MOHID

Water Modelling System

The Portuguese Forecasting System

Instituto Superior Técnico
Lisbon - Portugal

Guillaume Riflet, POL workshop, 22nd – 24th October, Mallorca

Contents

- The portuguese in the ECOOP framework
- Observation system
- Regional forecasting systems
- Local models

Who we are

MARETEC – Instituto Superior Técnico, Lisbon

Research unit specialized in the numerical modeling of marine systems

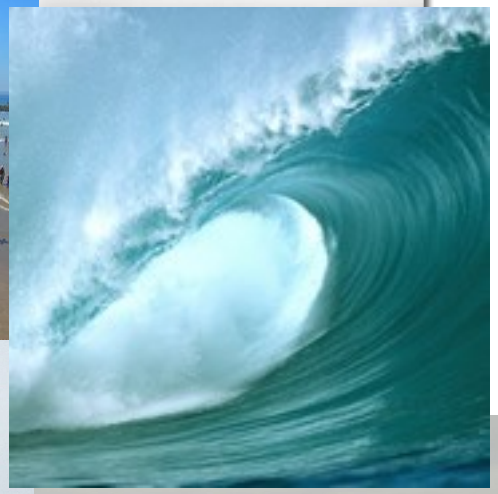
Who we are

Development of a forecasting tool of the marine environment

- Universidade Técnica de Lisboa
- Universidade de Coimbra
- Universidade do Algarve

Who are the end-users?

- Bathing and recreation
- Navigation
- Fisheries
- Aquaculture
- Human occupation
- Industry and agriculture
- Energy
- The natural ecosystem

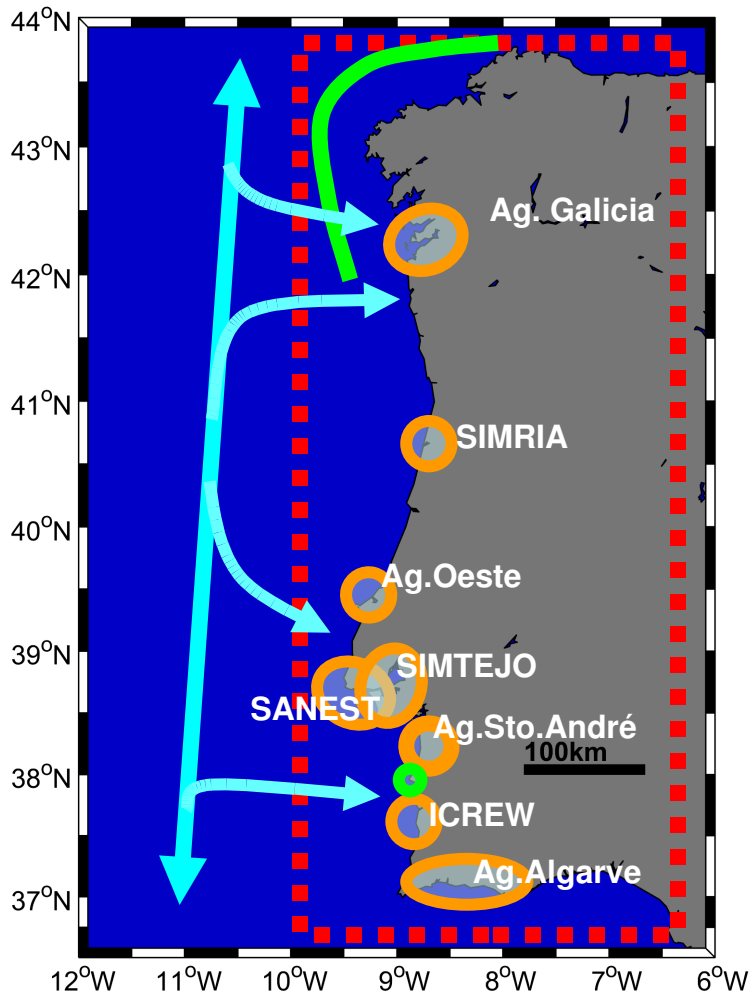

Overview

Waste waters

Pollutant dispersion/Oil spills

Navigation (debris, containers, people)

Monitoring (eutrophication, HAB's)

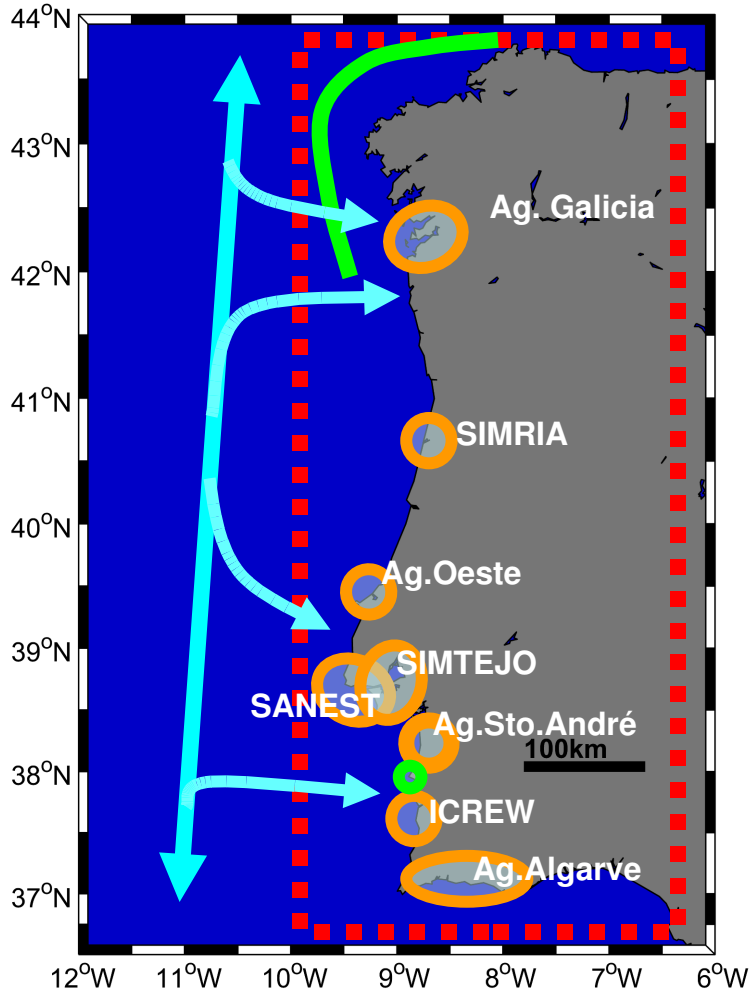


Objectives

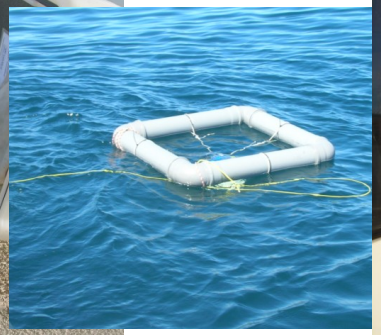
Build coastal management products for end-users

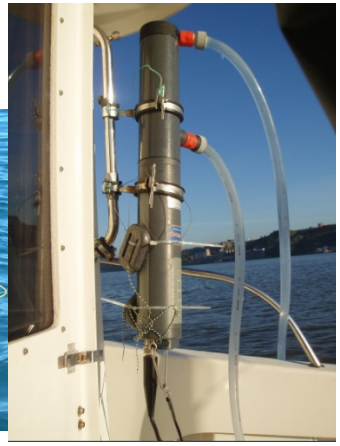
National authorities, institutes, public and private companies, researchers

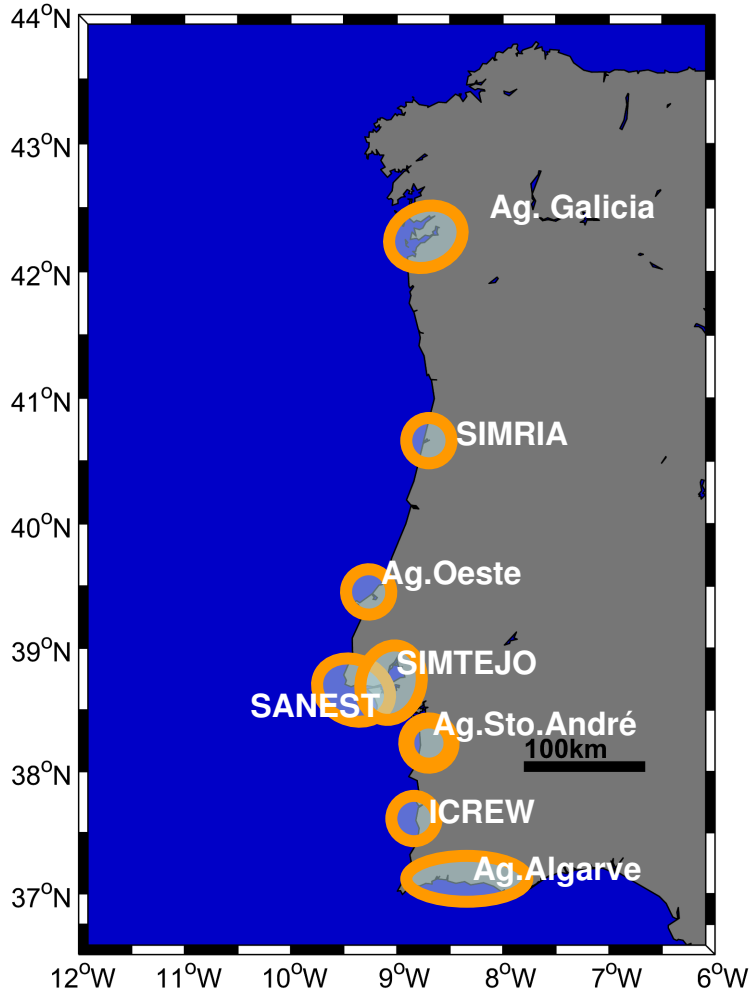
Regional and mostly local applications



Observation – field data

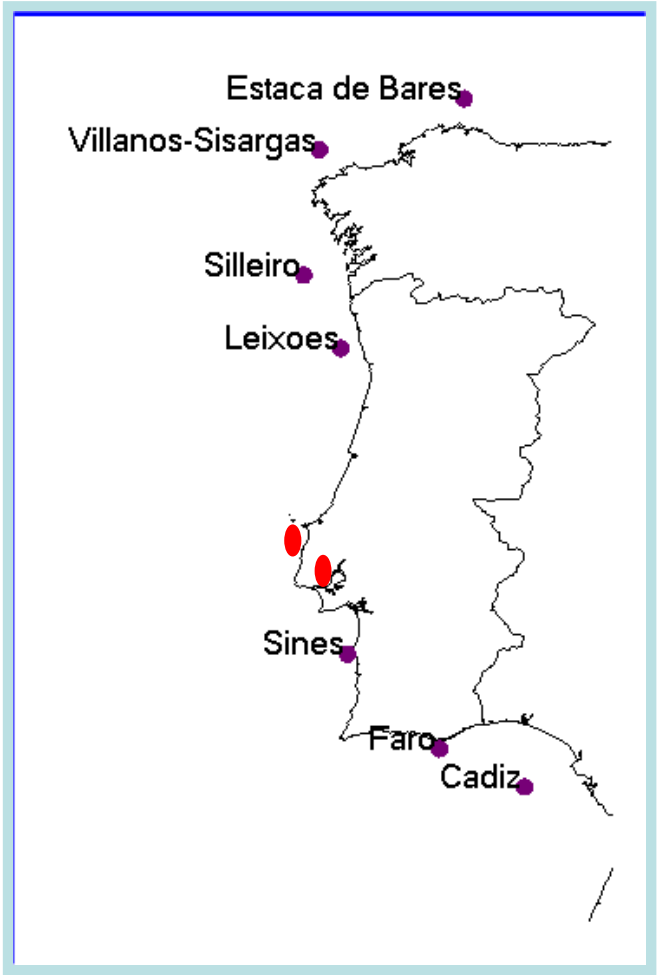




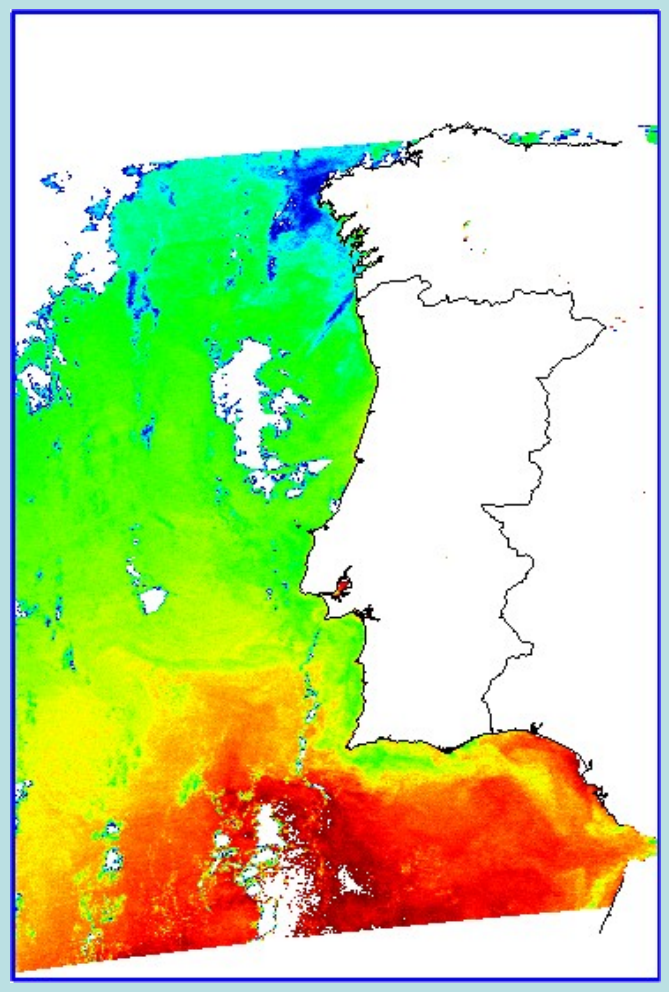


Observation – stations, buoys

- Instituto Hidrográfico buoys which are setup in harbours (Lisbon, Sines, Leixões, Oporto) that provide waves direction and intensity;
- Meteorological stations (Guia de Cascais, Nazaré);
- Buoys which measure freshwater inputs (Tagus, Mondego, Guadiana, INAG data);



Observation – remote-sensing data

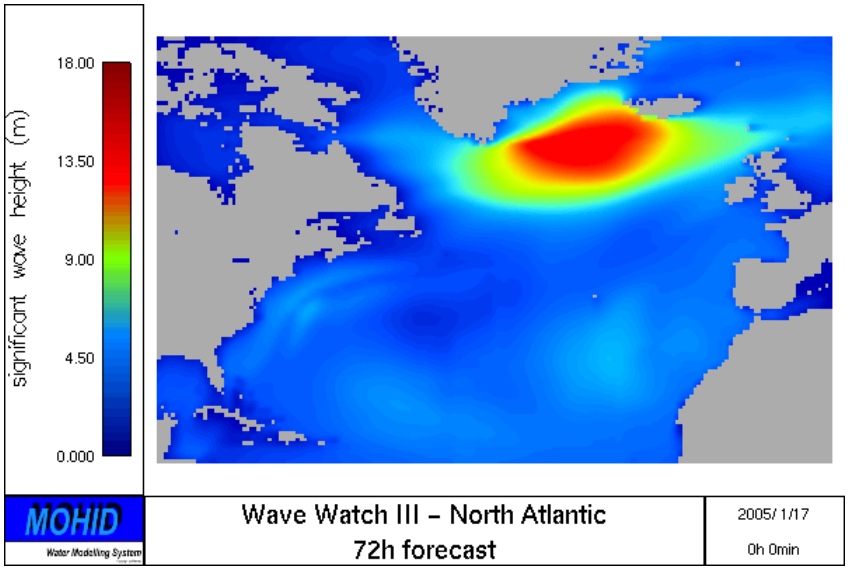


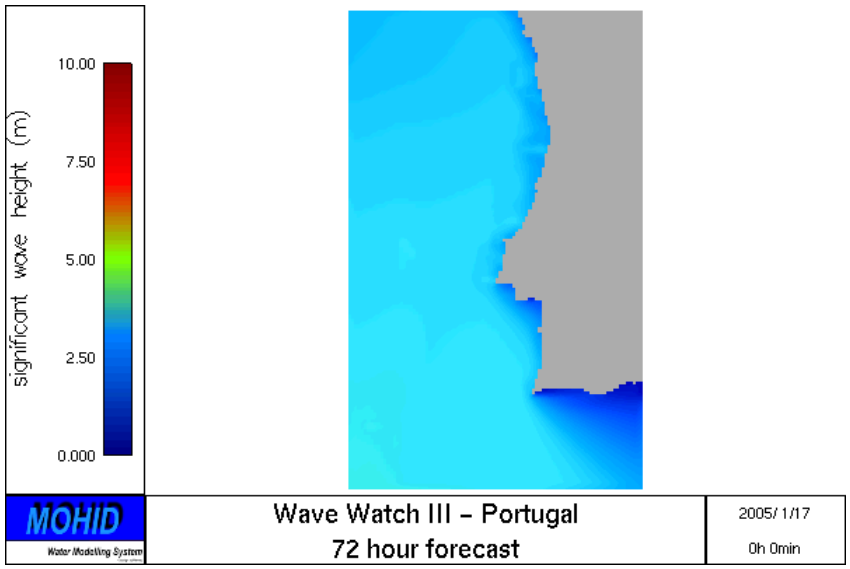
- MODIS
- SeaWifs

Regional scale models

Local models need regional models

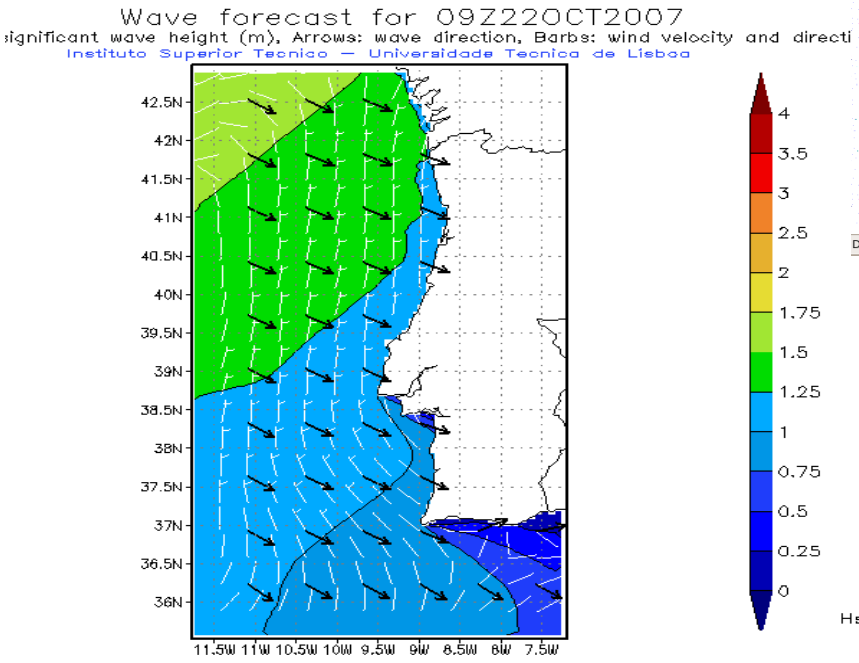
- ocean and atmospheric circulation
- waves

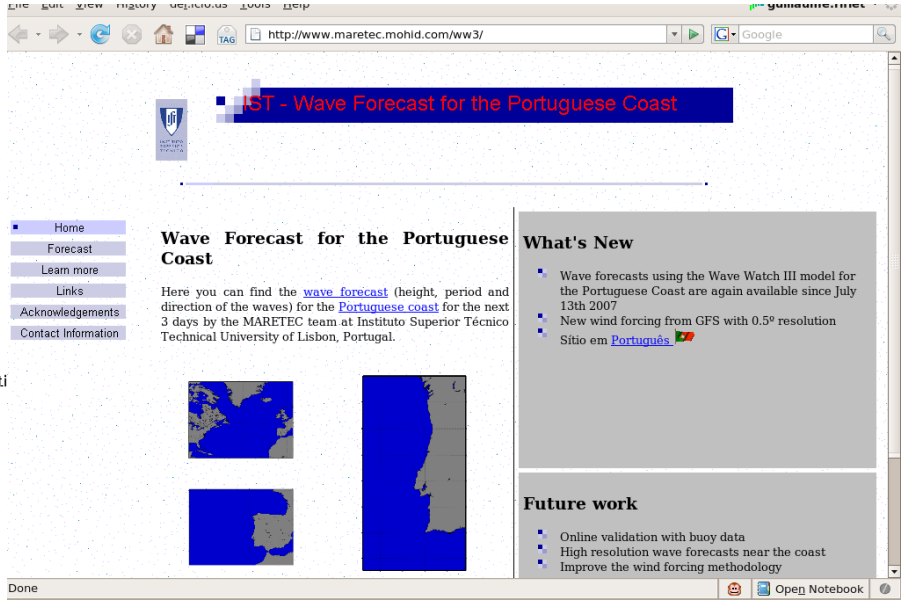




Regional scale models

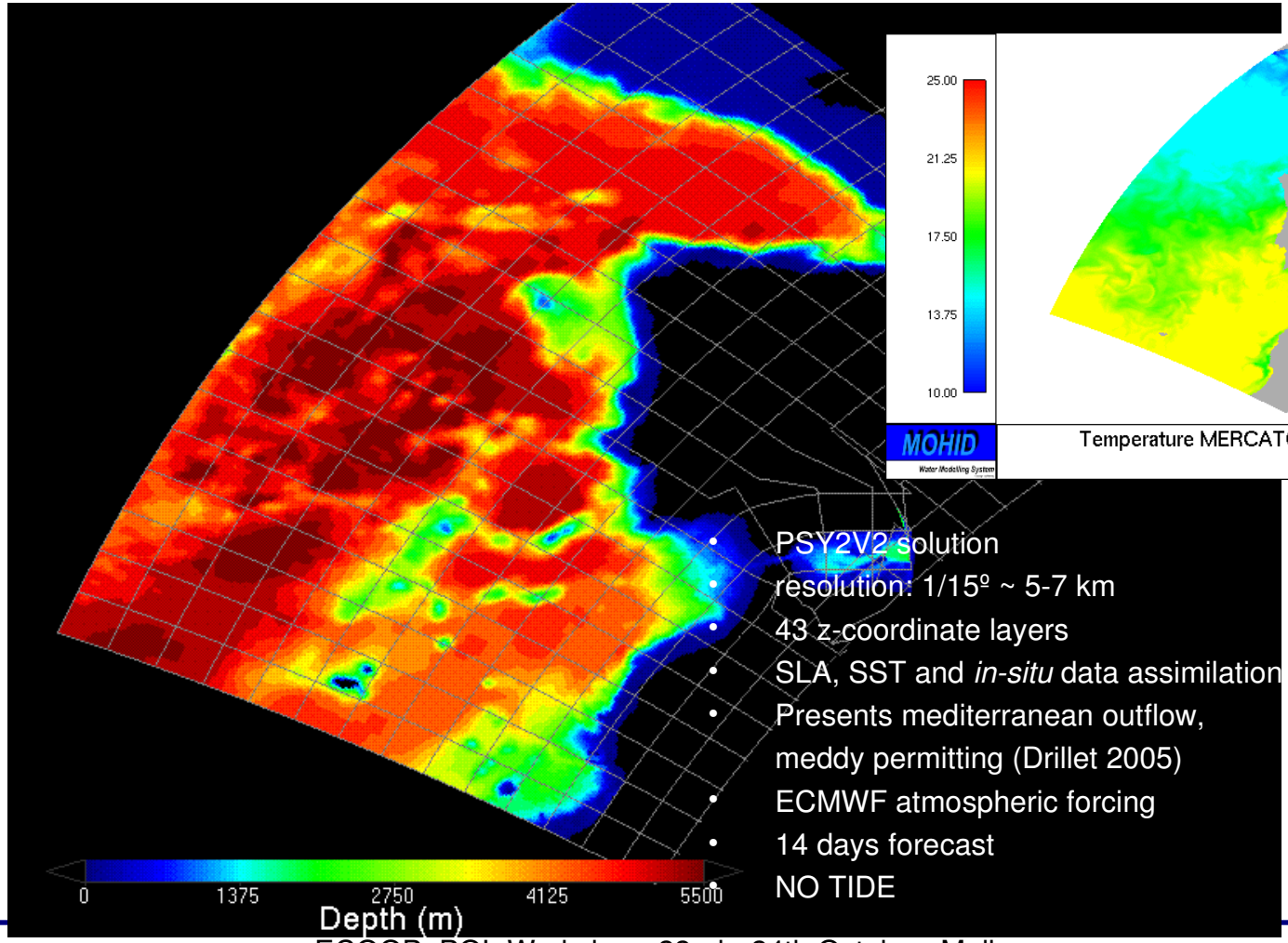
Wave model WW3, 3 day forecast.
objective: couple to swan into local models - harbours.





Regional scale models

Hydrodynamical operational modeling of portuguese coast.



- PSY2V2 solution
- resolution: 1/15º ~ 5-7 km
- 43 z-coordinate layers
- SLA, SST and *in-situ* data assimilation
- Presents mediterranean outflow, meddy permitting (Drillet 2005)
- ECMWF atmospheric forcing
- 14 days forecast
- NO TIDE

Regional scale models

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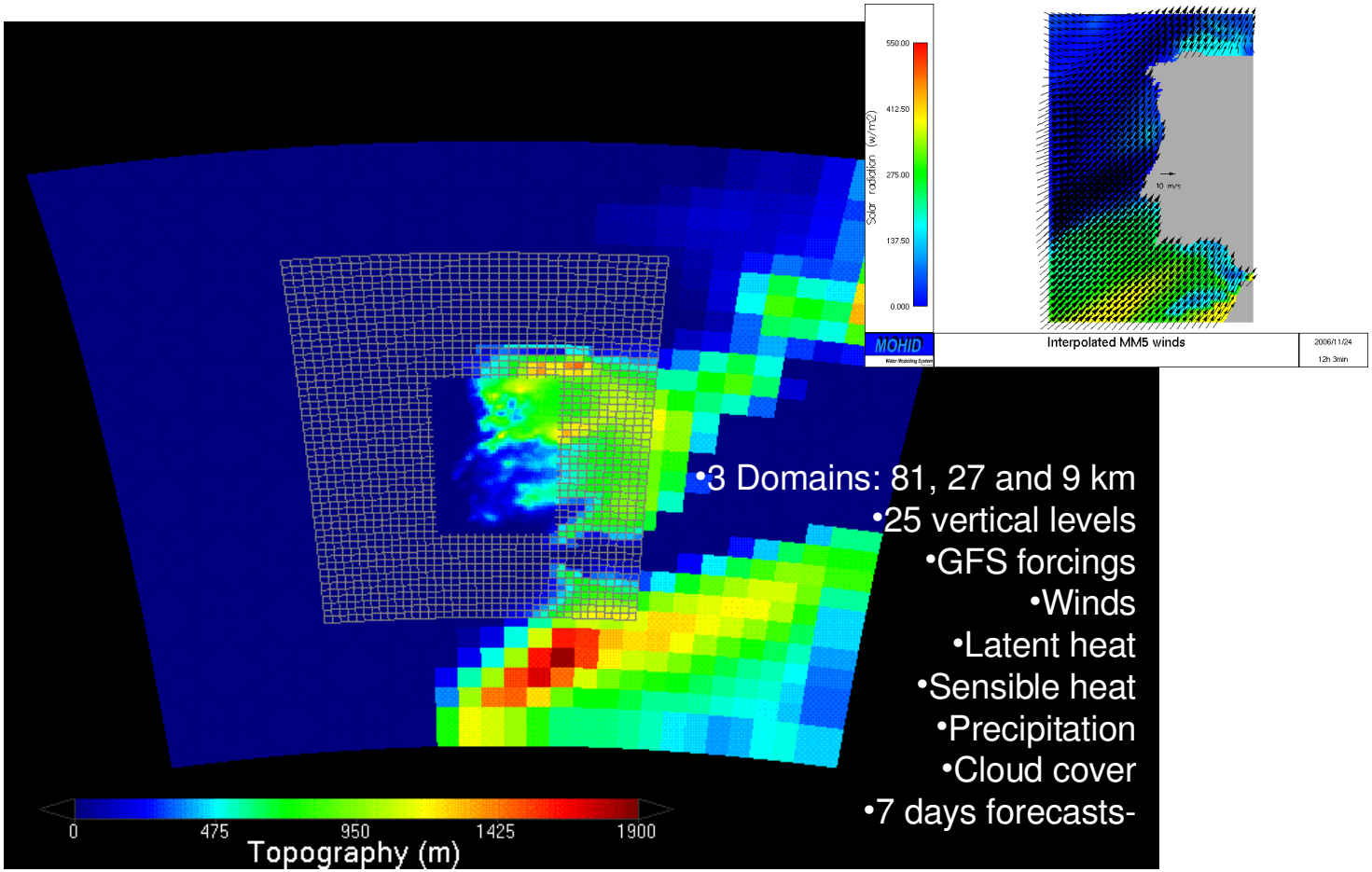

Regional scale models

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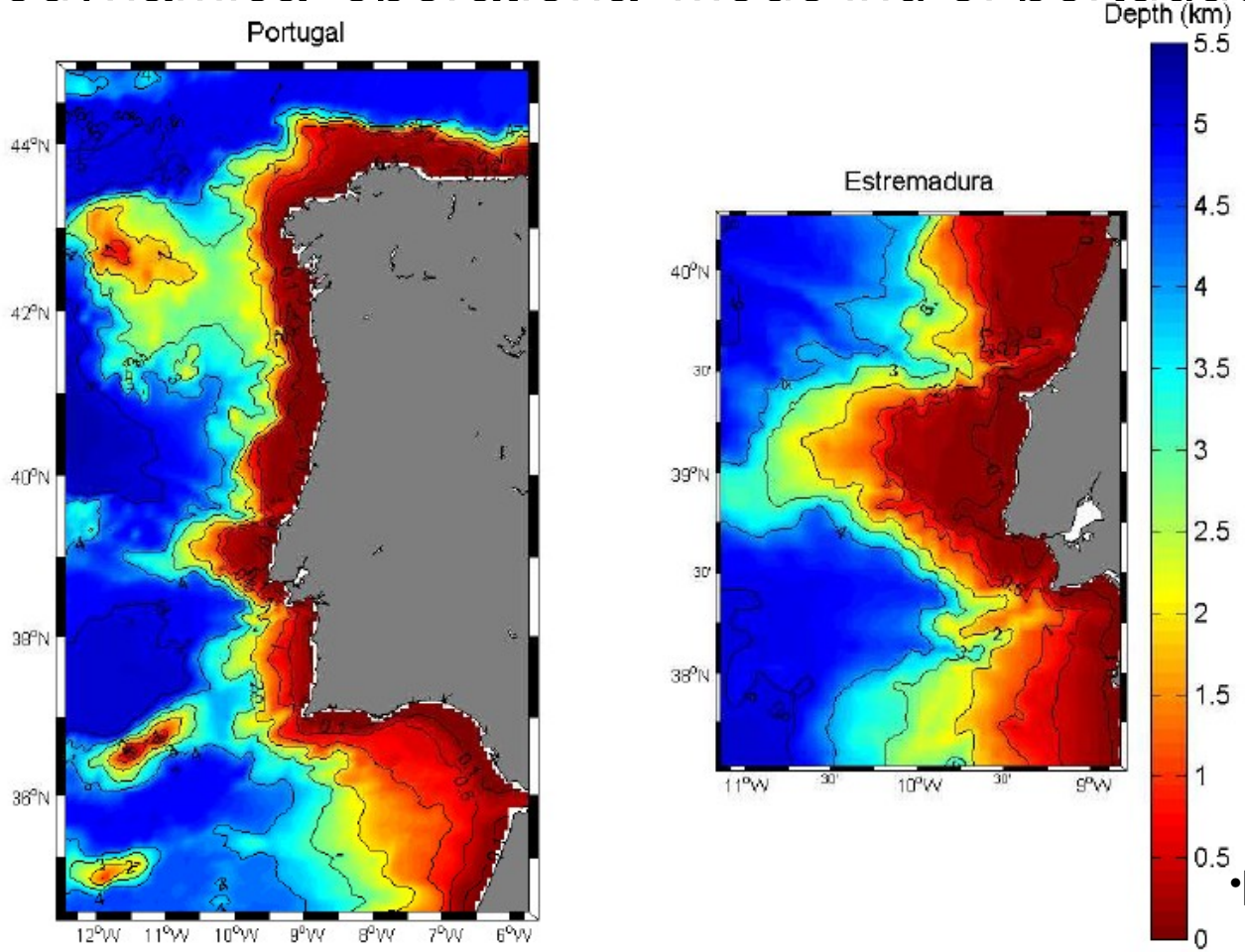
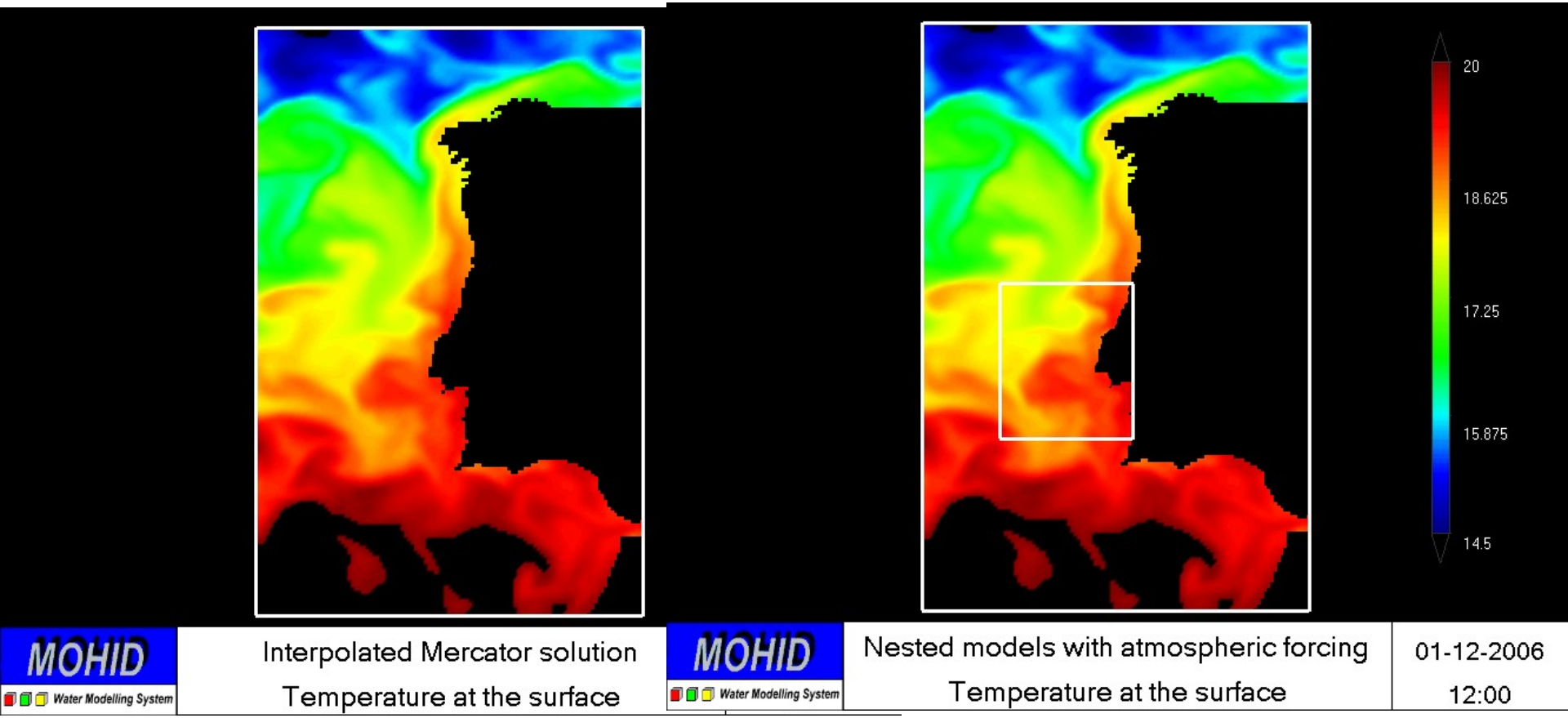


- One 2D domain (for recreating tide)
- Two 3D Domains: 0.06º and 0.02º
- 42 layers
- ETOPO2' baseline data interpolation
- 2D and 3D [-12.6º, -5.5º]Ex[34.4º 45º]N
- [-11.2º, -8.8º]Ex[37.5º 40.3º]N

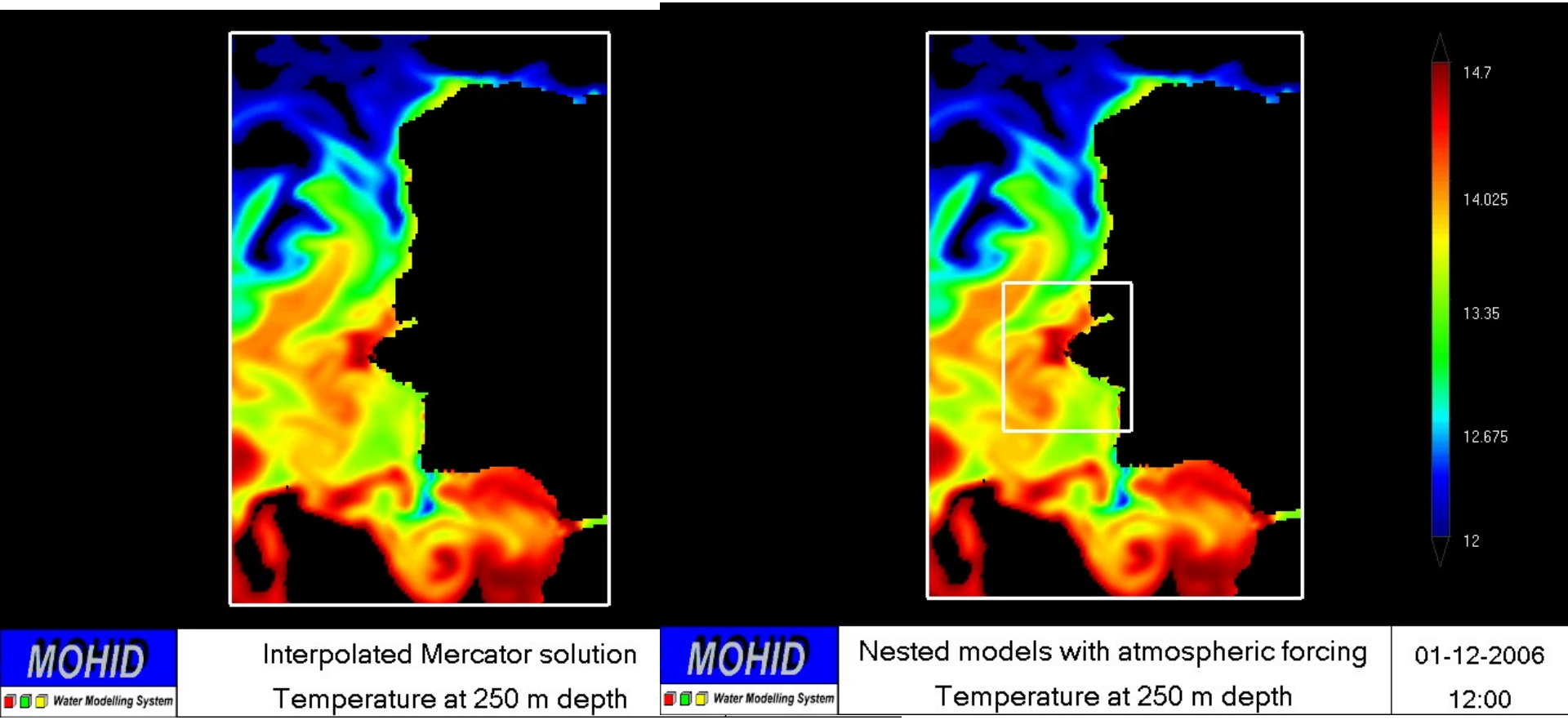
Regional scale models

Hydrodynamical operational modeling of portuguese coast.



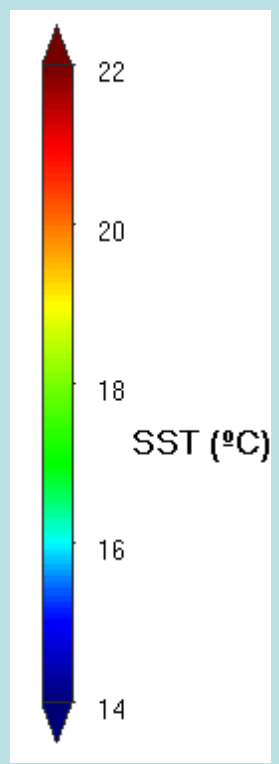
Regional scale models

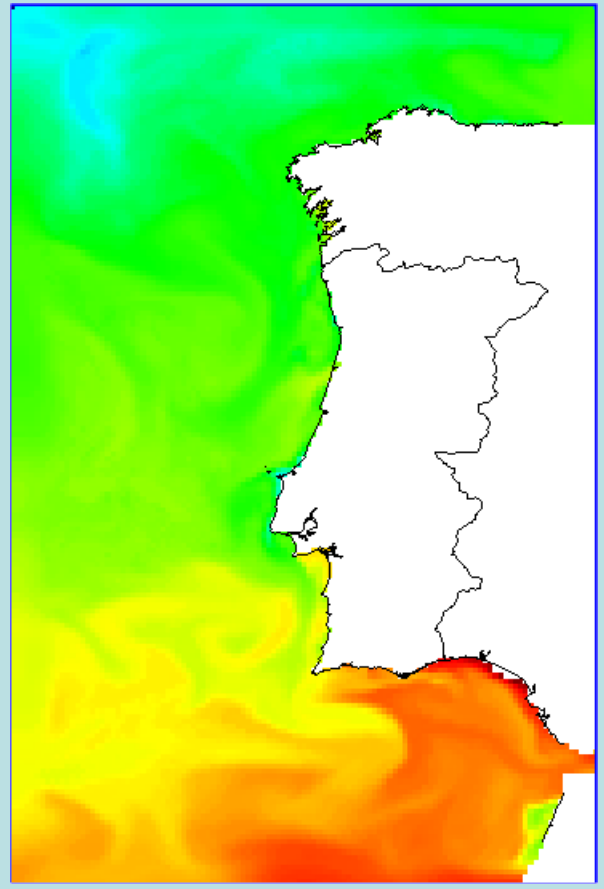
Hydrodynamical operational modeling of portuguese coast.



Remote sensing comparison

9 June 2007





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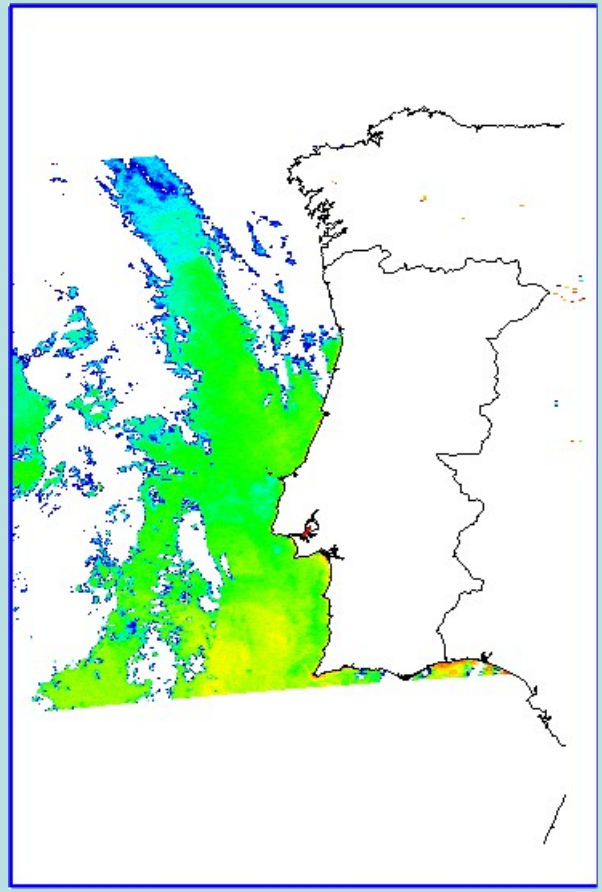
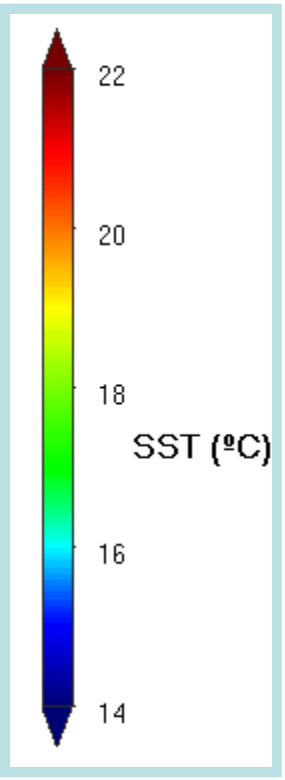
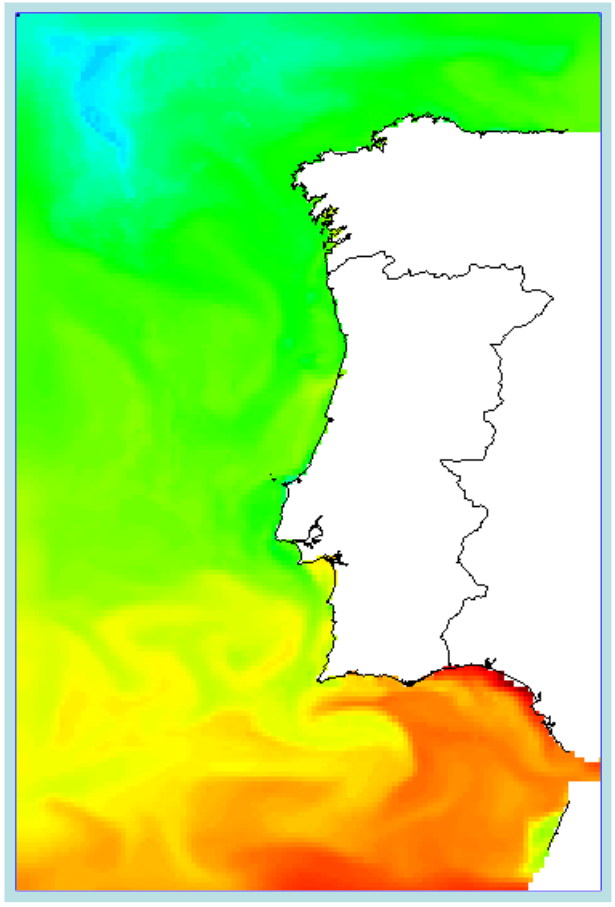


MODIS

Remote sensing comparison

10 June 2007





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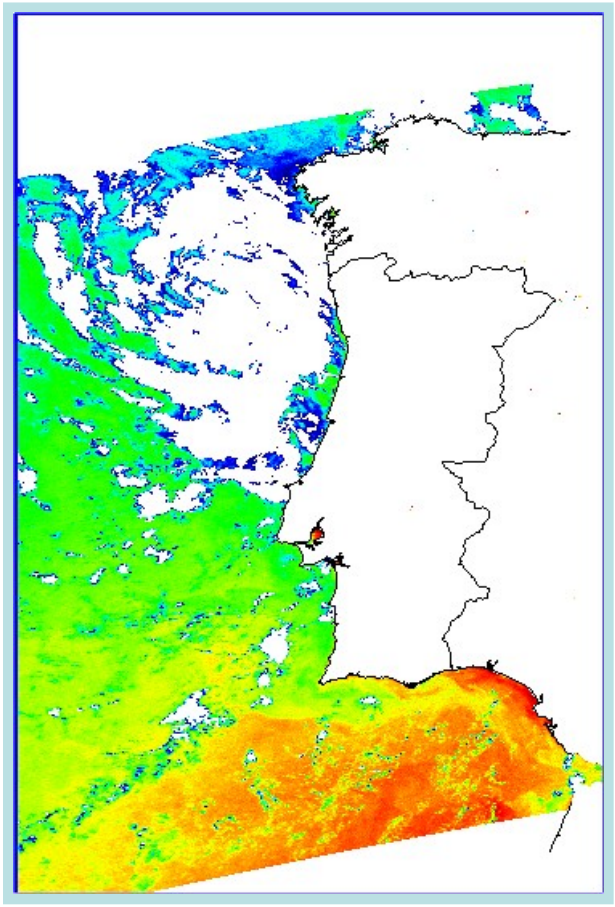
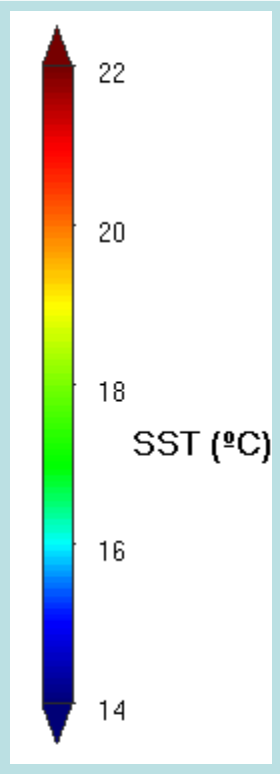
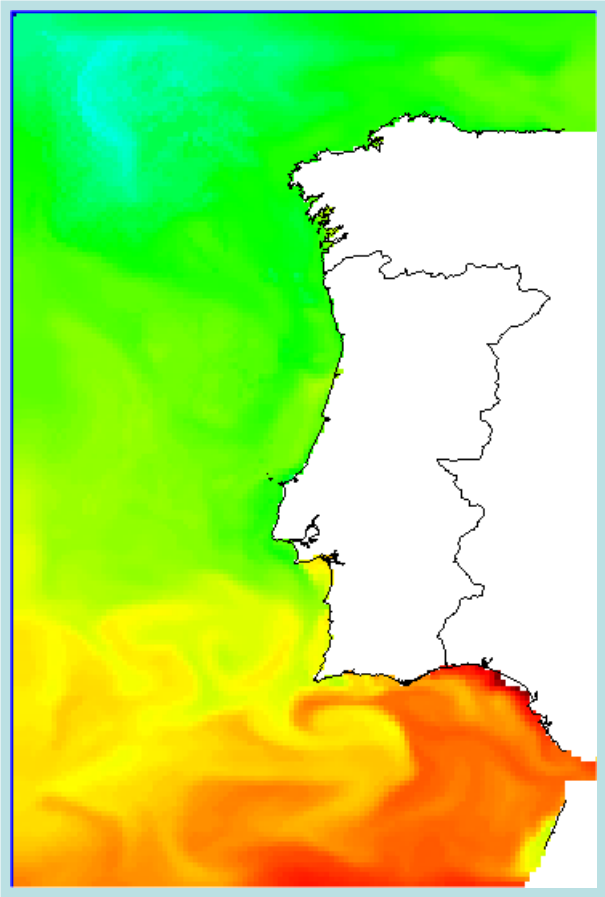


MODIS

Remote sensing comparison

11 June 2007





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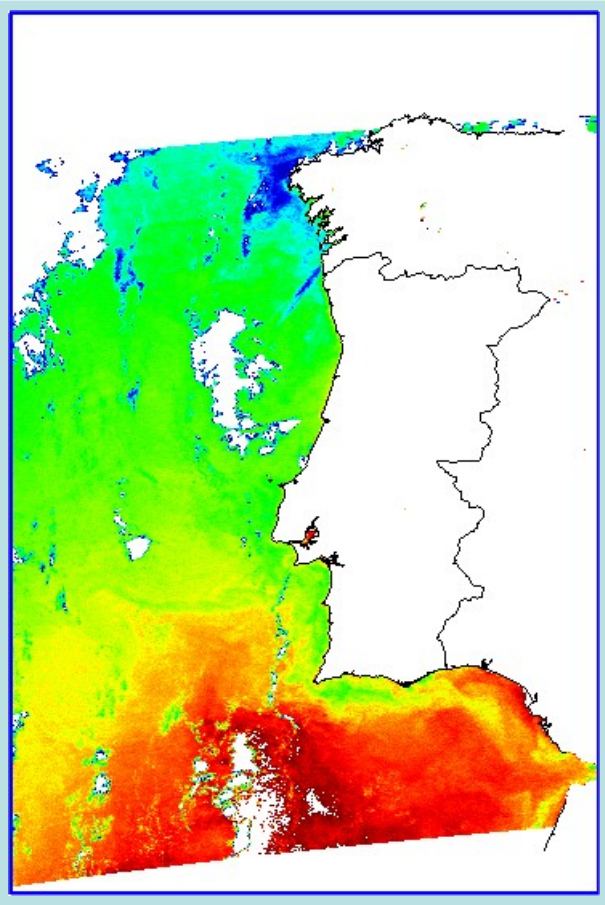
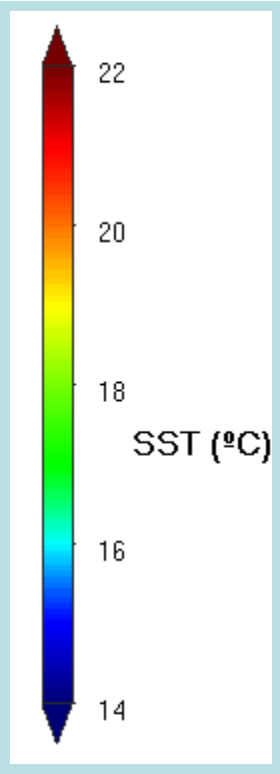
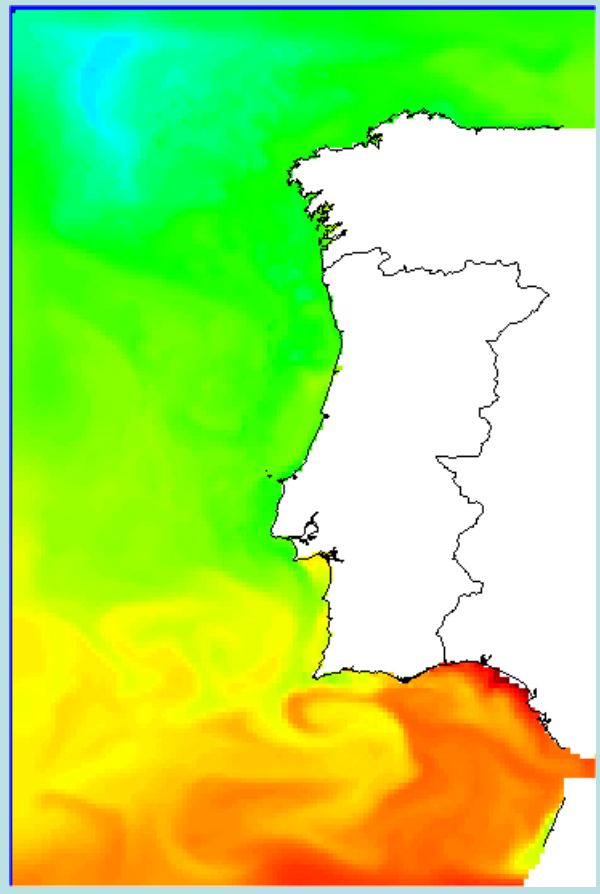


MODIS

Remote sensing comparison

12 June 2007





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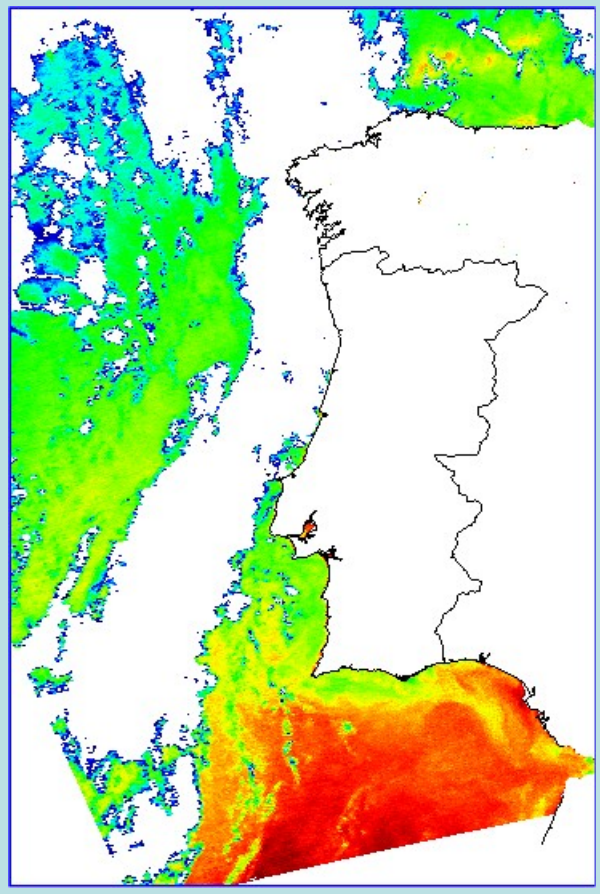
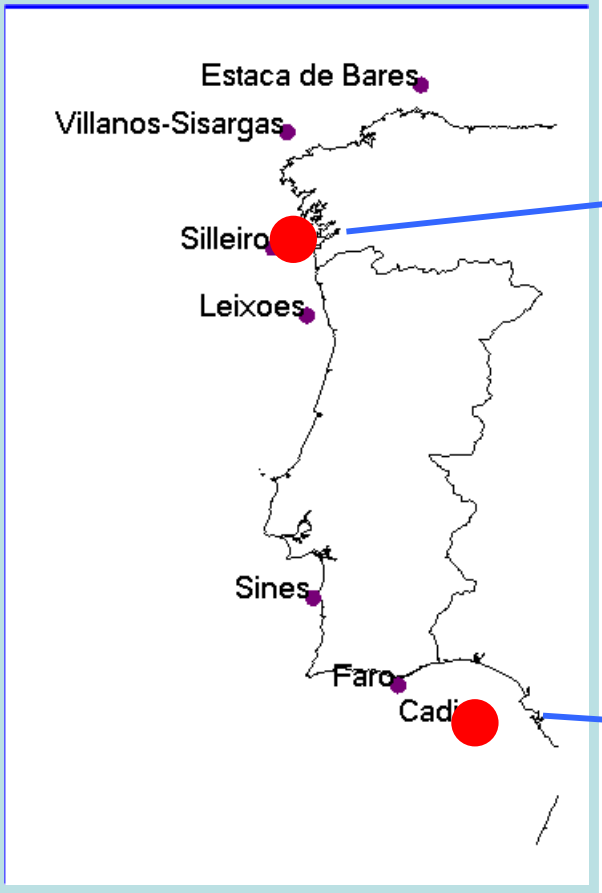
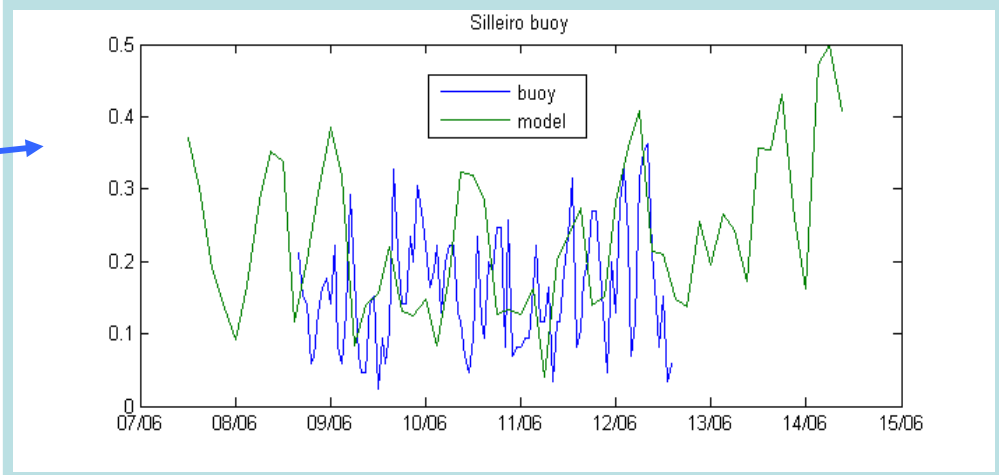


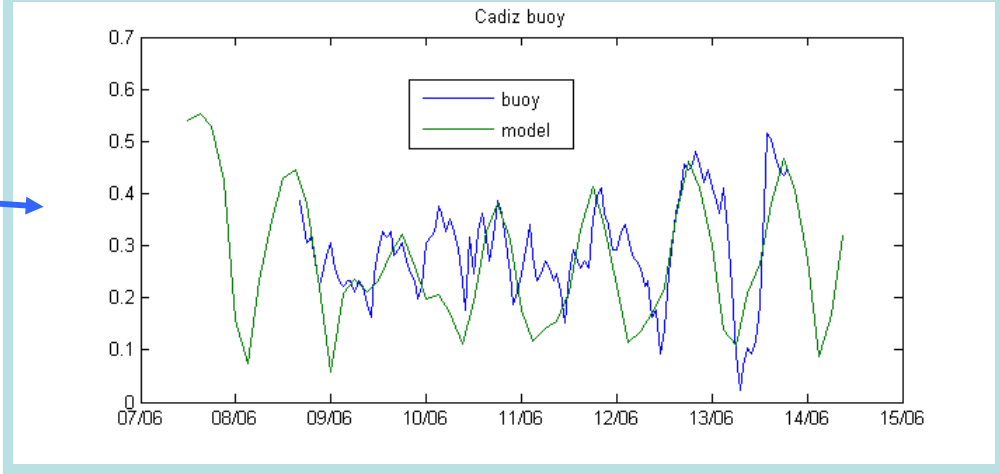
MODIS

Buoys comparison

Surface velocity modulus

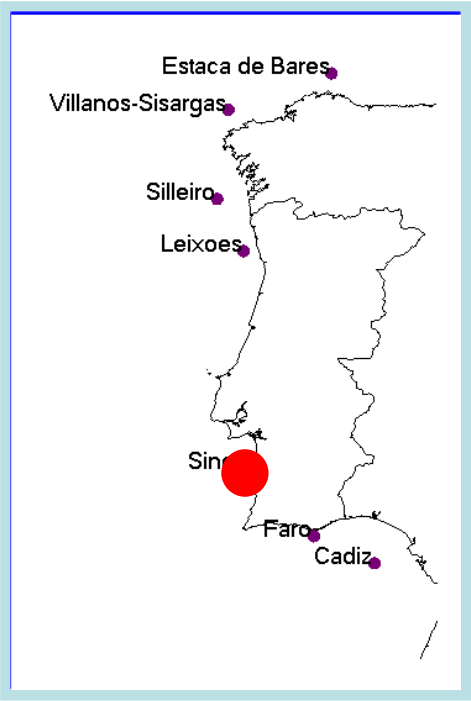


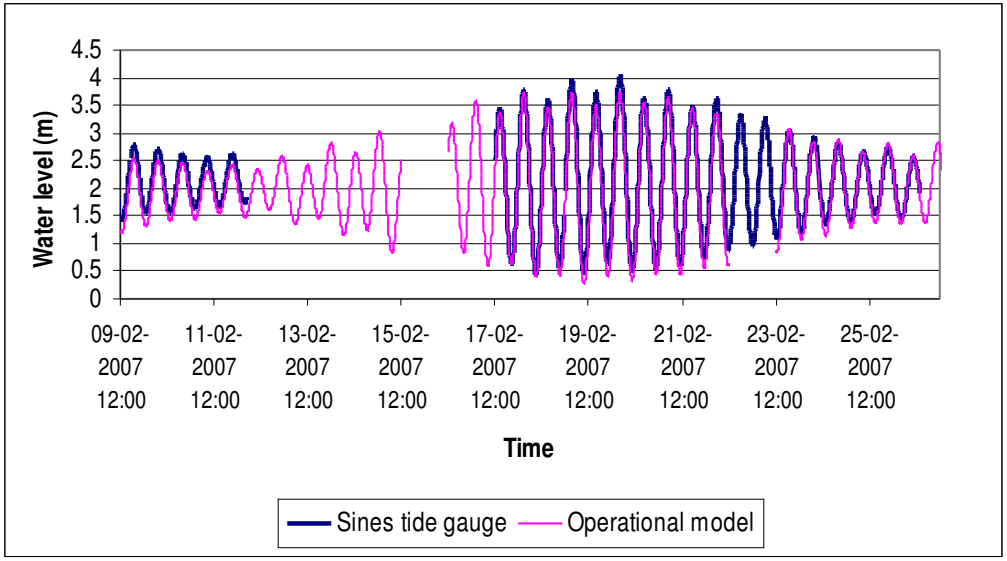




Buoy data kindly provided by Puertos del Estado

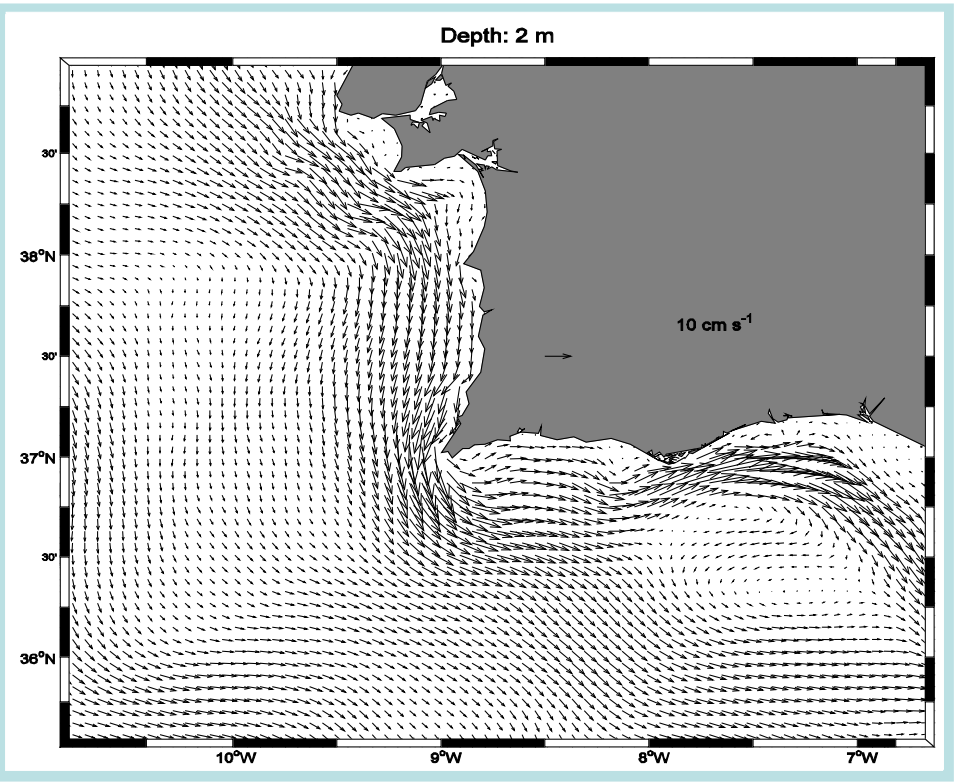
Buoys comparison

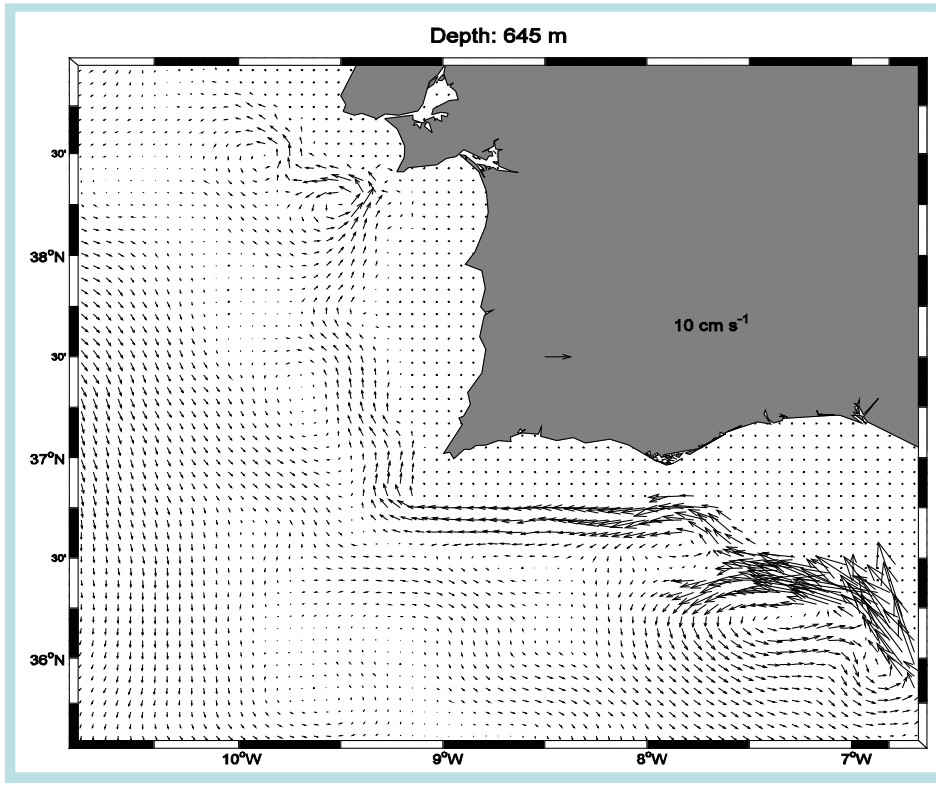




Water level from from a tidal station in pink located at 37º57' ºN and 8º55' ºW in Sines and illustrated in the the bathymetries figure. Water level from the pre-operational model in forecast mode for the same location. The correlation is 0.99 + 5e-3 and the RMSE is 0.19 + 5e-3 m.

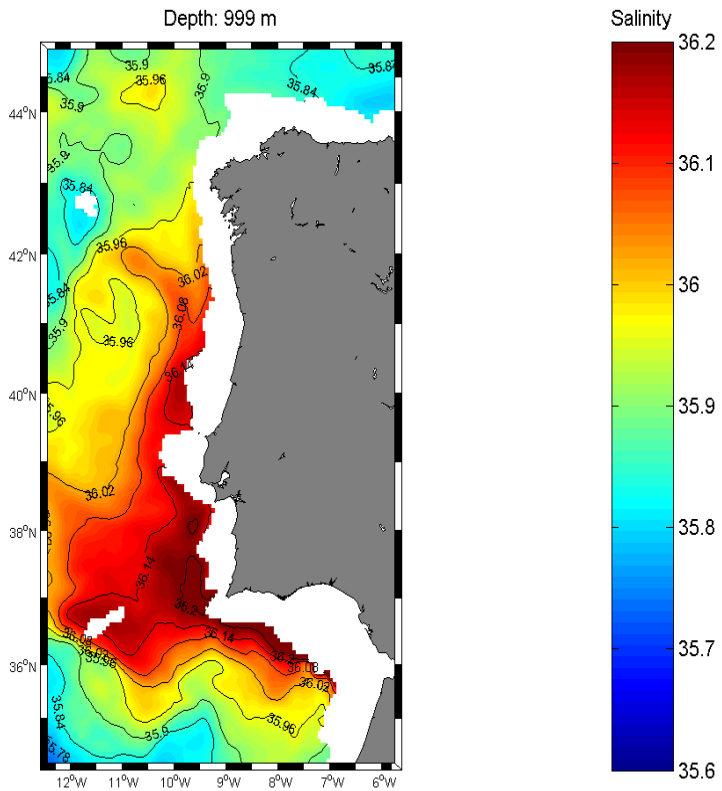
Integrated results mid-October 2006 mid-february 2007





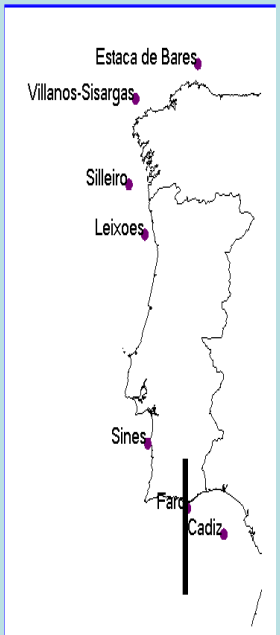
Horizontal distribution of velocity ensemble average at 2 m depth for the top panel and 645 m depth for the bottom panel. Two main branches of the MW spreading pathways are well pronounced in the bottom panel. the poleward slope current branch, and the cyclonic recirculation flowing southward.

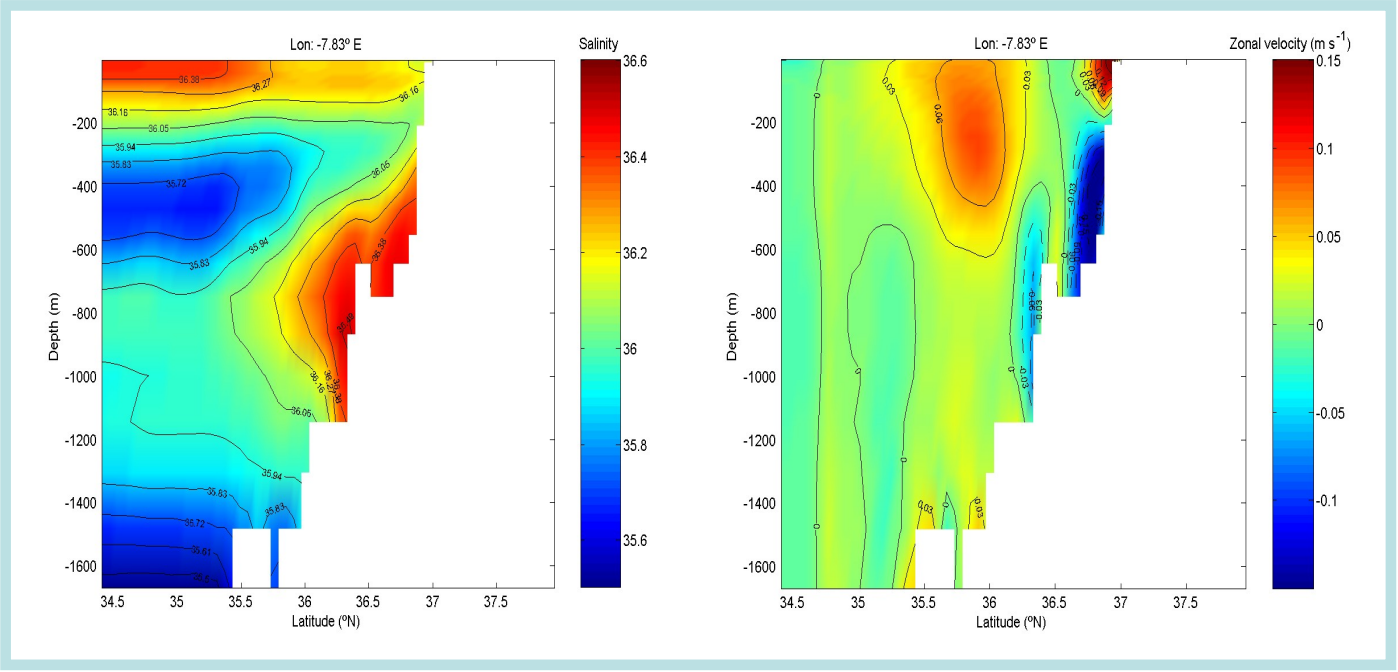
Integrated results mid-October 2006 mid-february 2007



Colour map and contours of salinity distribution ensemble average at 1000 m depth ranging in interval [35.6 36.2] showing the spreading pathway of the MO off western Iberia. Contour lines are valued [35.6; 35.78; 35.84; 35.9; 35.96; 36.02; 36.08; 36.14; 36.2]

Integrated results mid-October 2006 mid-february 2007





On the left panel, salinity contours of [35.5*;* 35.52*;* 35.83*;* 35.94*;* 36.05*;* 36.16*;* 36.27*;* 36.38*;* 36.49*;* 36.6] and color maps in the interval [35.5 36.6]. On the right panel, ensemble averages of zonal velocity contours of [-.15; -.12; -.09; -.06; -.03; 0; .03; .06; .09;.12; .15] ms^{-1} and color maps in the interval [-.15 .15] ms^{-1}. The plots are meridional sections in the Gulf of Cadiz at longitude 7.83 ºW. The MO shifts from a bottom current to a buoyancy driven intermediate depth jet current. The cross sections are shown in the bathymetries figure.

Results avaible on opendap

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Data repository

Click on a dataset to browse its content and extract data. To graphically inspect datase NcBrowse, a java client. Dowload it here. To open a dataset in NcBrowse simply click copy/paste its data-url in the OpenDAP menu in NcBrowse.

Project	File	Attributes
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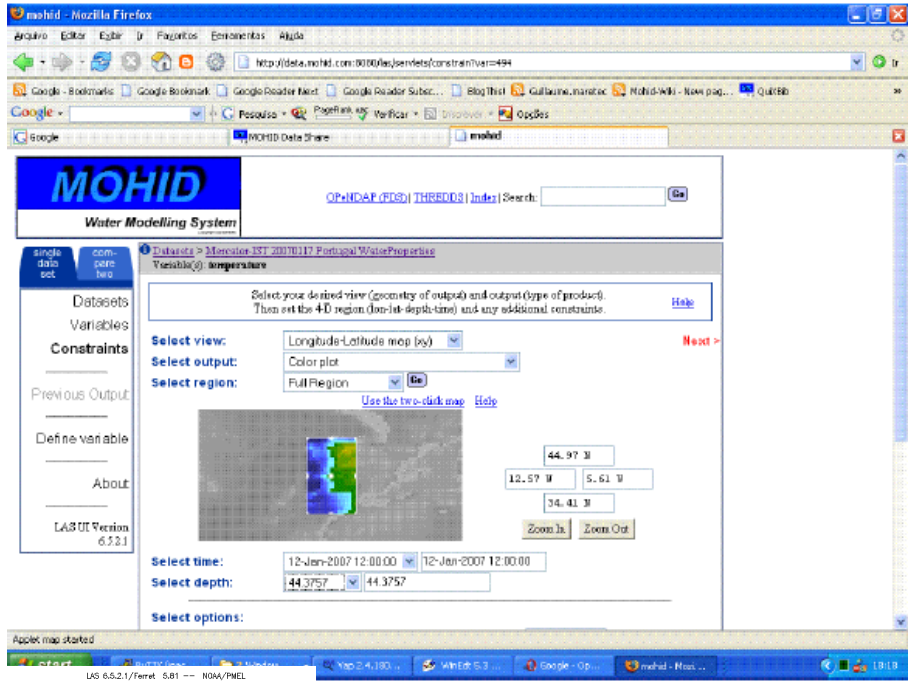
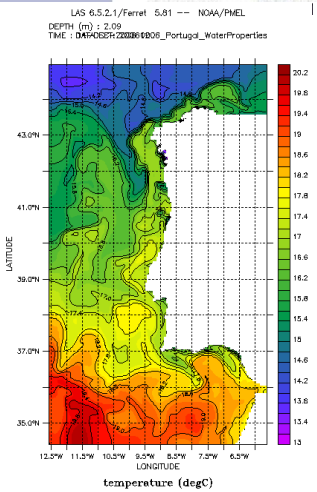
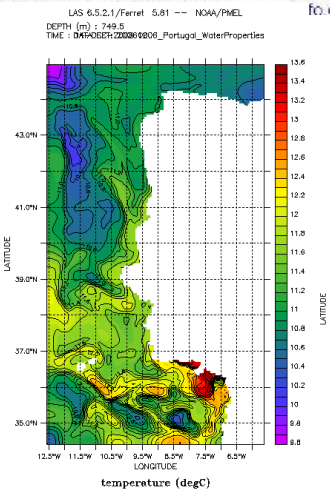
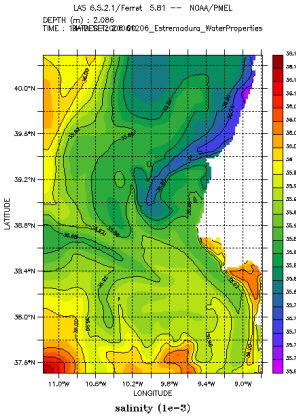
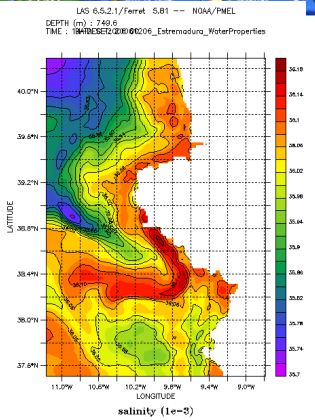
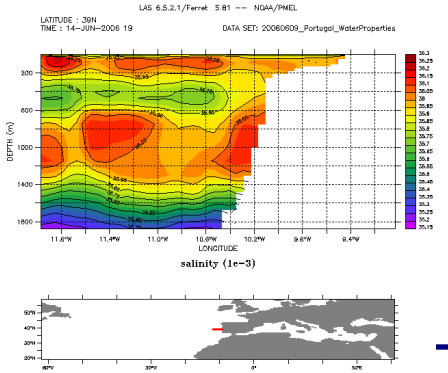




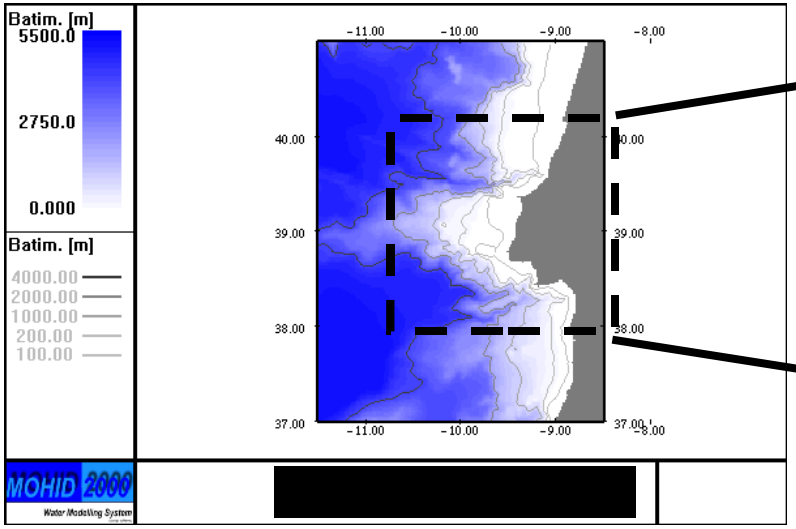


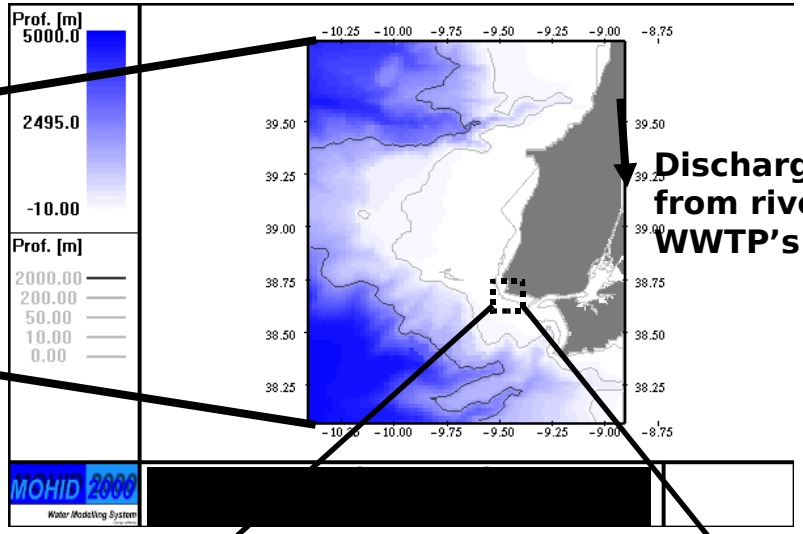




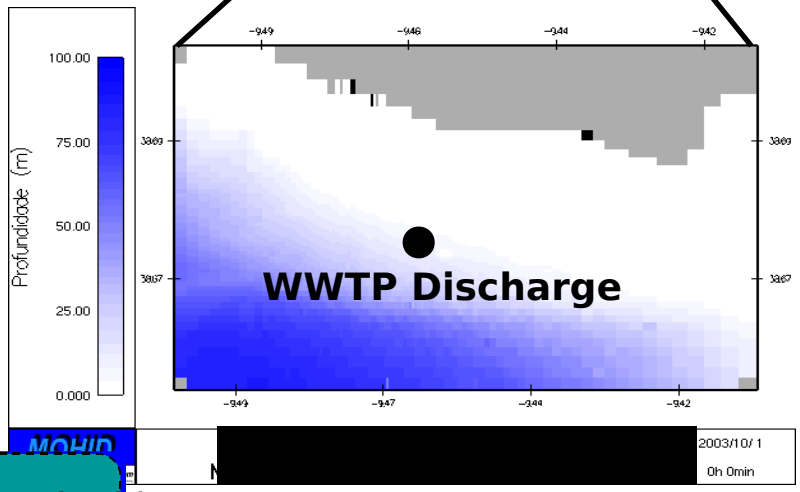


Local scale models: Tagus estuary





Discharges from rivers / WWTP's



Nazaré – Setúbal (2D)
-Hydrodynamics

Tagus (2D)
-Hydrodynamics
-Water quality

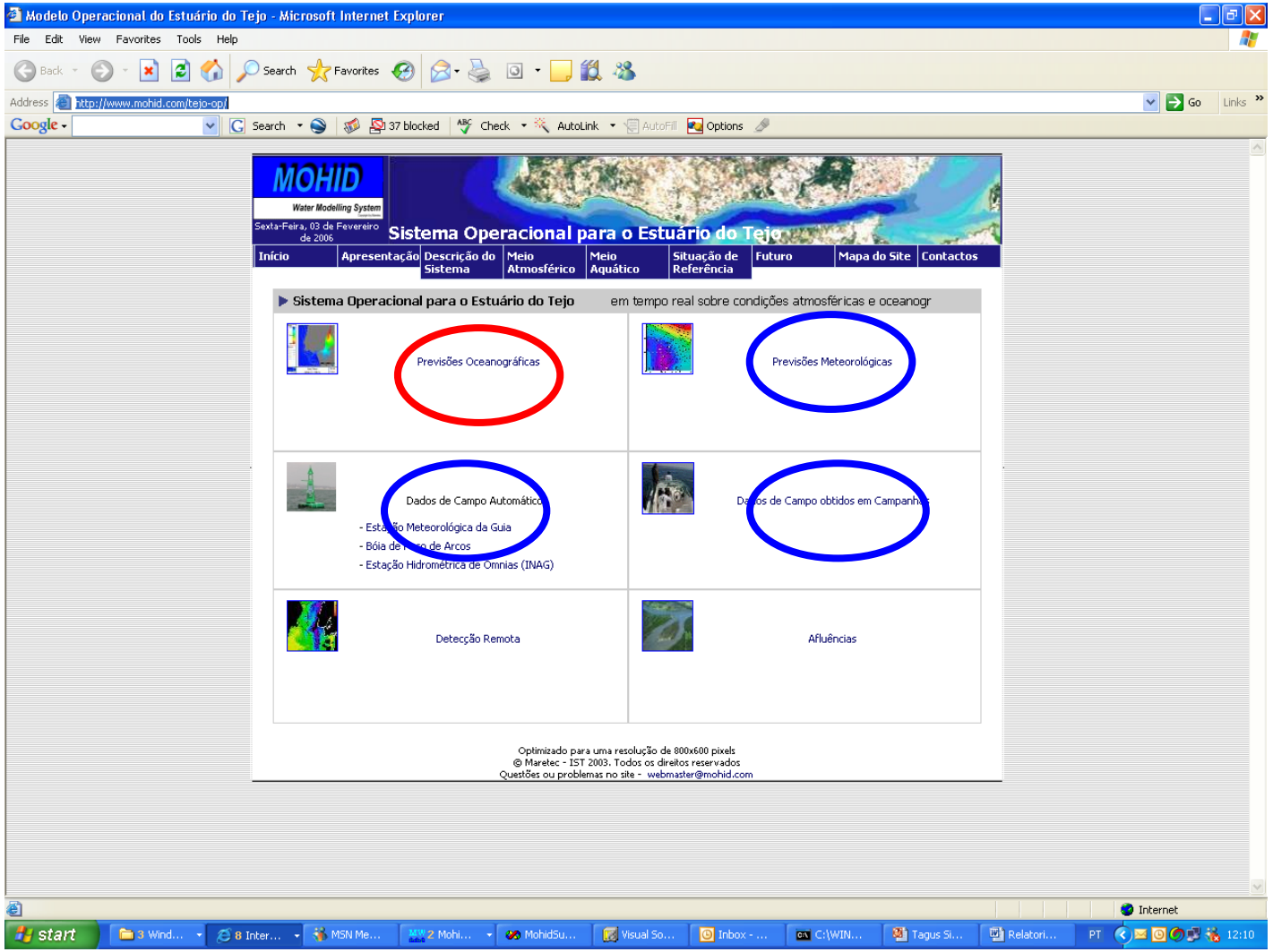
Tagus (3D-11 levels)
-Hydrodynamics

Carc. - P. Arcos (2D)
-Hidrodynamics

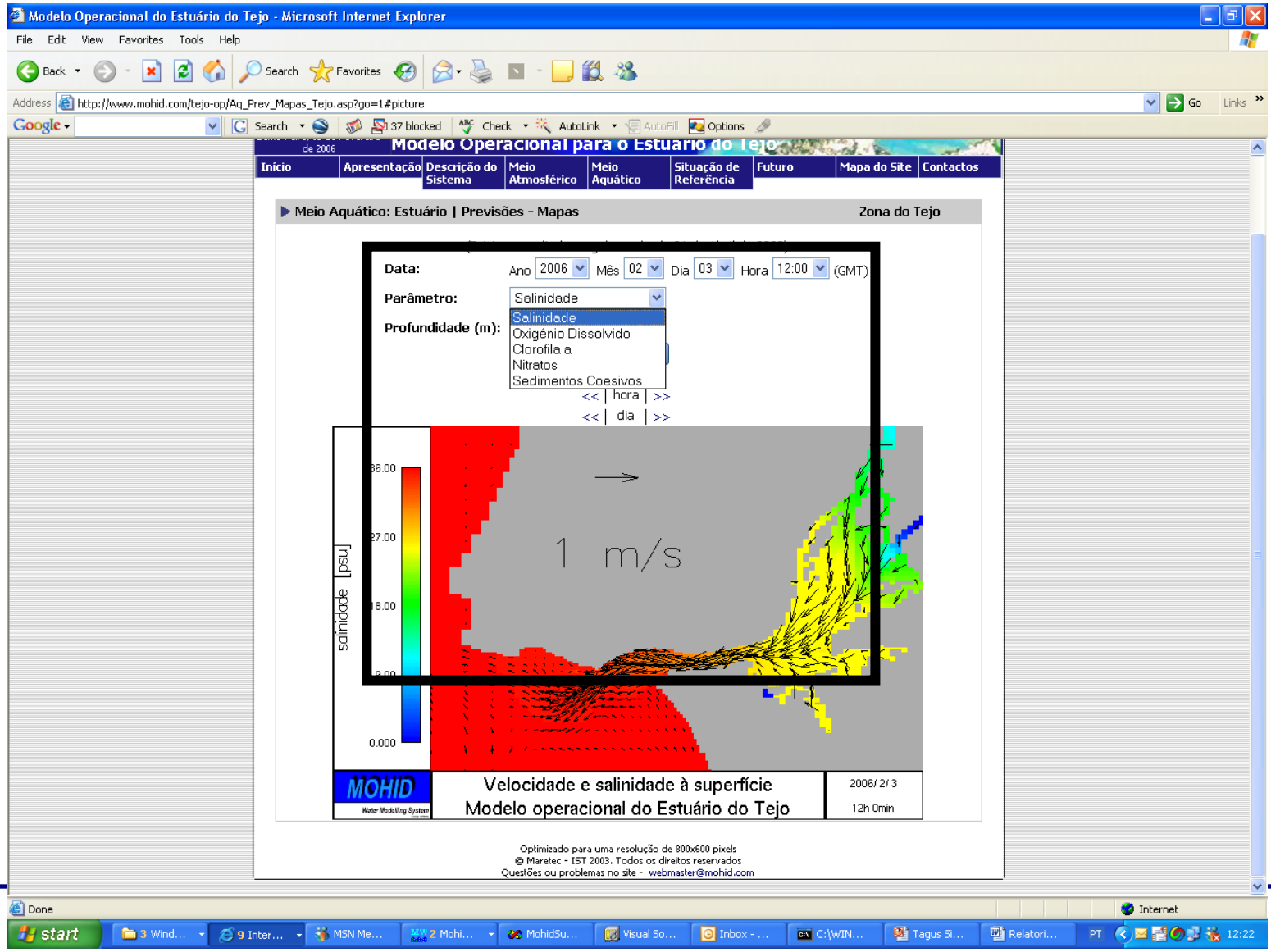
Guia (3D-11 levels)
-Hydrodynamic
-Initial Dilution (Mohid Jet)+
- Dispersion (Lagrangian)

Carc. - P. Arcos (3D-11levels)
-Hydrodynamics

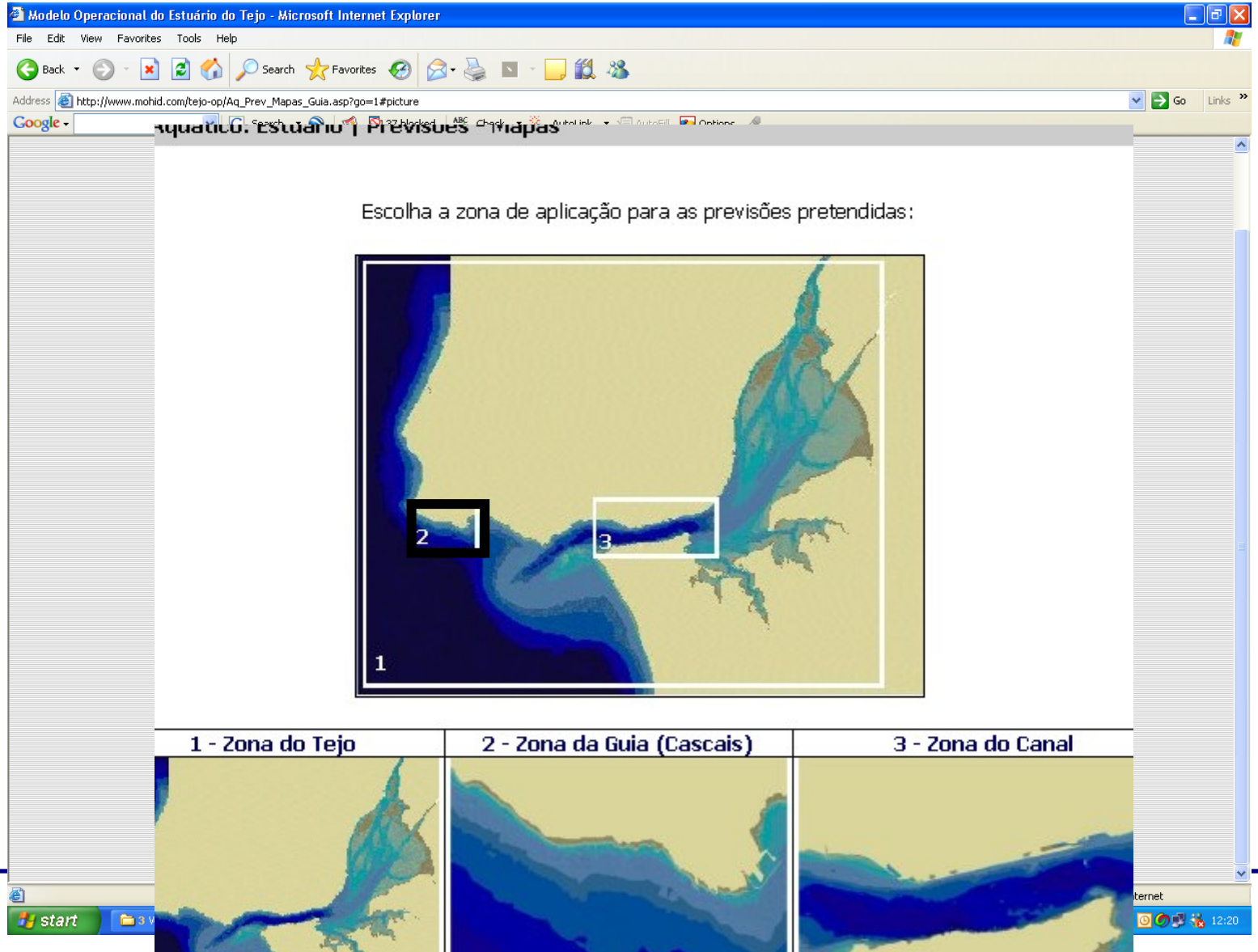
Local scale models: Tagus estuary



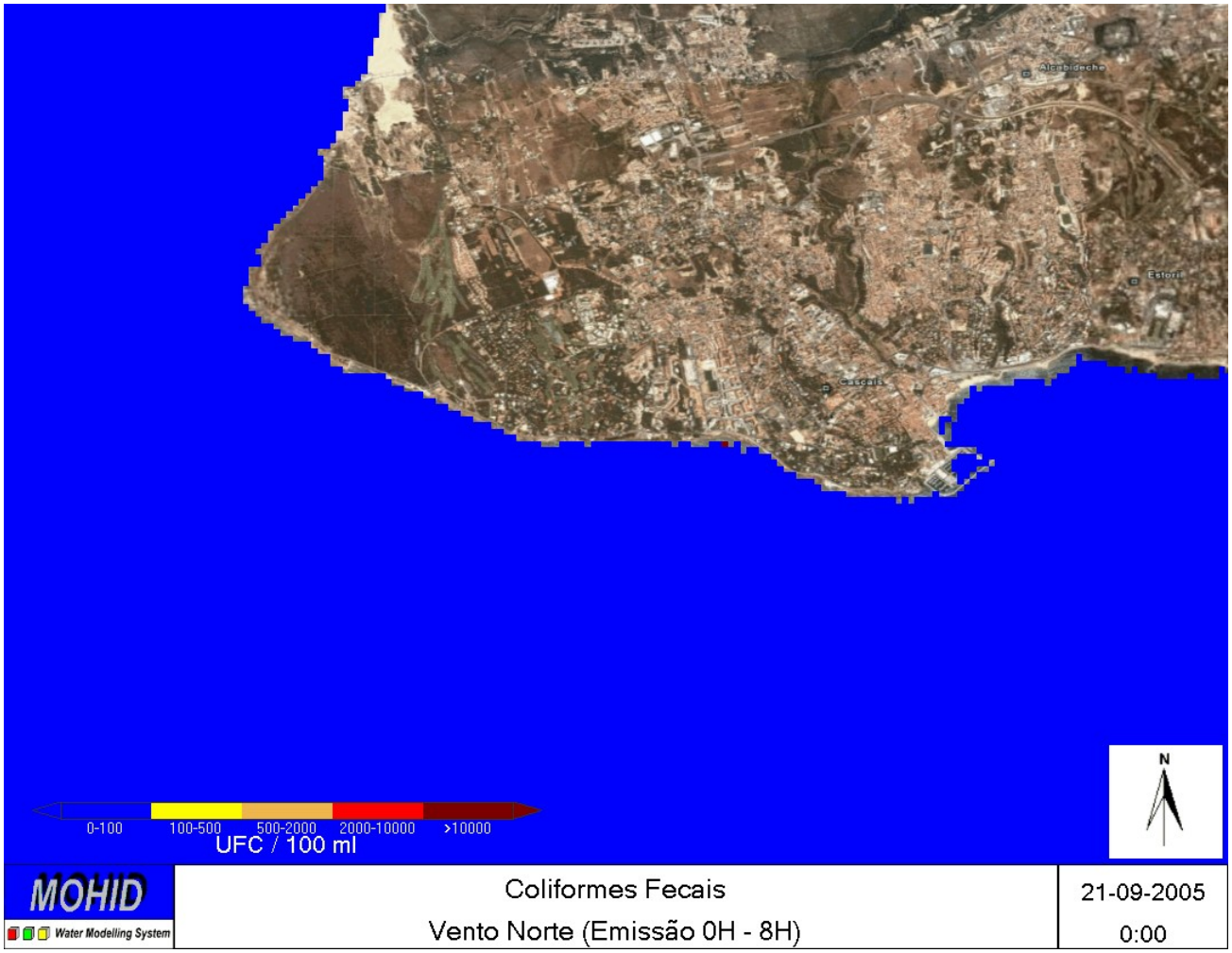
Local scale models: Tagus estuary



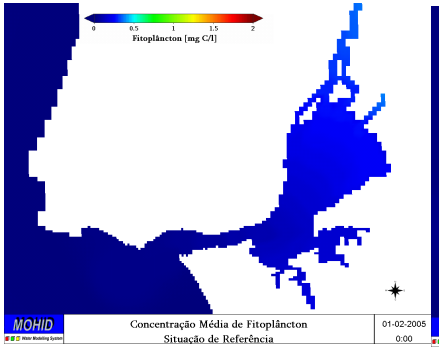
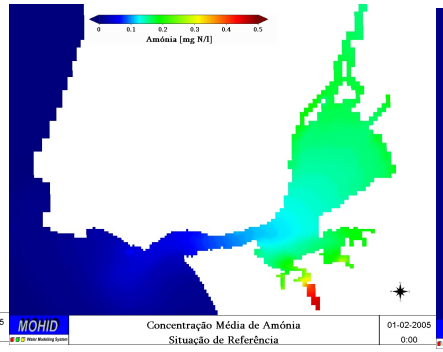
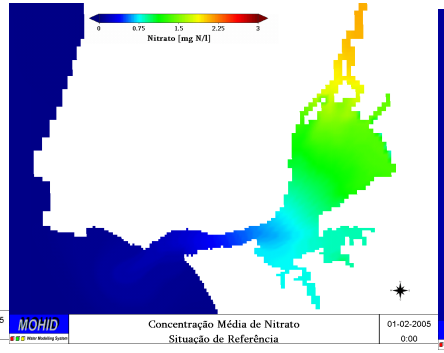
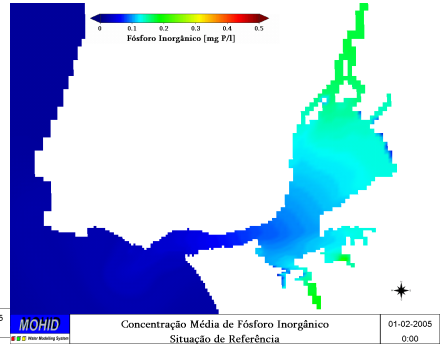
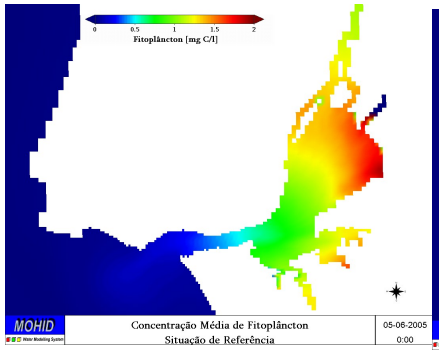
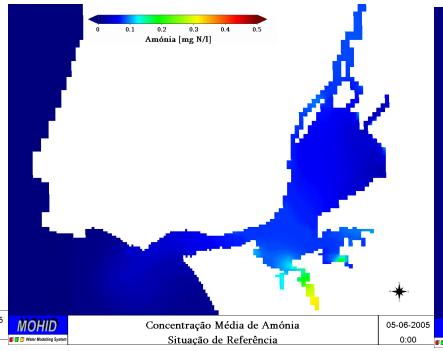
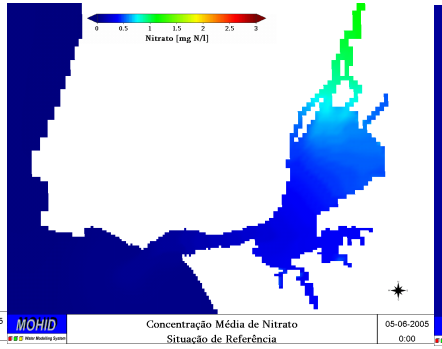
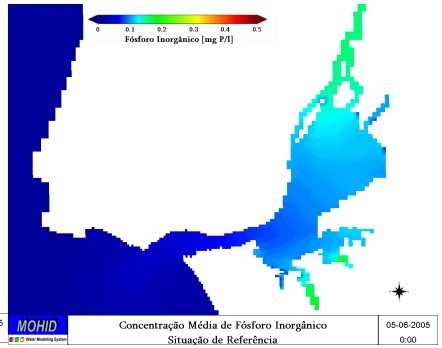
Local scale models: Tagus estuary



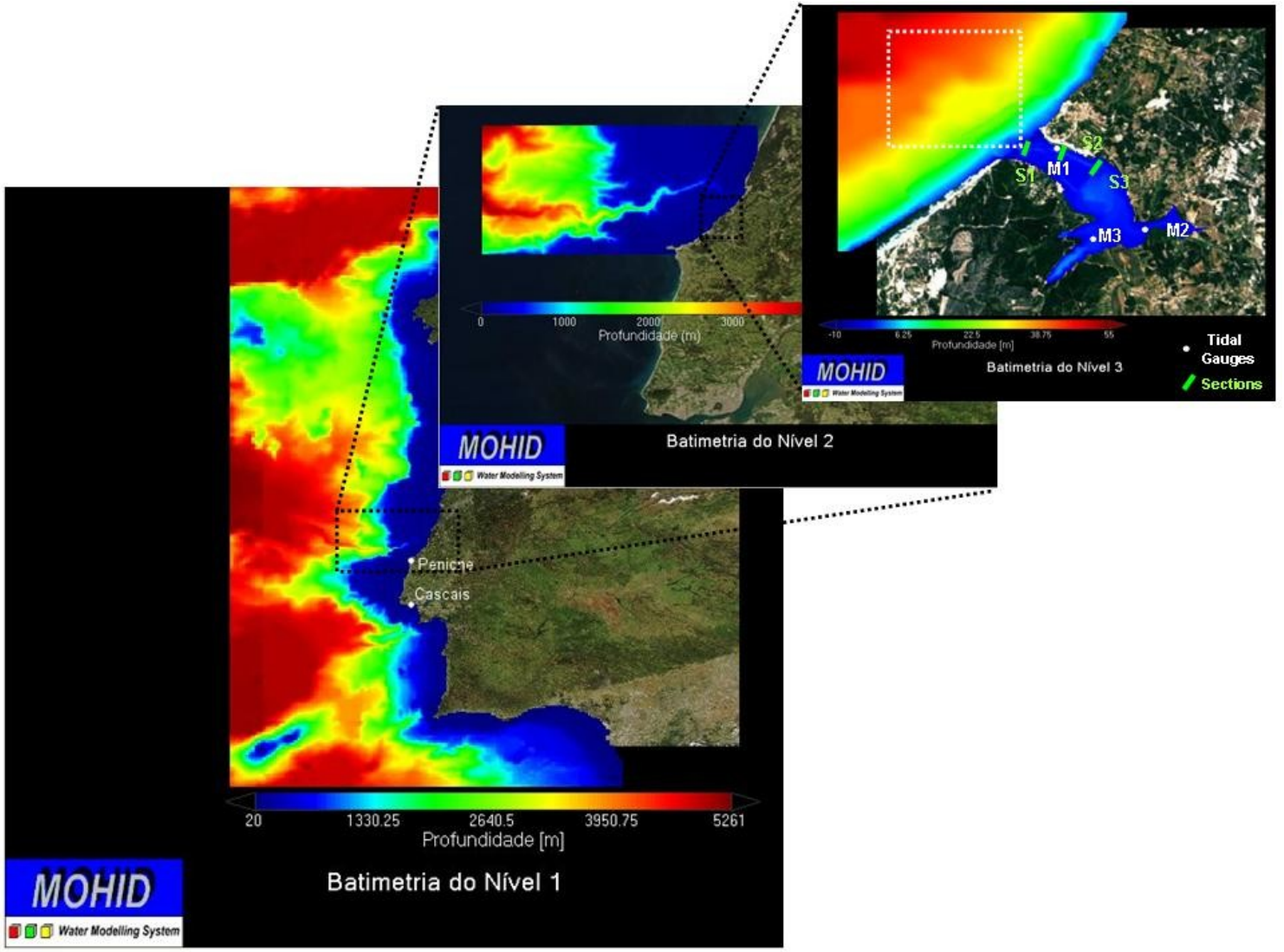
Estoril coast – process studies



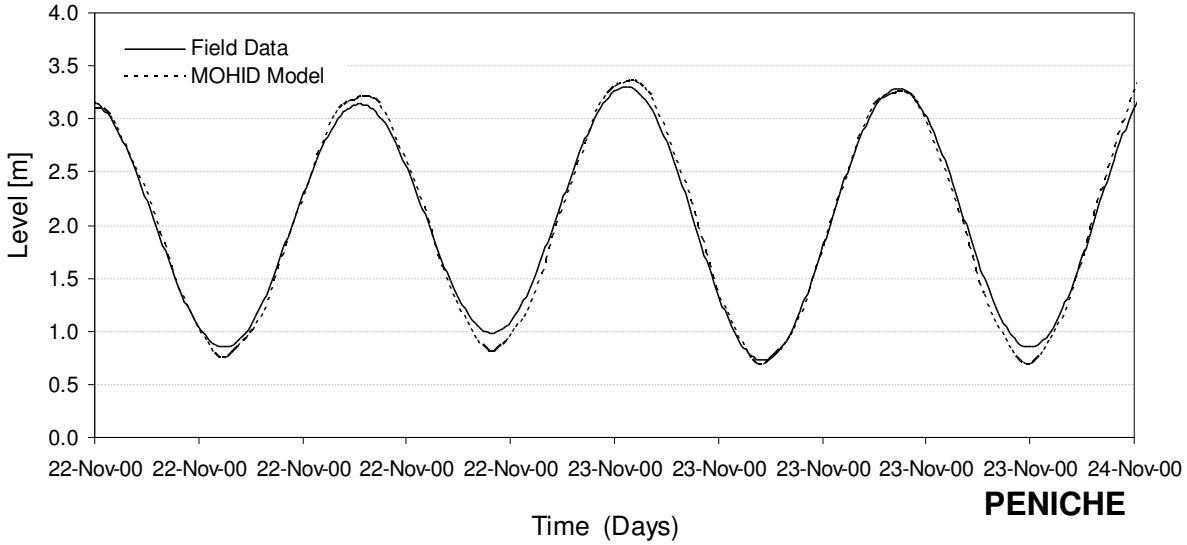
Tagus estuary – process studies

	Phytoplankton	Ammonia	Nitrate	Inorganic Phosphorus
FEBRUARY				
JUNE				

Foz do Arelho: lagoon + submarine outfall



Validation of coastal model

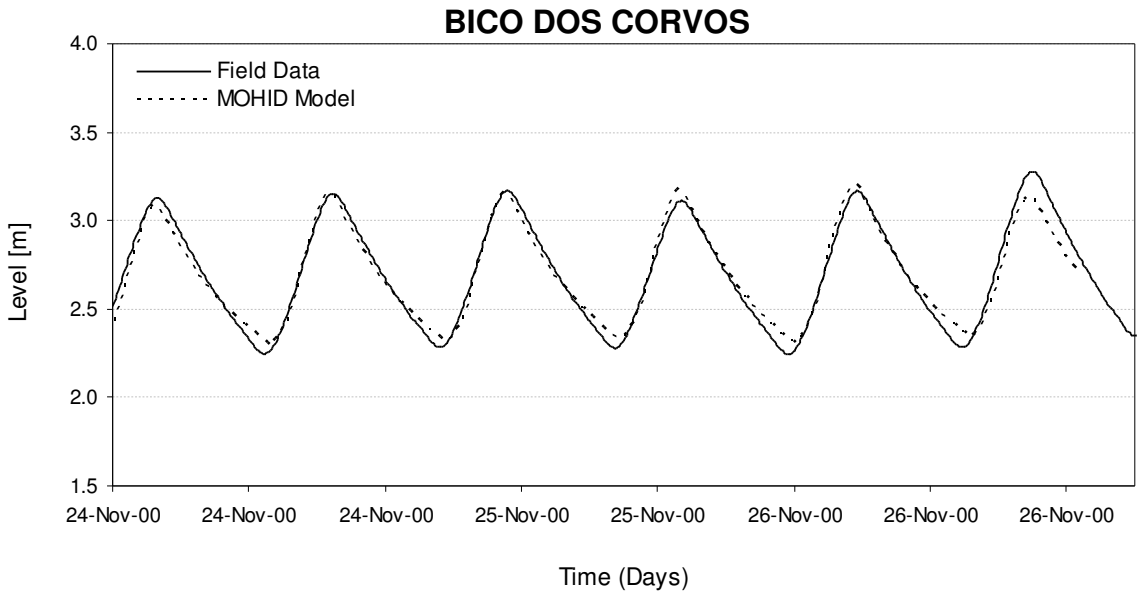


PENICHE

Tidal Stations	Average Value ($\bar{x} \pm \sigma$) (m)		Correlation Coefficient (R)	Root Mean Square Error (RMSE) (m)	Bias (m)
	Model	Data			
Peniche	1.990±0.894	2.081±0.920	0.985	1.367	0.100
Cascais	2.030±0.735	2.030±0.742	0.992	0.4124	0.020

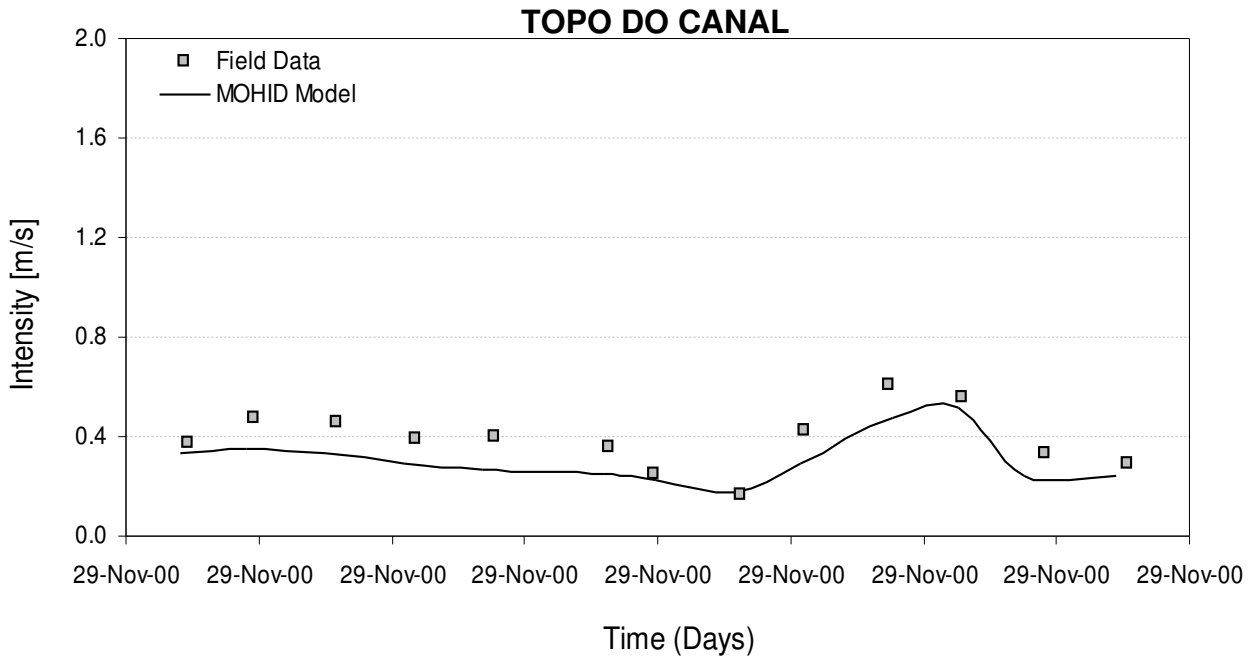
CASCAIS

Obidos lagoon model validation



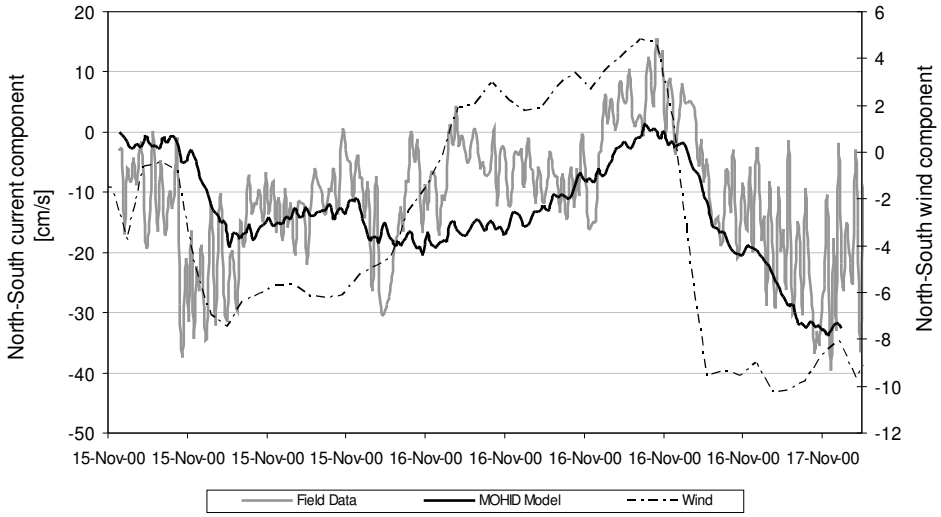
Tidal Gauge Stations	Average Value ($\bar{x} \pm \sigma$) (m)		Correlation Coefficient (R)	Root Mean Square Error (RMSE) (m)	Bias (m)
	Model	Data			
Cais da Foz do Arelho	2.691±0.290	2.667±0.230	0.987	0.081	0.025
Bico dos Corvos	2.695±0.266	2.719±0.299	0.988	0.072	0.024
Barrosa	2.704±0.273	2.706±0.299	0.989	0.062	0.001

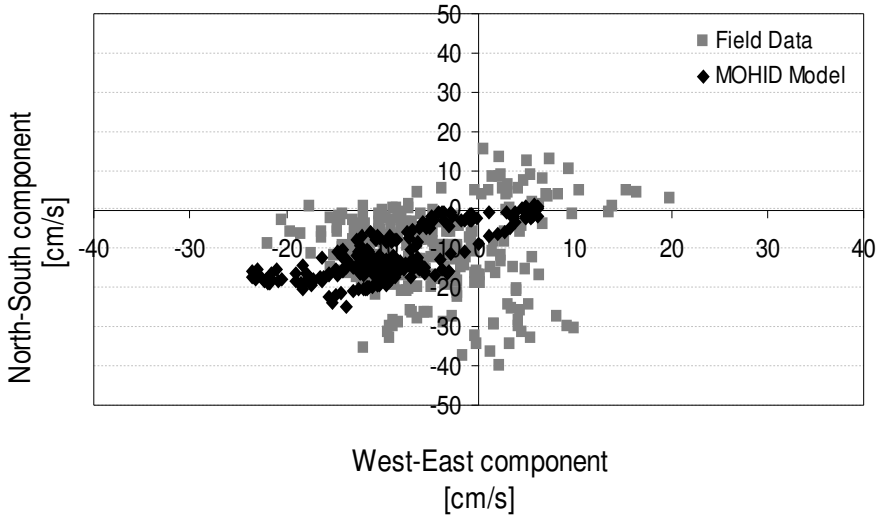
Obidos lagoon model validation



Currents transects stations	Average Value ($\bar{x} \pm \sigma$) (m/s)		Correlation coefficient (R)	Root Mean Square Error (RMSE) (m/s)	Bias (m/s)
	Model	Data			
Cais da Foz do Arelho	0.382±0.086	0.427±0.130	0.891	0.090	-0.045
Topo do Canal	1.103±0.445	0.974±0.372	0.904	0.276	0.129
Barra	0.307±0.097	0.392±0.119	0.957	0.098	-0.086

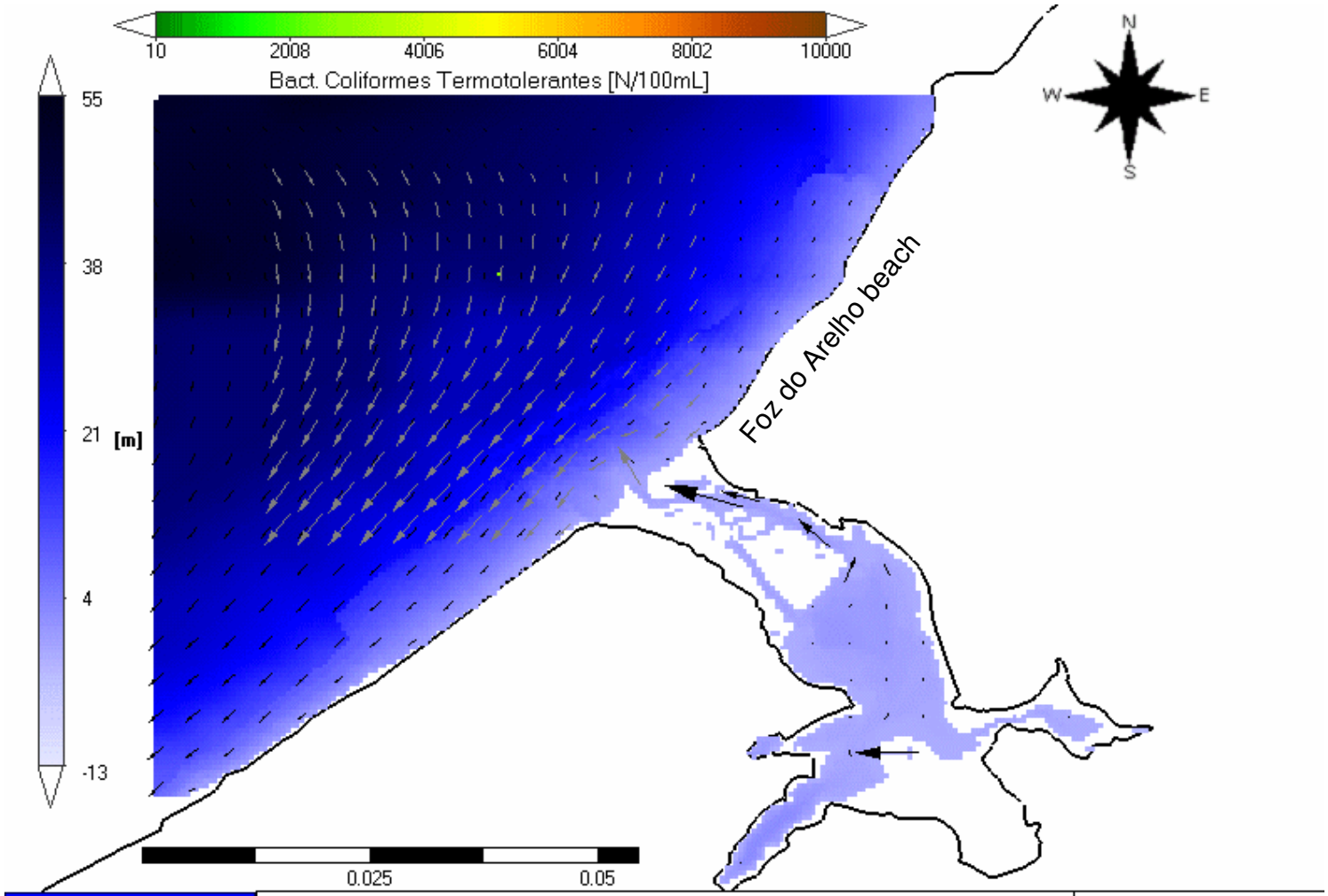
COASTAL AREA MODEL VALIDATION





Depth (m)	Average Value ($\bar{x} \pm \sigma$) (cm/s)		Correlation Coefficient (R)	Root Mean Square Error (RMSE) (cm/s)	Bias (cm/s)
	Model	Data			
5	-13.380±8.389	-10.730 ±10.528	0.711	10.109	3.007

Animação



MOHID Water Modelling System

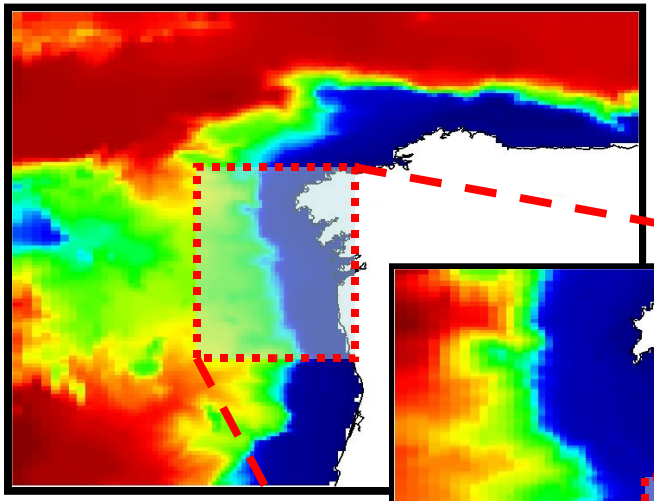
Emissário da Foz do Arelho

Bactérias Coliformes Termotolerantes

24-10-2005

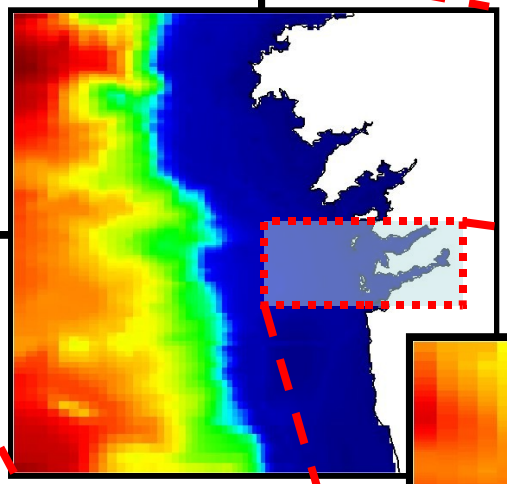
0:00

Nesting



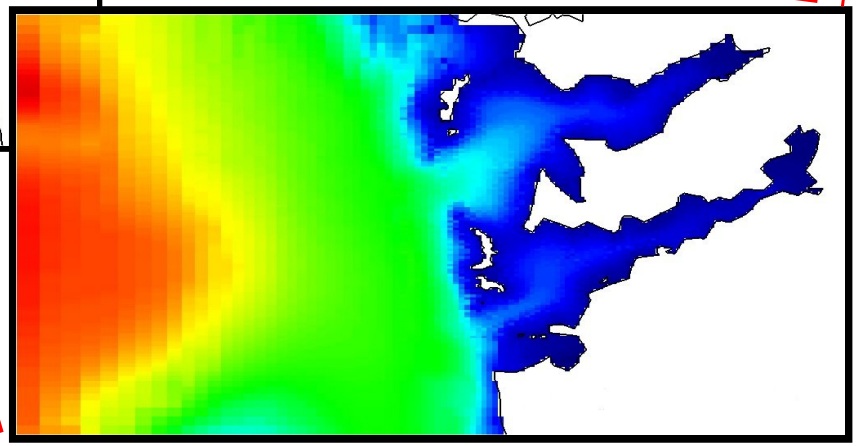
Galician coast

(2D)



Rias Baixas

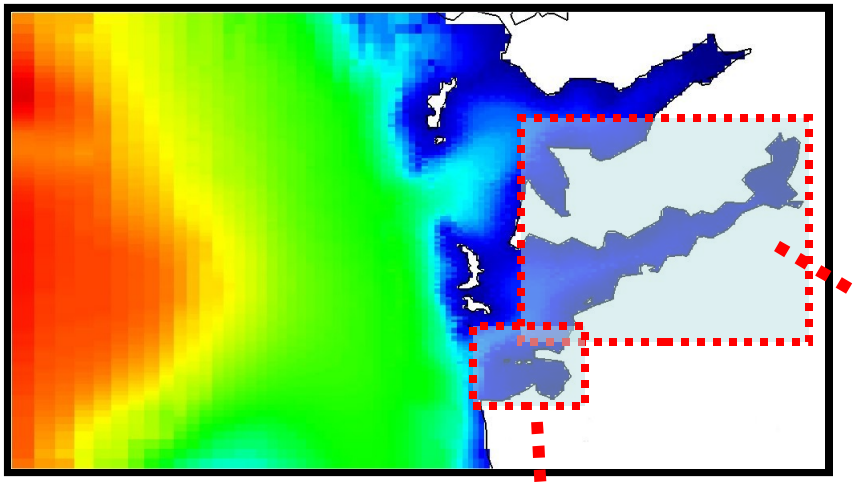
(3D – 20 layers)



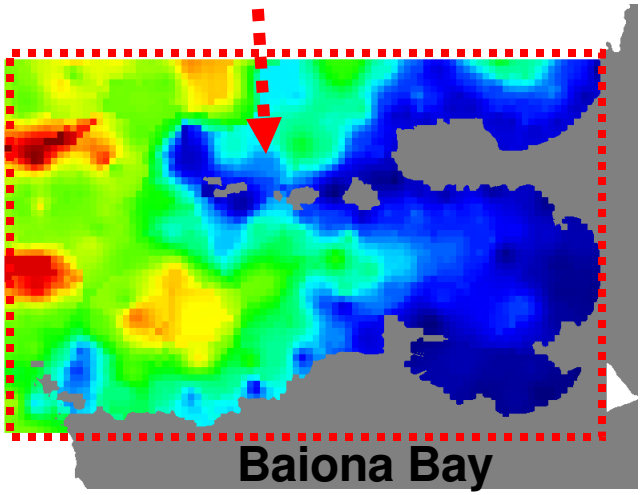
Rias de Vigo and Pontevedra

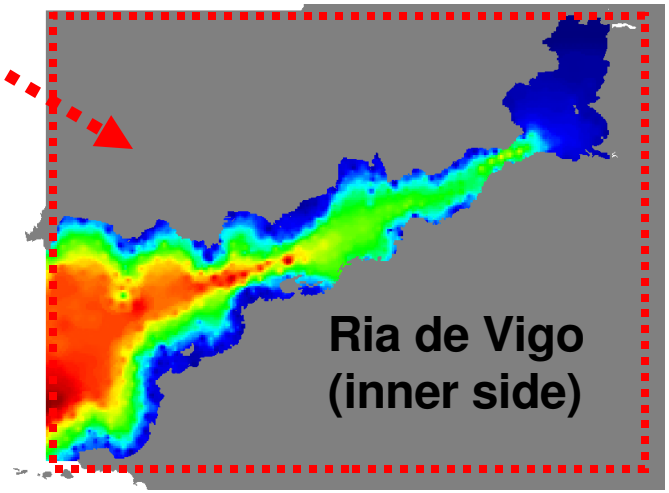
(3D – 13 layers)

Nesting

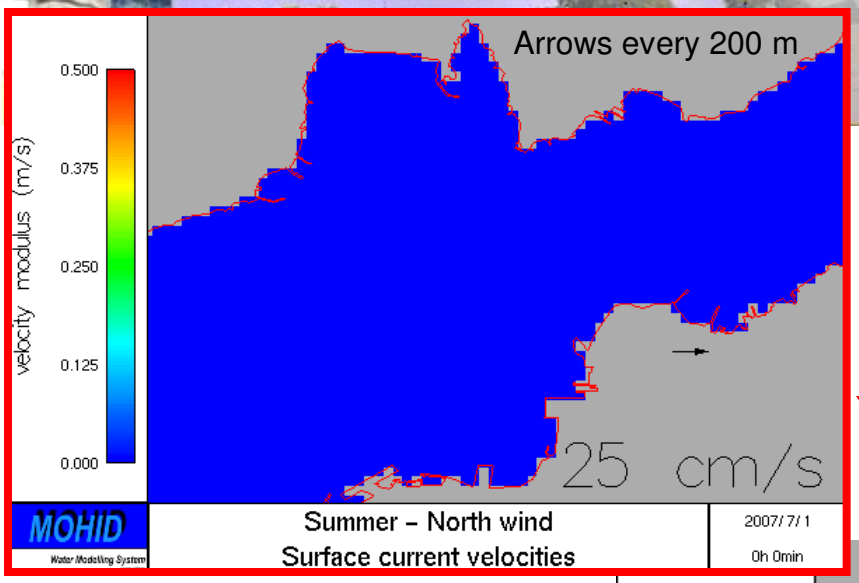


New sub-domains with grid resolution = 100m





Nesting

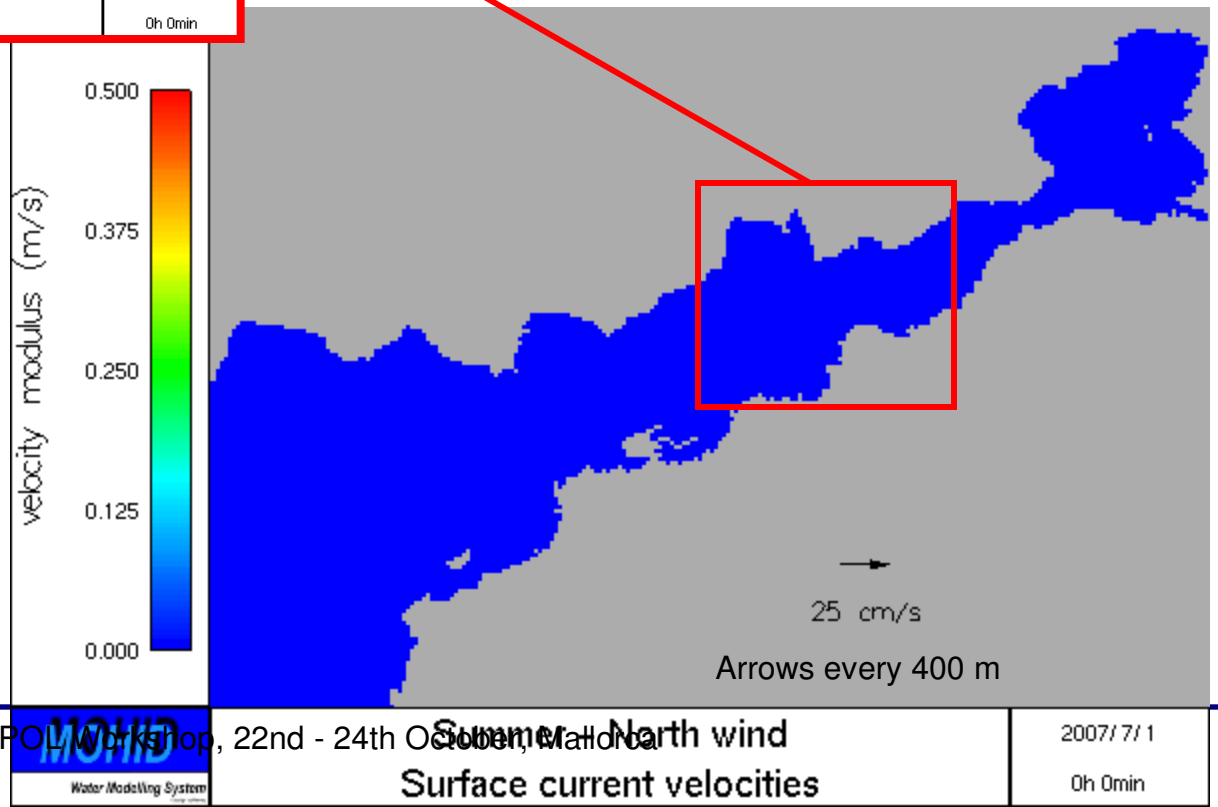


Ria de Vigo (3D – 8 layers)

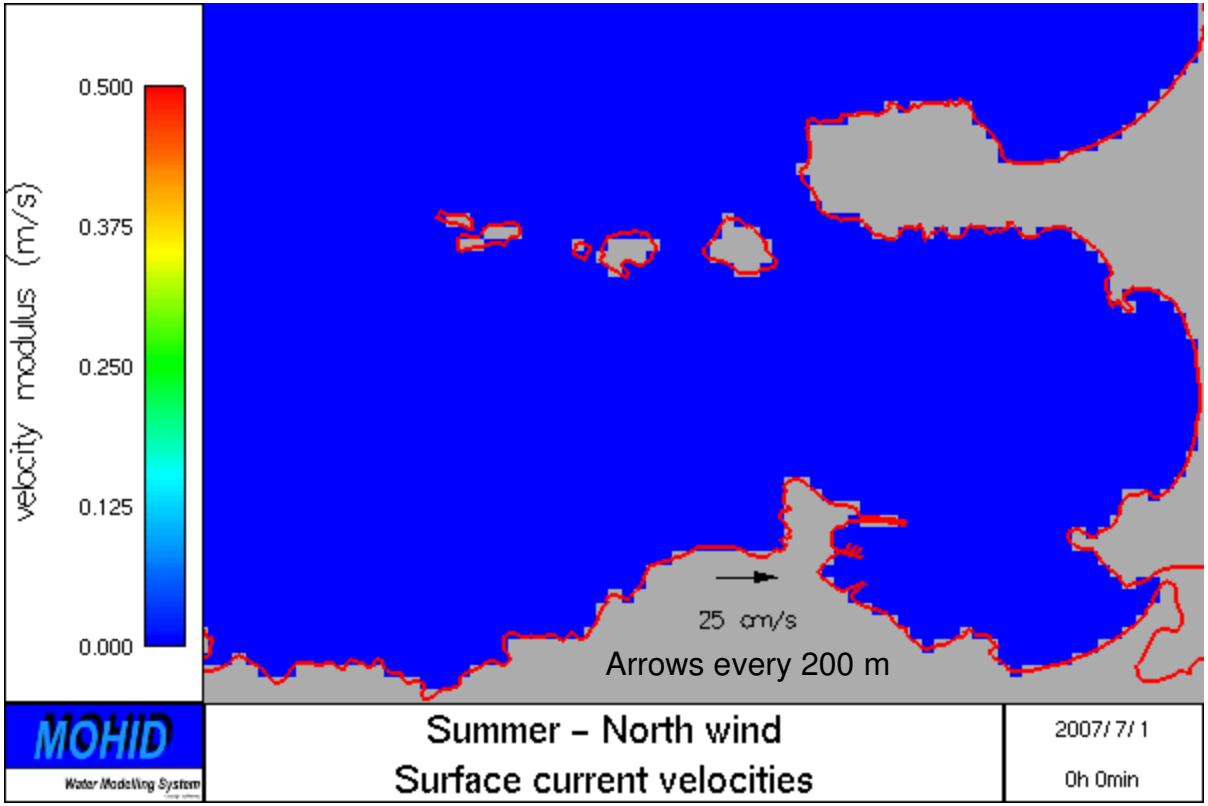
grid resolution = 100m

Detailed view

Extended view



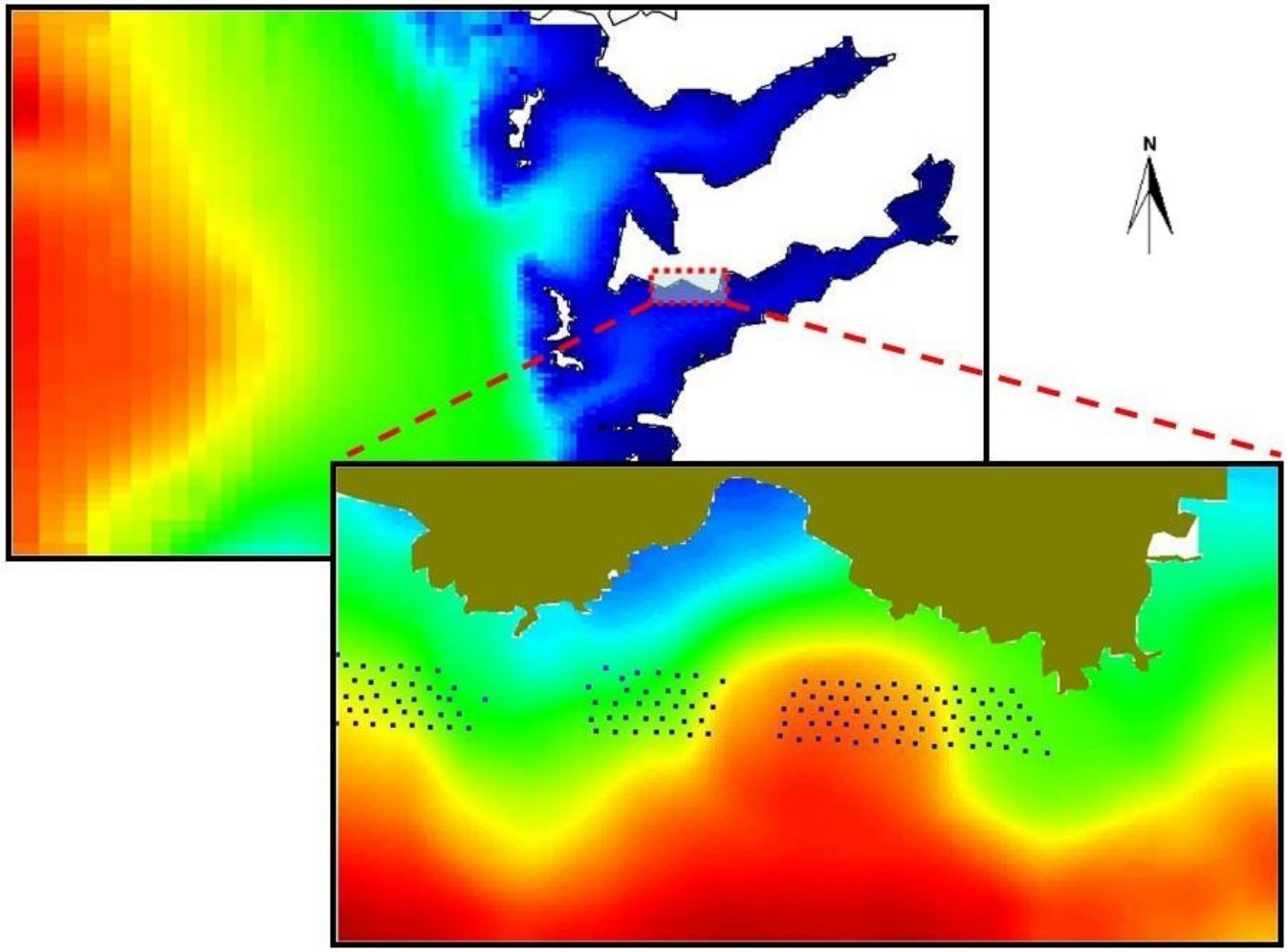
Nesting



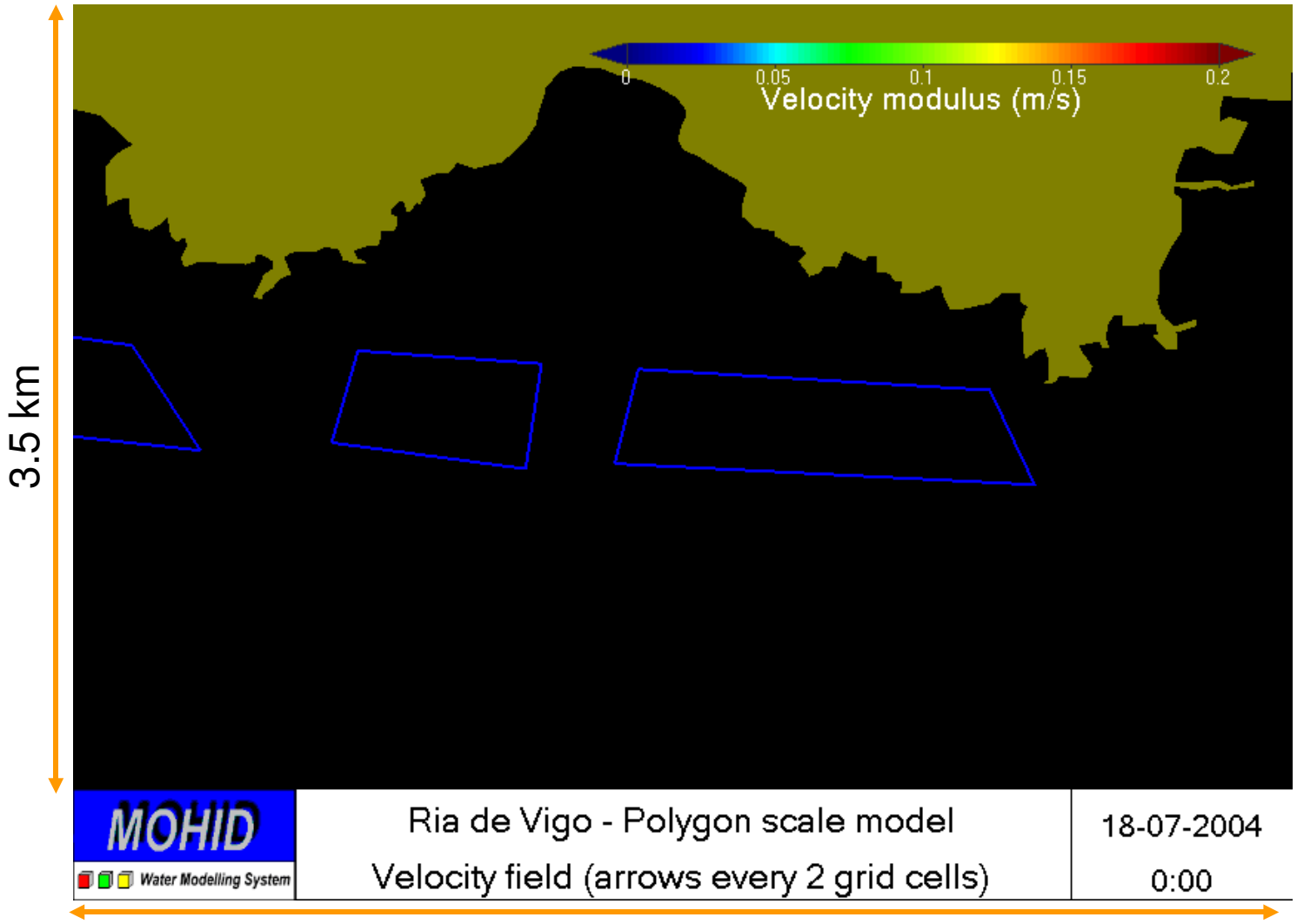
Baiona (3D – 8 layers)

grid resolution = 100m

MaBenE – Rafts' polygon scale

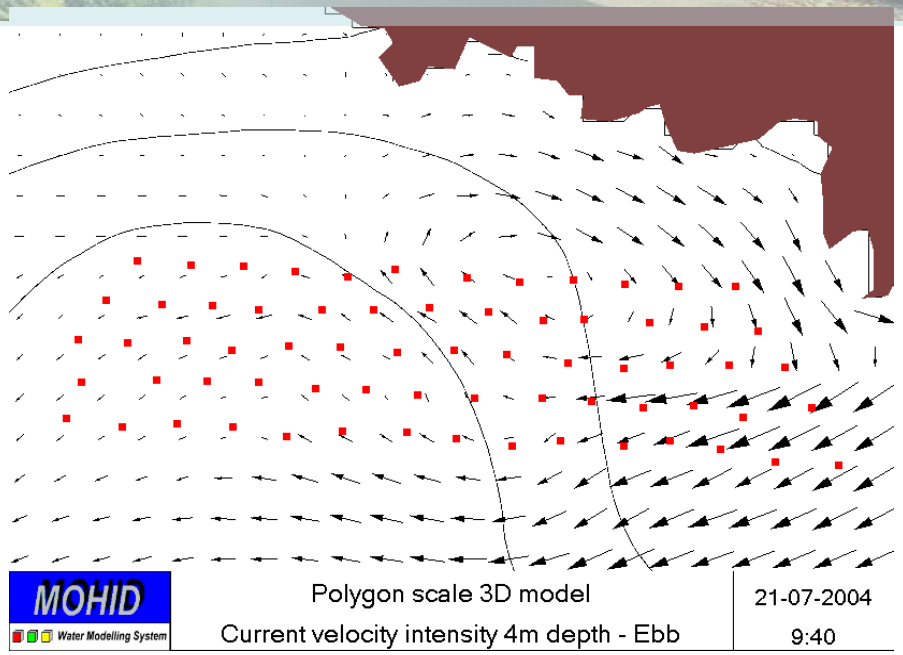


MaBenE – Rafts' polygon scale



MaBenE – Rafts' polygon scale

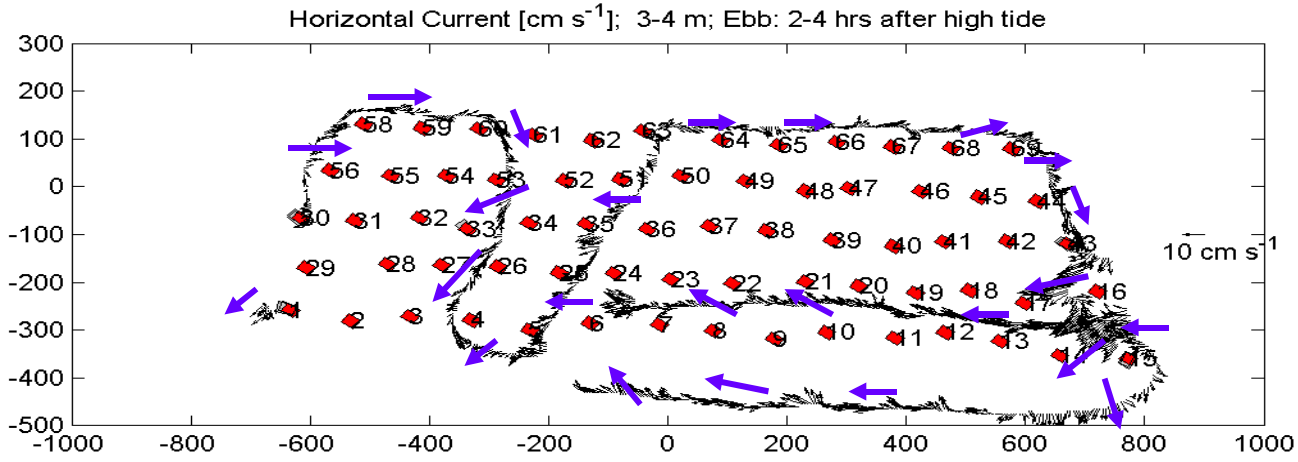
Model

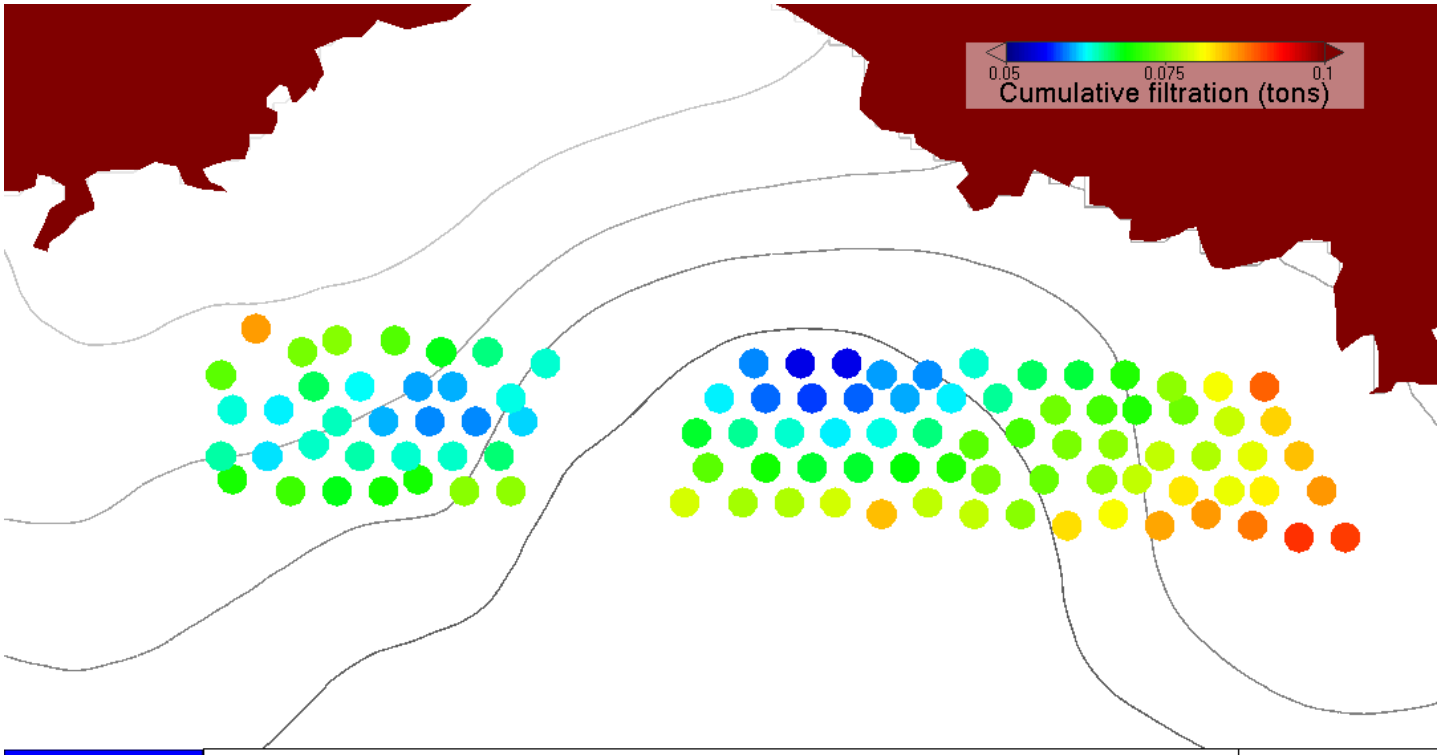


3-4 meters layer
EBB 2-4 hours after high tide

ADCP

(GKSS)





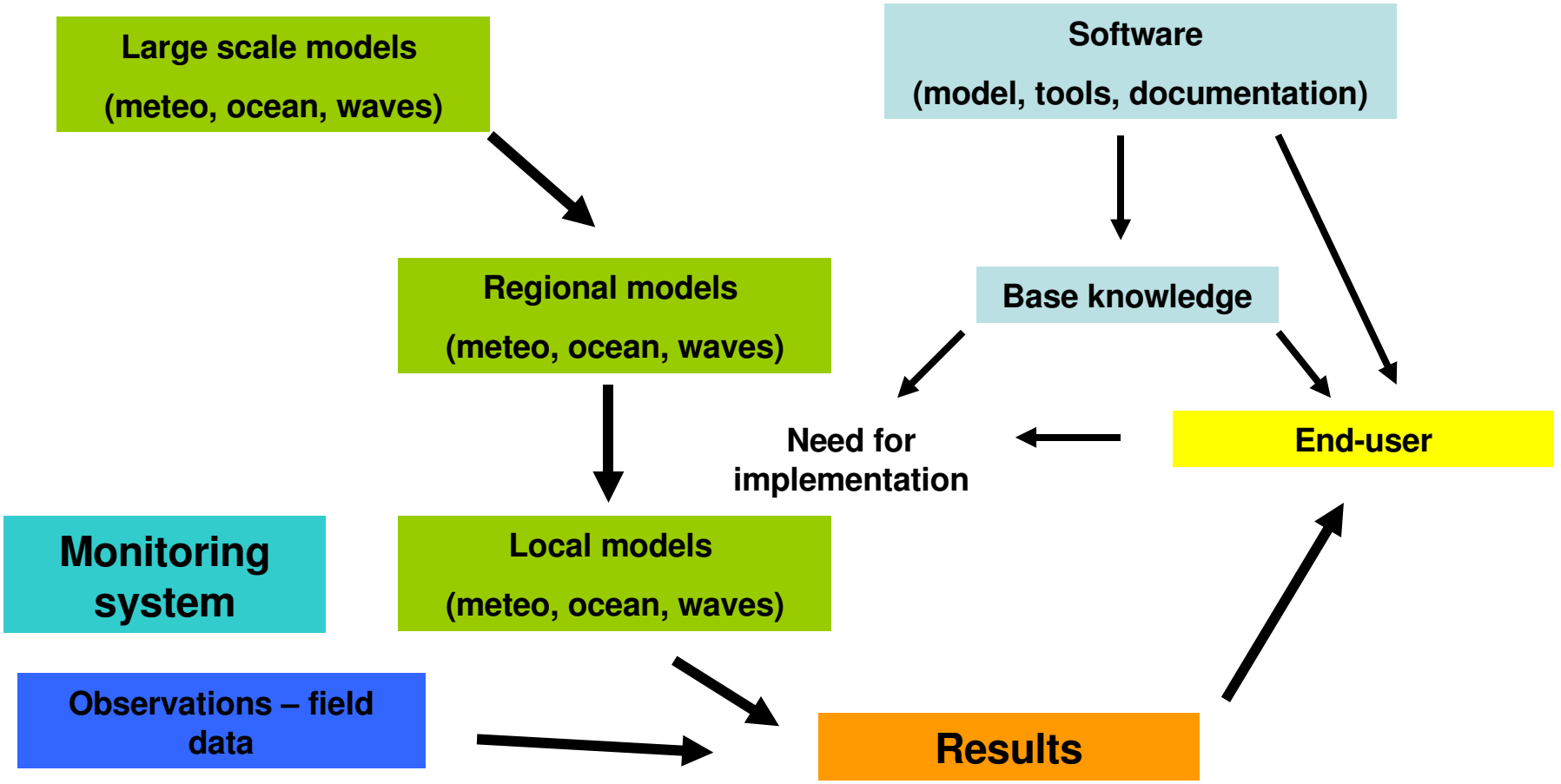
MOHID Water Modelling System

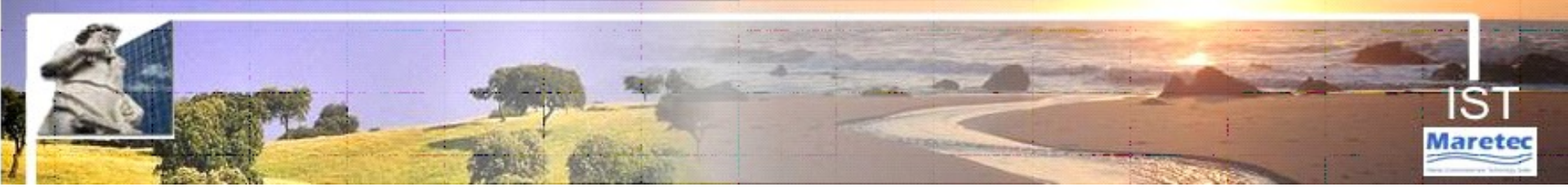
3D Polygon model

Surface layer cumulative filtration over 2 tidal cycles

Products

Operational systems





Thank you