Ocean modelling – ocean atmosphere interaction

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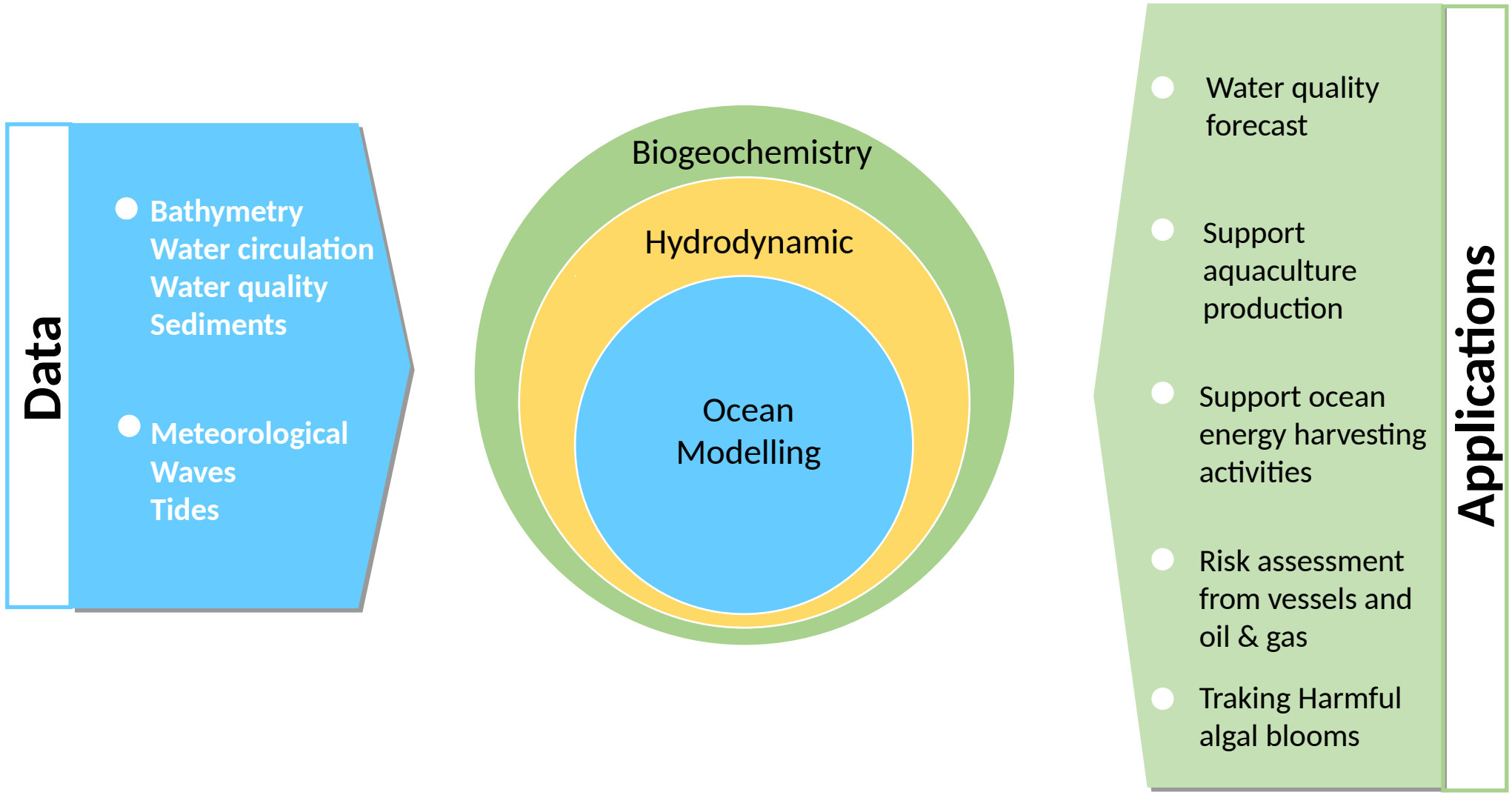
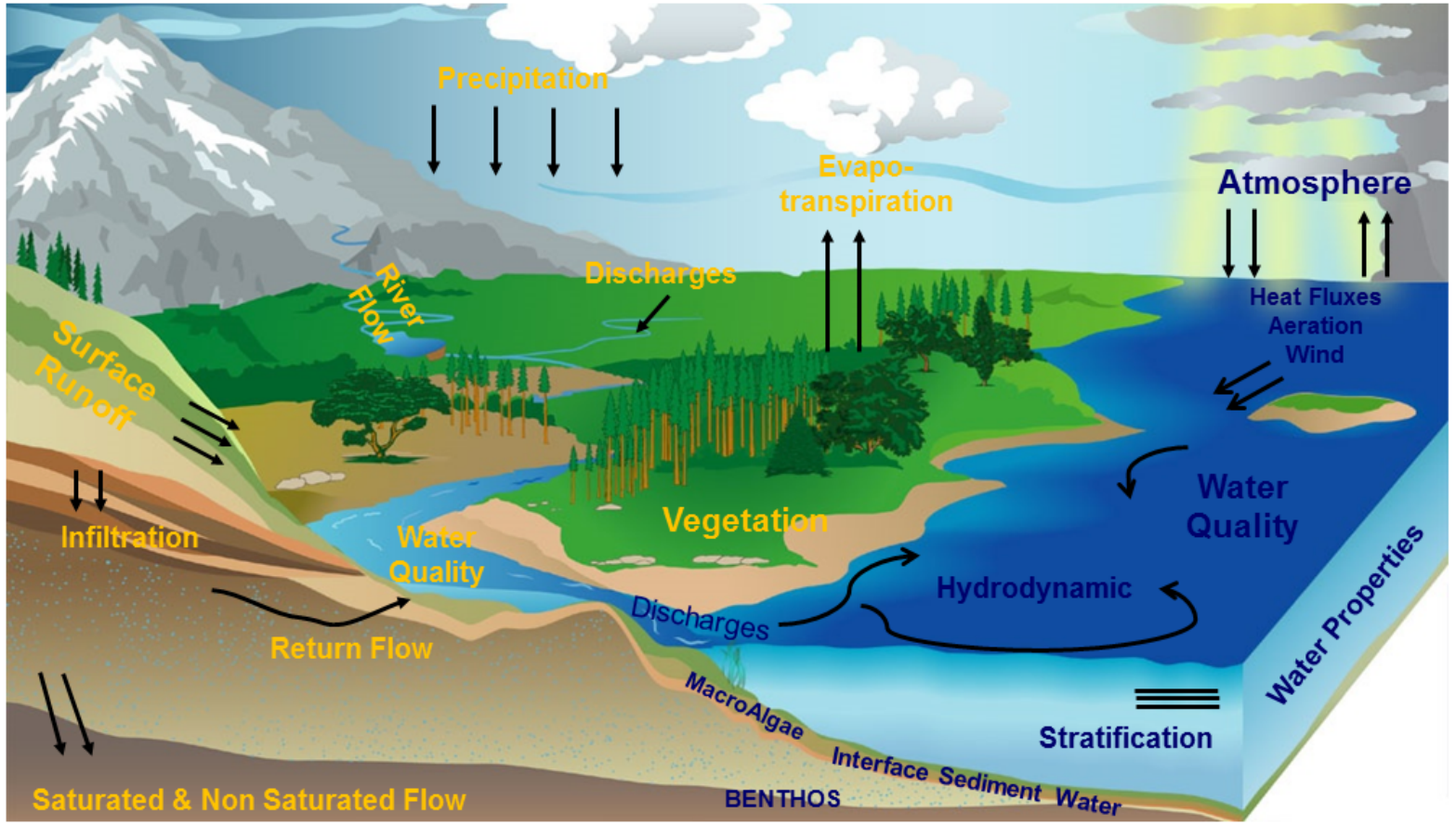
Ocean modelling



MOHID modeling system



MOHID
Water Modelling System
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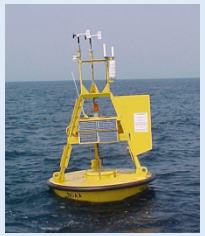
www.mohid.com

Open-source community model

Research and engineering purposes

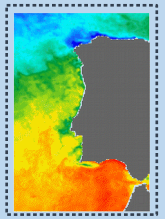
Applied by scientific and engineering
community all over the world

Looking to the future - forecast



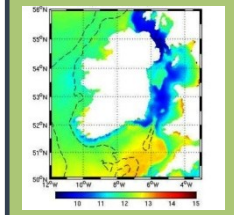
***In situ* data**

- monitoring programs
- moored equipment
- low spatial/temporal resolution



Remote sensing

- large synoptic sampling
- model validation (temp, chla)
- need for adequate algorithms



Model simulations

- identification major structures
- high spatial/temporal resolution
- study of BGC processes

hindcast → **nowcast** → **forecast**

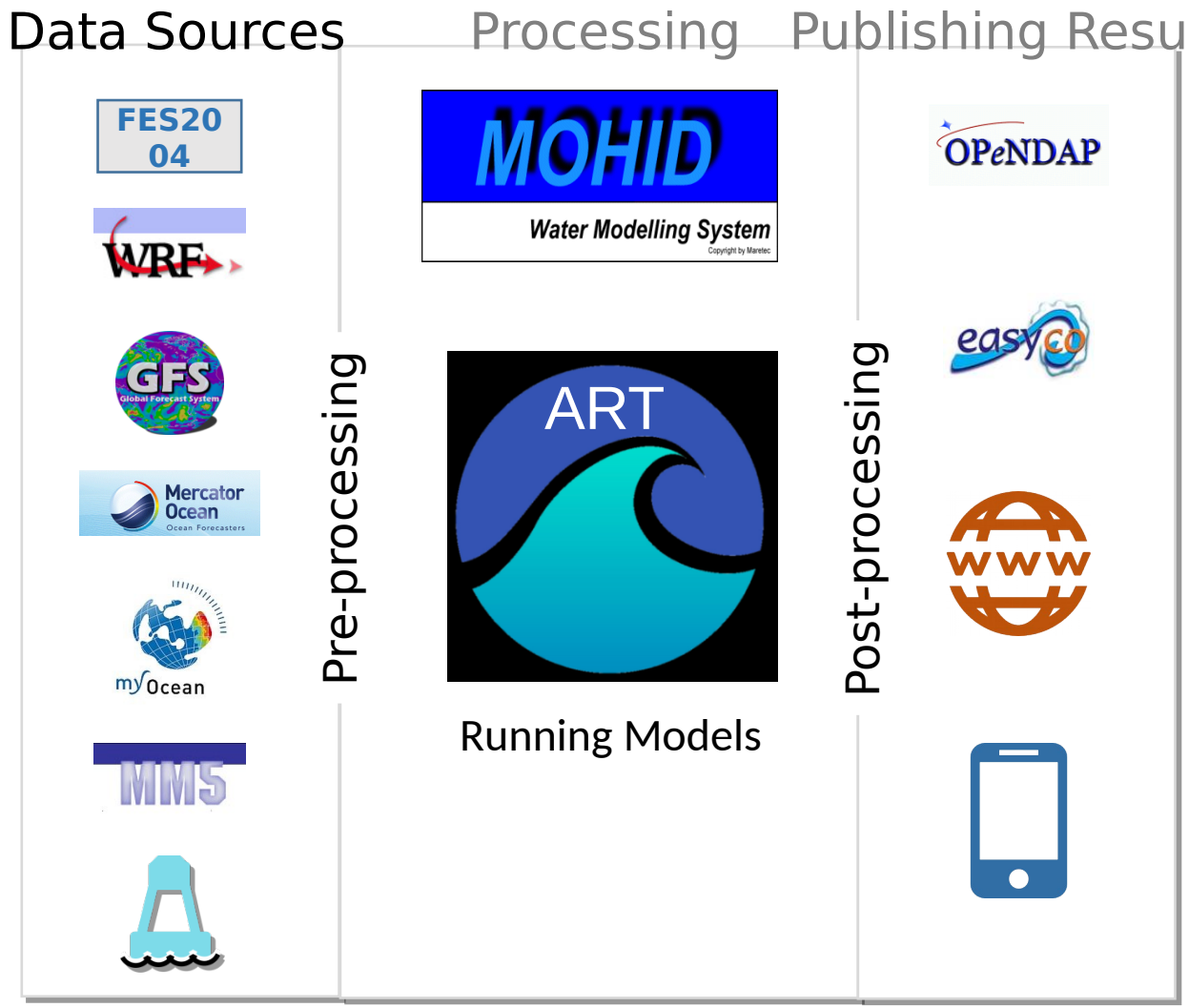
- Study of past events for training the modelling system
- Tuning and calibration (improve model performance and skill)

- Description of ocean conditions (physical, BGC, etc.)
- Aid to ocean activities

- Provision of expert interpretation of available data by via web-portal on a periodic basis
- Valuable help for Decision Support System

Warning systems

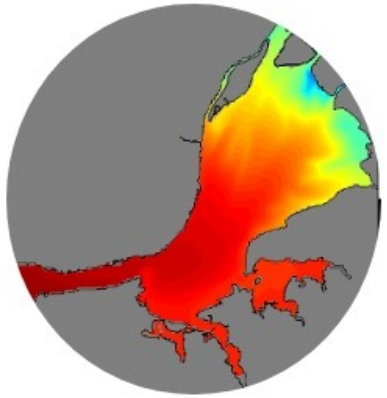
Operational system



MOHID products

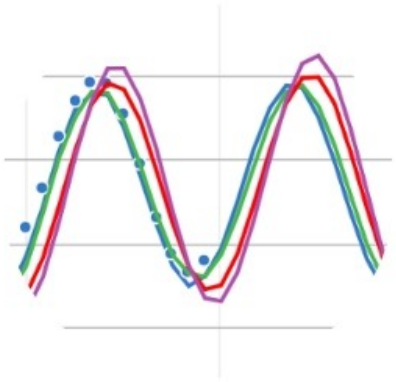
Operational Modelling

MARETEC
MARINE ENVIRONMENT & TECHNOLOGY CENTER



Modelling Maps

Graphic representation of the modelling results and forecasts



Modelling Charts

Chart representation of the modelling results, forecasts and observations.

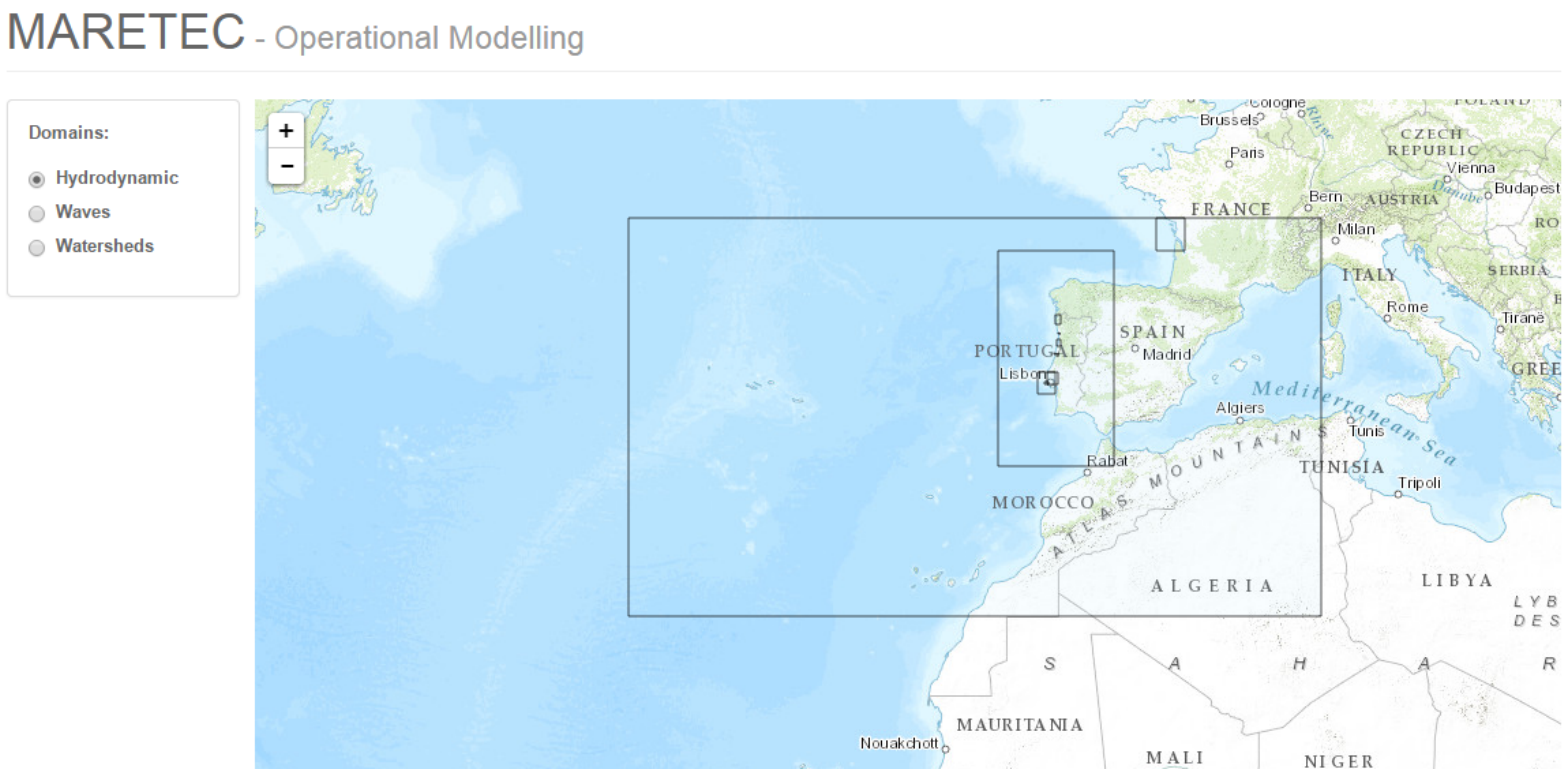
Weather Forecast

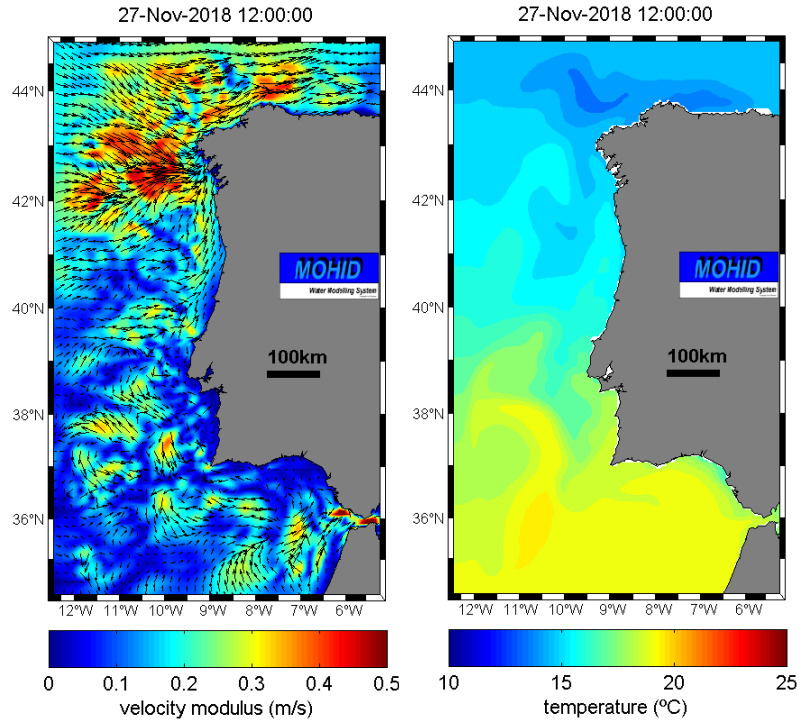
7 day weather forecast for Portugal Continental

http://forecast.maretec.org/

MOHID products

PCOMS - Portuguese Coast Operational Modelling System



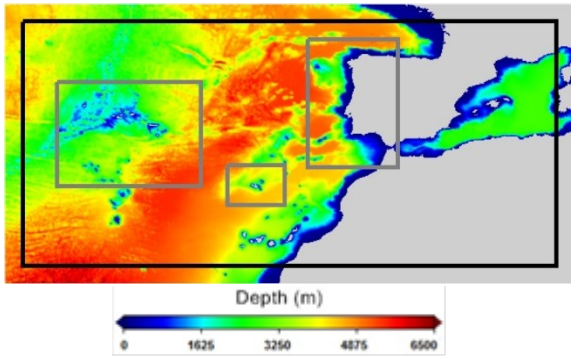


- 3-day ocean forecast
- Results available online at http://forecast.maretec.org/

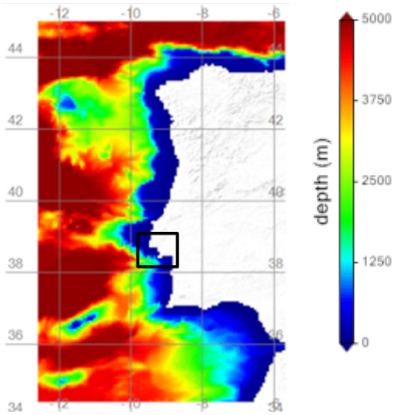
Modeling the 3D structure of the ocean

From the regional scale to the local scale

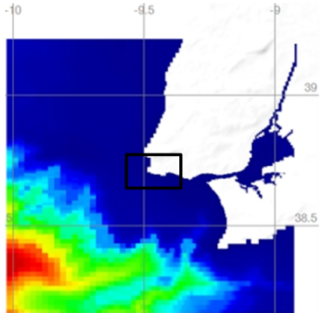
Portuguese EEZ



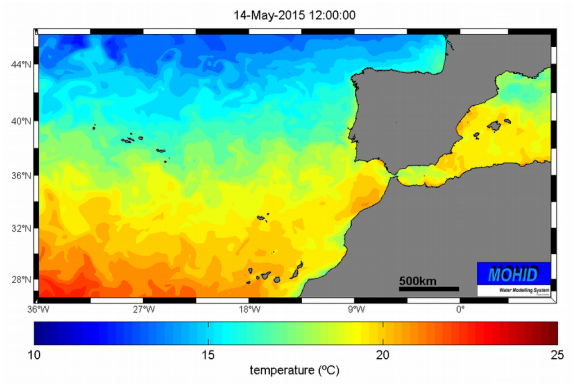
Portuguese Coast

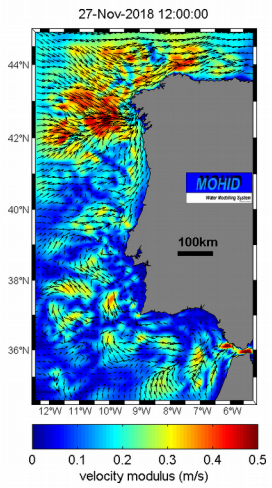


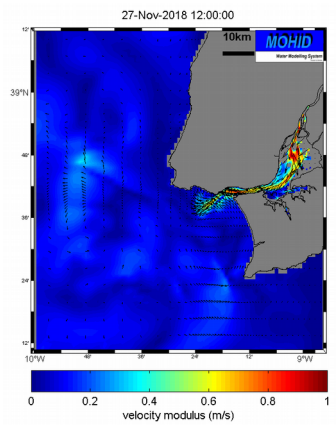
Tagus mouth

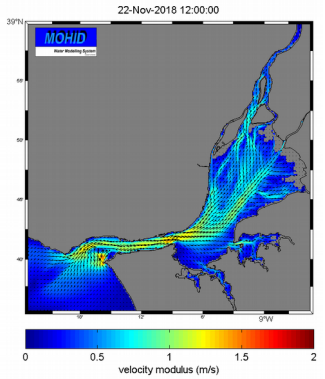


Tagus estuary



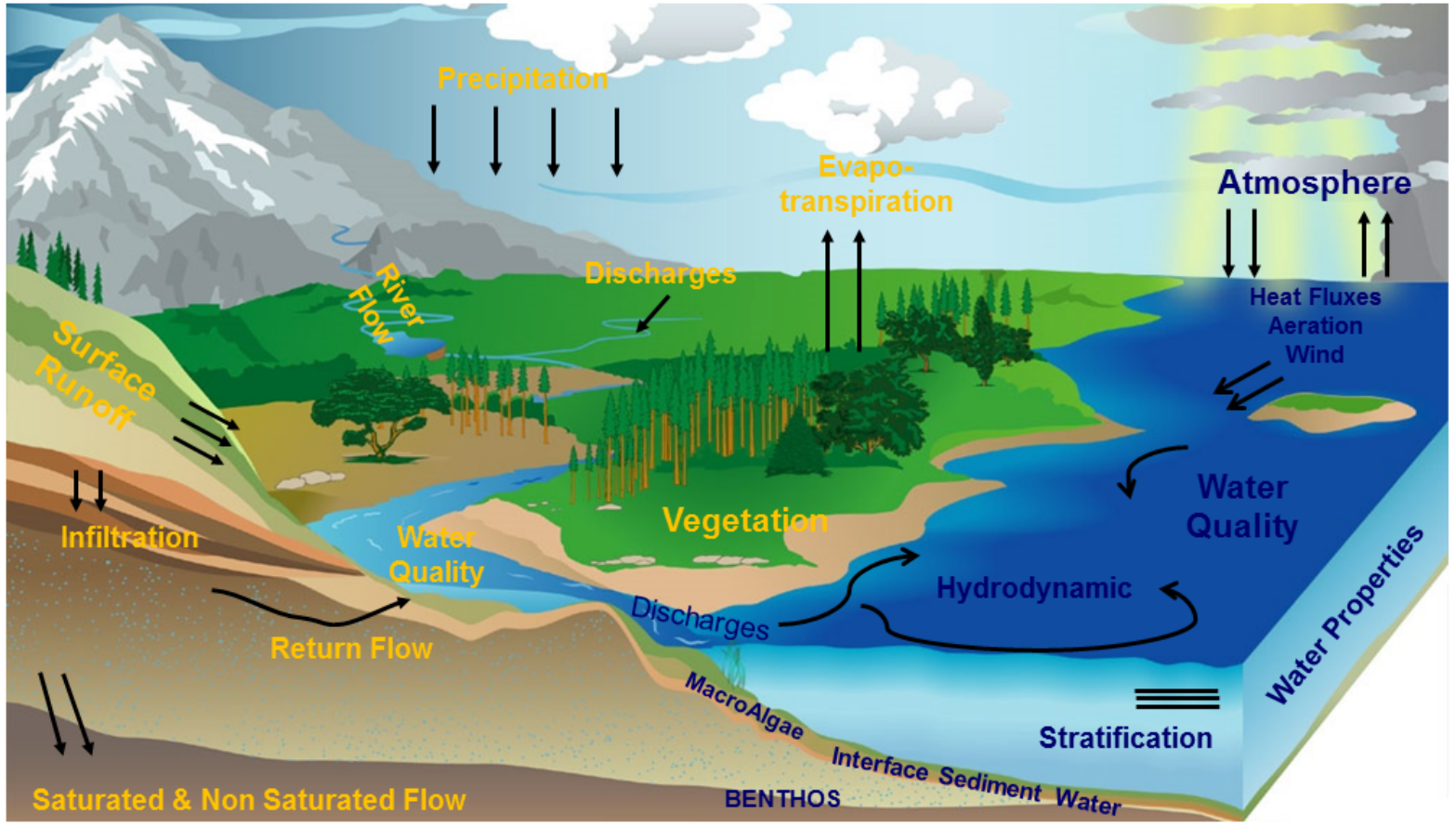






Regional → Local

MOHID modeling system



MOHID
Water Modelling System
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Ocean –atmosphere system

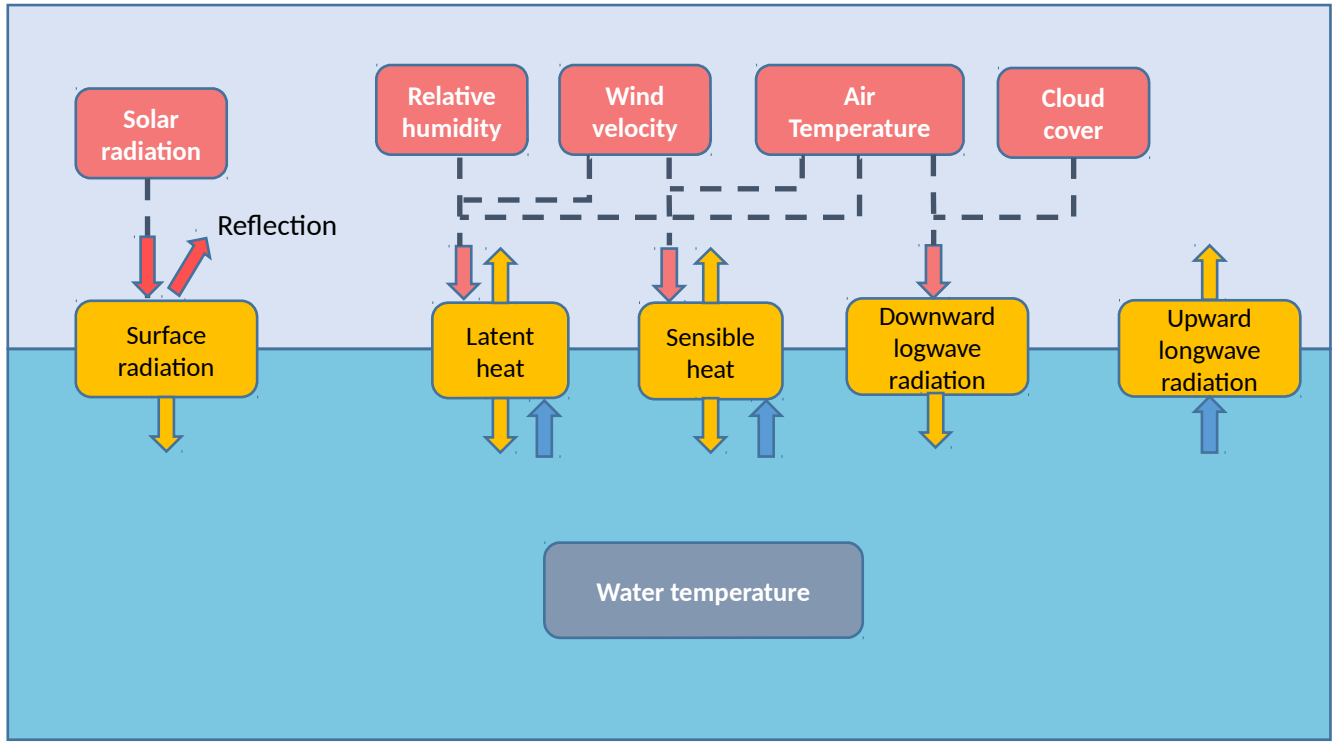
The coupled domain of the surface ocean and lower atmosphere is a complex, highly dynamic component of the earth system.

- Oceans and atmosphere store and exchange energy in the form of heat, moisture, and momentum;
- Oceans are the Earth's largest reservoir of moisture;
- Ocean absorb heat more effectively than land and ice surfaces, and store heat more efficiently than land;
- Oceanic heat is released more slowly than on land, keeping coastal areas more temperate;
- Ocean absorbs solar radiation very rapidly:
  - The rate of absorption varies with wavelenght and with the amount of suspended material;
  - The total energy falls off exponentialy with depths;
  - Typical decay rates are such that about 80% is absorbed in the top 10m.

Mohid Water-atmosphere interface

Three main processes:

- Momentum (Surface rugosity, wind shear stress, wind shear velocity, turbulent kinetic energy)
- heat fluxes between air and water;
- mass fluxes between air and water (surface water, oxygen, carbon dioxide).



Non solar flux = Latent heat + Sensible heat + net longwave radiation

MOHID heat fluxes

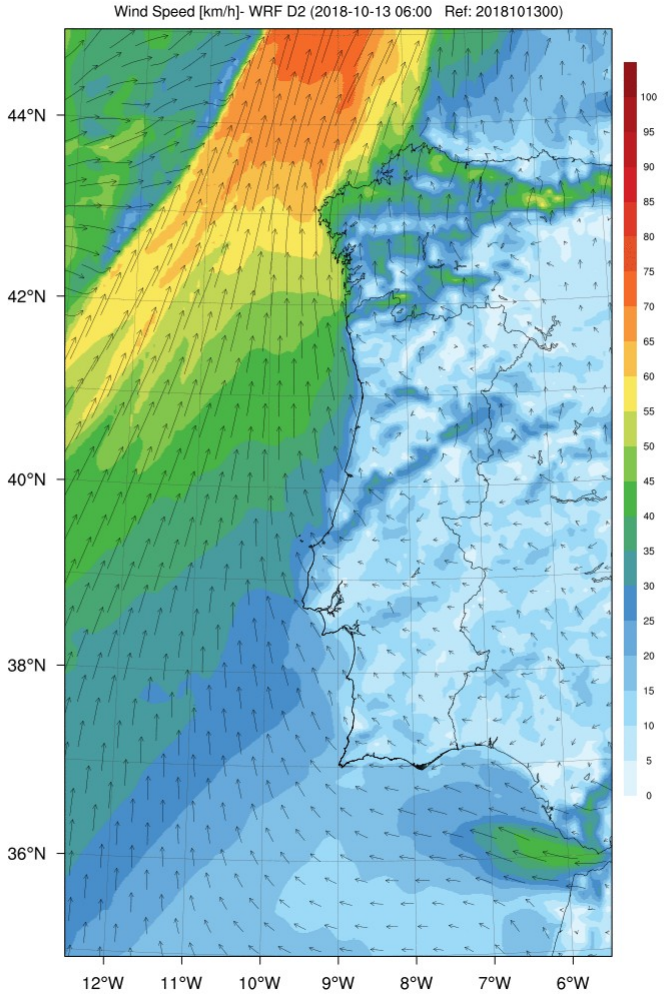
- The COARE algorithm is designed to give estimates of the turbulent fluxes of sensible and latent heat and the stress from inputs of bulk variables
  - developed by C.Fairall (NOAA/ERL), E.F.Bradley (CSIRO), and D.Rogers (Scripps)
  - algorithm is ready to receive albedo and PBL height from meteorological models
  - version 3.0
- COARE details are documented in:
  - on the algorithm (Fairall et al., 1994a; Bradley and Weller, 1995);
  - cool skin and warm layer effects (Fairall et al.,1994b);
  - bulk transfer coefficients are based on the Liu, Katsaros, Businger (LKB) model (Liu et al., 1979) with some modifications.

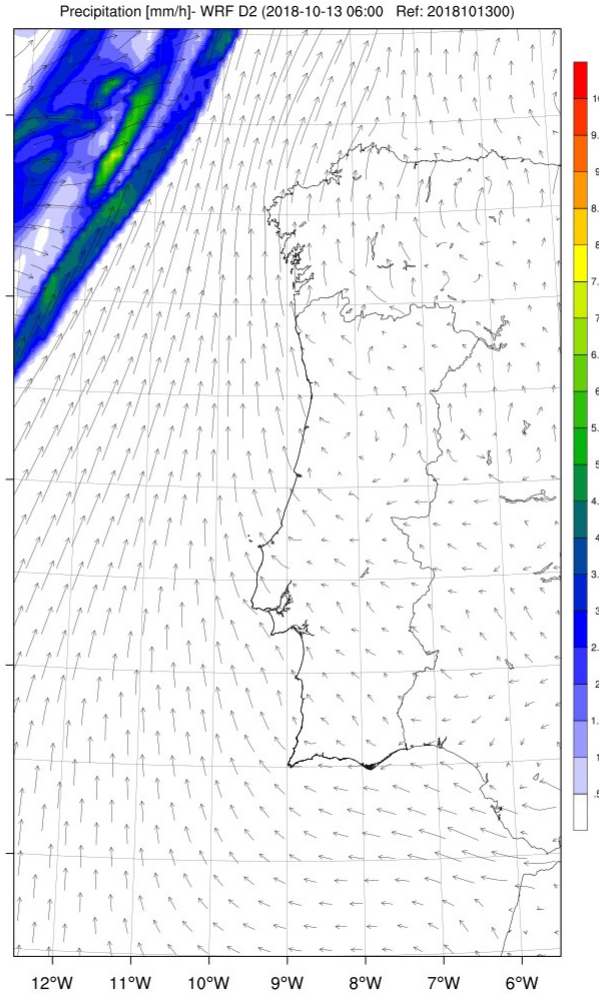
Meteorological models

From the regional scale to the local scale

- GFS 0.25°/0.5° (Lusitânia)
- WRF 9Km → 3km

  (Portugal, Tagus, Douro, Mondego, Guia)
- WRF 36km, 12km, 4km MeteoGalicia





Atmospheric Deposition

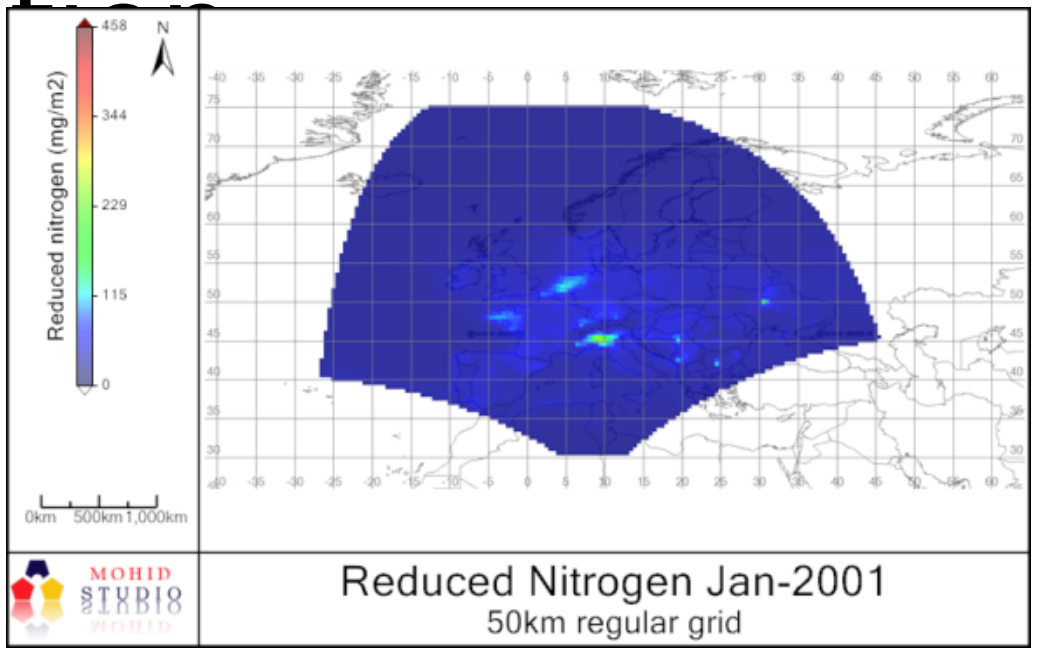
EMOSEM Project

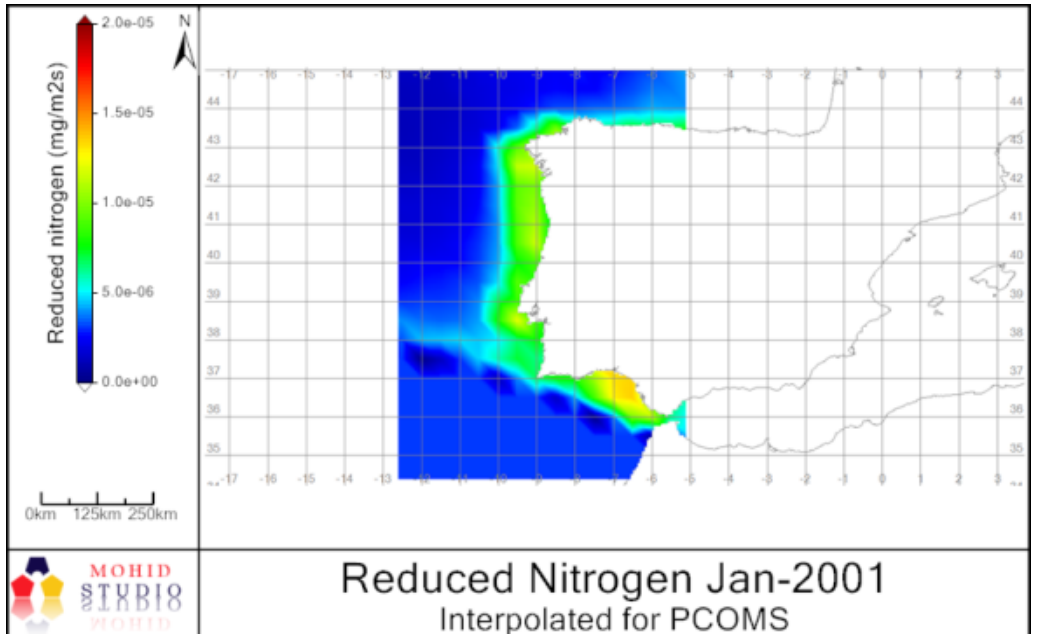
Atmospheric deposition data obtained from EMEP program (http://www.emep.int/)

Available values are monthly depositions of wet and dry reduced nitrogen and wet and dry oxidized nitrogen in mg/m^2 as N.

The atmospheric depositions of nitrogen (N) are considered as direct input in biological state variables NH_4 (ammonium) and NO_3 (nitrate).

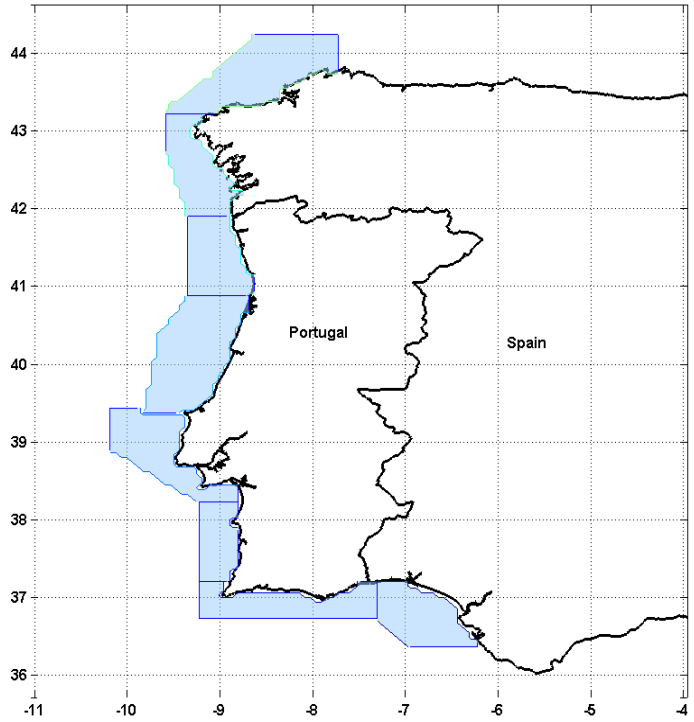
Introduced in the Mohid system as surface fluxes





Eutrophication in coastal waters

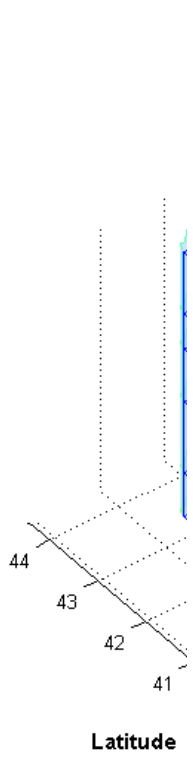
EMOSEM Project

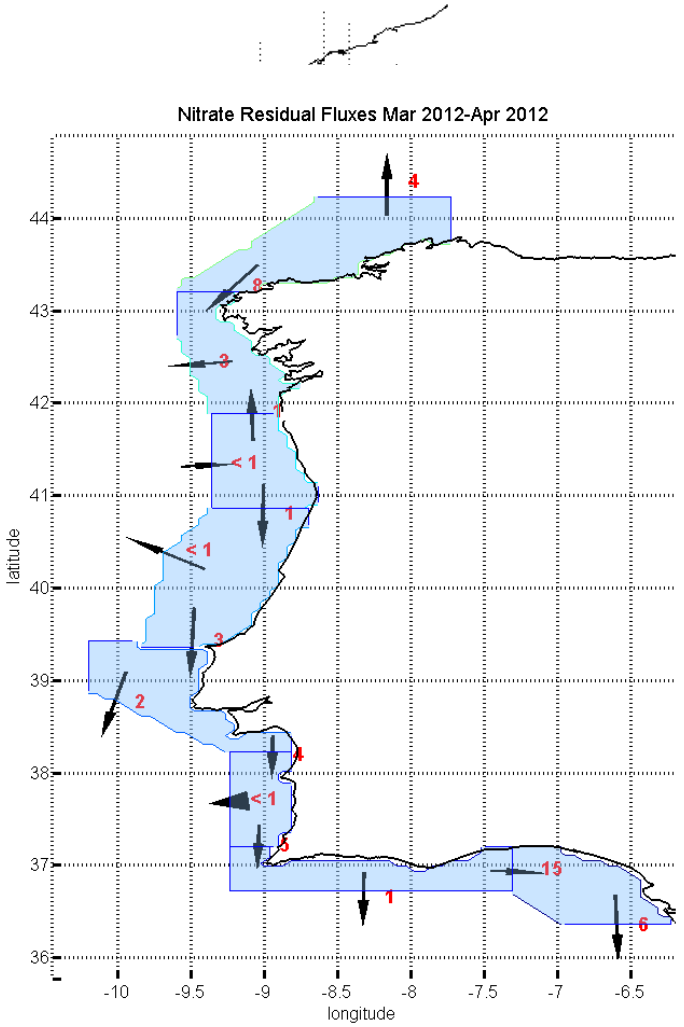


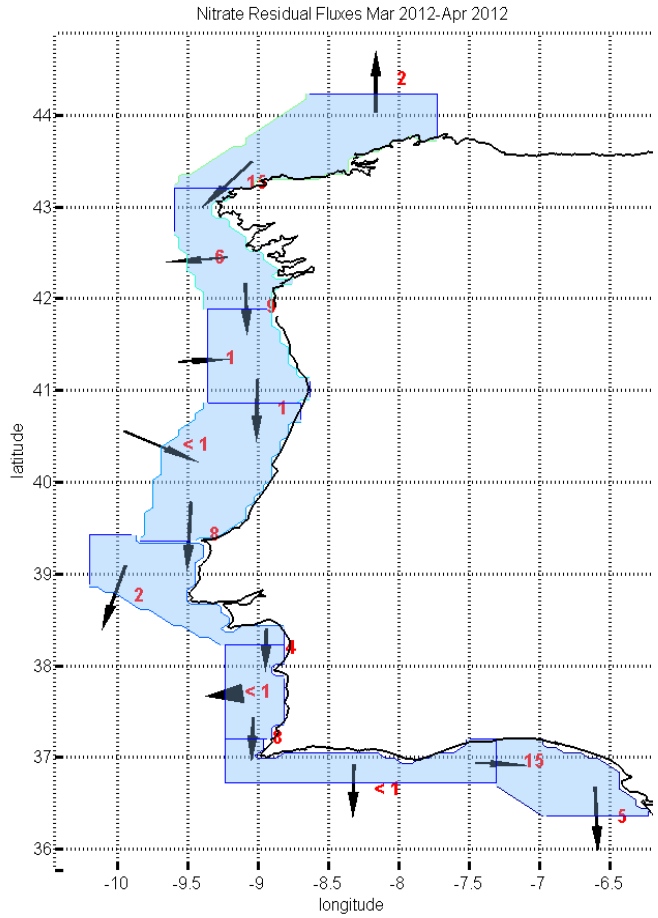
RIVERS

Tons Nitrogen/N

NO RIVERS



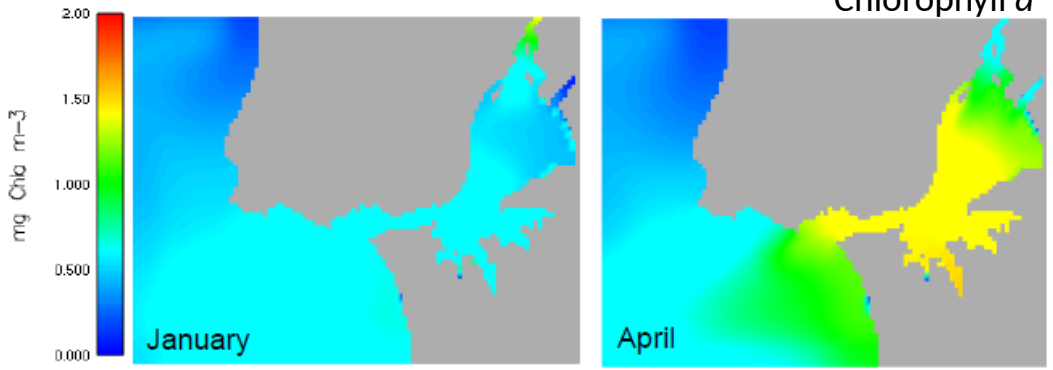




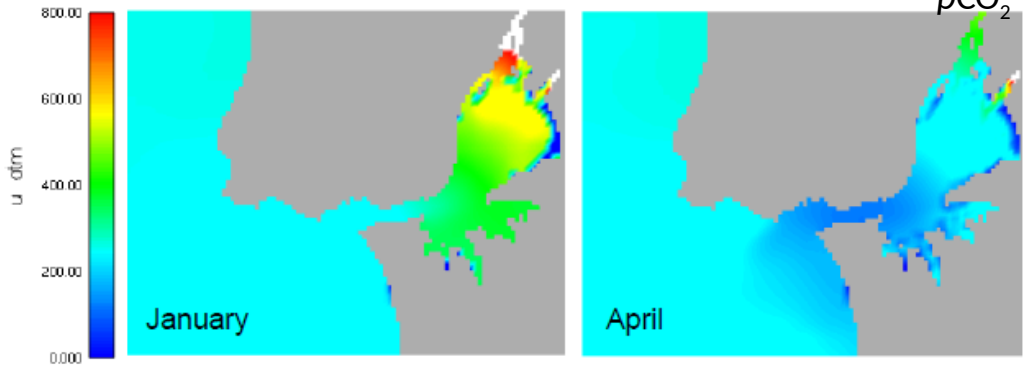
Desmit X. et al. (2018). Reducing marine eutrophication may require a paradigmatic change. Science of The Total Environment, 635: 1444-1466.

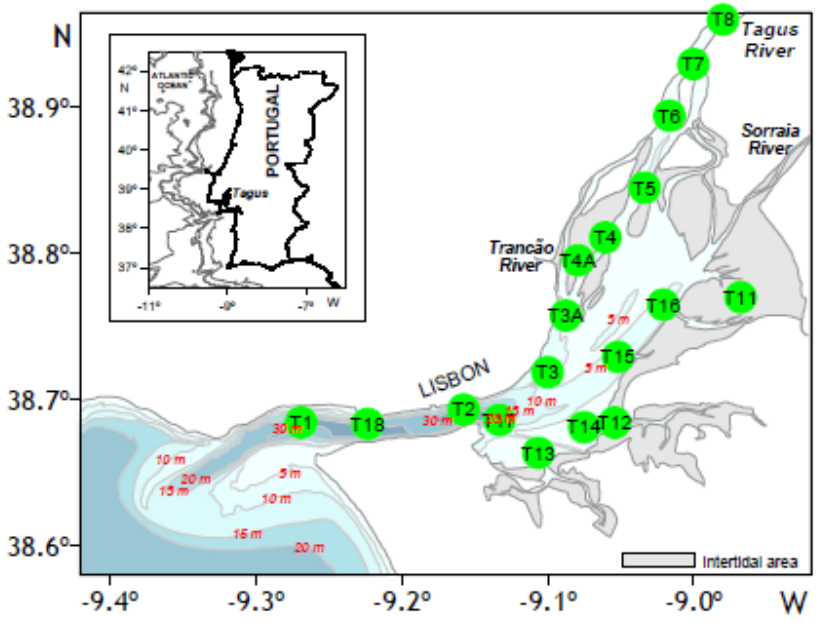
Numerical study of CO_2 in Tagus estuary

Chlorophyll *a*

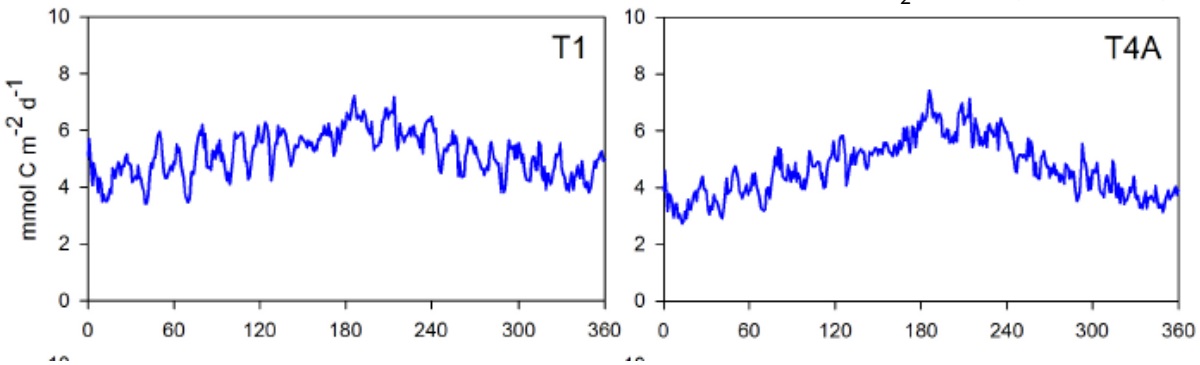


pCO_2



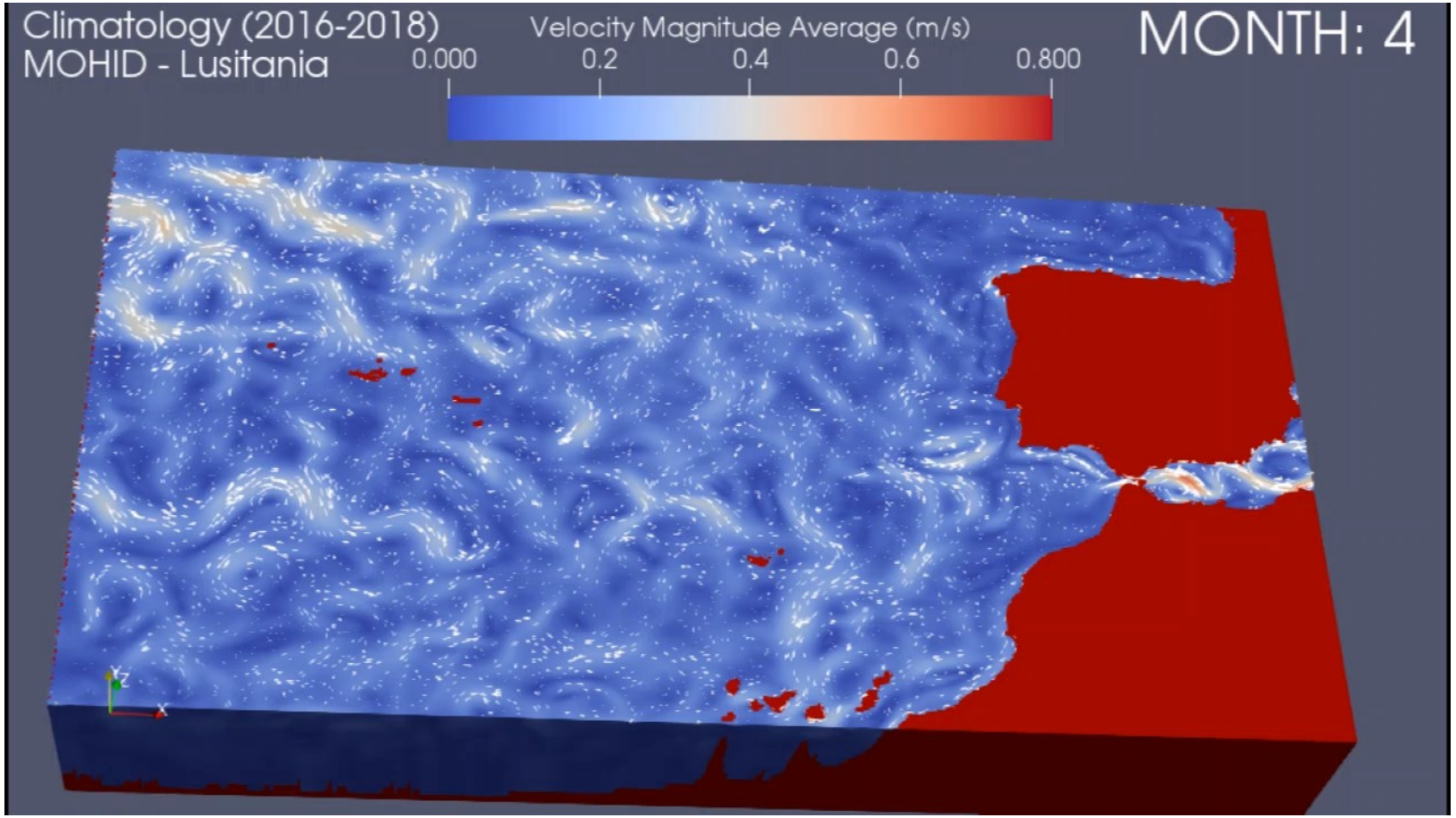


CO_2 fluxes (air-water)

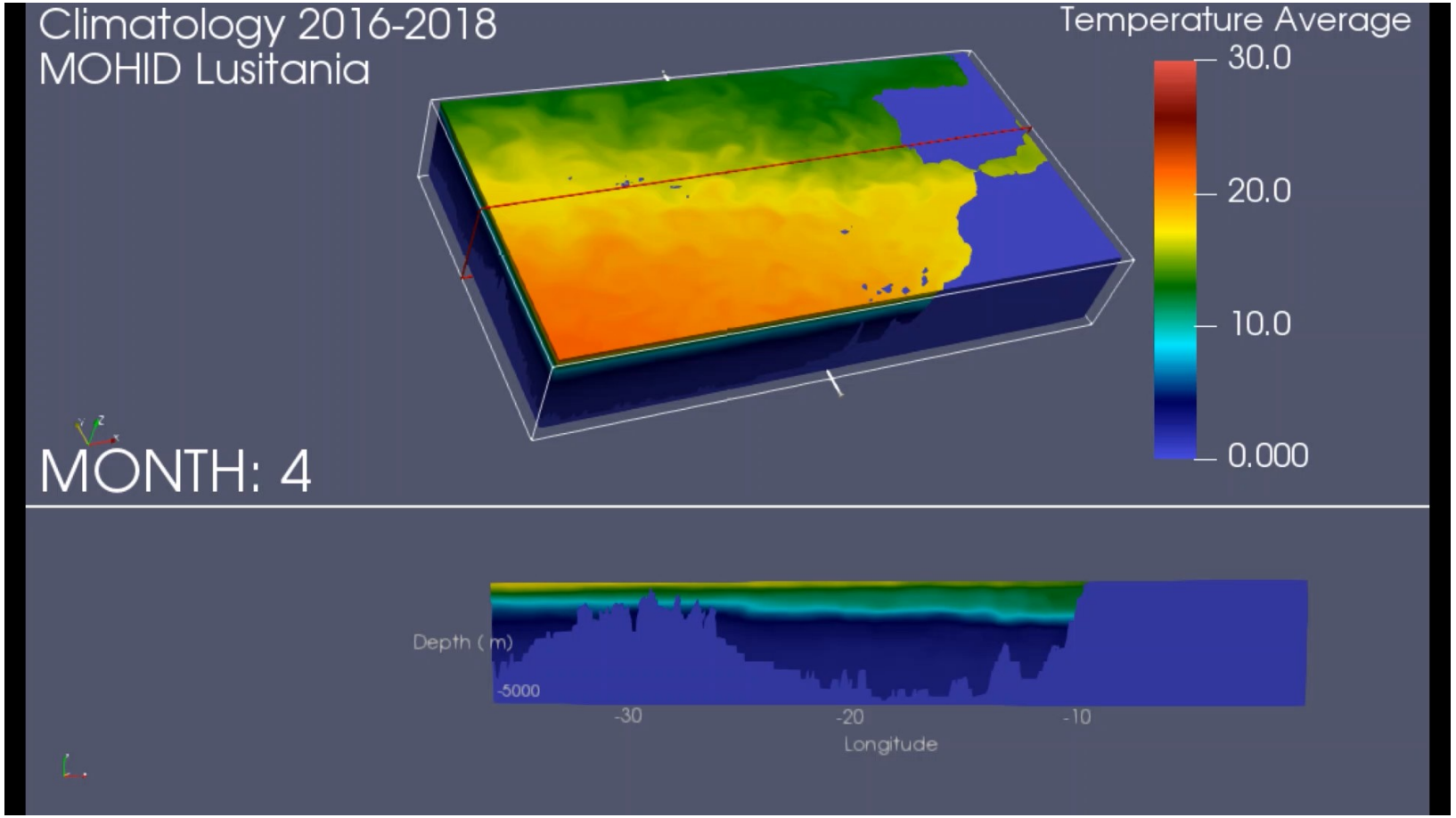


Oliveira AP (2011). Fluxos de CO2 na interface ar-água num sistema estuarino português e zona costeira adjacente. PhD thesis.

Lusitânia (2016-2018)



Lusitânia (2016-2018)



WRF 4.0

- dx = 9km -> 3kmdy = 9km -> 3km
- vert 40 layers

- Microphysics - WRF single moment (WSM) 6-class graupel scheme
- Radiation LW - RRTM (rapid radiative transfer model) scheme
- Radiation SW - Dudhia scheme
- Surface Layer - Revised MM5 Monin-Obukhov scheme
- Land Surface - Thermal diffusion scheme
- Boundary Layer - YSU (Yonsei University)scheme
- Cumulus - Kain-Fritsch (new Eta) scheme