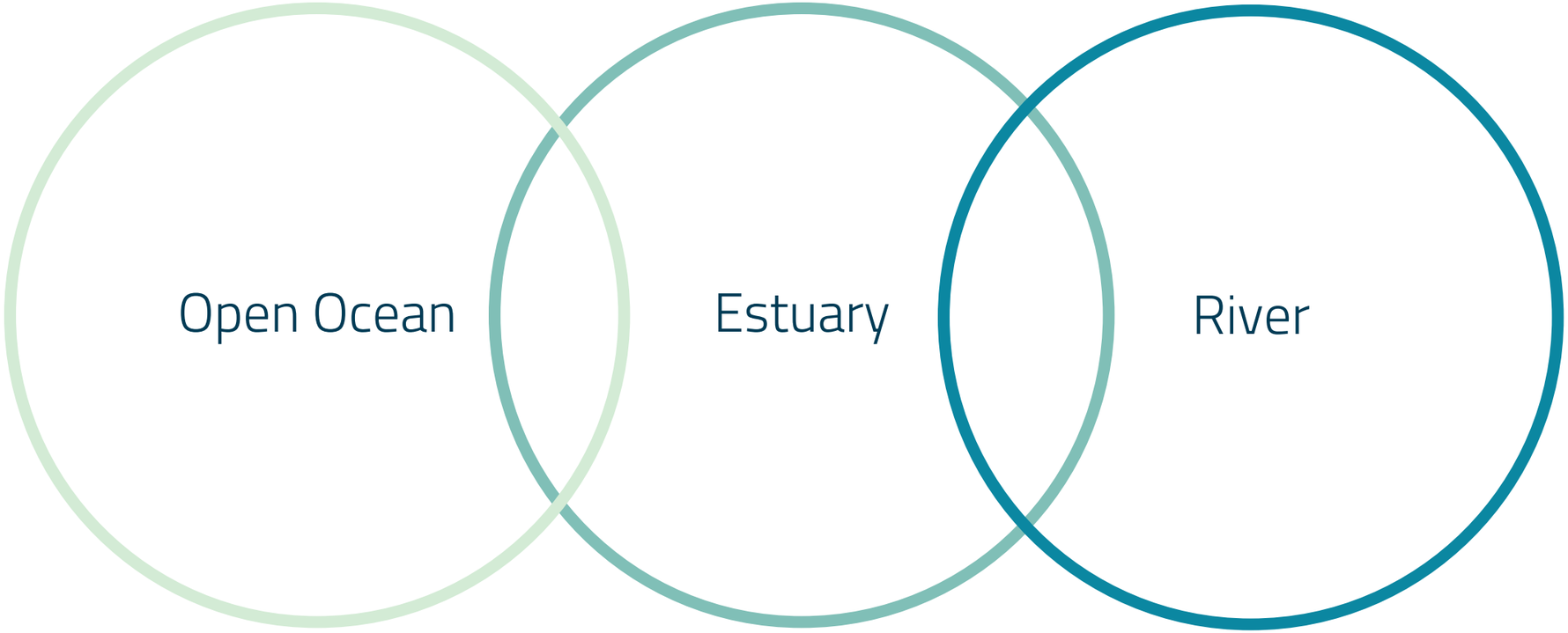
Main Challenges:

- Obtain river data near its mouth;
- Imposing those inputs in regional ocean models;
- How to validate the results.



+ WATER CONTINUUM conceptual diagram

Coping with Water continuum interfaces



Complete description at:

Campuzano F (2018). Coupling watersheds, estuaries and regional seas through numerical modelling for Western Iberia. PhD Thesis, Instituto Superior Técnico, Universidade de Lisboa, Portugal.

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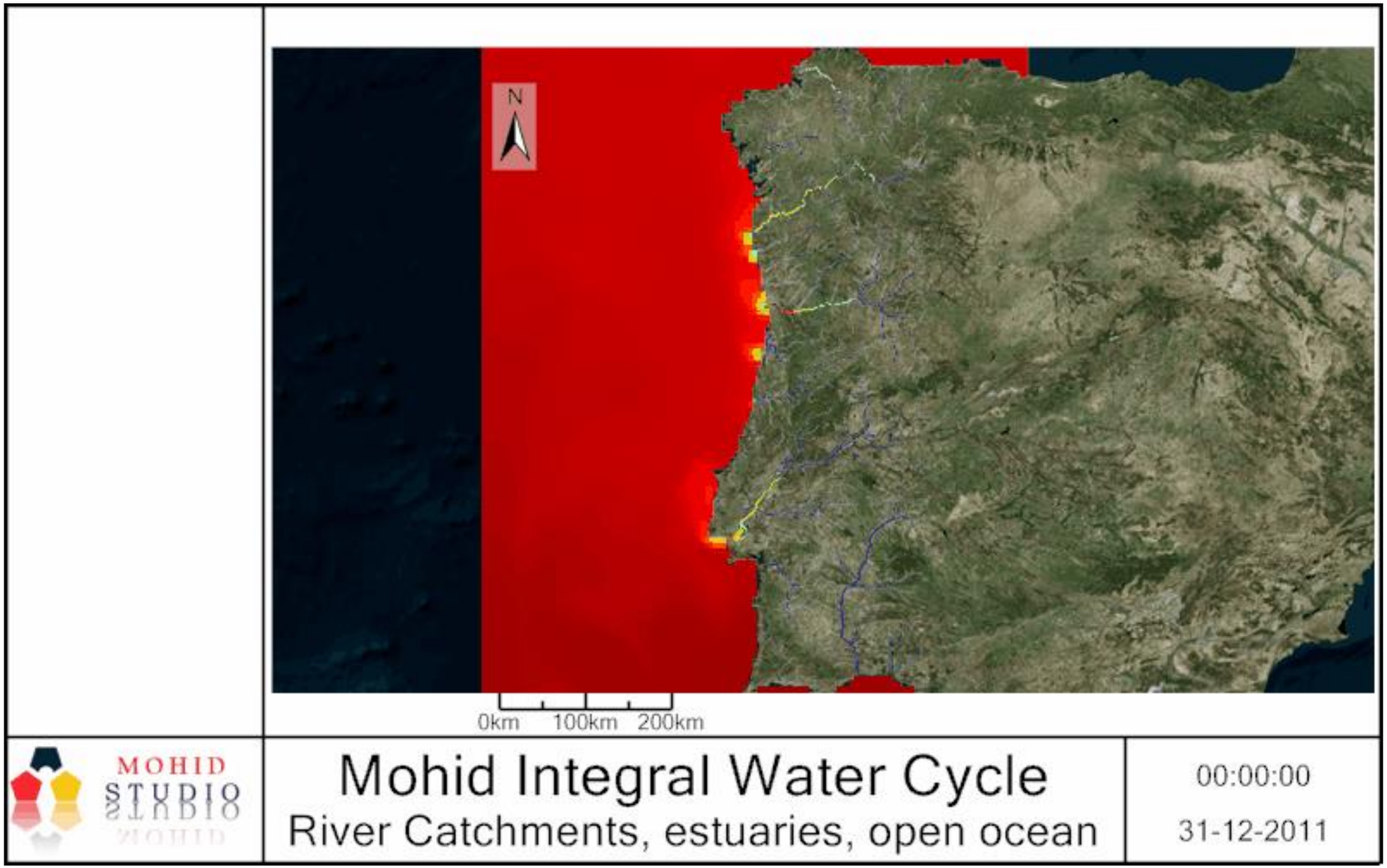
+ Integral Water Cycle in the Portuguese continental coast



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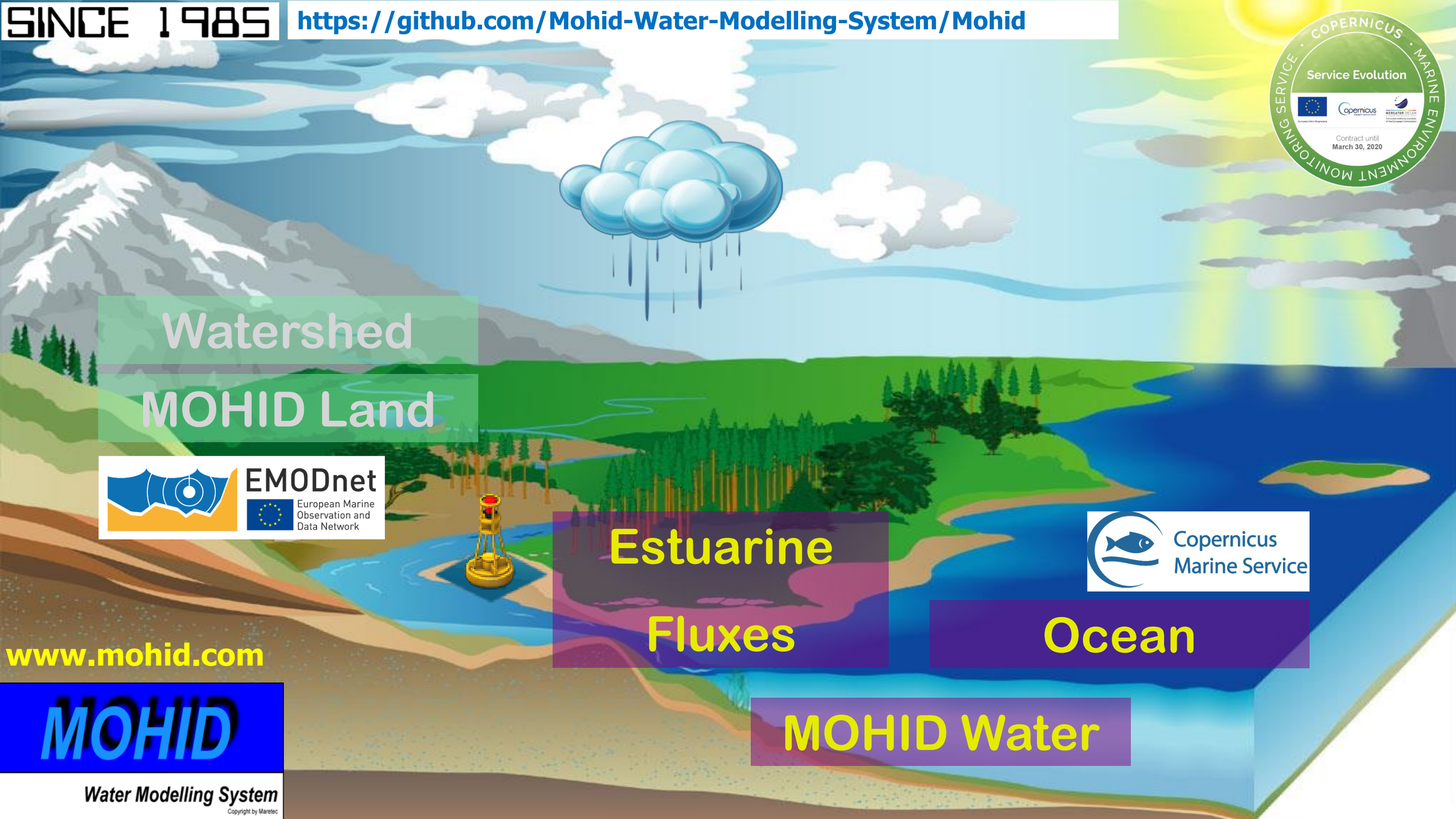
SINCE 1985

https://github.com/Mohid-Water-Modelling-System/Mohid



www.mohid.com

MOHID

Water Modelling System

Operational River data constraints

- Sparse data in national/regional webpages sometimes only in local language;
- Multiple data sources with GIS portals that eventually may offer access to the actual data;
- Global databases that provide historic data flows but lack of near real time data;
- Water level data without rating curve for conversion into river flow;
- River runoff reaching the coastal area is unavailable or unmonitored for many rivers. This is an increasing problem in the current context of a global decline of the hydrometric networks (Mishra and Coulibaly, 2009).
- Numerical models complete NRT data spatial and temporal coverage. They can add other variables such as water temperature and nutrients and allows to produce forecasts.

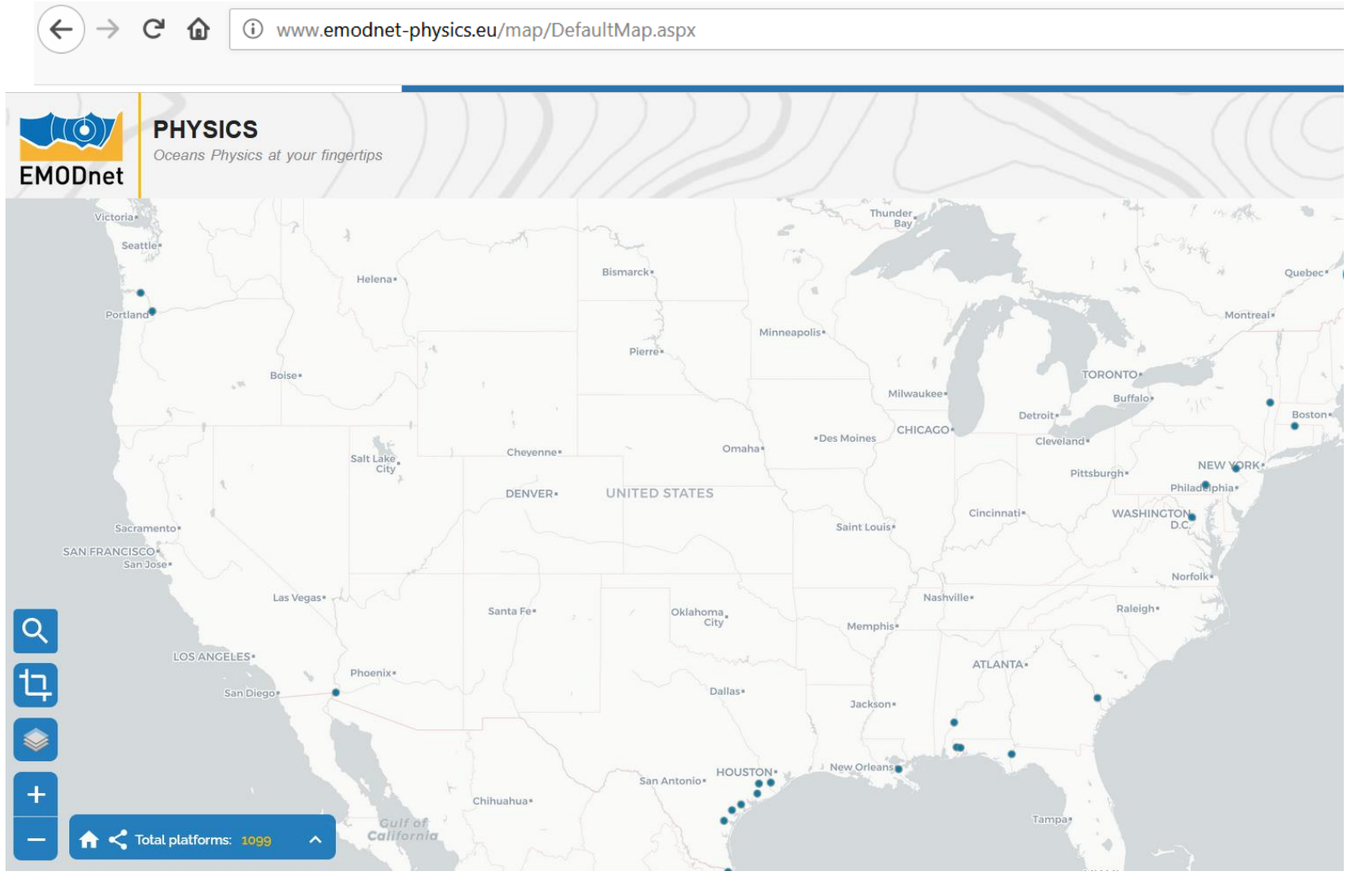
EMODnet rivers objectives

- Identify the main river inputs and the institutions responsible for setting up and maintaining the hydrographic networks;
- Select the most reliable stations near the coastal area. Coastal/ocean local experts contribution is important;
- Provide the river observations in a one stop shop and with a common format and metadata information;
- River data is provided in a daily and monthly basis as commonly done in other *in situ* data services.
- Complete the observations with properties from watershed models and provide forecasts.

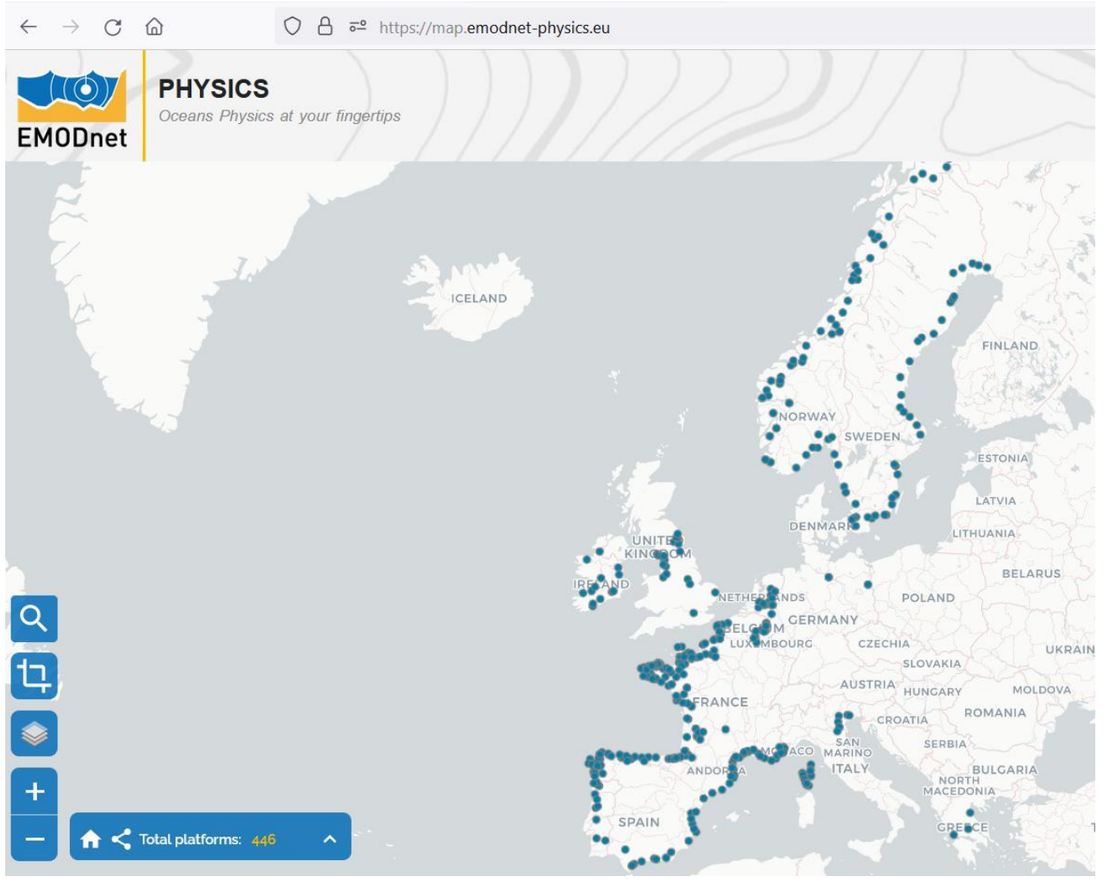
EMODnet rivers initiative current status (more than 500 stations)

Assembly centres:

Since June 2017



April 2018



February 2022

Acknowledging the sources

PLATFORM CODE

EbroTortosa

PLATFORM NAME

EbroTortosa

INSTITUTION

Confederacion Hidrografica del Ebro

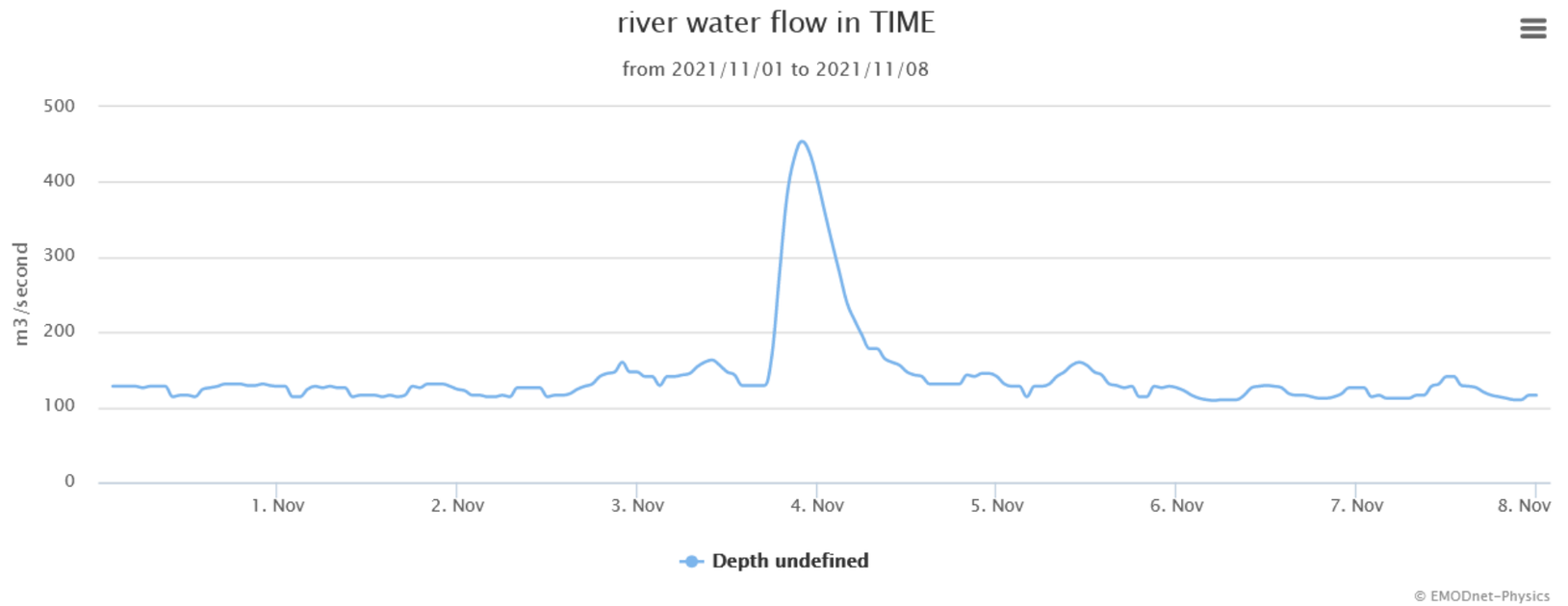
7 Days | 60 Days | Older data

quick download(60 days): select data format and go

NetCDF | CSV | Download | Preview

plots are a Runtime undersampled view of the dataset. to see full details open the "preview"

River / river water flow - m3/second



QC any

QC doc

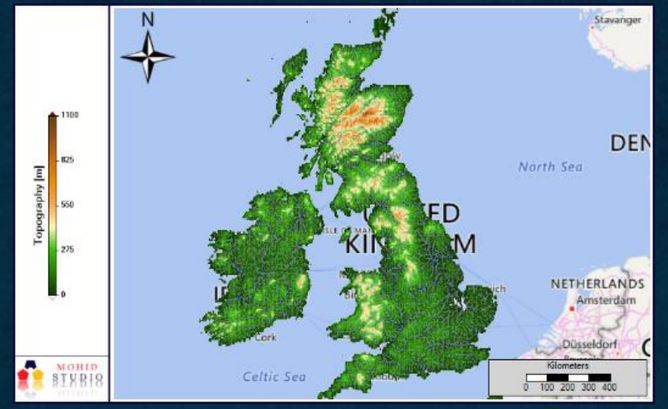
Select other depths to see more timeseries

Watershed modelling domains

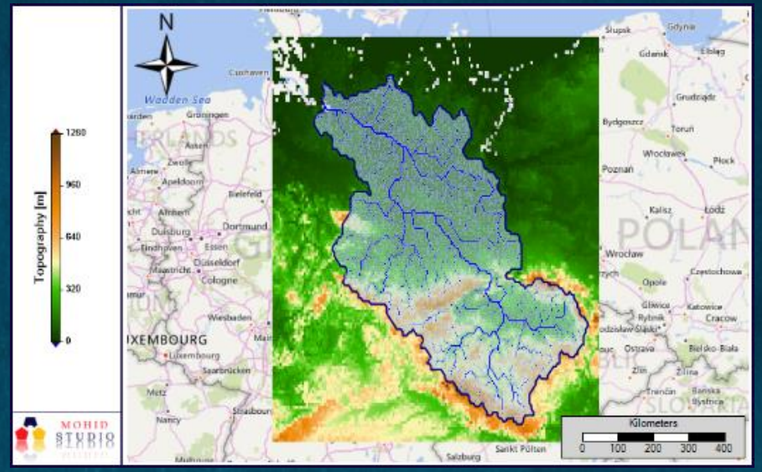
a) Western Iberian Peninsula

b) Western France

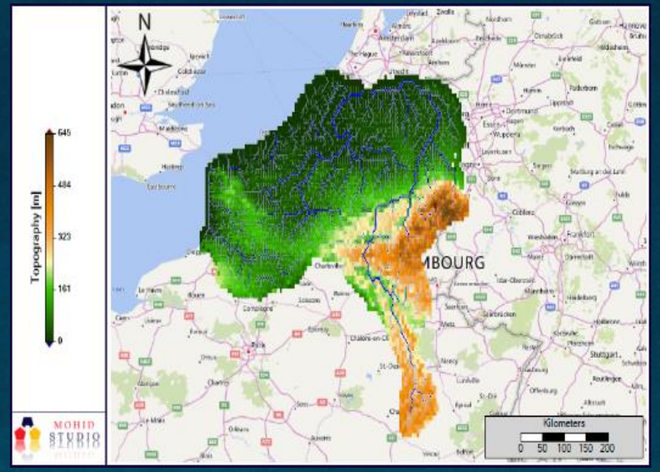
c) United Kingdom and Ireland



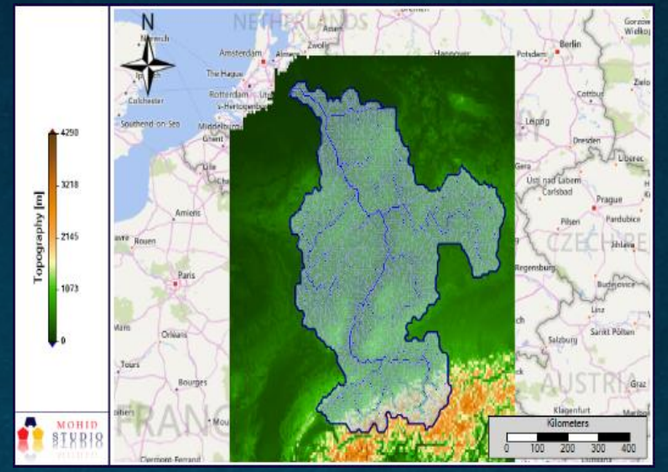
d) Elbe watershed



e) Somme, Escault and Meuse

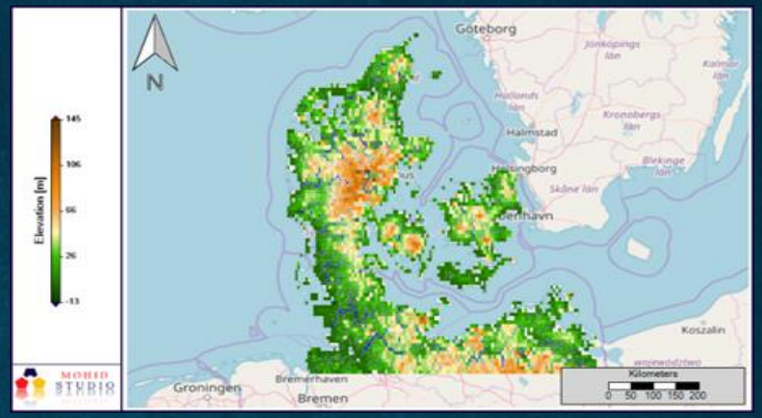


f) Rhine watershed

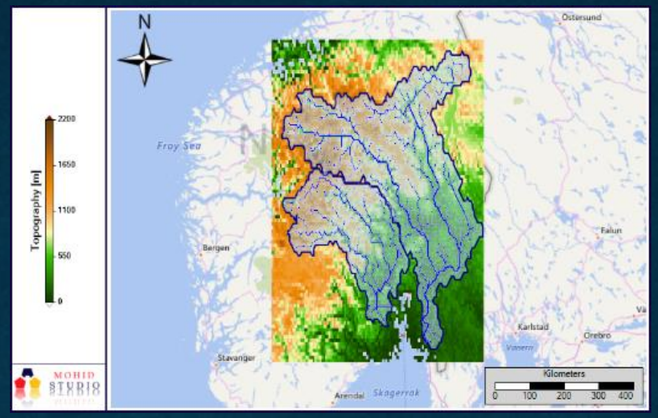


Watershed modelling domains

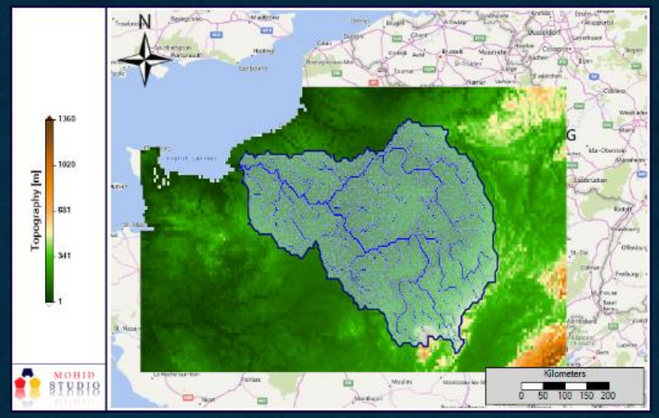
g) Denmark domain



h) Glomma and Drammen



i) Seine watershed



j) Ems and Weser watersheds

=

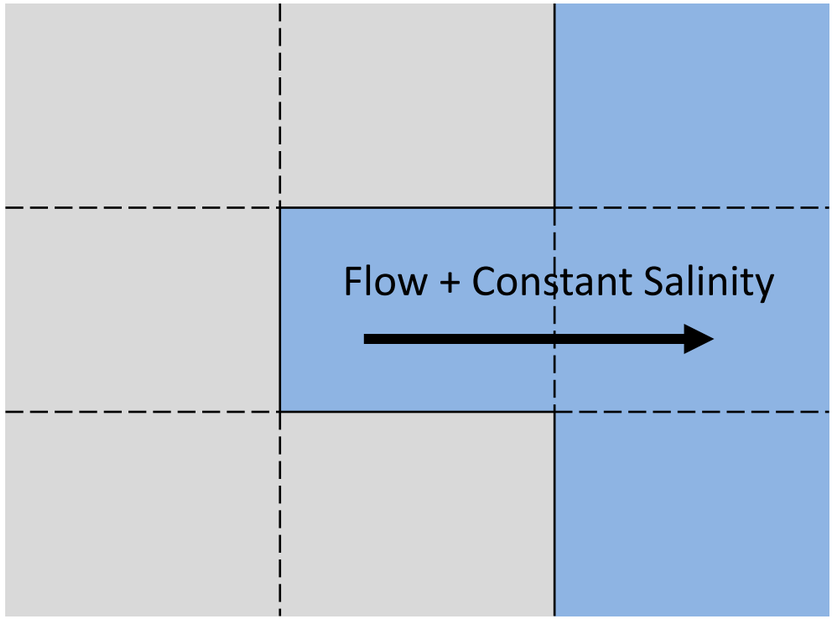
54 main Rivers*

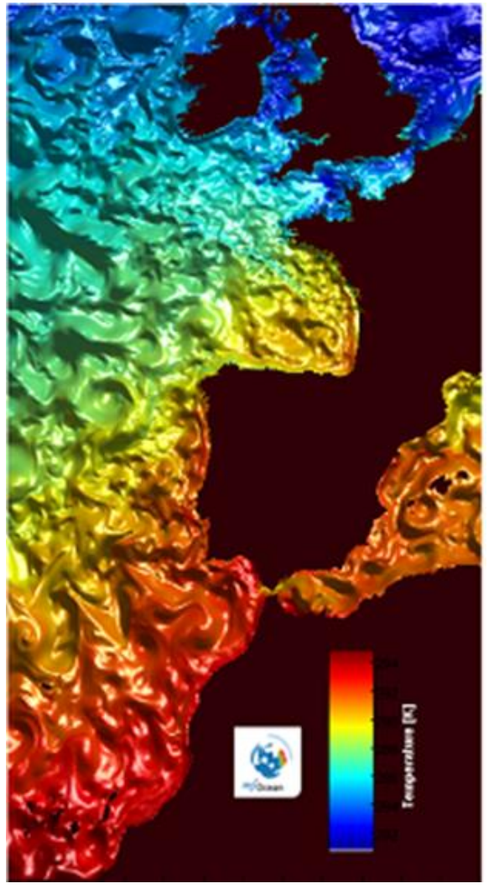
* 70 and 364 extra rivers were produced for Western Iberia and Ireland-UK domains respectively

River input in the coastal area methods

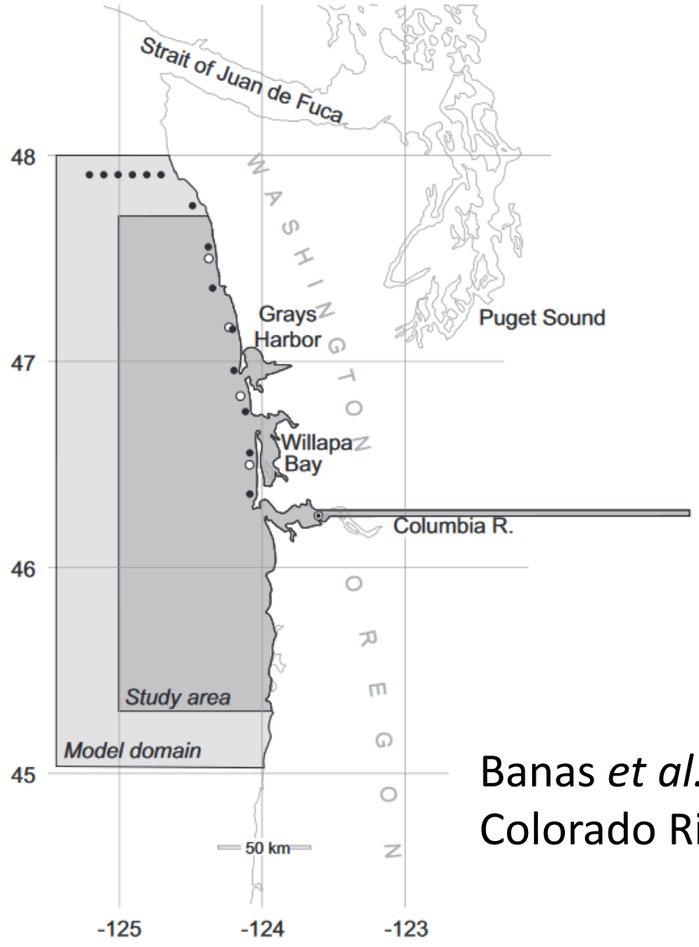
Direct Discharge (Flow + constant salinity)

Initial dilution through single inlet (Flow + constant salinity)
such as the Copernicus marine service for the IBI-Region





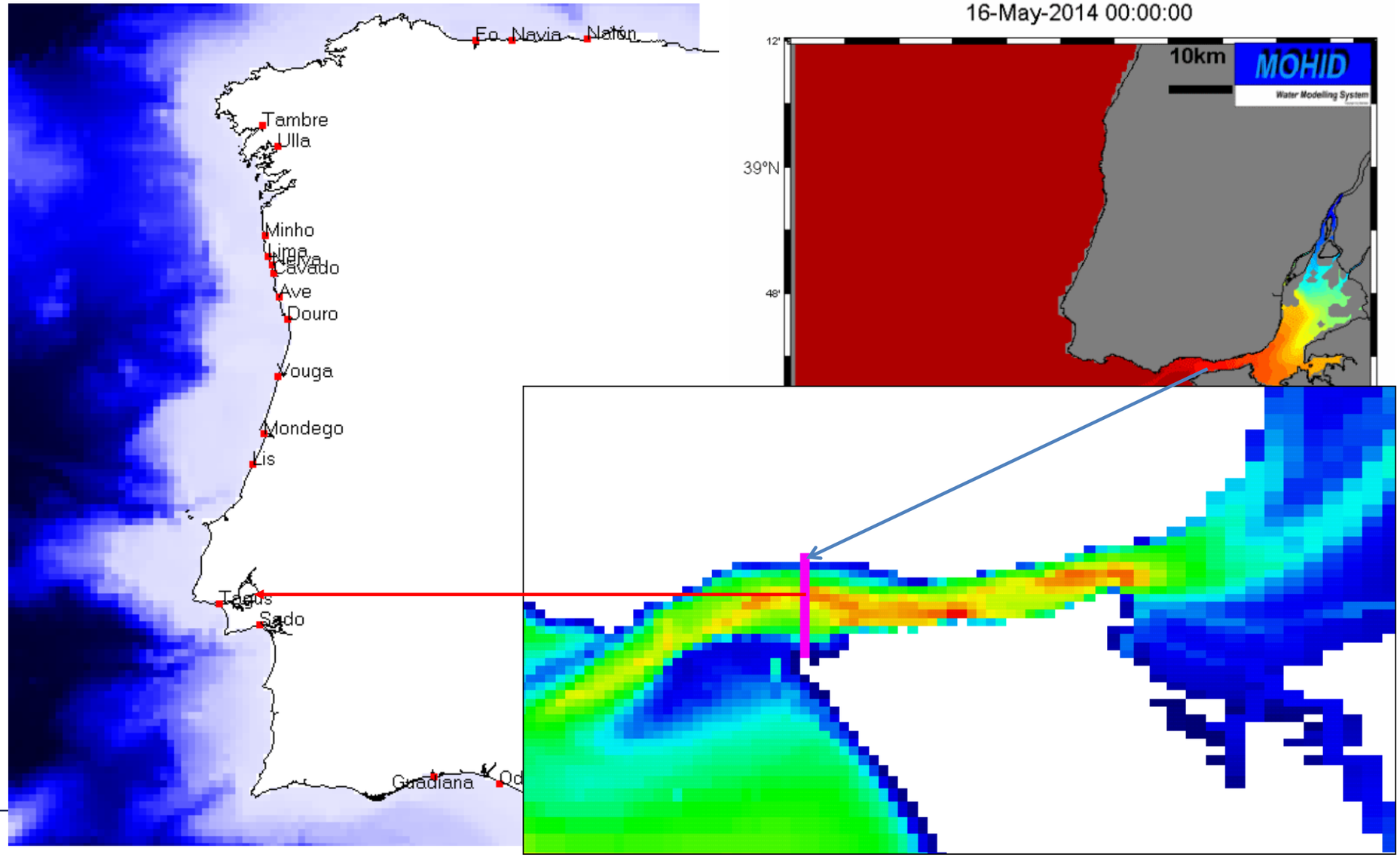
Integrating estuary in the model grid



Banas *et al.* 2009
Colorado River (USA)

+RIVER-ESTUARY-OCEAN COUPLING

Estuaries are very dynamic areas with influence from tides, river inputs and the open ocean conditions. Due to the tide, and their cycles, their discharges vary in time from ebb to flow and varying from spring to neap tides.



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MOHID Water

Estuarine Proxy

OCEAN INPUTS

Tides and ocean water properties

FES2014

Tides

PCOMS

Timeseries of ocean salinity and temperature

Copernicus Marine Service

Outer estuarine cell & outputs

- Water salinity
- Temperature
- Flow
- Velocity
- Oxygen
- Nutrients

LAND INPUTS

River flow and temperature

MOHID Land

Modelled flow +
Modelled Temperature +
Salinity constant 0.01

Observations

Observed flow +
Modelled Temperature +
Salinity constant 0.01

EMODnet

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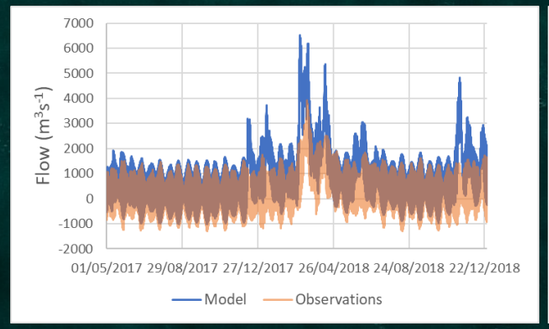
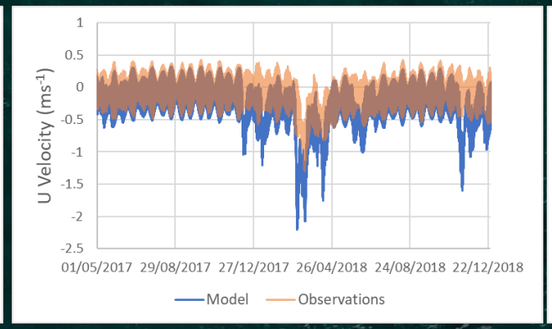
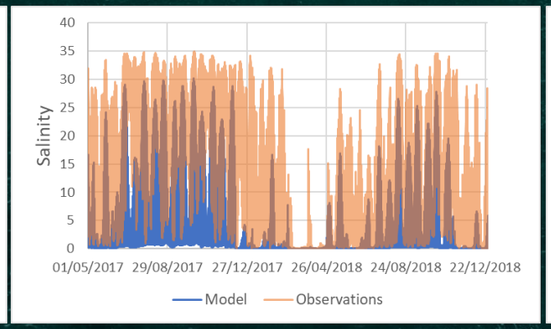
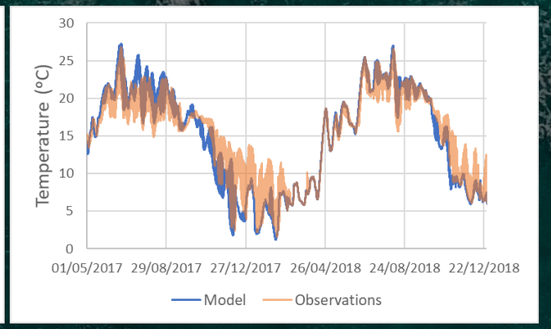
Estuarine Properties

Douro (B)

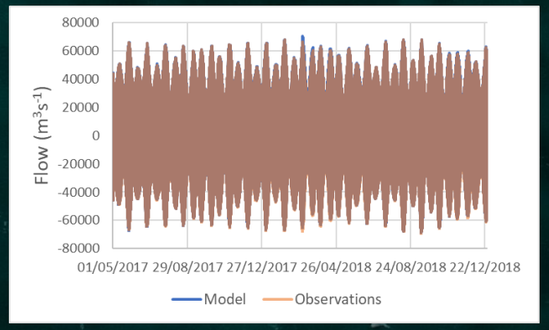


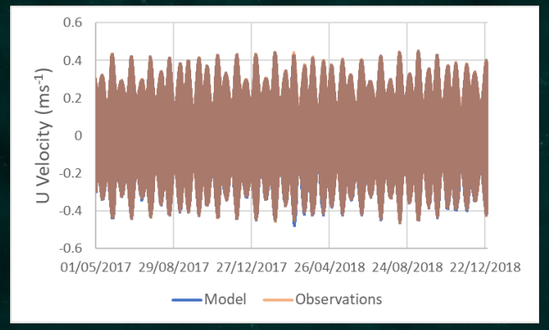


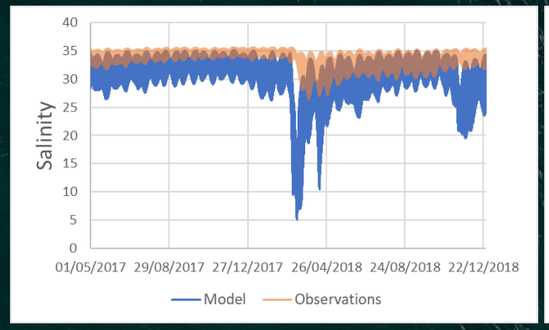


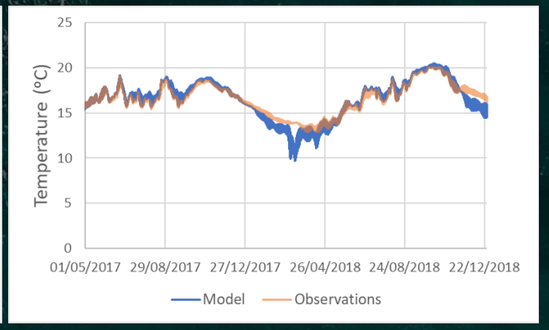


Tagus (E)

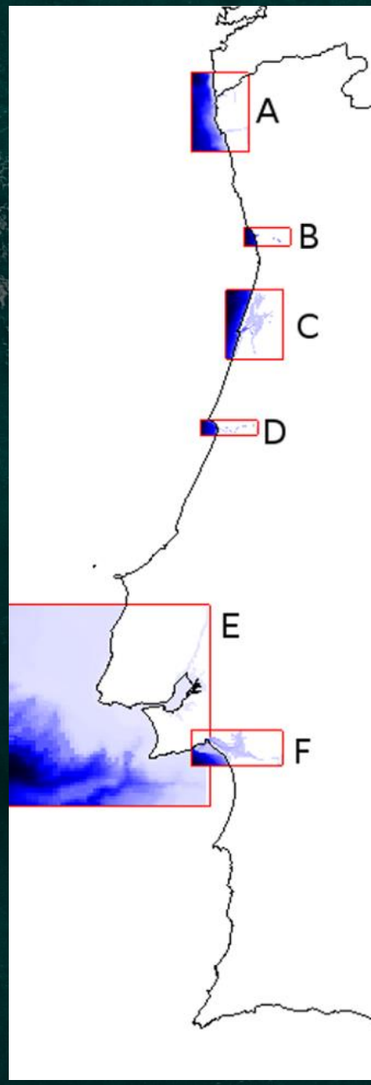








Flow **Velocity Y** **Salinity** **Temperature**



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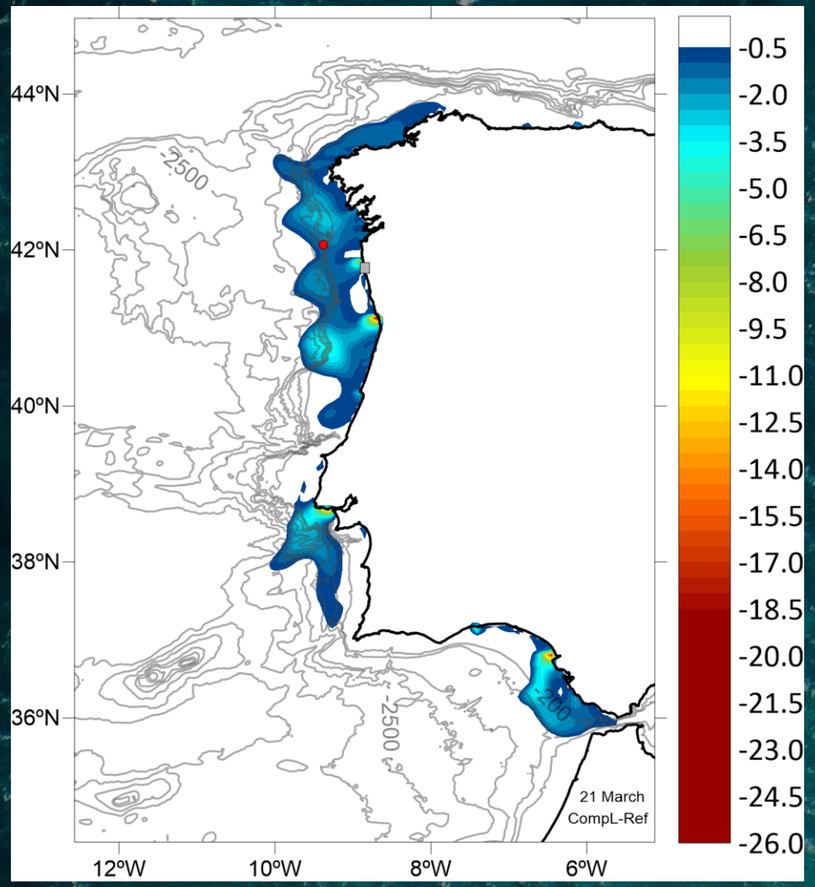
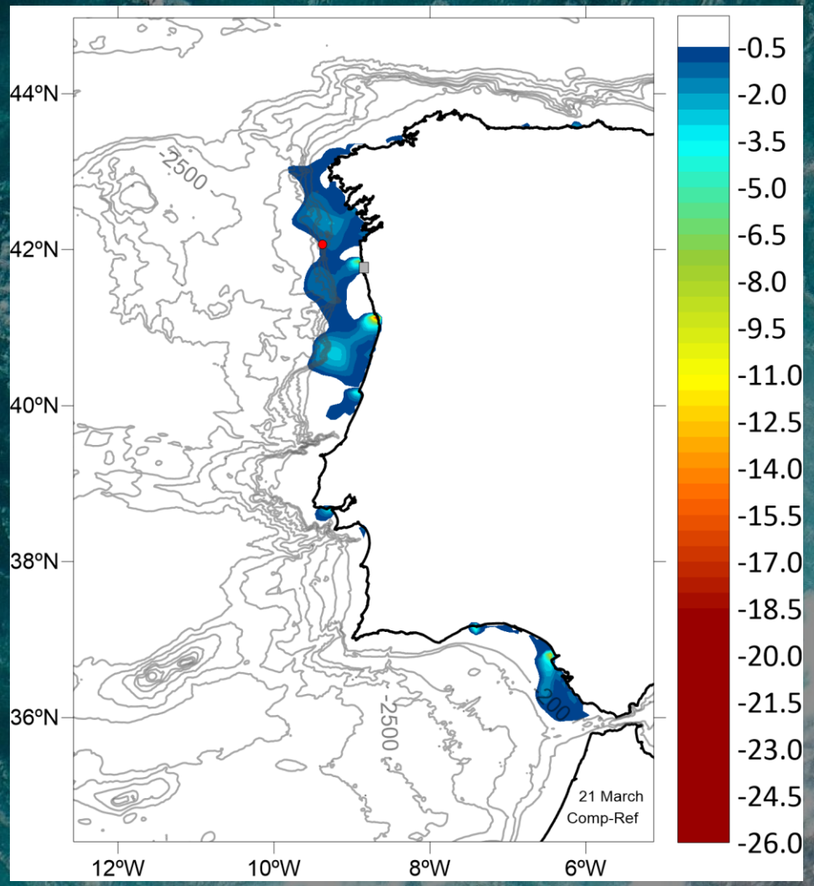
+ Fresh Water Influence

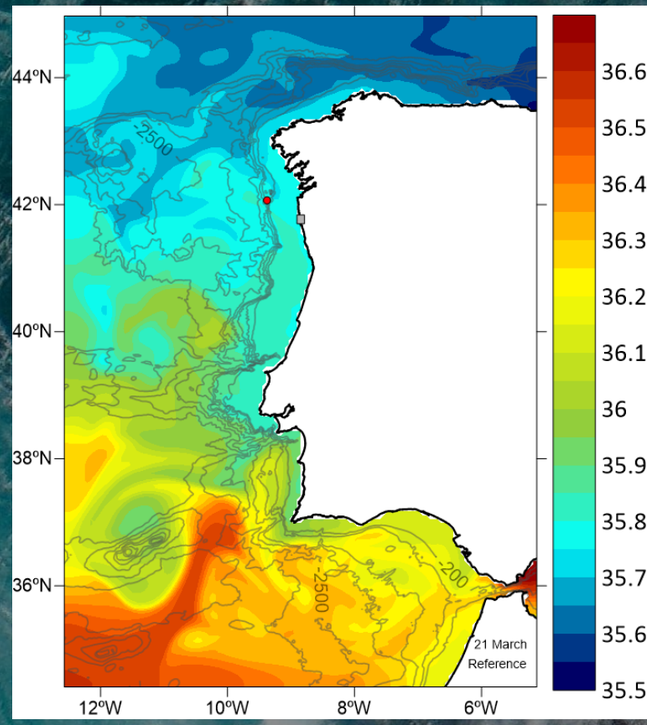
Large rain event in late March 2018

LAMBDA Watershed Model



Observations





Reference (No rivers)

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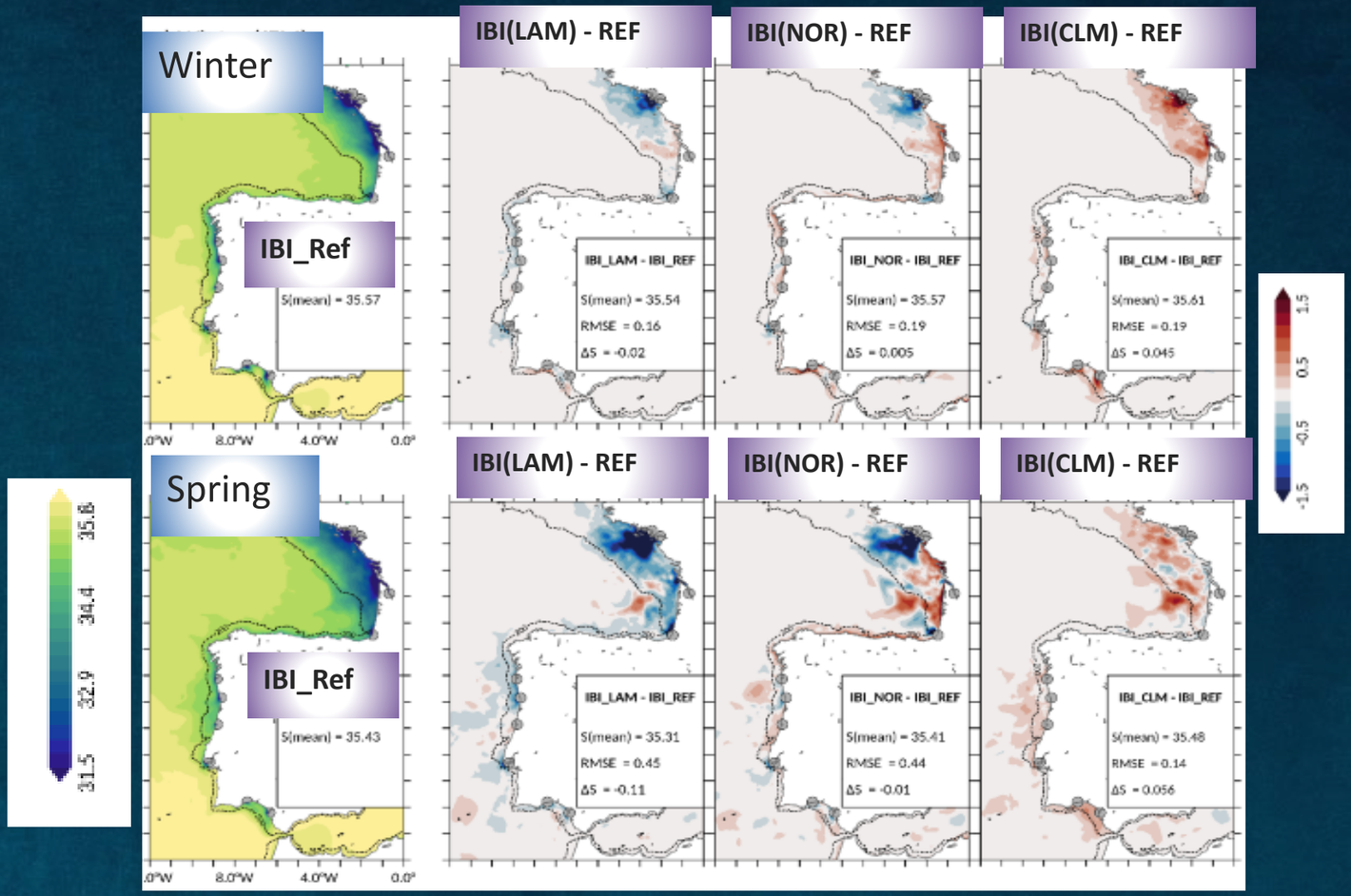
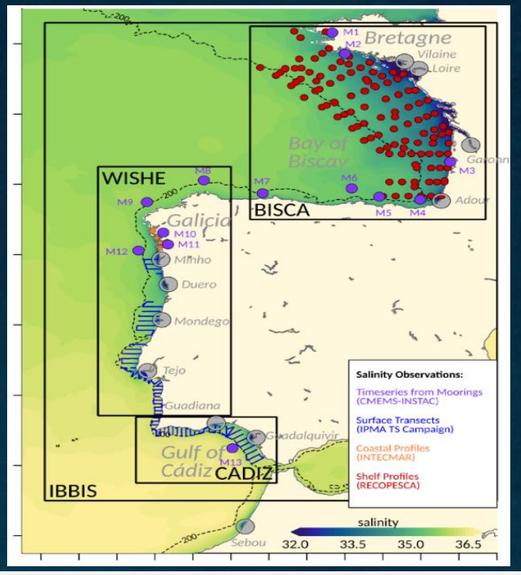
IBI-MFC tests new CMEMS-LAMBDA product

Seasonal surface salinity (IBI-Ref & Test differences)



IBI Model scenarios validated with several in-situ salinity obs sources:



- The river forcing play a significant role in the regional IBI SSS simulation.
- Use of a LAMBDA-like realistic product in the IBI set-up can avoid the need of an extra coastal run-off climatological input.
- Use LAMBDA Product as forcing potentially improves IBI solution, specially, in terms of SSS variability.

Further info in:

Sotillo et al. *River freshwater contribution in operational ocean models along the European Atlantic Façade: Impact of a new river discharge forcing data on the CMEMS IBI regional model solution. J. Mar. Sci. Eng. 2021, 9(4), 401; https://doi.org/10.3390/jmse9040401*

Future work

Future work includes:

- keep adding new stations
- database of estuarine main characteristics
- made operational the CMEMS SE LAMBDA products
- explore links with OSPAR/EuroGOOS activities

Main Conclusions:

- A novel methodology for calculating the overall inputs to the coastal area, simulate its evolution in the estuary continuum and inserting the volume and properties dynamics in a regional model was developed and tested successfully.
- Numerical modelling is currently the only tool able to represent and estimate the temporal and spatial scale of the WIBP and other estuarine plumes.
- This set of tools improve significantly salinity fields and aid to the delimitation of region of fresh water influence and salinity fronts which are relevant to fisheries management.
- The developed methodology is generic and could be set for any region using open source data and models.

Thank you so much for your attention!

Questions?

Stay in touch: francisco.campuzano@colabatlantic.com

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Full Partners

MARETEC – Marine, Environment & Technology Center

Técnico Lisboa

Bentley – Advancing Infrastructure

BEC – Barcelona Expert Center (ICM, UPC, IEEC)

ETT – People and Technology

Associated Partners

Puertos del Estado

Met Office

Marine Institute – Foras na Mara

Helmholtz-Zentrum Geesthacht – Zentrum für Material- und Küstenforschung

Interreg Atlantic Area – European Regional Development Fund

EUROPEAN UNION

iFADO – Innovation in the Framework of the Atlantic Deep Ocean

EMODnet – European Marine Observation and Data Network

Copernicus Marine Environment Monitoring Service – Service Evolution – Contract until March 30, 2020

More info at http://www.cmems-lambda.eu/