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HIGH RESOLUTION COASTAL FORECASTING MODELS AS TOOLS TO AID SECURITY AND EFFICIENCY TO THE PORTS OF THE FUTURE

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Porto, January, 20, 2015

Summary

- Concept Overview
- Scientific Background
- Global Architecture of the system
- Models description
- Preliminary Results
- Applications for a smart port strategy
- Conclusions

Concept Overview

Meteorological Forecast

Should I wear rain coat or t-shirt?

Do I need my umbrella?

Is it better to use sunscreen?

Will a tornado hit my house?

Ocean Forecast

(still no prime time on TV)

Direction and intensity of ocean currents?

Water temperature?

Wave Height?

Best shipping routs?

Maximize navigational port constraints

How to plan operations in a disaster situation?

Concept Overview

Dynamic definition of ship routs (improve logistics)

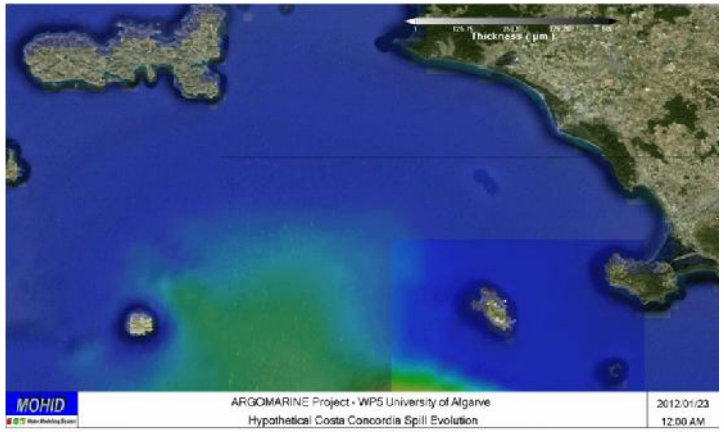
Support to emergencies and disasters

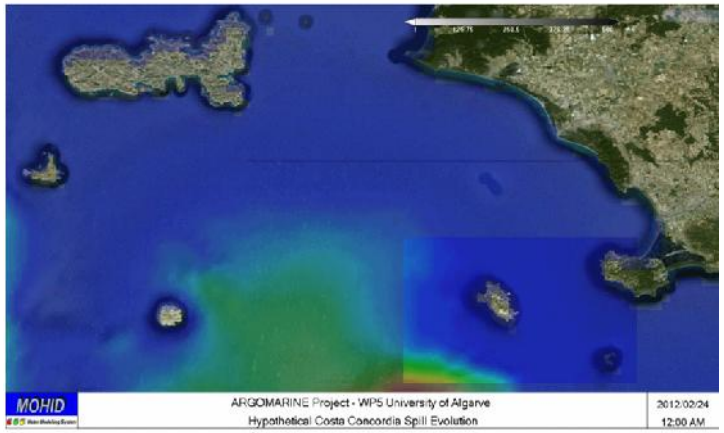
Support to security and safety plans

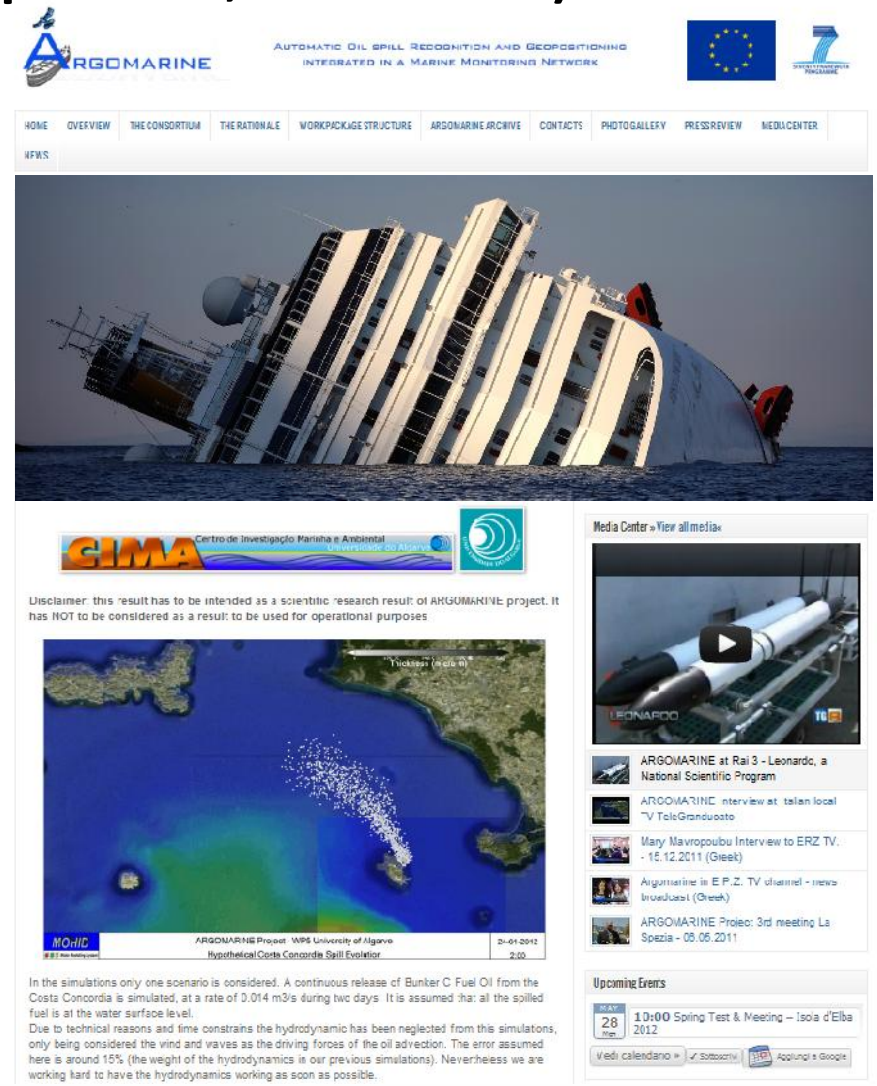
Environmental assessment

Scientific Background

ARGOMARINE – FP7 Project (8 partners; 5 countries)







Concept Overview

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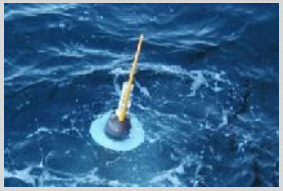
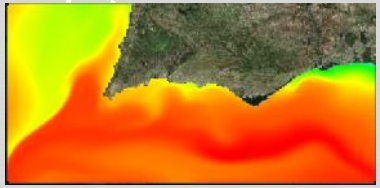
Observations



Analysis and Forecasts

Ocean Modelling
Data Analysis



End-Users

- Improve Marine Activities;
- Marine Safety;
- Marine Monitoring;
- Decison support;

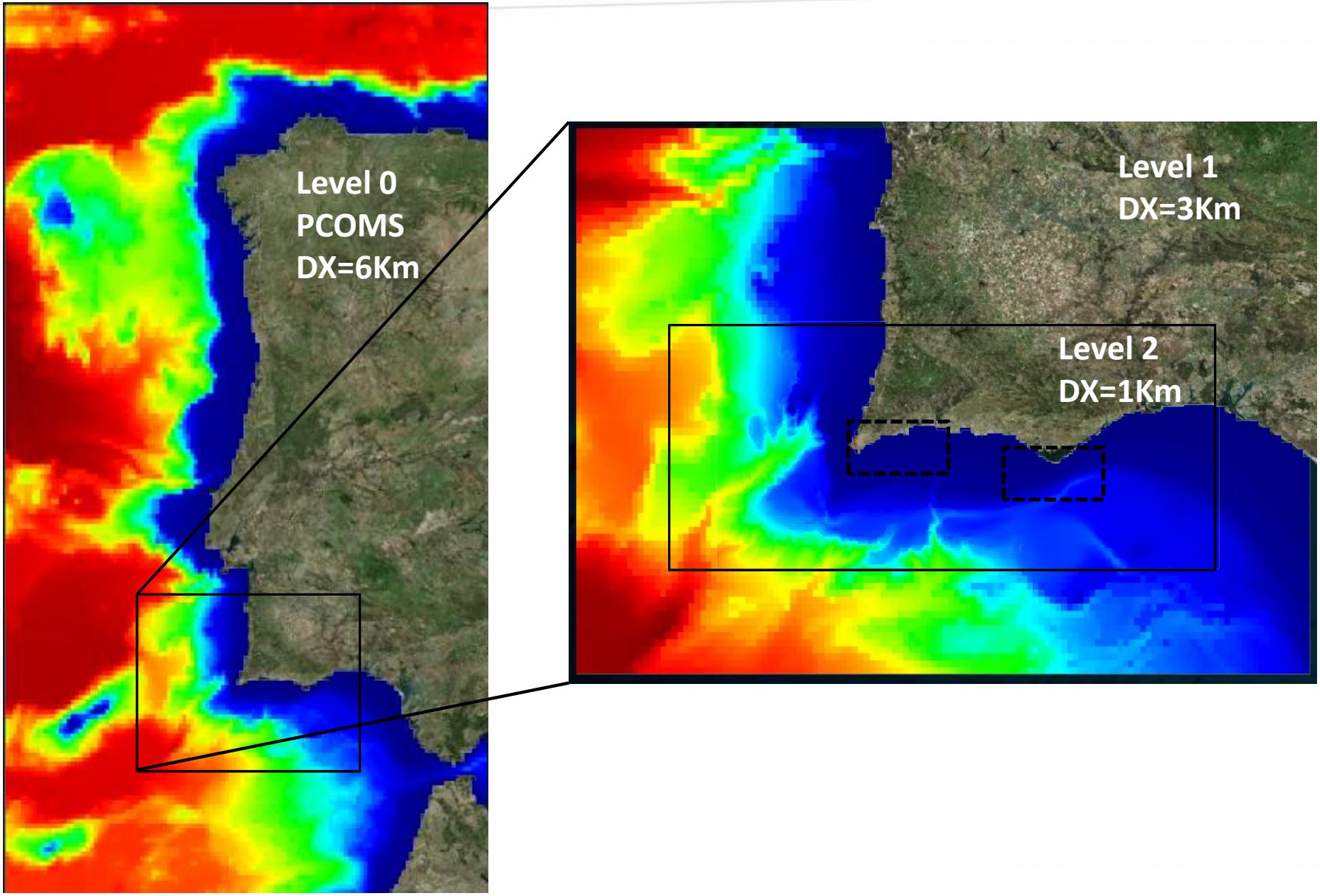
Copernicus The European Earth Observation Programme

myOcean

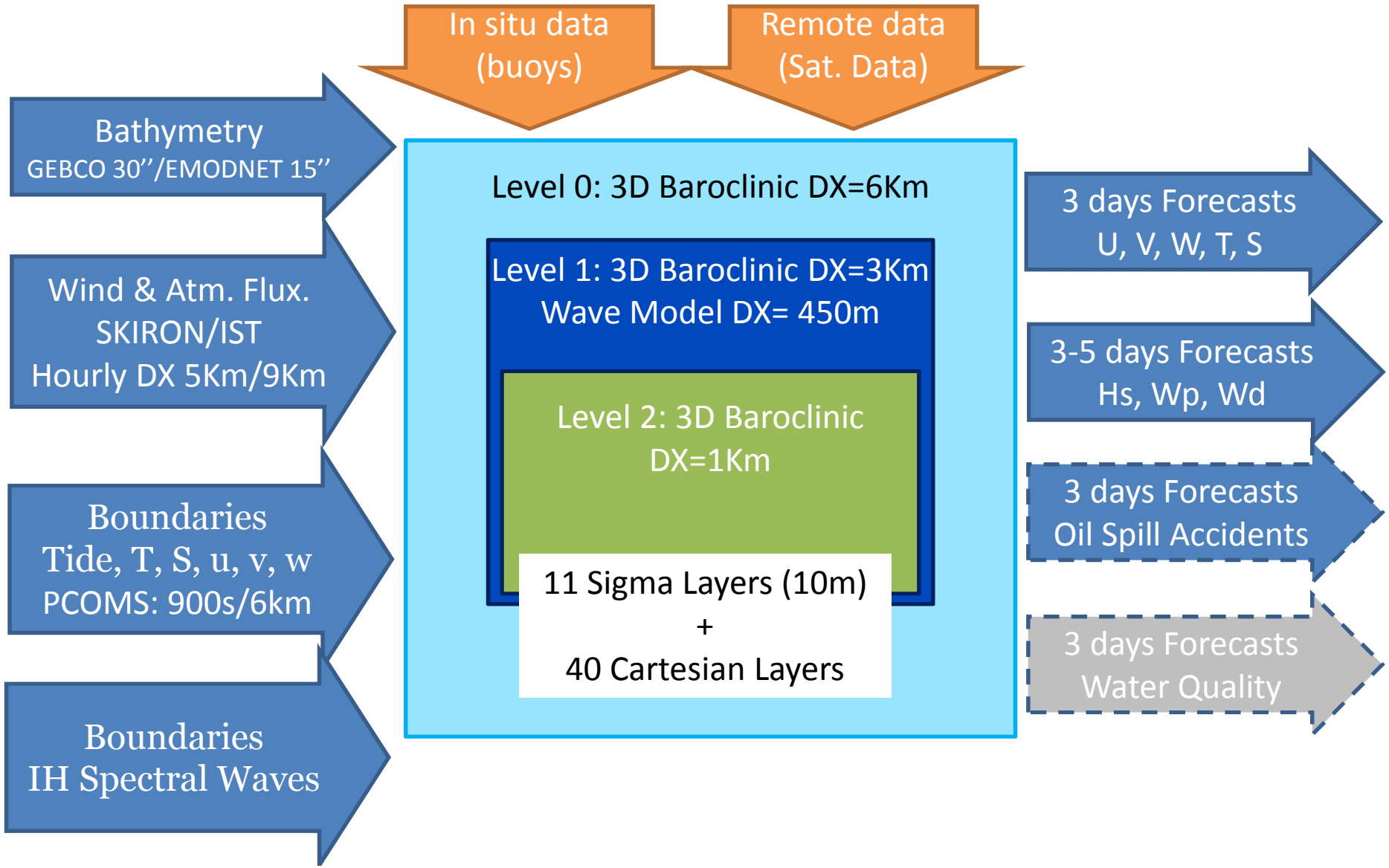
Coriolis

Valorization

System Architecture

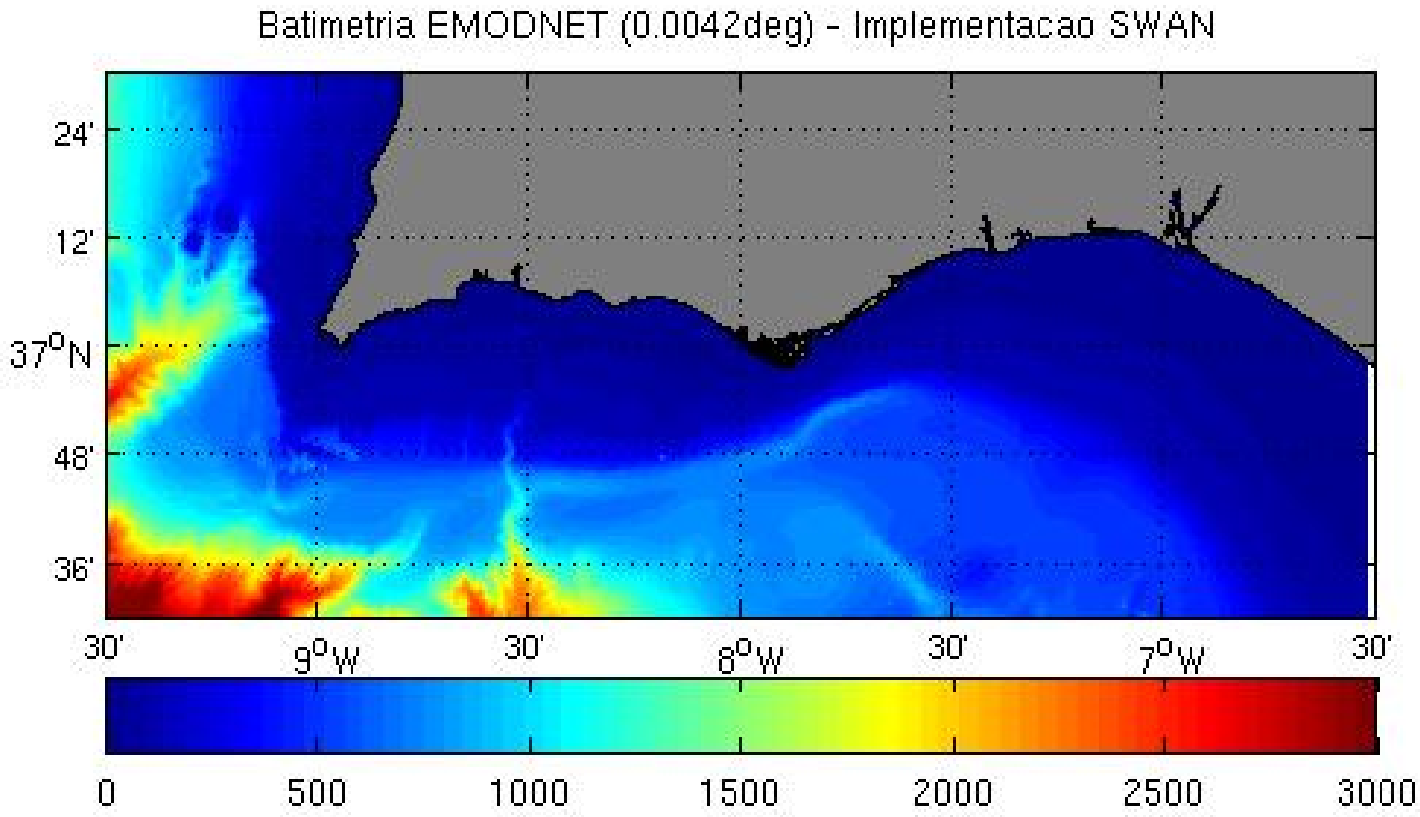


Global Architecture of the system

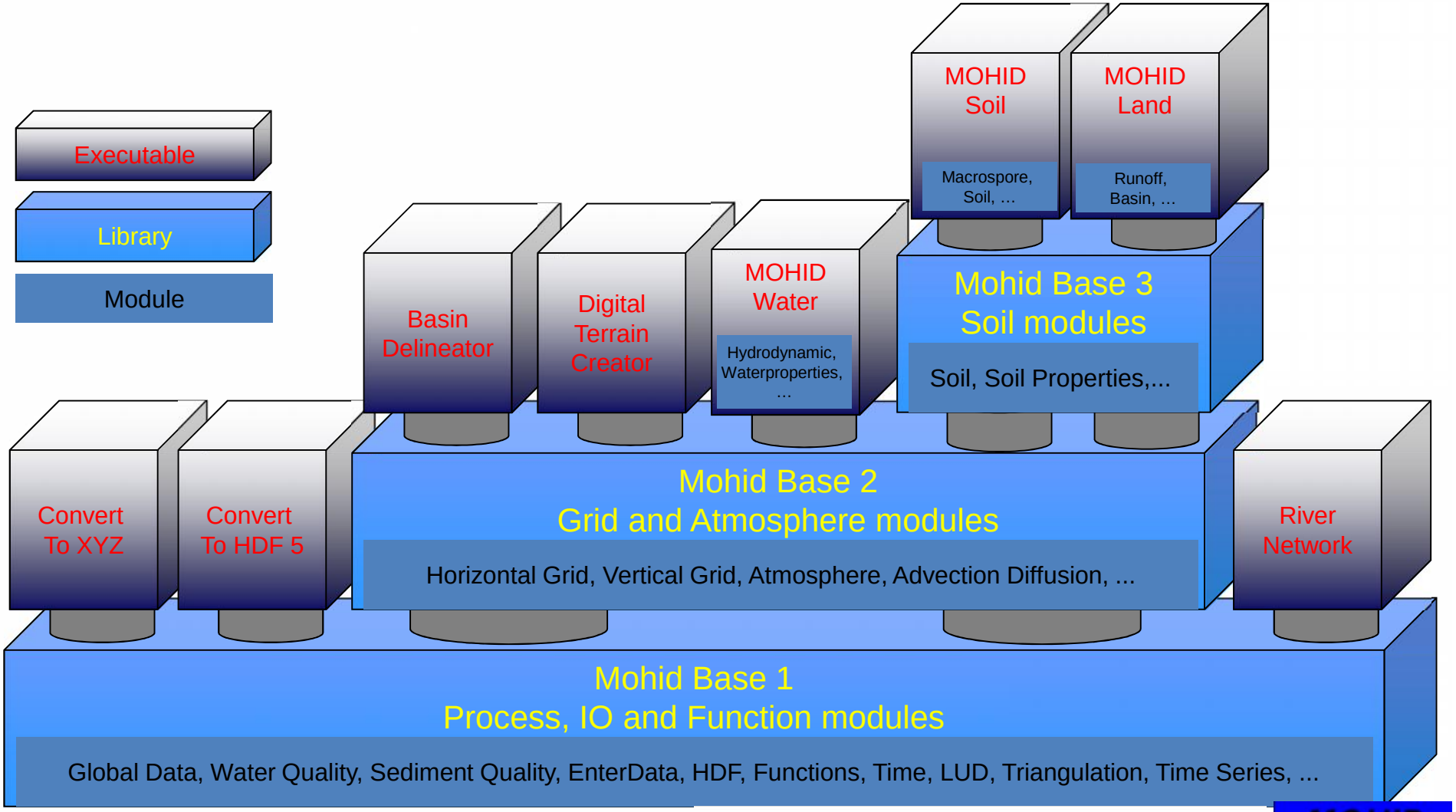


Wave Model Grid and Bathymetry

- Source: EMODNET
- Resolution: 15’’ (≈450m)
- Grid: 238 x 714 cells



The Hydrodynamic Model



www.mohid.com

The Hydrodynamic Model

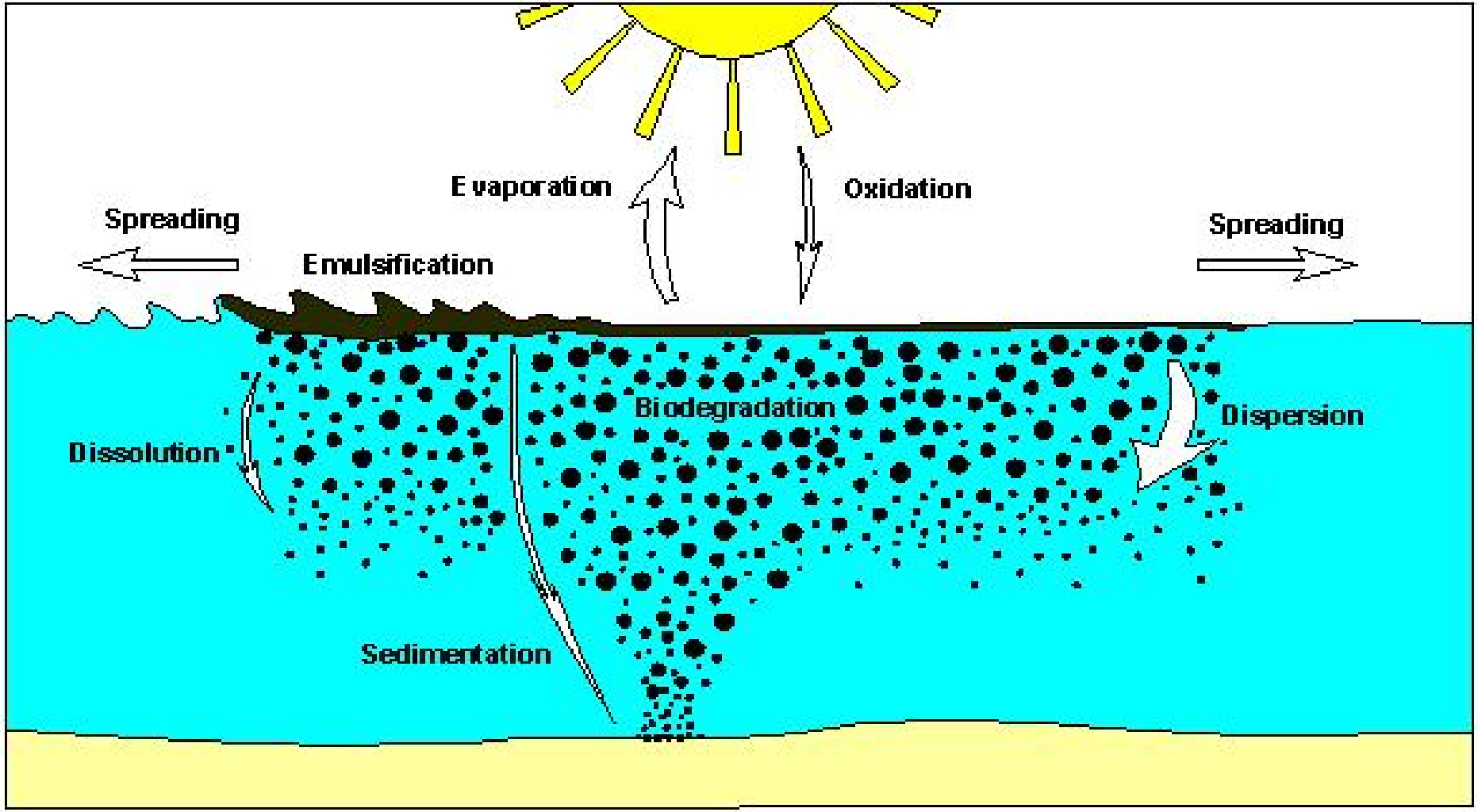
- 3D finite volumes hydrodynamic and transport model
- Shallow Water (Hydrostatic and Boussinesq Approx.)
- Baroclinic
- ADI temporal discretization
- Generic vertical coordinate system
- Orthogonal horizontal coordinates
- Arakawa C grid
- High order advection-diffusion schemes library
- Sub-model nesting
- Several turbulence models including GOTM library
- OOP FORTRAN95 structure
- Input/output via ASCII and HDF5 format

The Wave Model

- SWAN (3rd. Generation Spectral Wave Model):
  - Shoaling
  - Refraction
  - Diffraction.
  - Frequency shifting
  - Wave generation by wind.
  - Three- and four-wave interactions.
  - Whitecapping, bottom friction and depth-induced breaking.
  - Dissipation due to vegetation.
  - Wave-induced set-up.
  - Transmission and reflection against obstacles

SWAN
Simulating WAves Nearshore

The Oil Model



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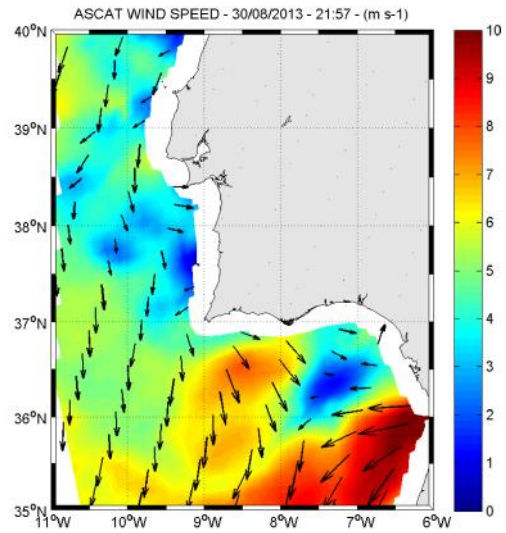
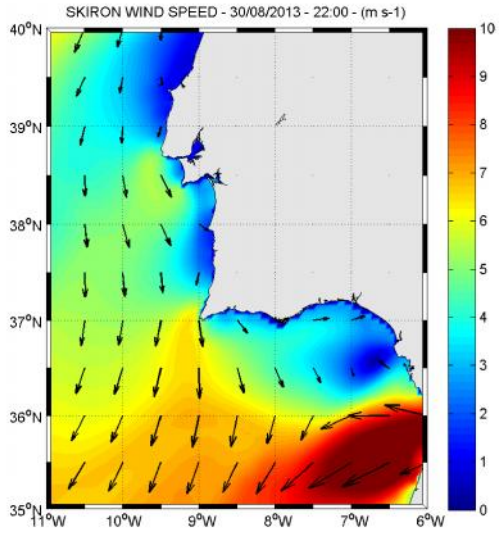
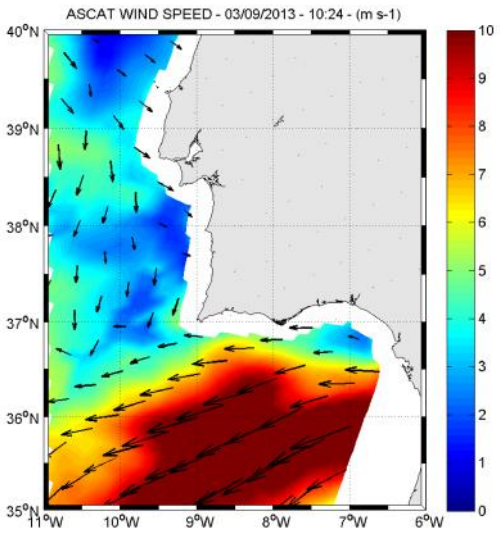
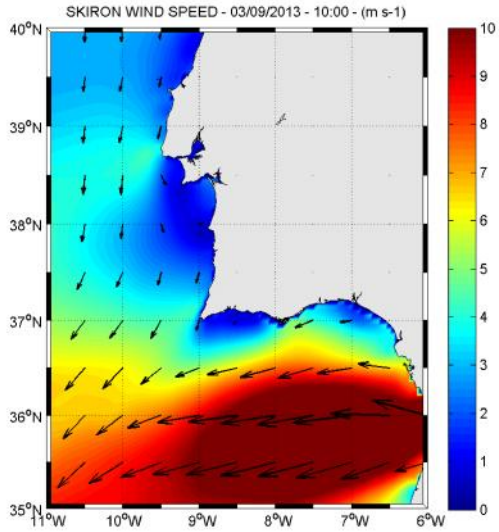
Resultados pré-operacionais

Validação do forçamento: SKIRON vs ASCAT (METOP)



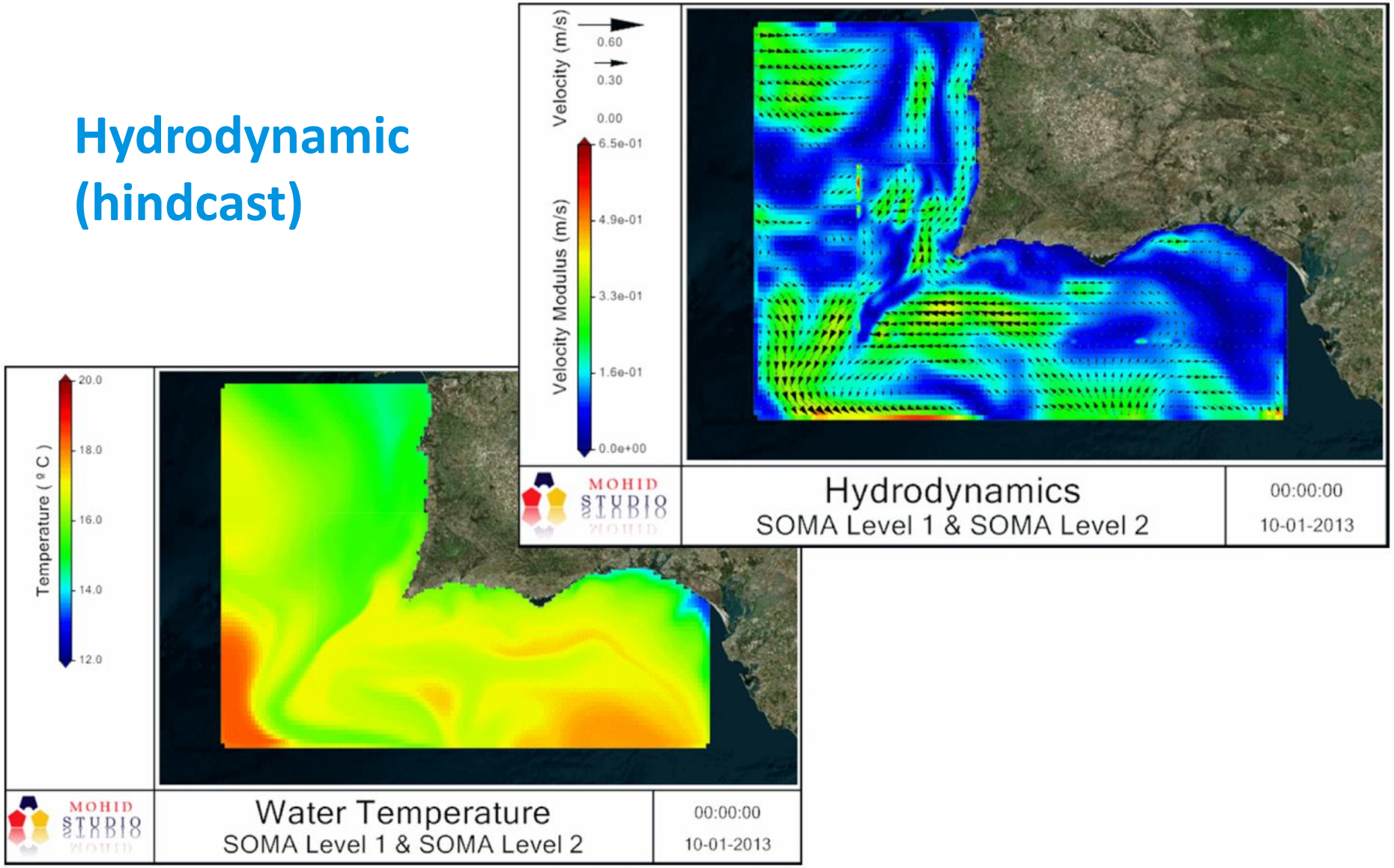




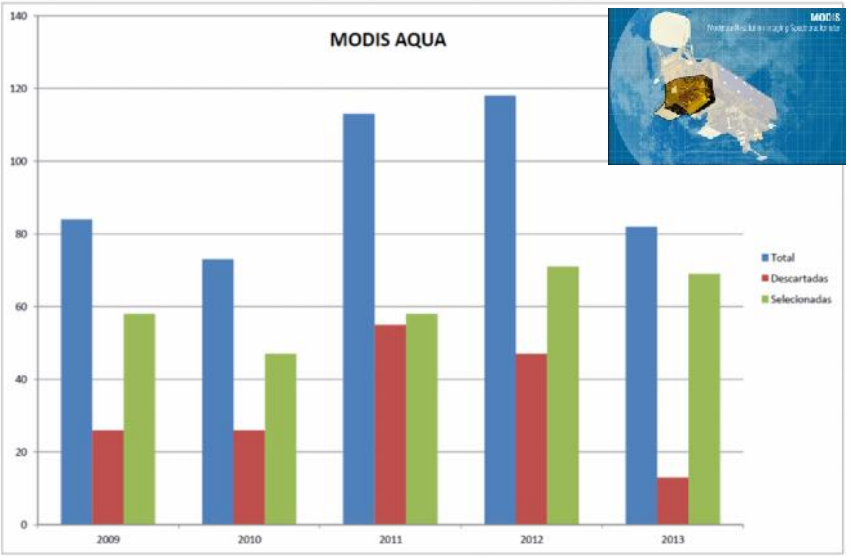


Pre-Operational Results

Hydrodynamic (hindcast)

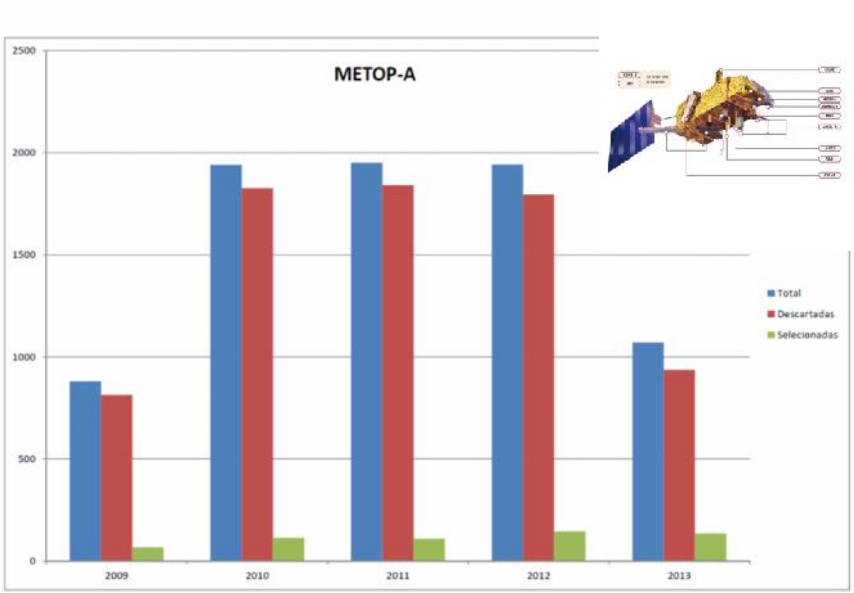


Pre-Operational Results



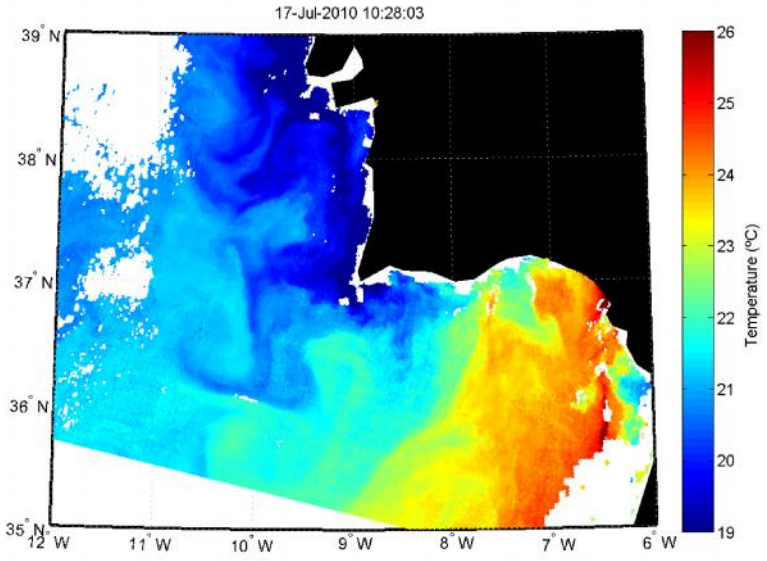
Period: 01/01/2009 – 31/10/2013

- Step 1: Extraction from the world database L2 - Nightime 11 µm (2 Images/day from OceanColor Website)
- Step 2: Visual Selection
- Step 3: Selection and classification of events

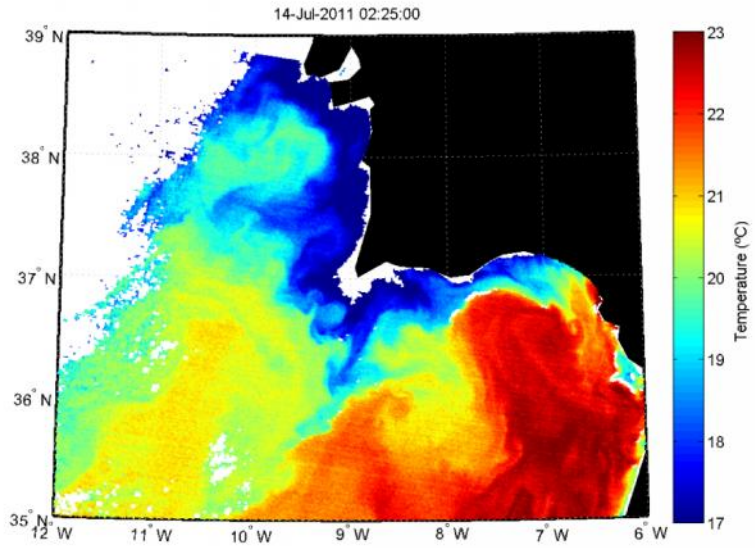


Period: 01/07/2009 – 31/10/2013

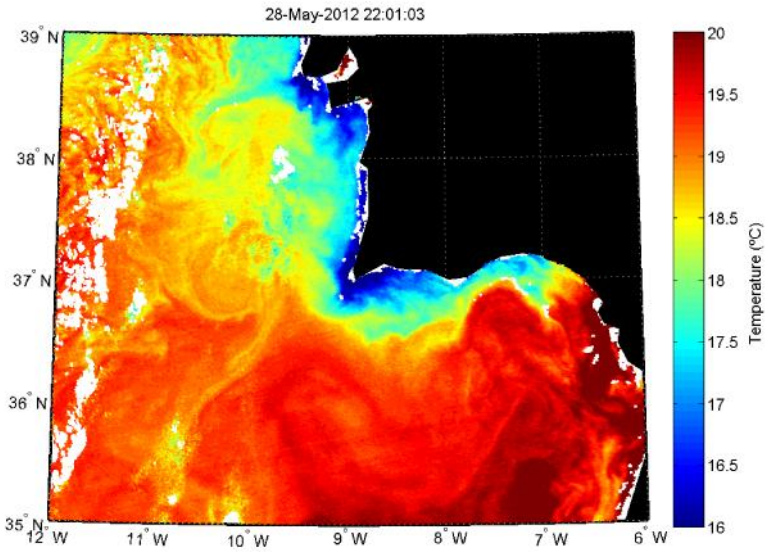
- Step 1: Extraction from the world database (2= sun glint or possible cloud contaminated 480 Image/day with Matlab and Python routines)
- Step 2: Visual Selection
- Step 3: Selection and classification of events



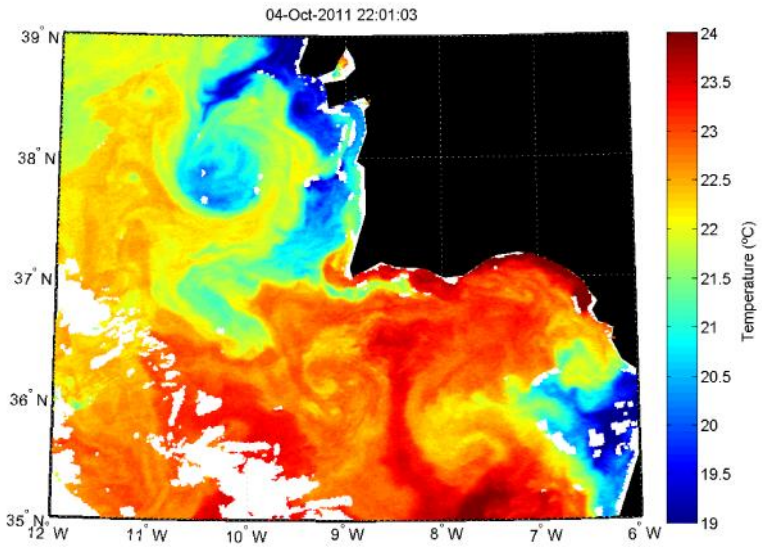
Event Type 1 –Upwelling filament towards West, starting from S.V. Cape



Event Type 2 –Upwelling filament towards South



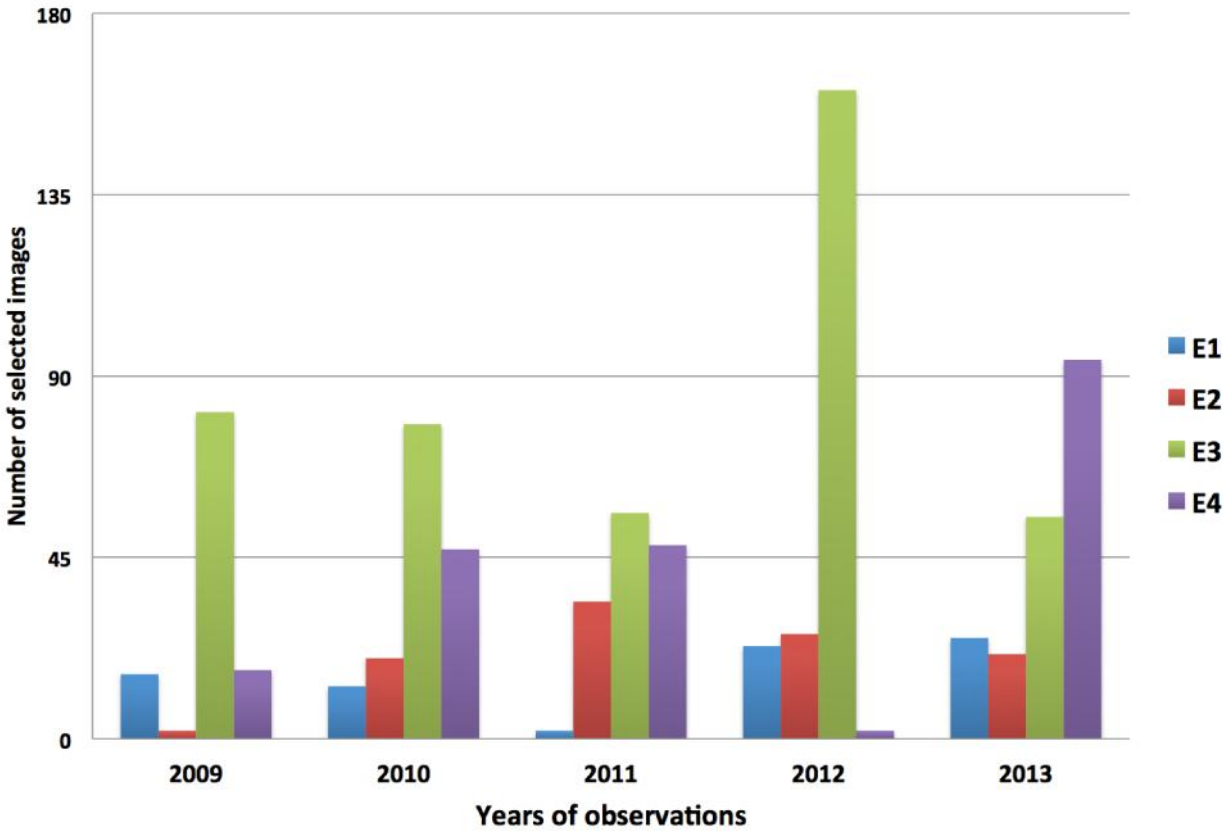
Event Type 3 –Upwelling in the South coast



Event Type 4 –Counter current in the South coast

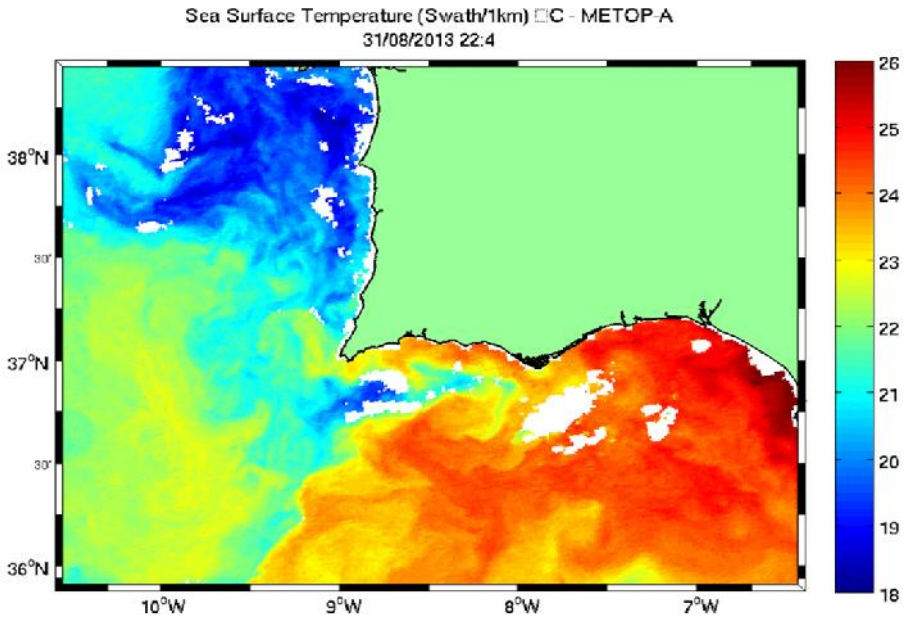
Pre-Operational Results

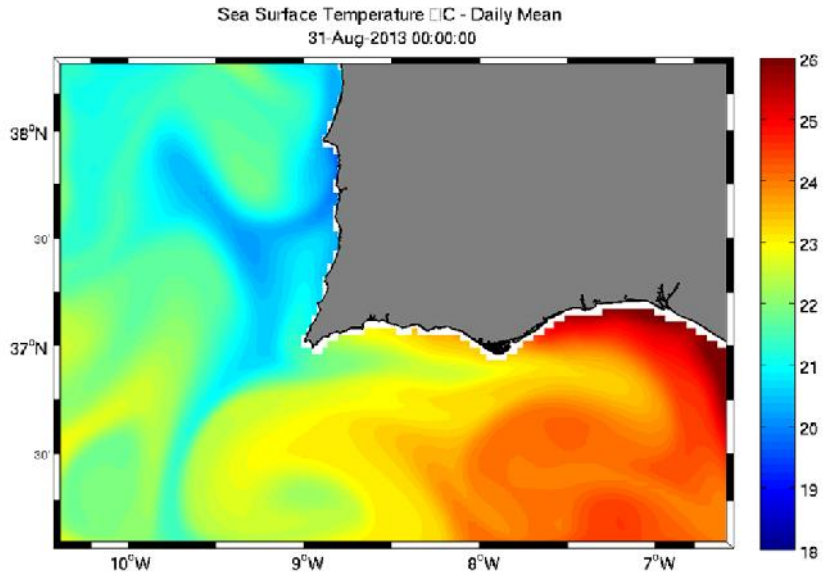
Image classification according to the type of event (METOPO-A)

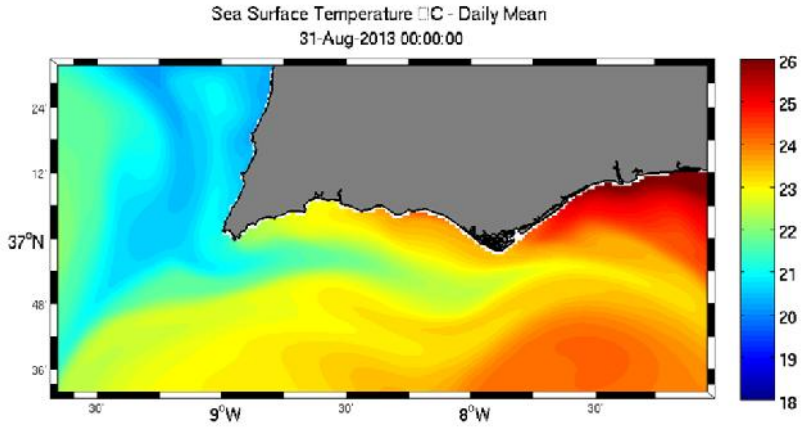


Pre-Operational Results

Surface temperature validation:
METOP-A vs MOHID
(Type 1 event)

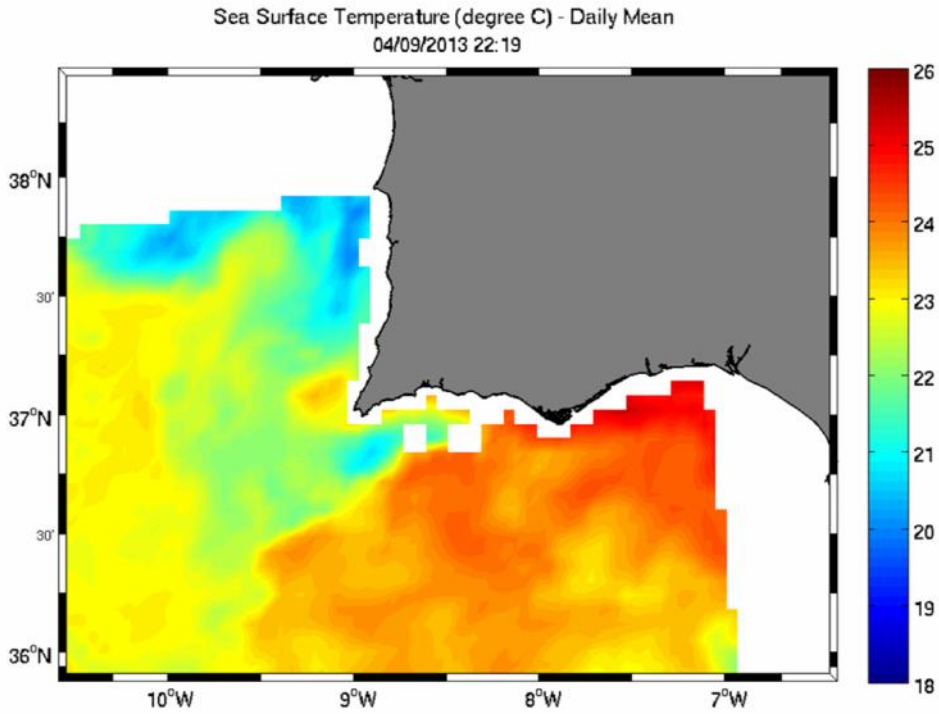


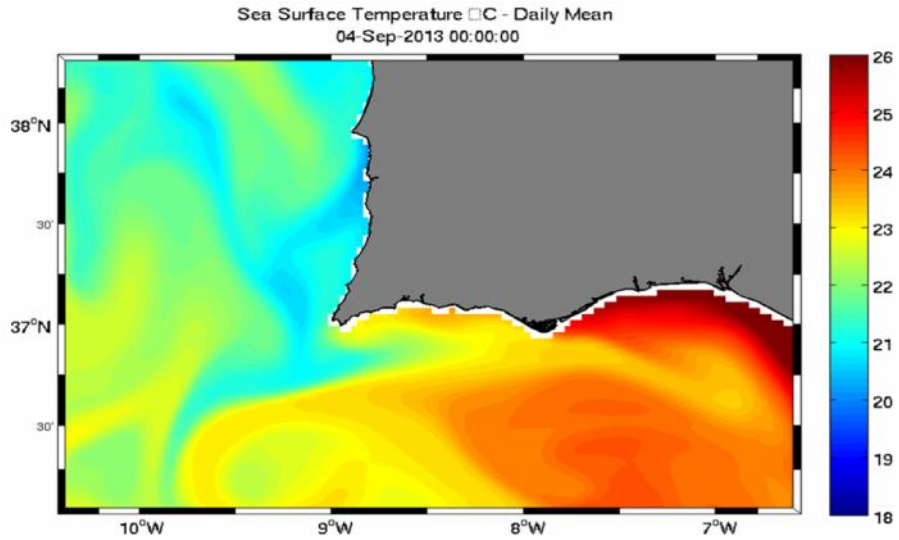


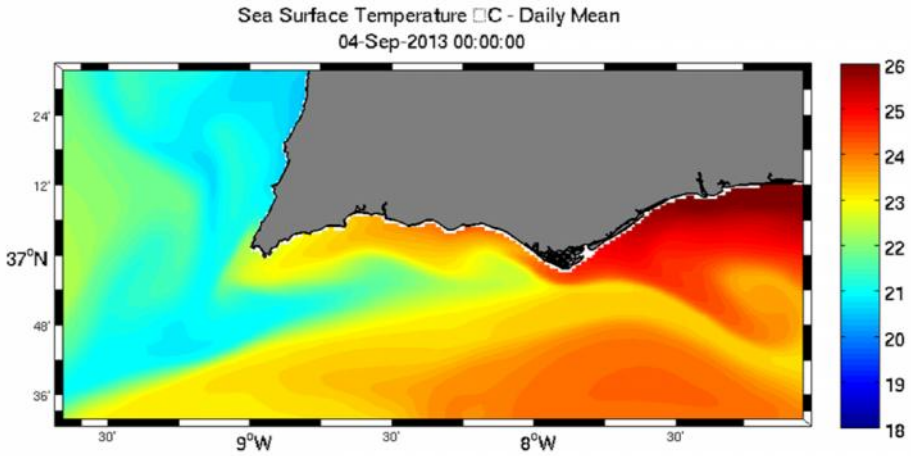


Pre-Operational Results

Surface temperature validation:
METOP-A vs MOHID
(Type 3 event)

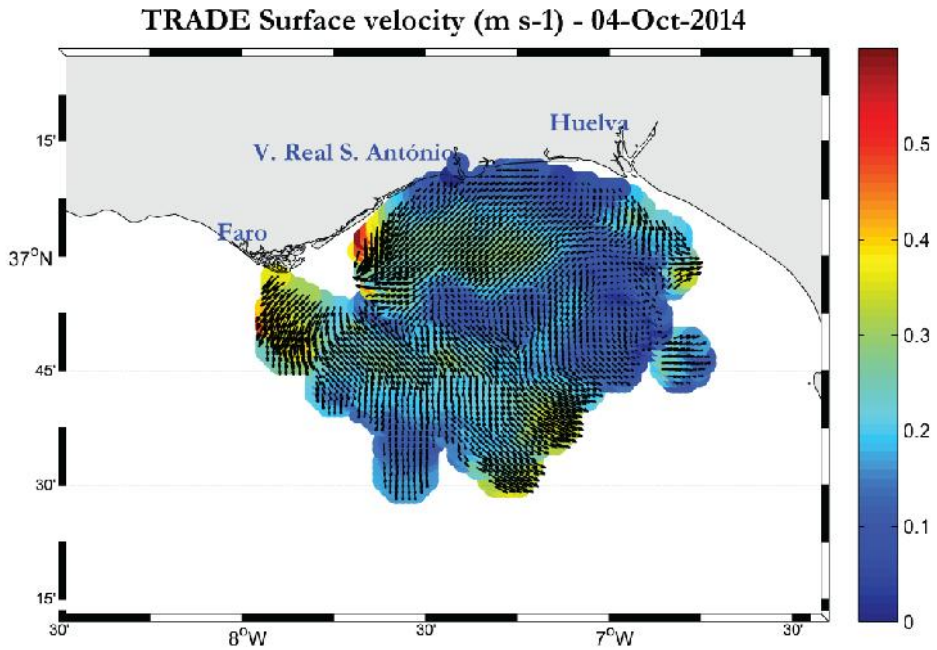


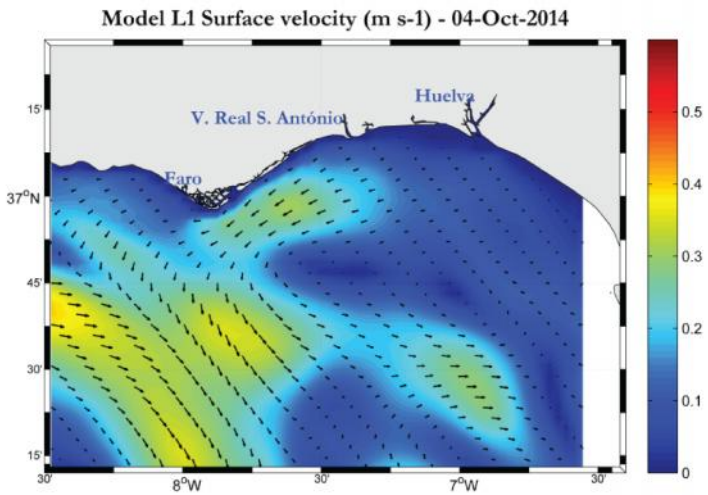


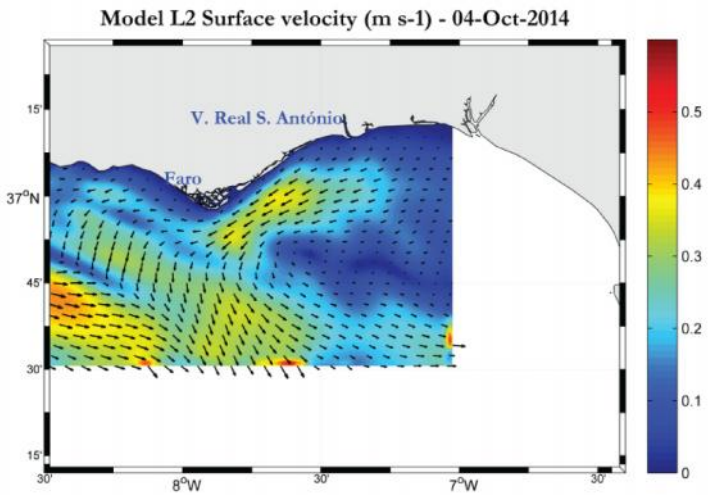


Pre-Operational Results

Surface velocity validation:
CODAR (TRADE) vs MOHID

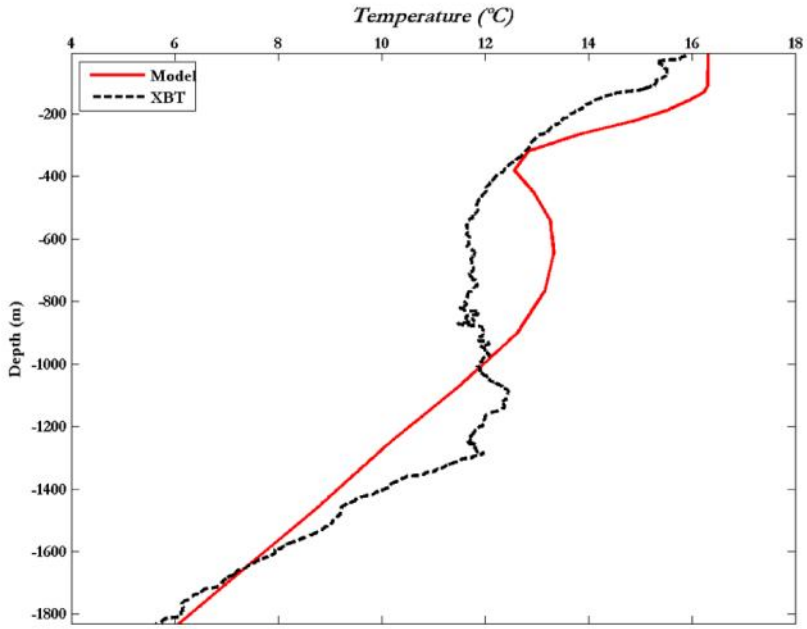


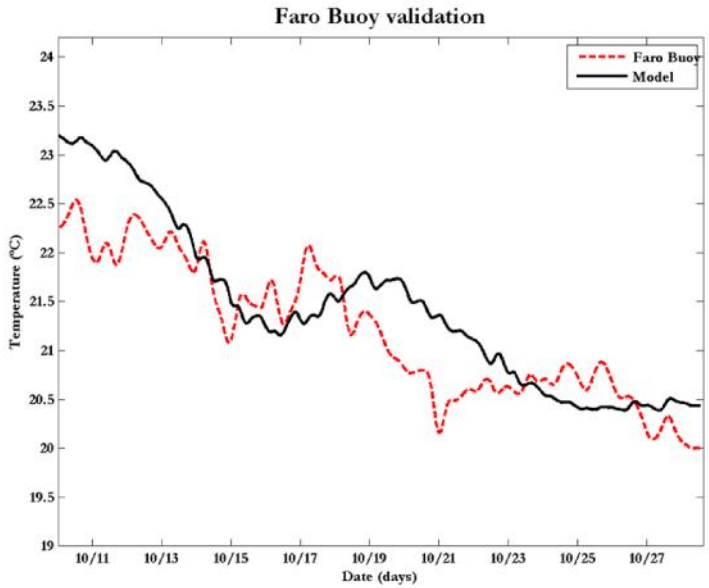


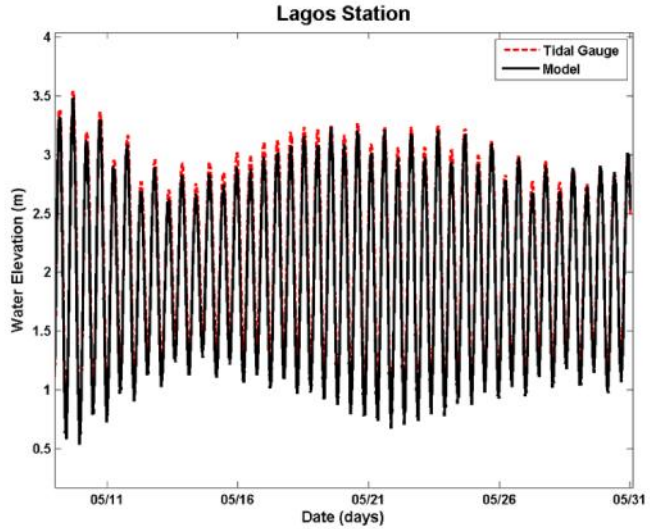


Pre-Operational Results

Validation

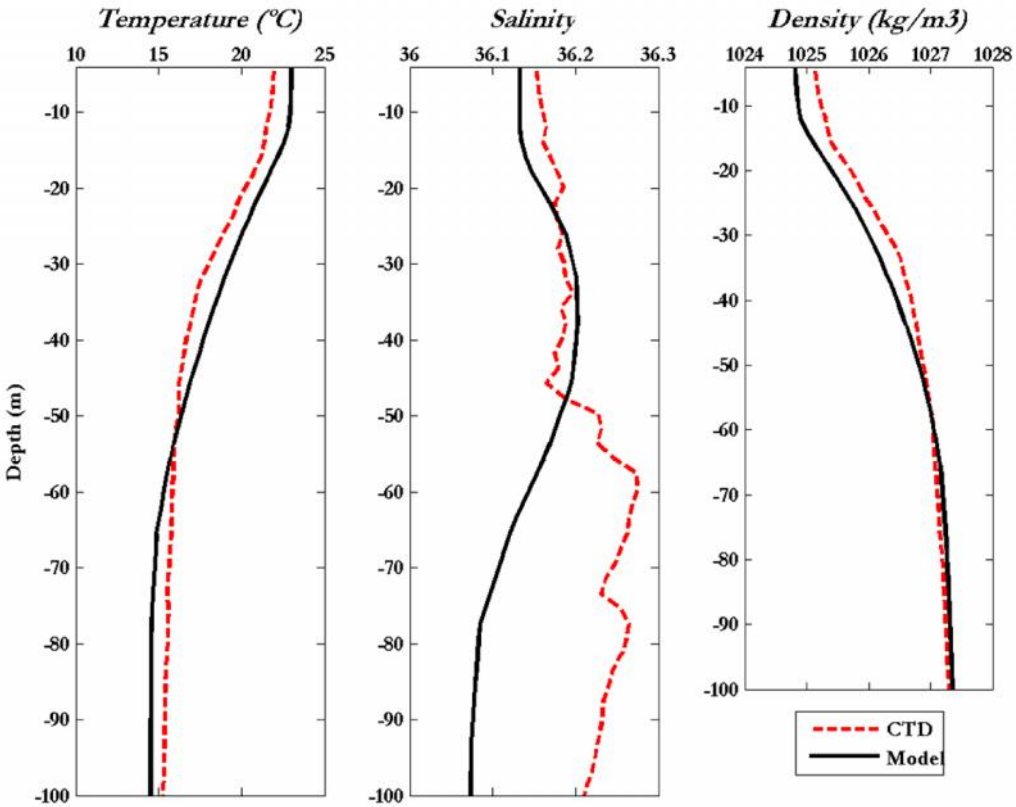


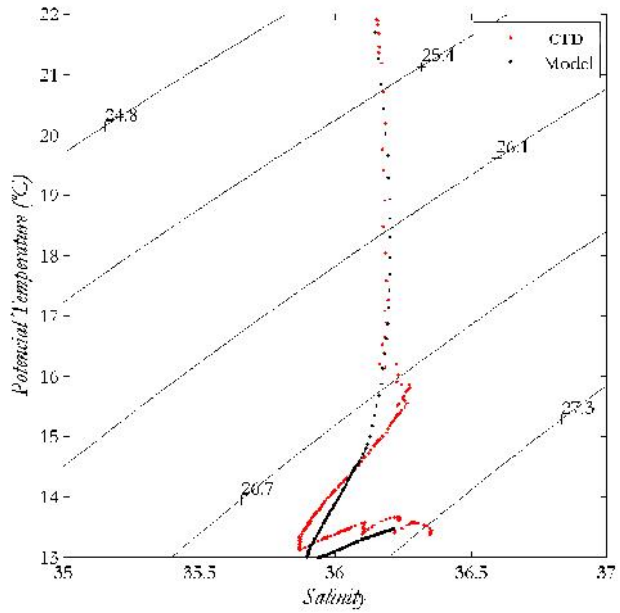




Pre-Operational Results

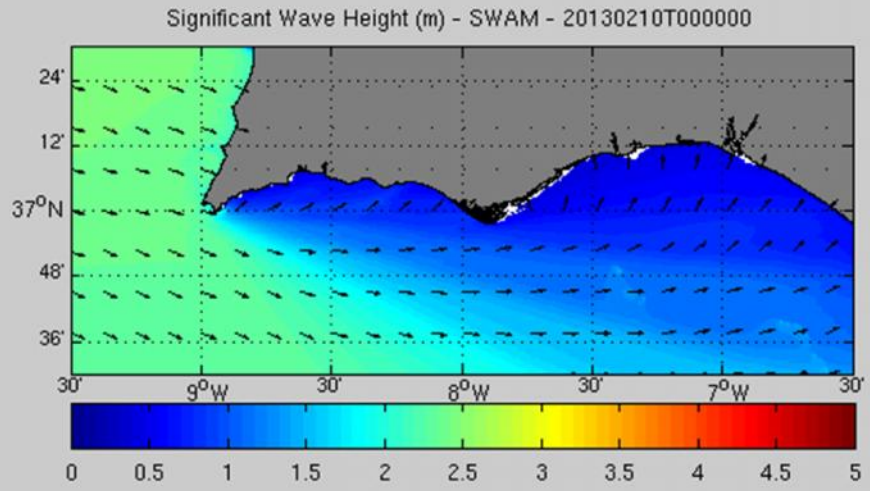
Validation

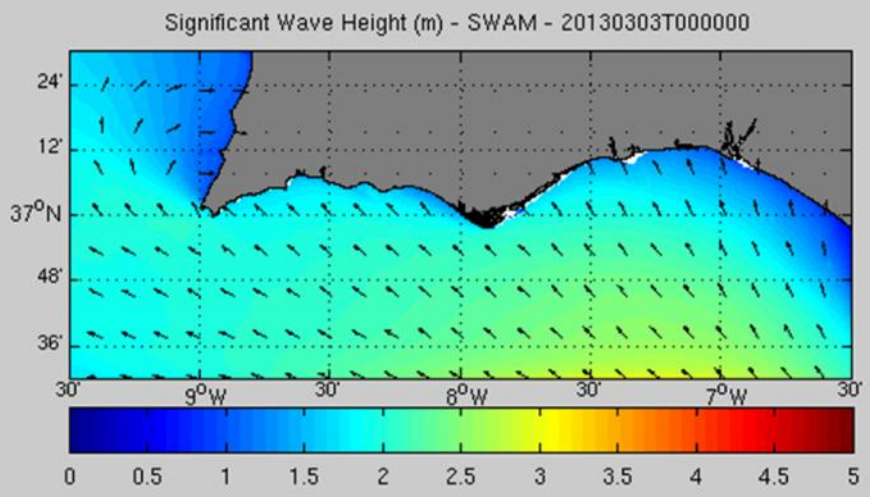




Pre-Operational Results

- Waves, Calm Weather

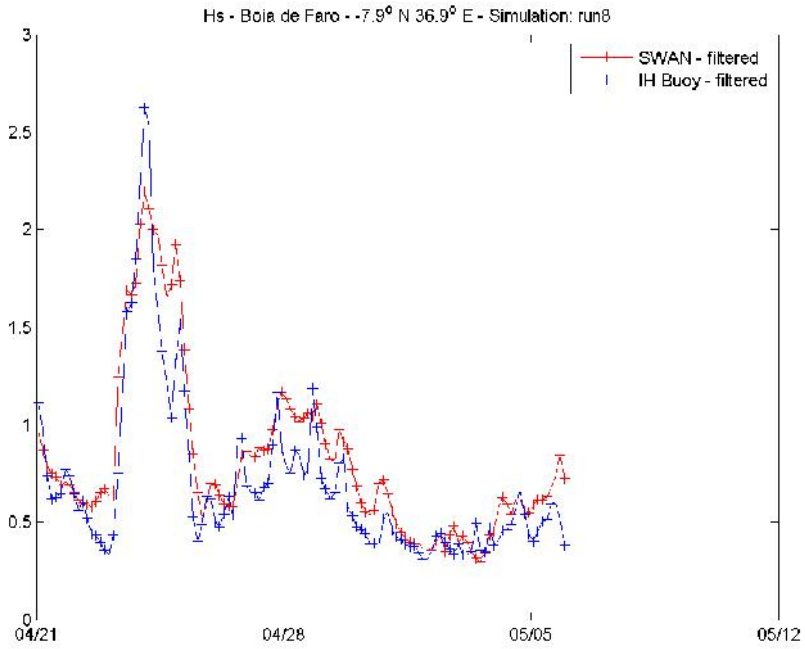


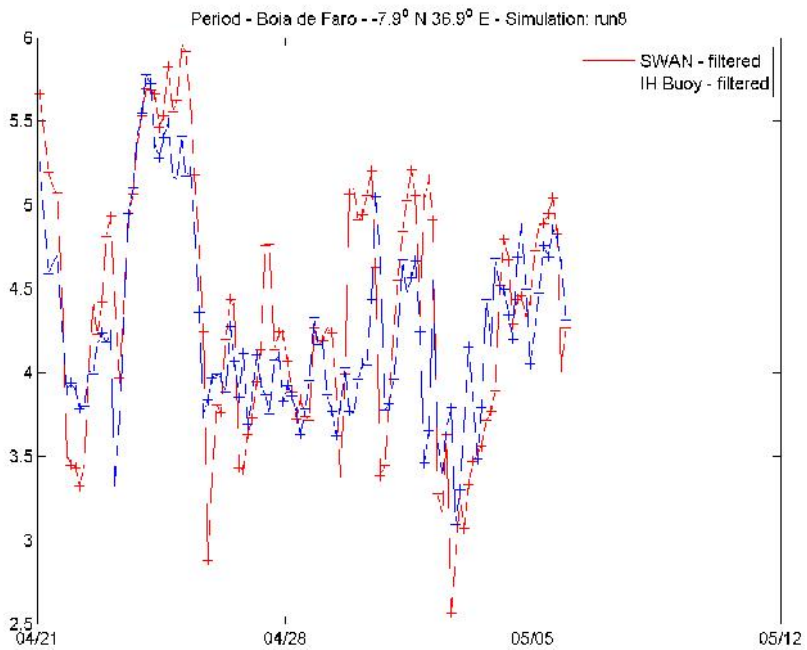


- Waves, Stormy Weather

Pre-Operational Results

- Comparison with the Faro Buoy:
  - Significant Height
    - Corrcoef: 0.924
    - BIAS: -0.116 m
    - RMS: 0.205 m

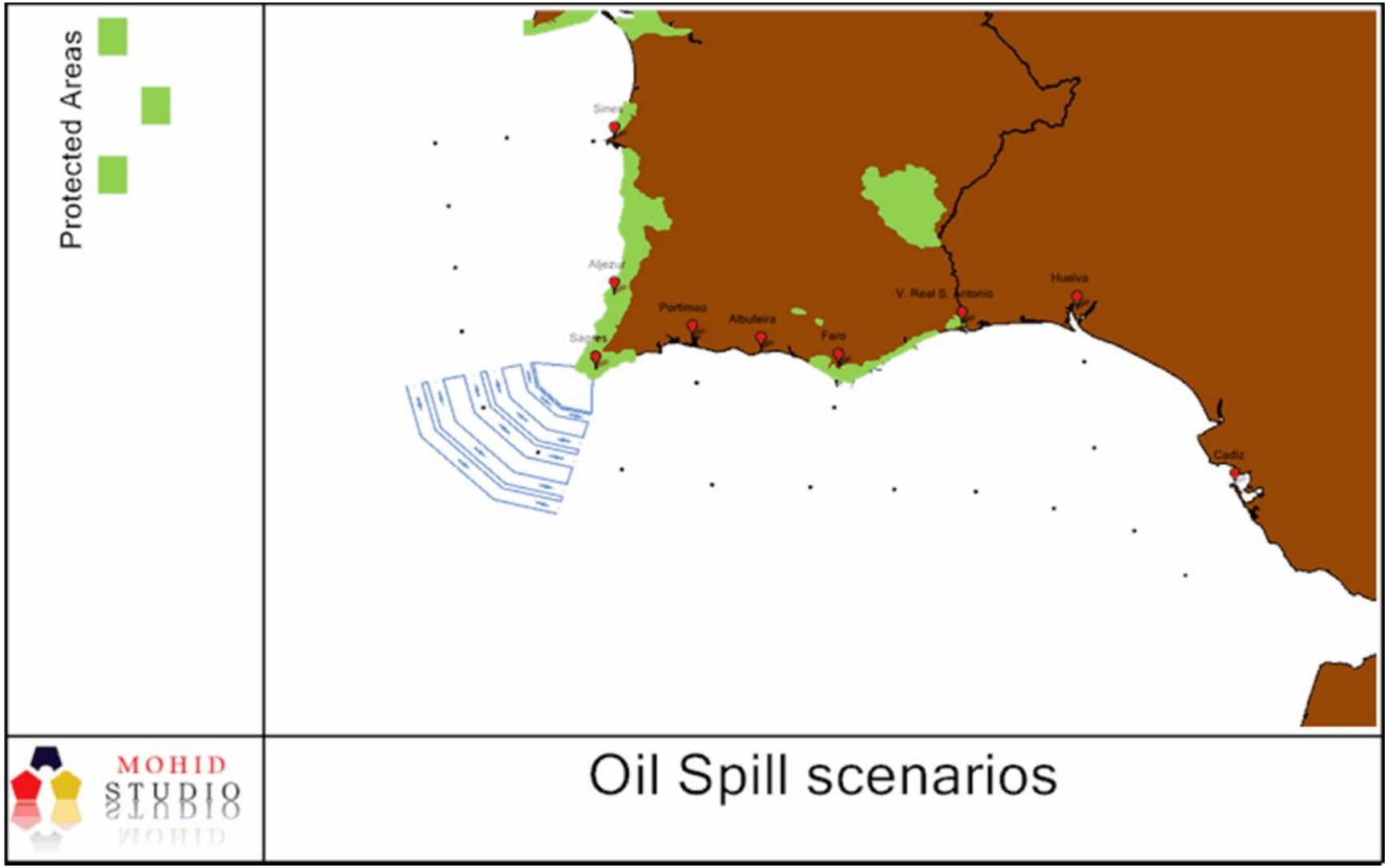




- Period
  - Corrcoef: 0.750
  - BIAS: - 0.120 s
  - RMS: 0.205 s

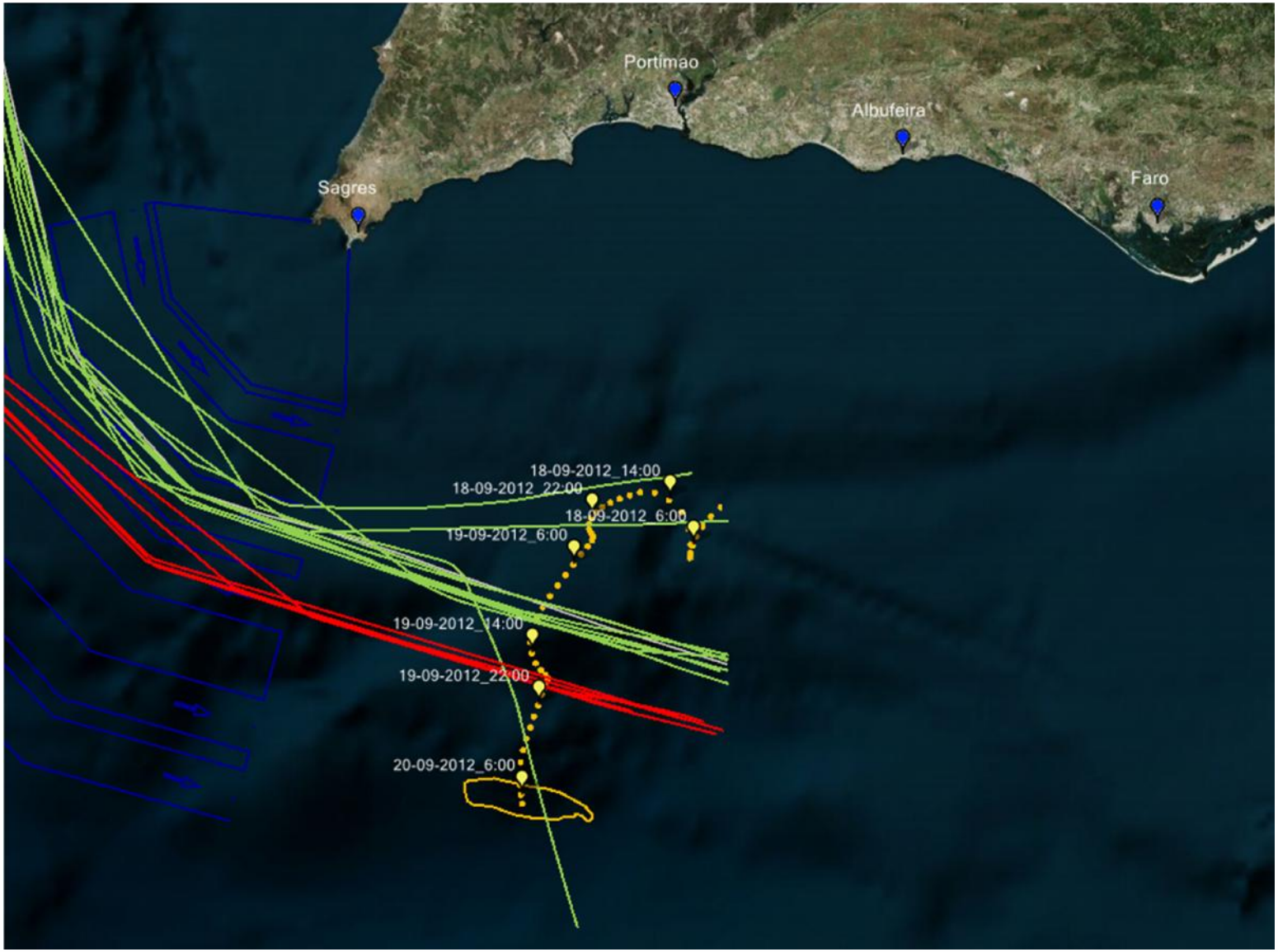
Pre-Operational Results

Oil Spill Risk Assessment



Pre-Operational Results

Oil Spill Detection and Law Enforcement

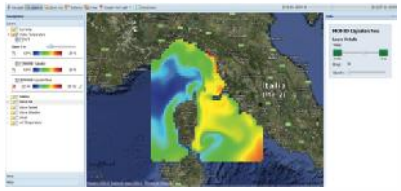


Needs (Operationalization)

- Purchasing & Maintenance of data acquisition systems;

- Purchasing & Maintenance of servers and models;

- Development & Maintenance of web interfaces;

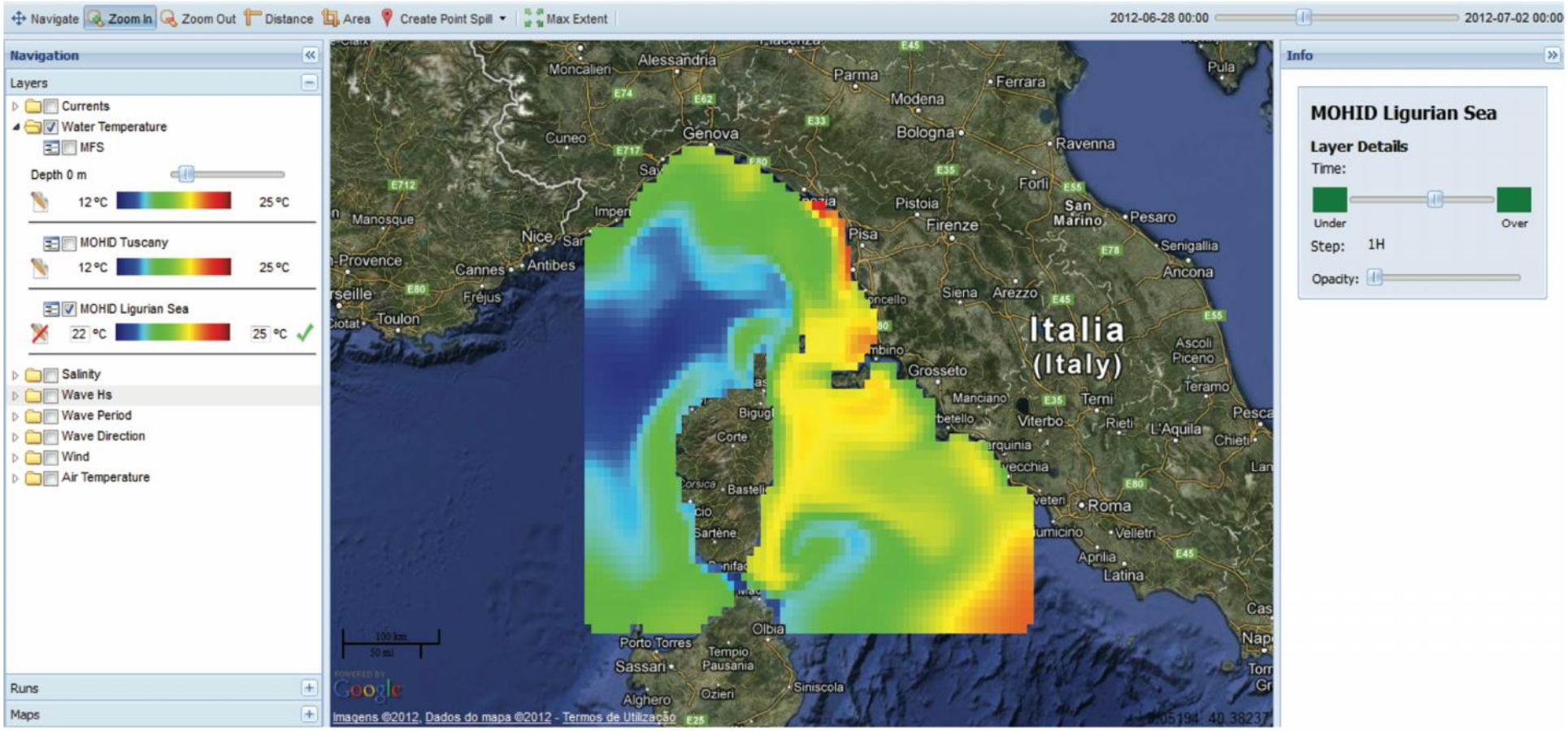


- End-User feedback;

Needs (Operationalization)

ARGOMARINE

Operational Modeling system



Applications for a smart port strategy

- Efficient planning of port traffic
- Reduction of fuel consumption
- Environmental impact of port activities
  - Hydrocarbon leakages
  - Ballast waters discharges
- Emergency planning
- Accident support
  - Oil spill contention support
  - Debris and container dynamics

General Applications (products)

Marine recreational activities

- Water temperature;
- Ocean currents/wind speed;
- Wave height & period;
- Water quality and visibility;

Marine safety

- Ocean currents/wind speed;
- Wave height & period;
- Lagrangian tracers;

Fisheries & Aquaculture

- Ocean currents;
- Water temperature;
- Water salinity;
- Water quality;

General Applications (products)

Marine Pollution

- Ocean currents/wind speed;
- Water temperature and salinity;
- Wave parameters;
- Lagrangian tracers;

Marine and Coastal management

- Ocean currents/wind speed;
- Water temperature and salinity;
- Water quality;
- Wave parameters;
- Sediment transport;
- Lagrangian tracers;

Research & Data Valorisation

- All results produced by the system have research interest and can be used by innovative companies to develop new products/services.

Conclusions

- **Modelling concepts are now mature.**
- **Research needed in the linkage to specific applications for ports**
- **Research needed for fast response systems and interfaces**
- **Good potential for the development of new innovative and transversal products and services.**
- **Need to make the system operational through a integrated network.**
- **Need to maintain the system in the future by creating a exploitation model for it.**

Thank You