



# Operational Modelling in Portugal: applications, tools and validation

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# Summary

- Study Area
- Validation Status
- Tools:
  - Intercomparison tool
  - Bi-directional tool
- Applications



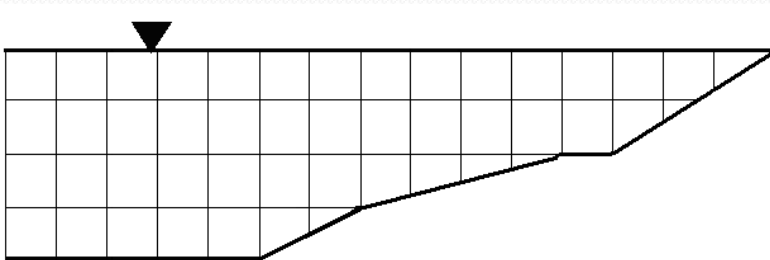
# Study areas

- Hydrodynamic and ecological models for
  - Continental Portugal
  - Madeira Islands
  - Azores Region



# Vertical Discretisation

50 vertical layers  
corresponding to the layers  
defined in the model  
Mercator Ocean mercator  
Psy2v4

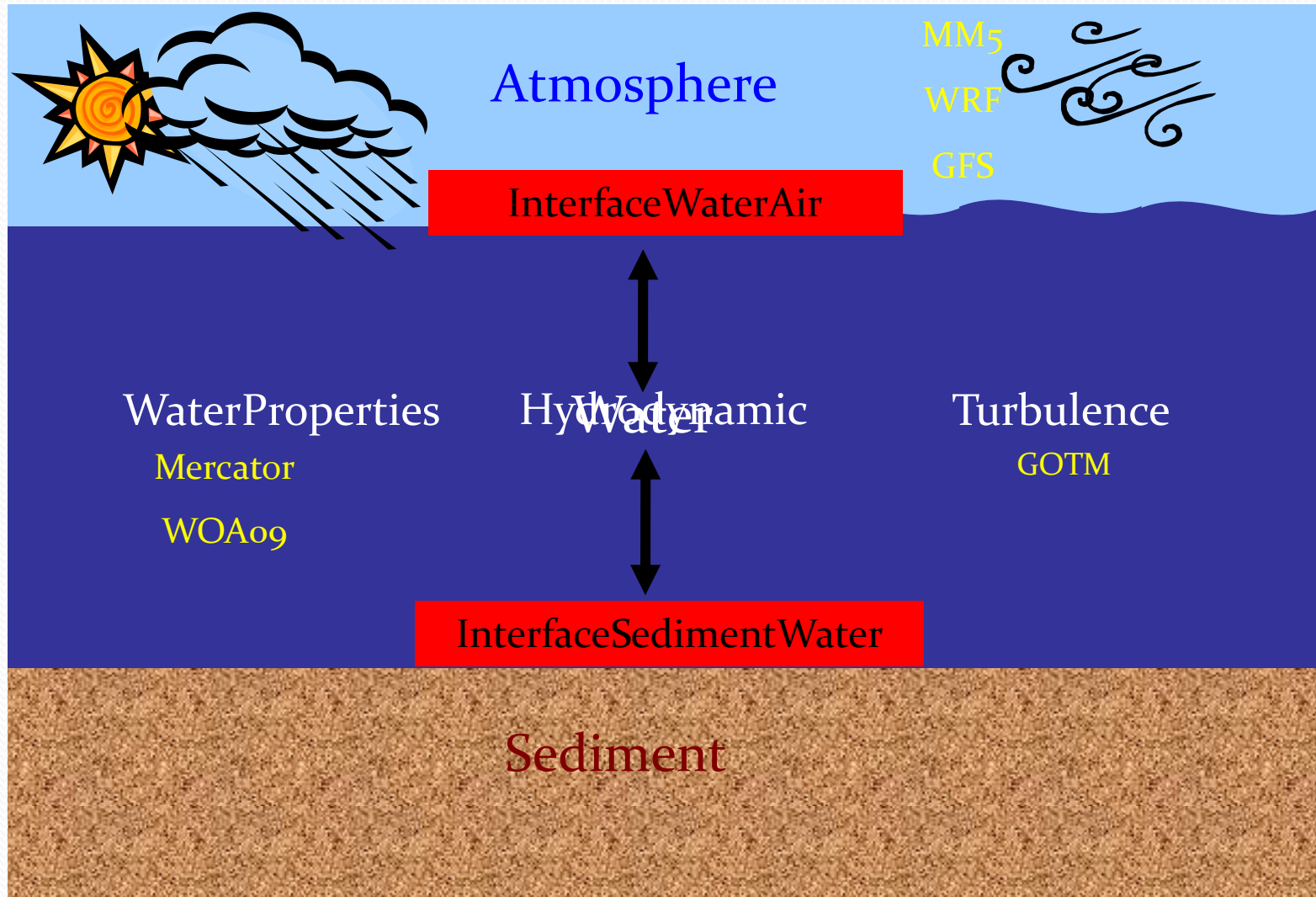


L	W (m)	C	W (m)	C	W (m)	C	W (m)	C	W (m)
1	0.98	11	2.44	21	13.06	31	79.87	41	295.81
2	1.12	12	2.93	22	15.89	32	94.43	42	320.71
3	1.09	13	3.27	23	18.91	33	110.53	43	344.02
4	1.25	14	3.96	24	22.97	34	129.00	44	366.22
5	1.27	15	4.50	25	27.40	35	149.01	45	386.20
6	1.46	16	5.48	26	33.15	36	171.19	46	404.70
7	1.51	17	6.34	27	39.55	37	194.52	47	420.78
8	1.78	18	7.72	28	47.58	38	219.40	48	435.36
9	1.88	19	9.06	29	56.59	39	244.66	49	447.62
10	2.25	20	11.03	30	67.58	40	270.56	50	458.65

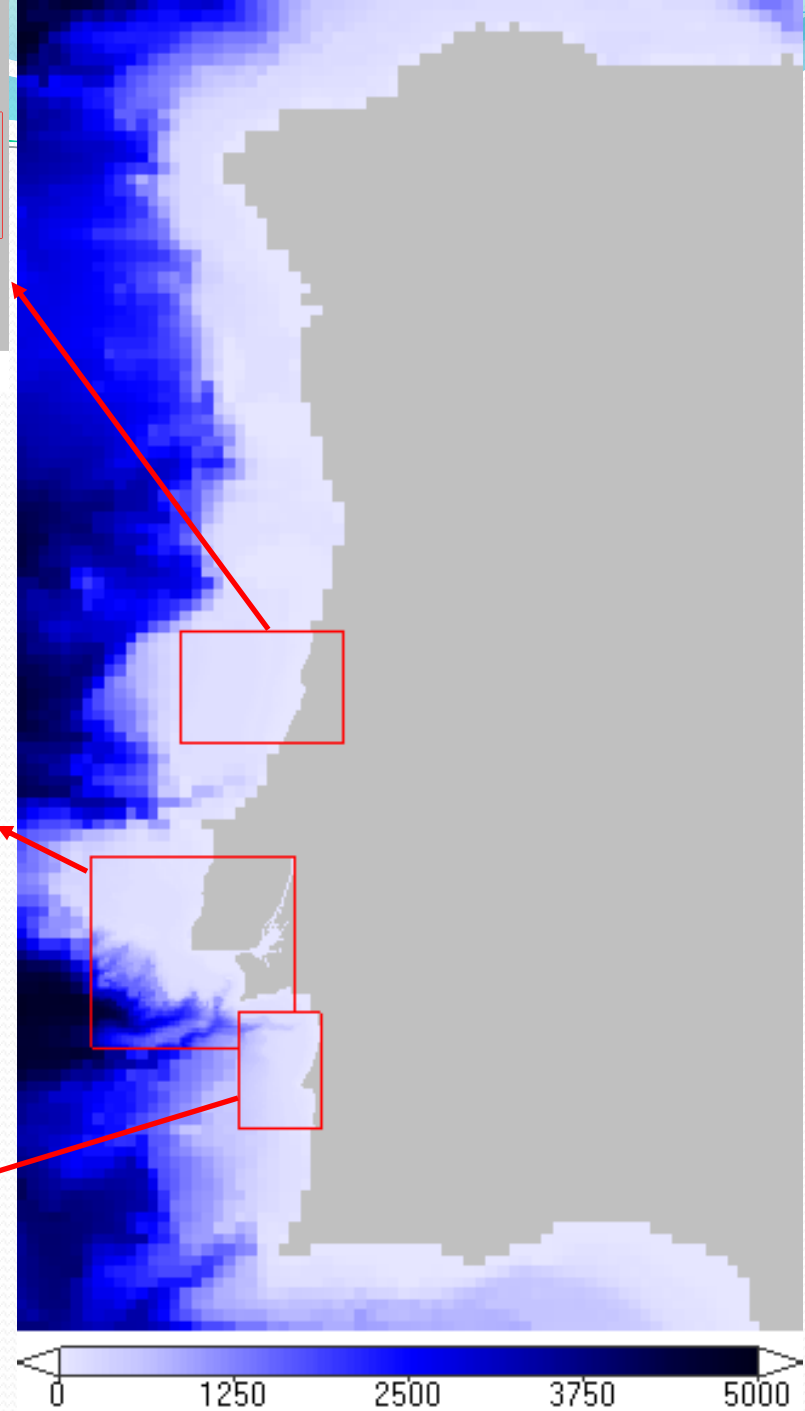
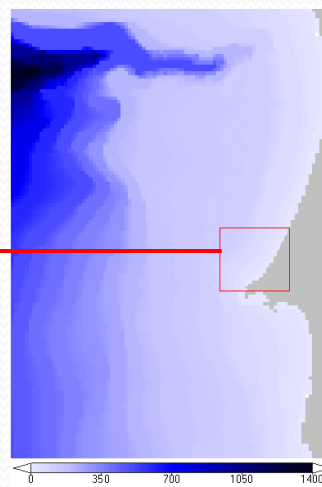
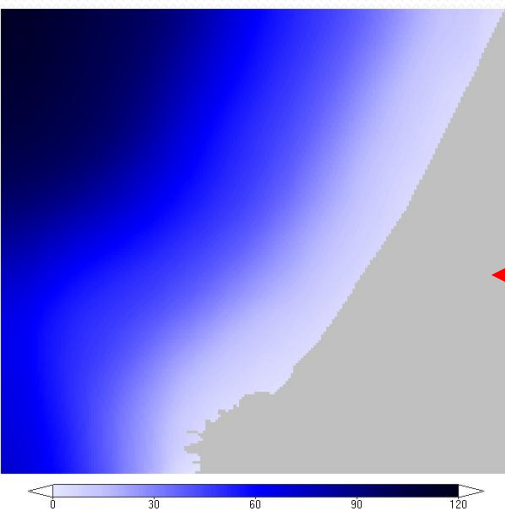
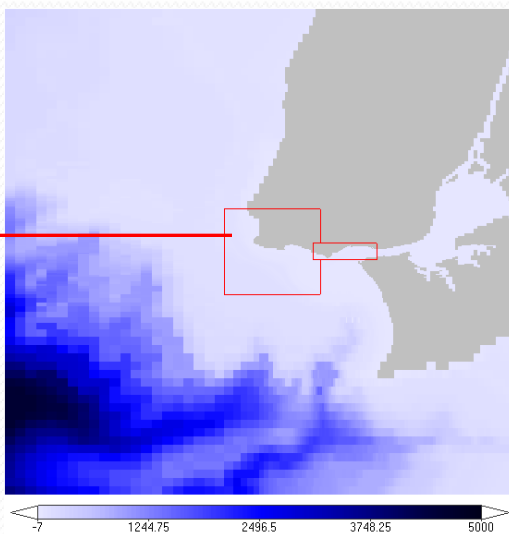
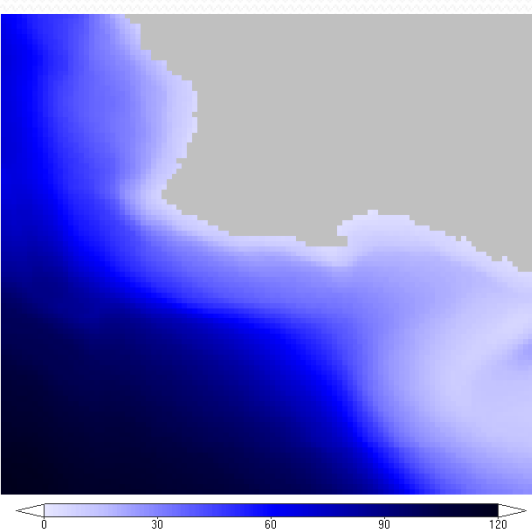
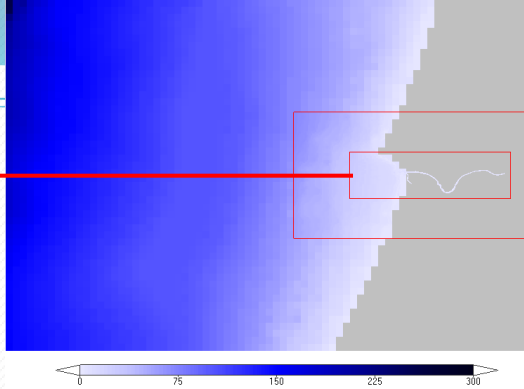
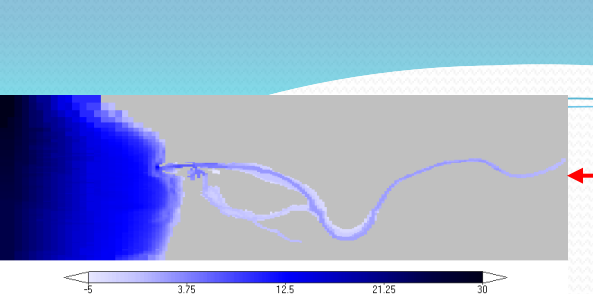
L = Layer W = Width



# Coupled Atmospheric-Hydro-Ecological model









**Level 1**

**Level 2**

**Level 3**

**Level 4**

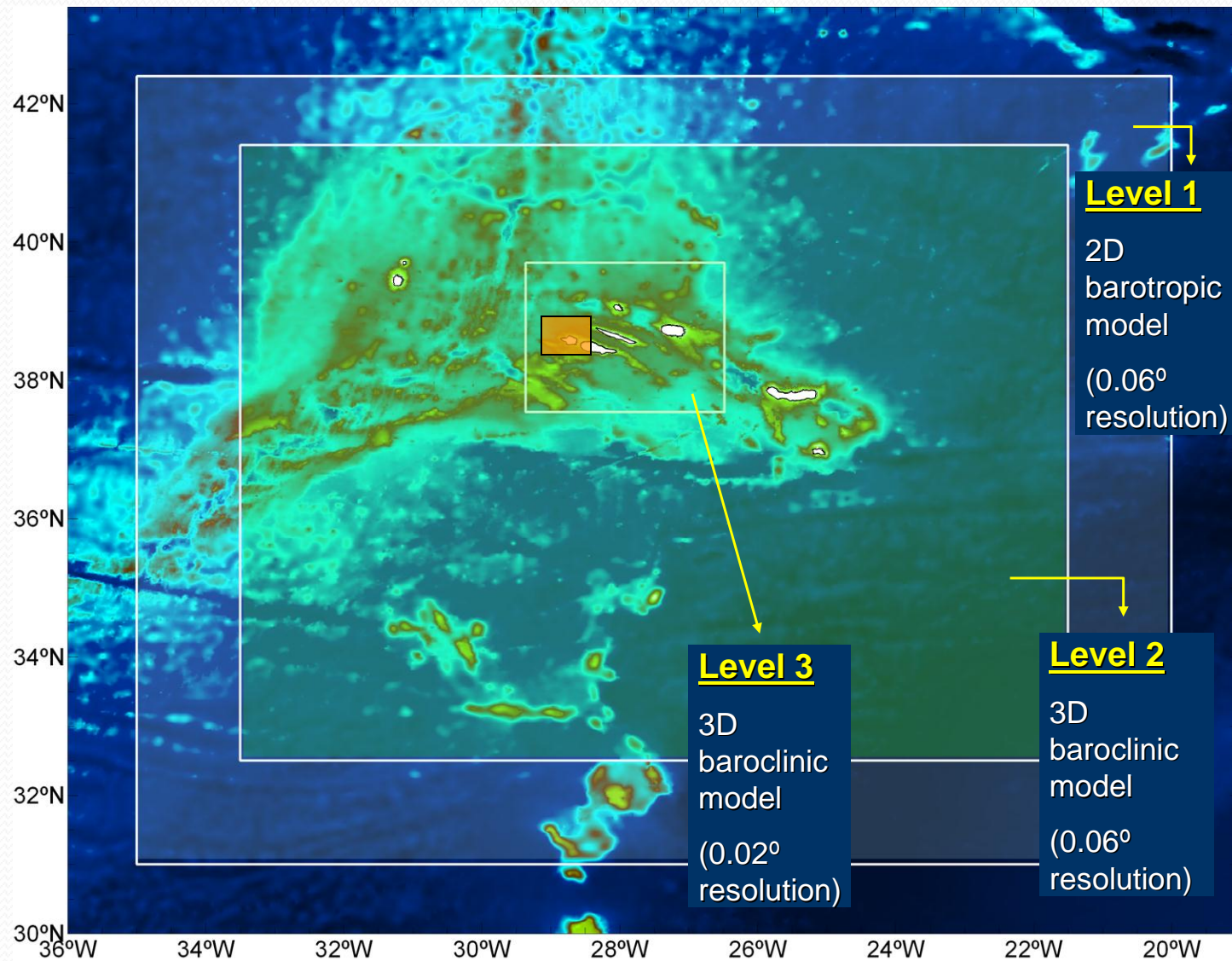
**Level 5**



Profundidade (m)

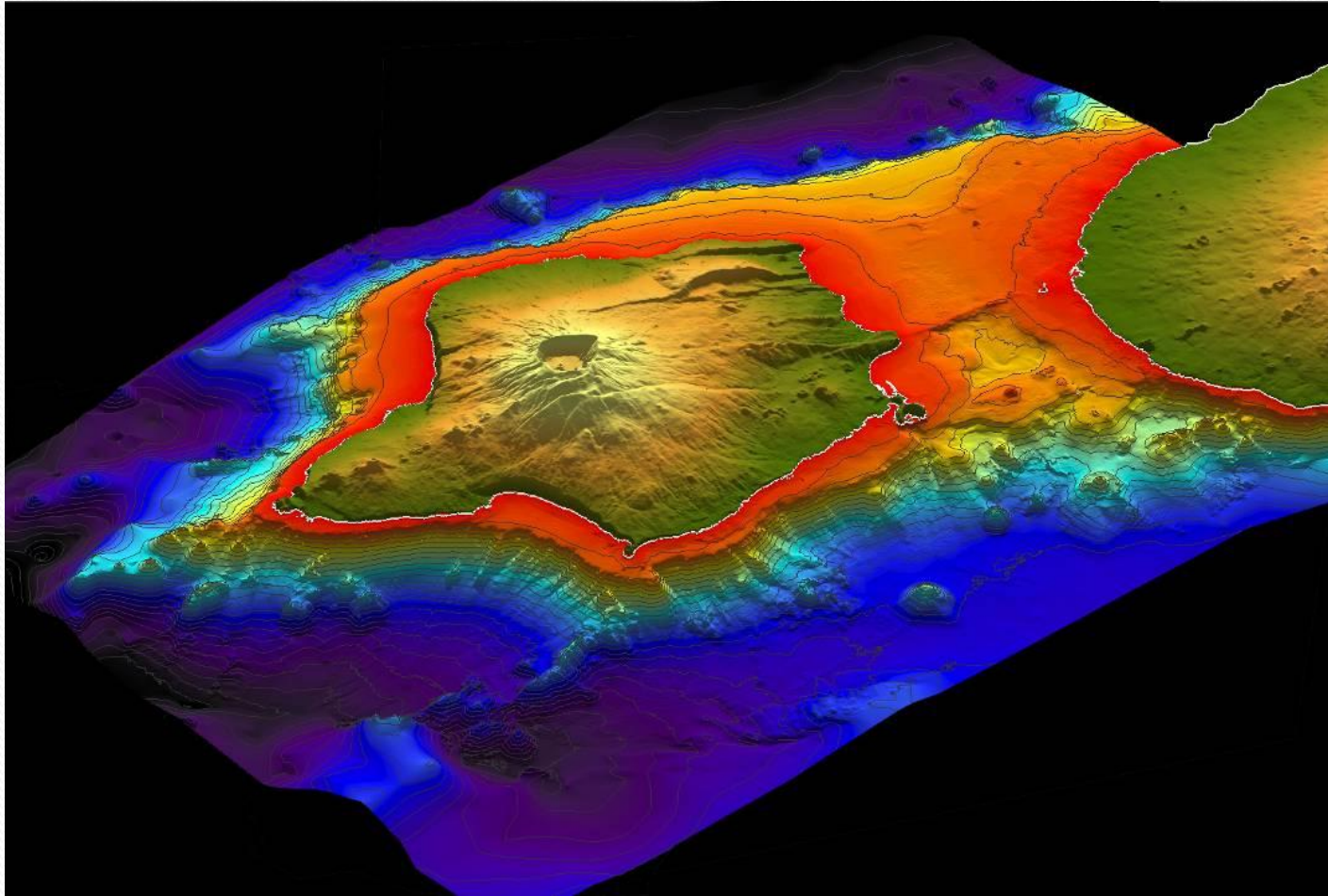


# The Azores region





# Faial-Pico channel





**Level 4A - Faial – Pico Channel**

**Level 4B - Condor Seamount**

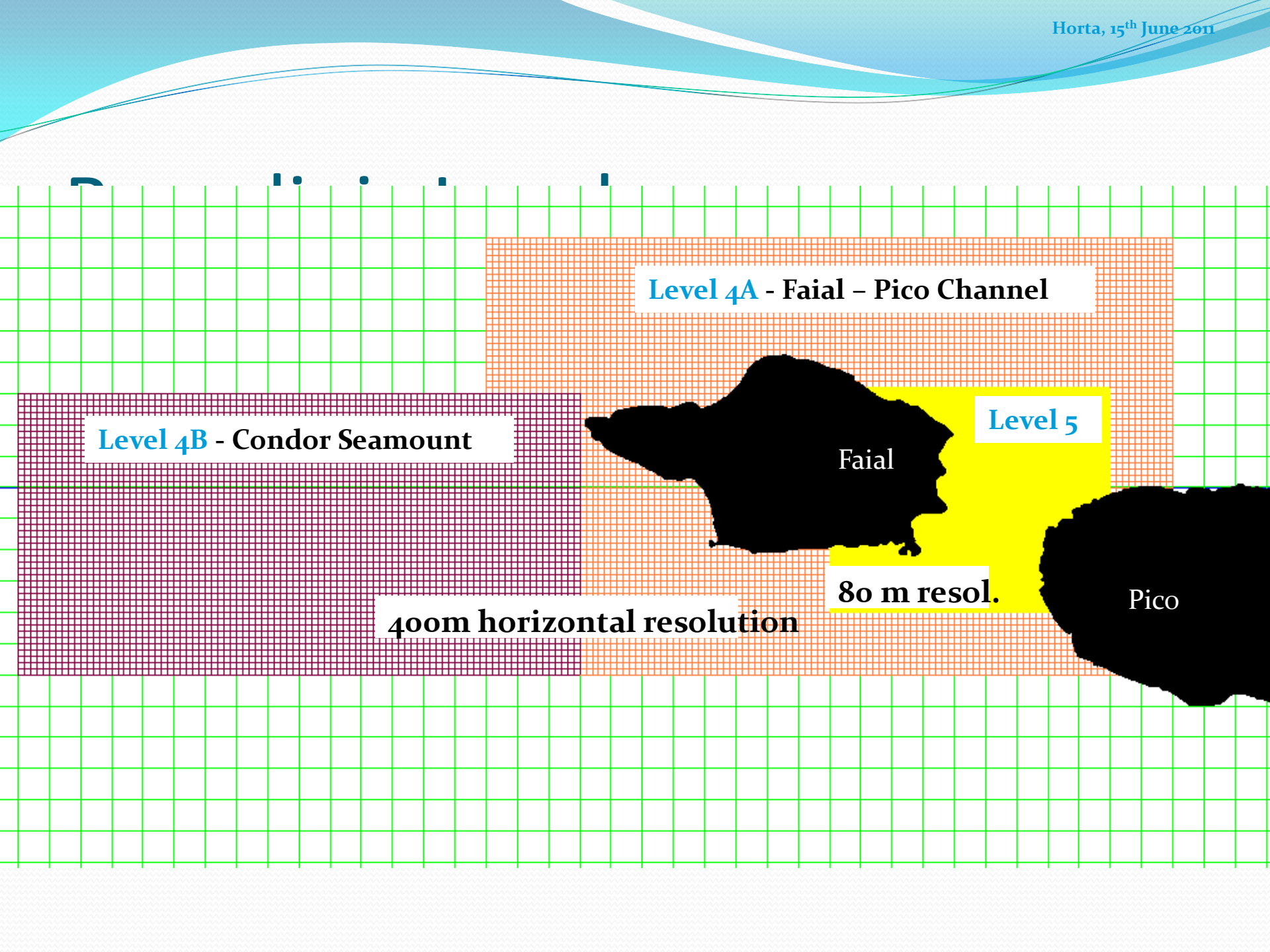
**Level 5**

Faial

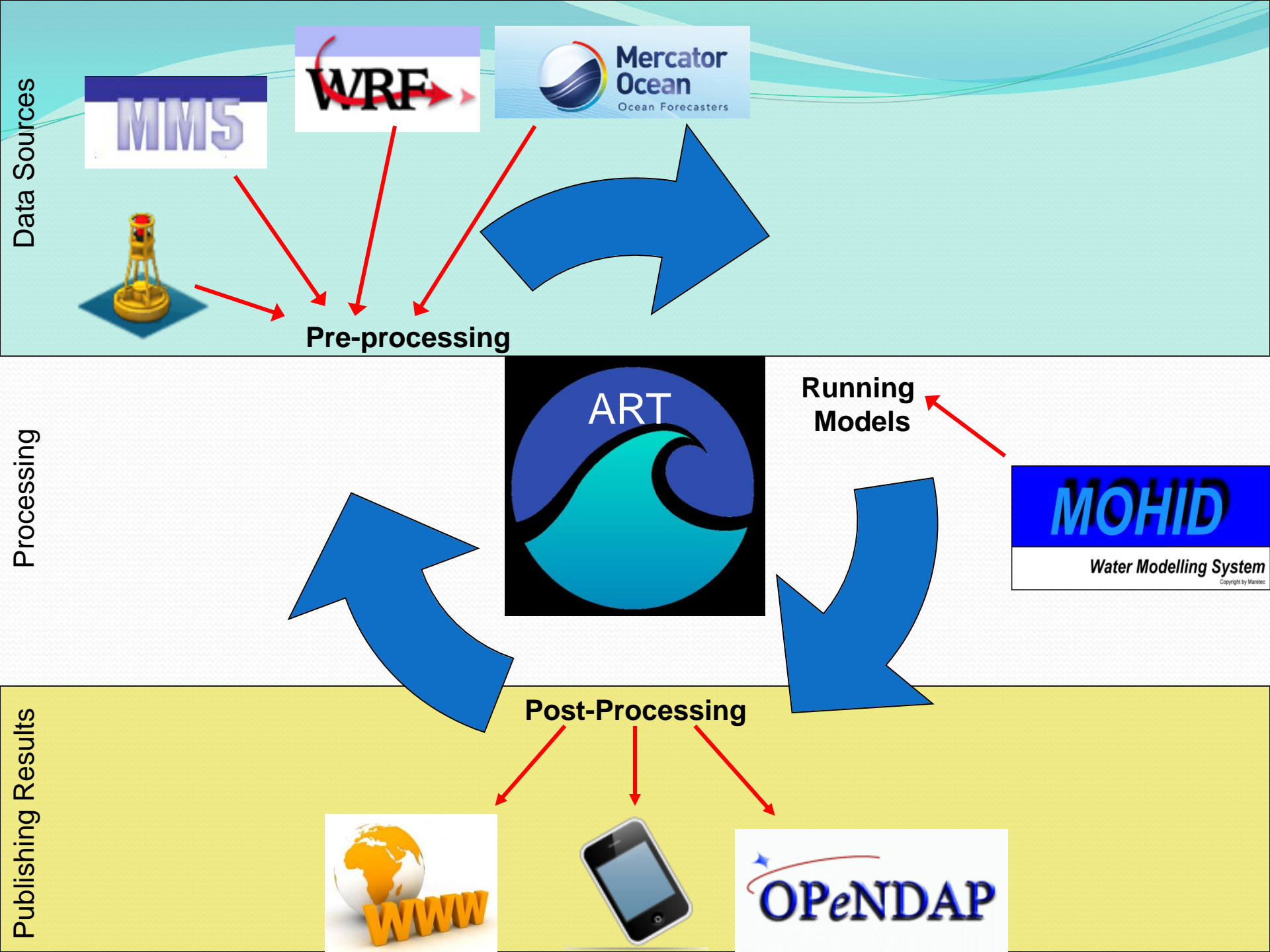
**80 m resol.**

Pico

**400m horizontal resolution**







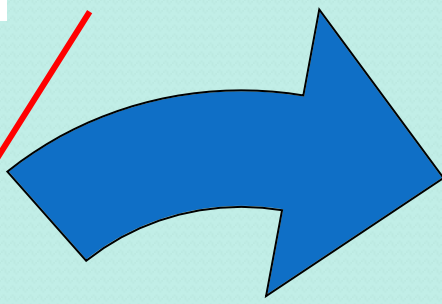
Data Sources

Processing

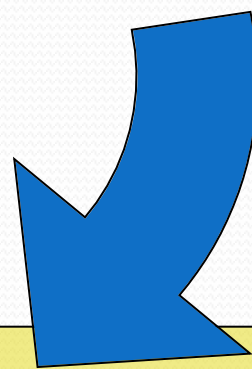
Publishing Results



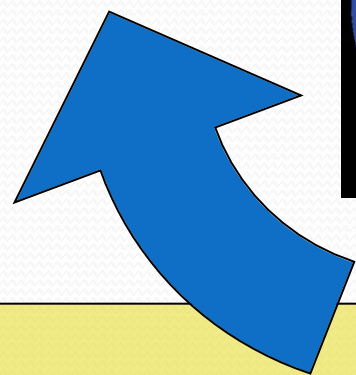
Pre-processing



Running Models



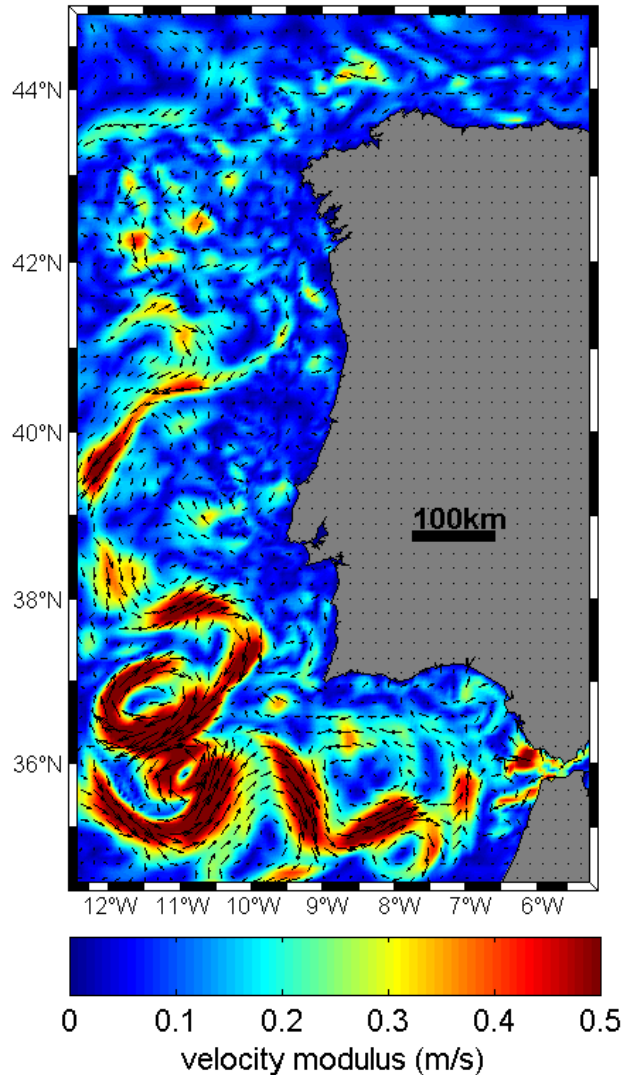
Post-Processing



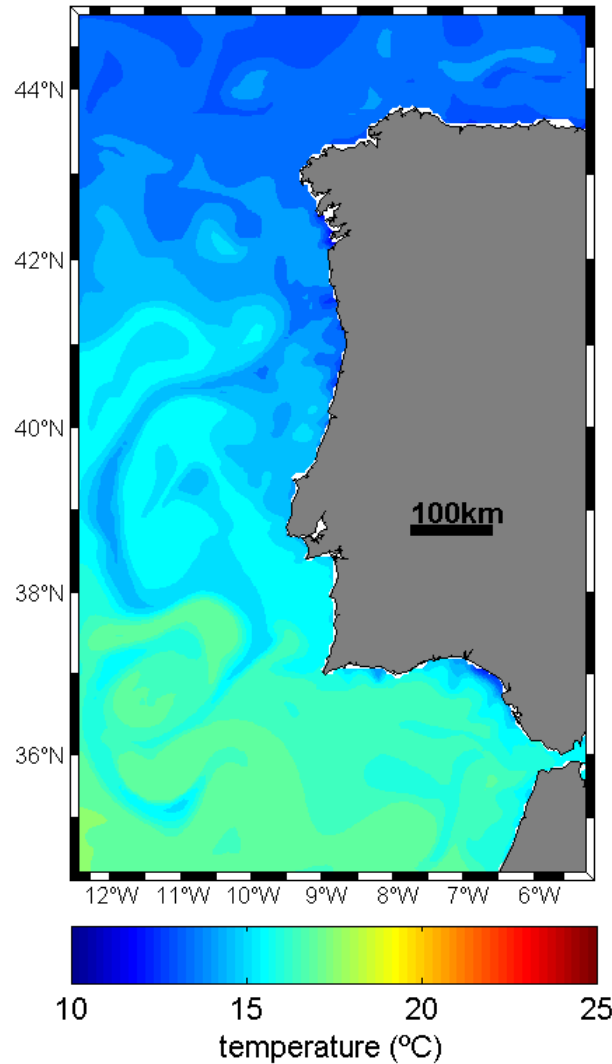


# Surface plots

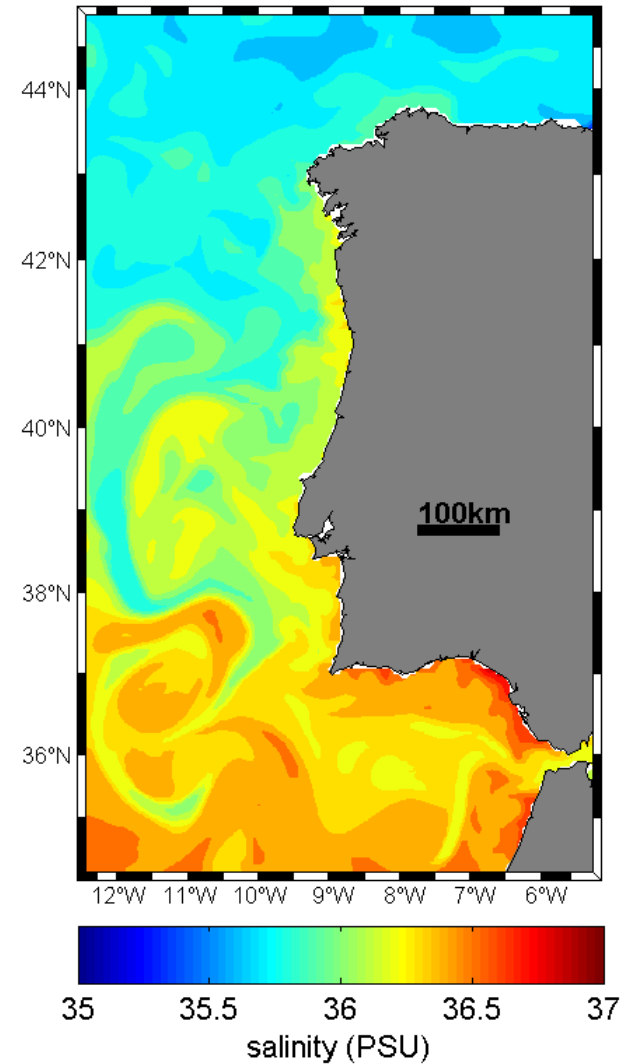
25-Jan-2012 00:00:00



25-Jan-2012 00:00:00



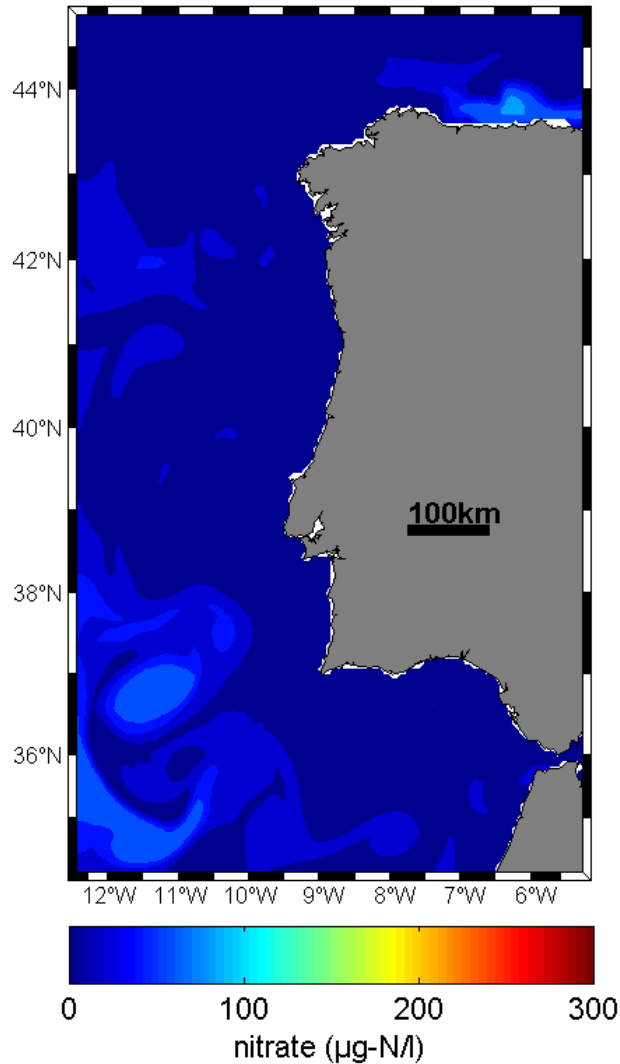
25-Jan-2012 00:00:00



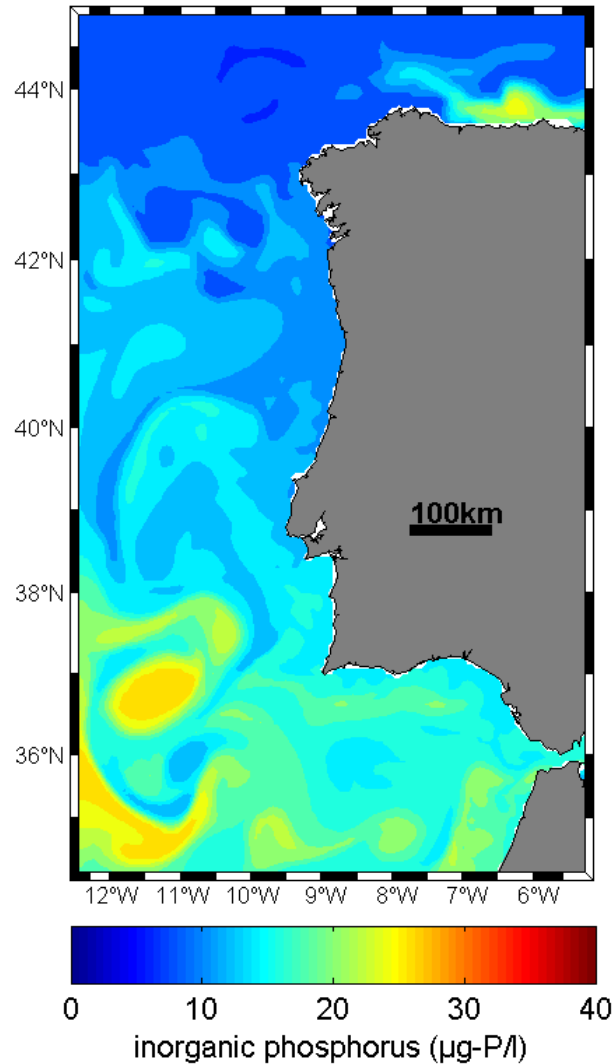


# Surface plots

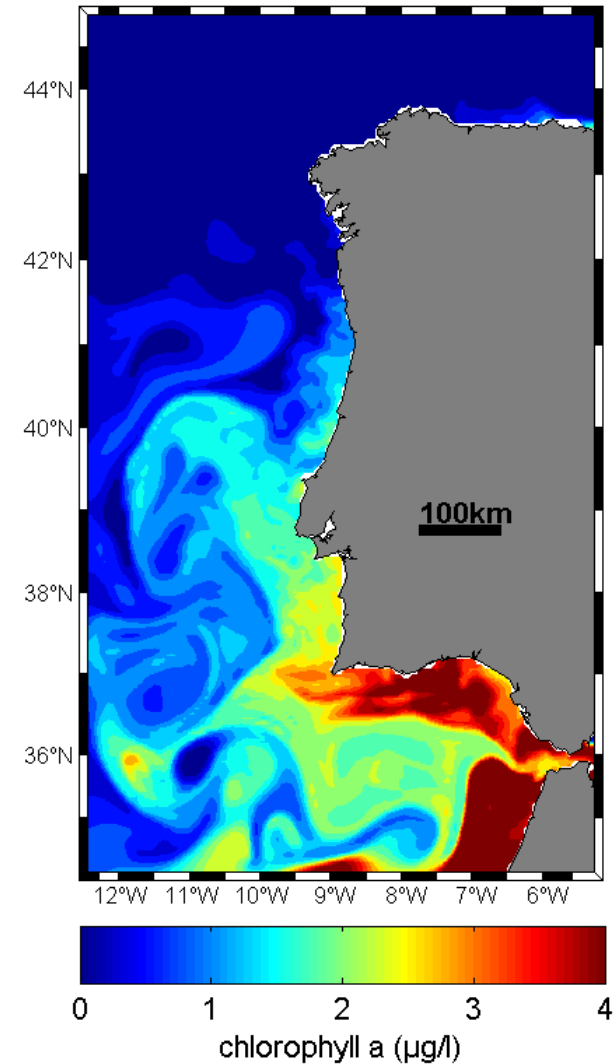
25-Jan-2012 00:00:00



25-Jan-2012 00:00:00

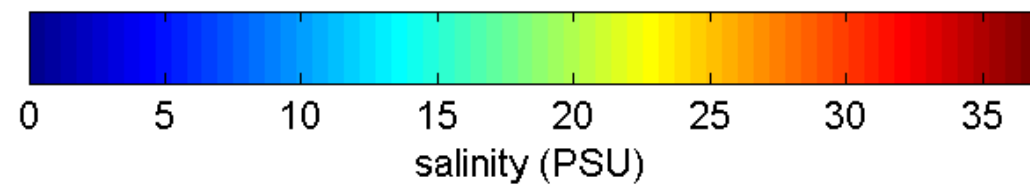
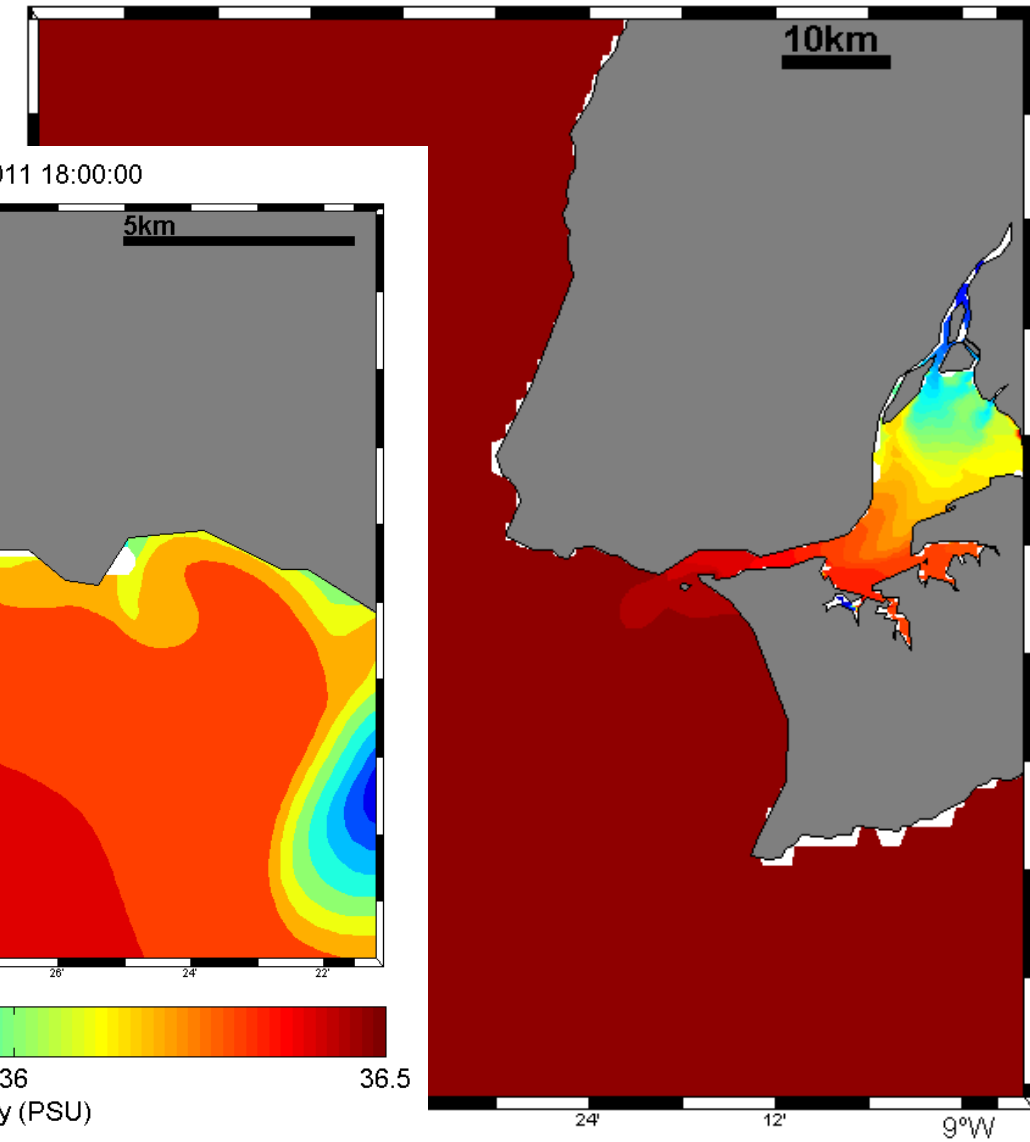
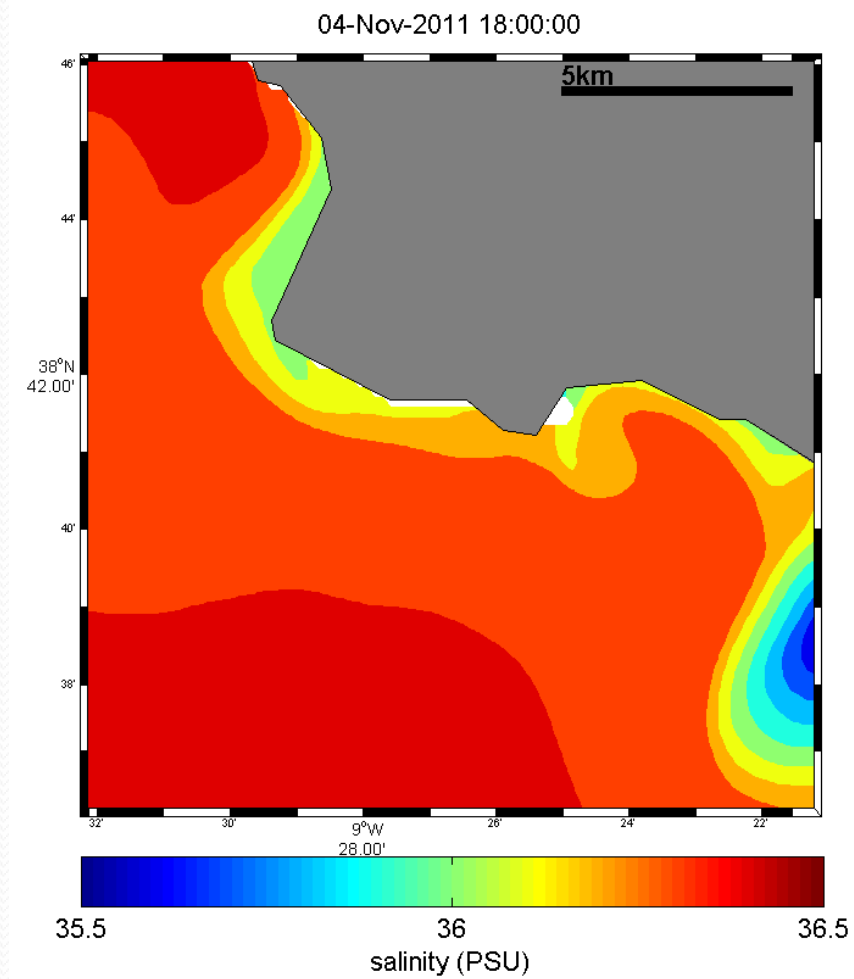


25-Jan-2012 00:00:00



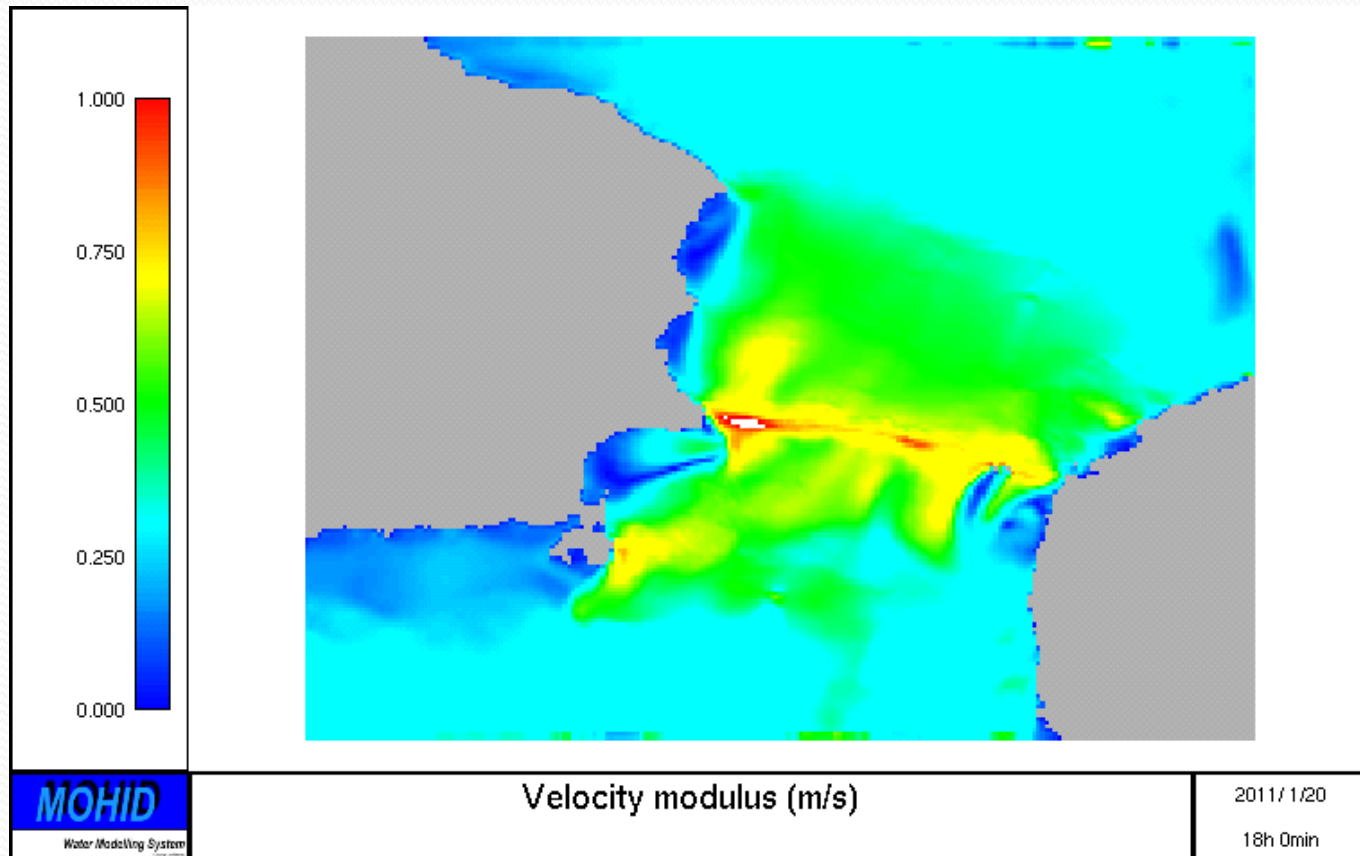


04-Nov-2011 18:00:00



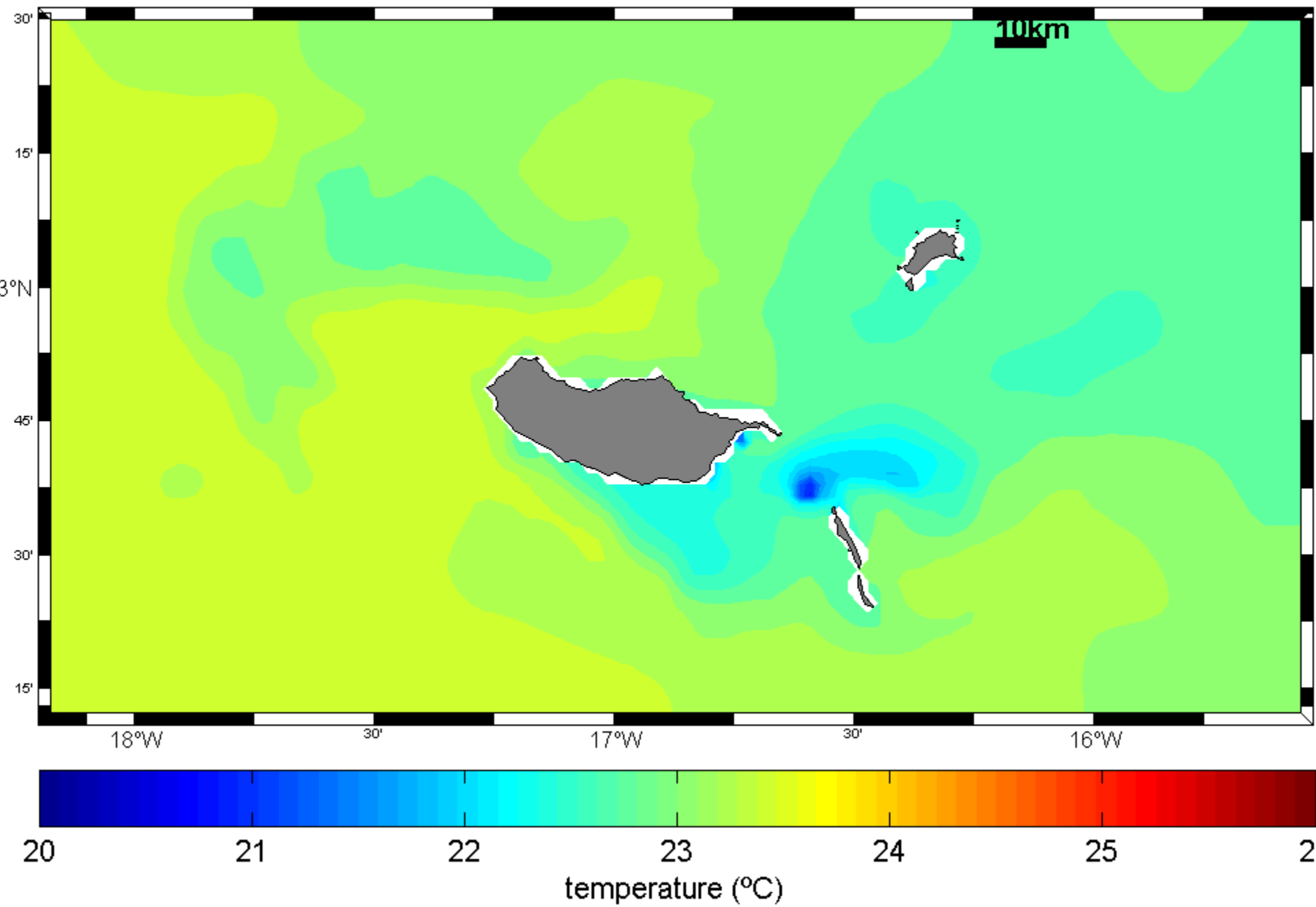


# Results





29-Sep-2011 08:00:00



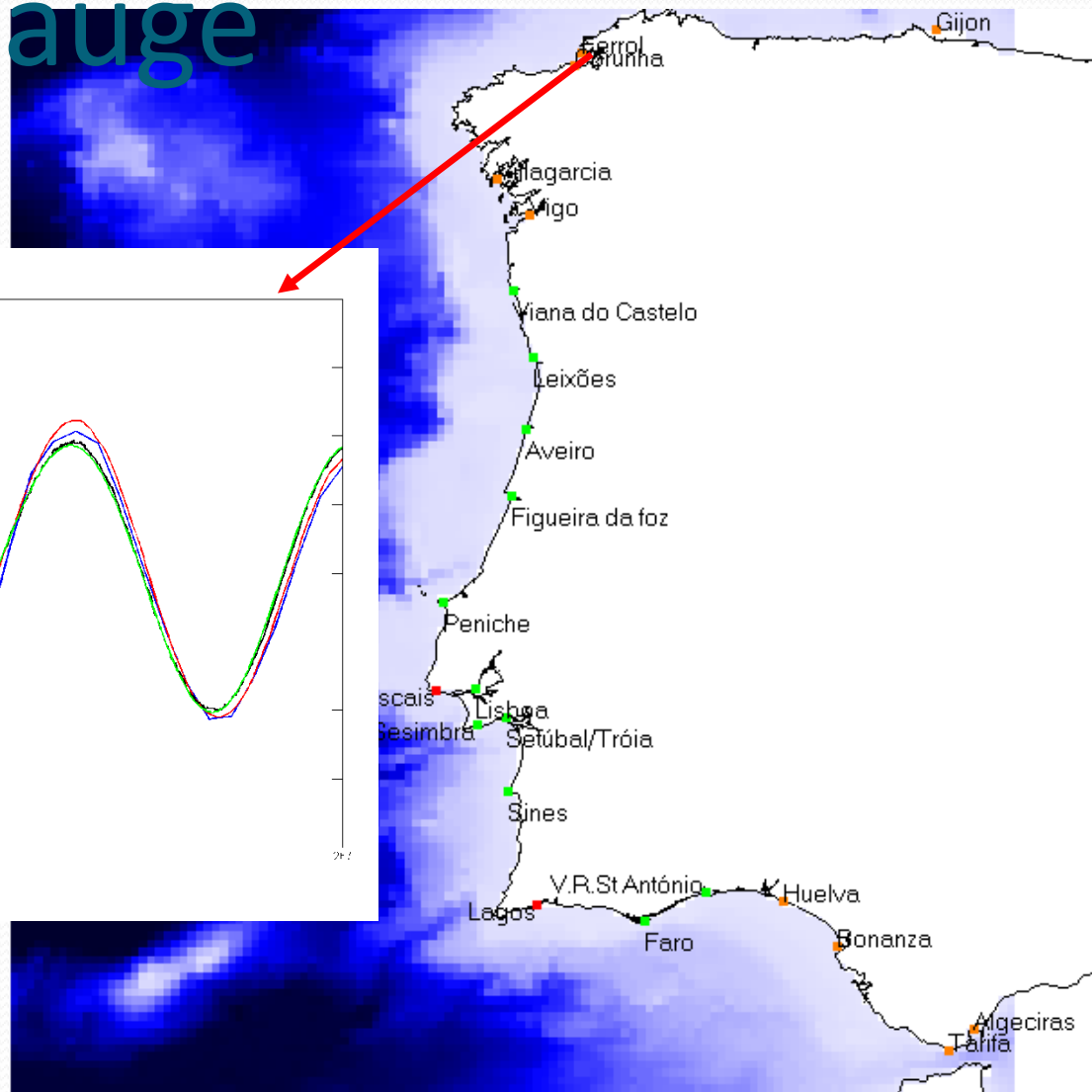
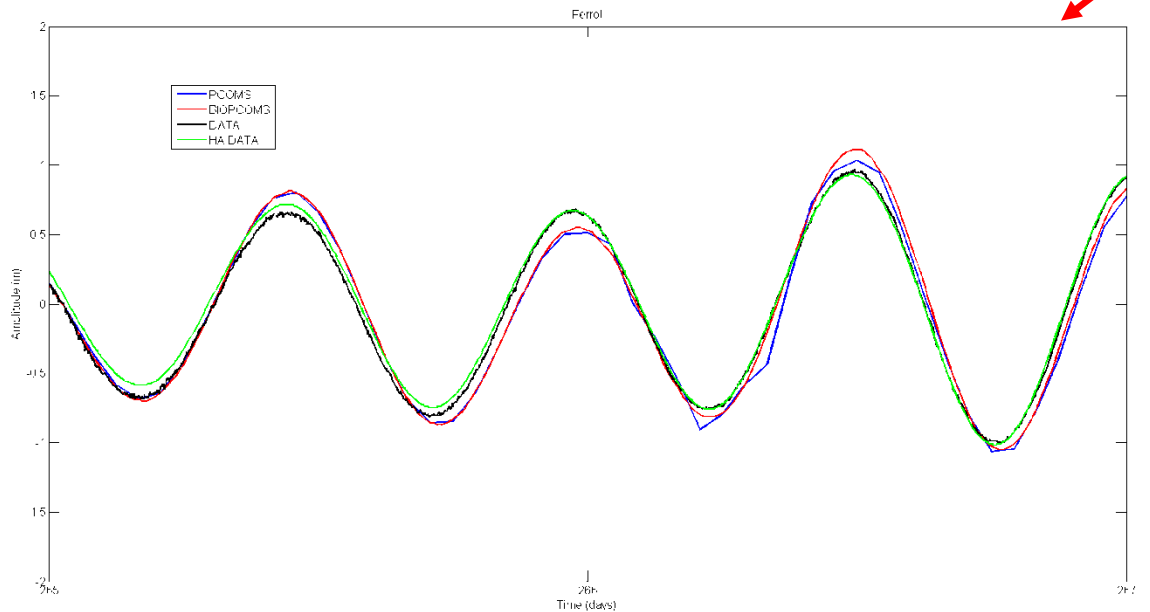


# Validation

- Using sea level data from puertos del estado ftp
- Argos buoys
- Satelite Images

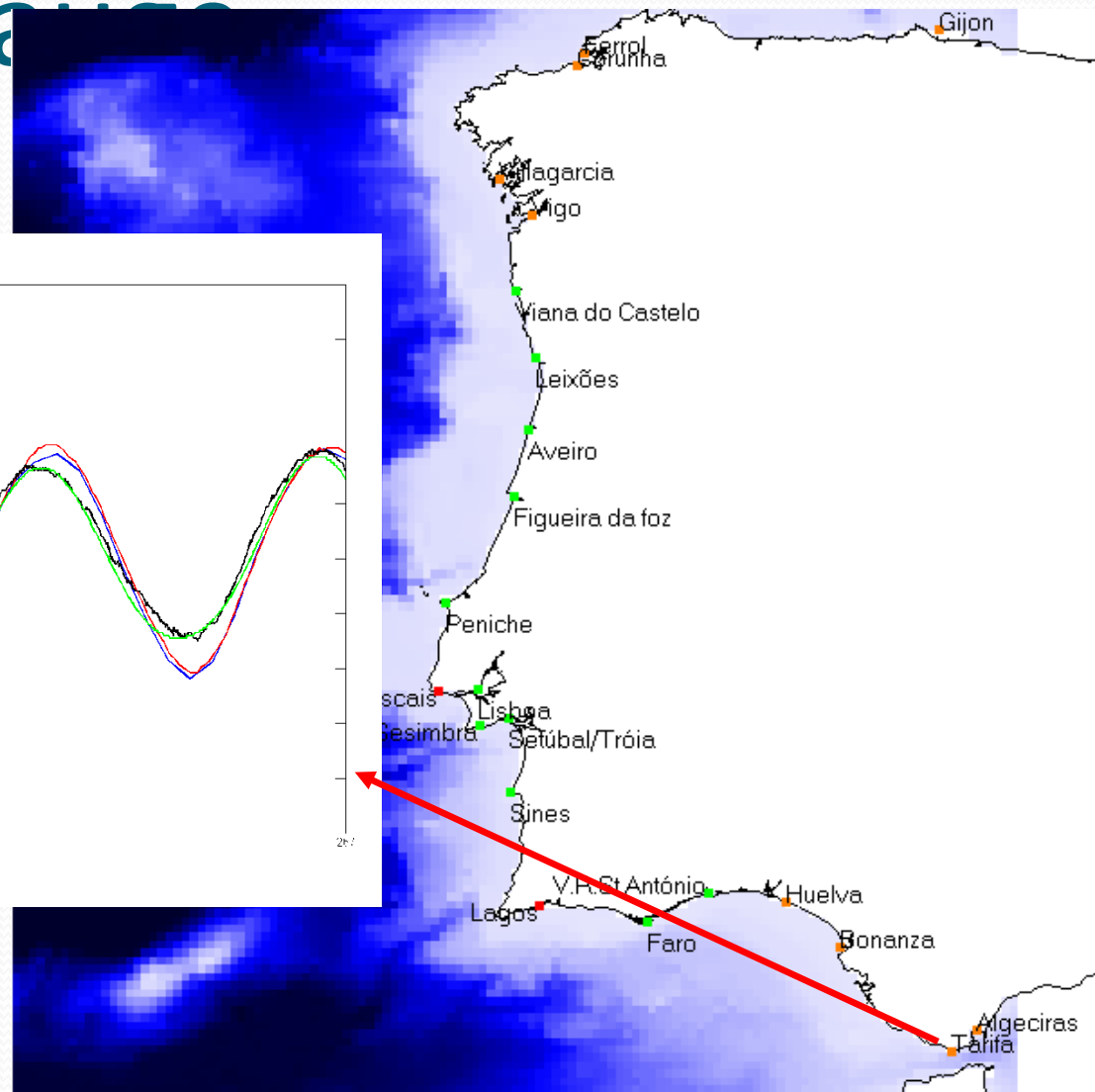
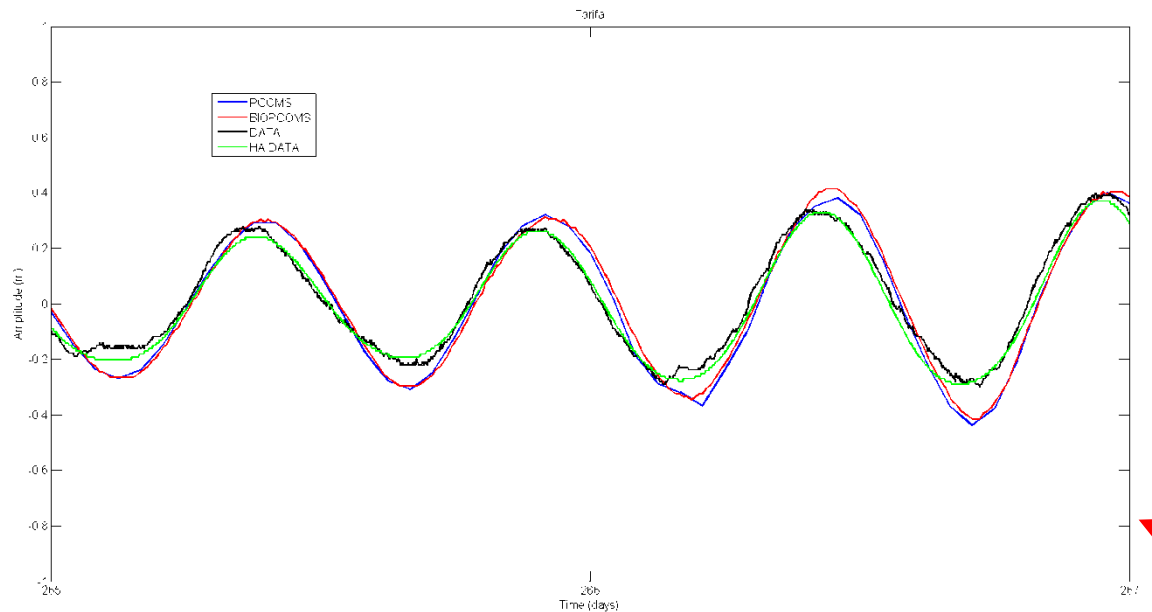


# Ferrol Tidal Gauge



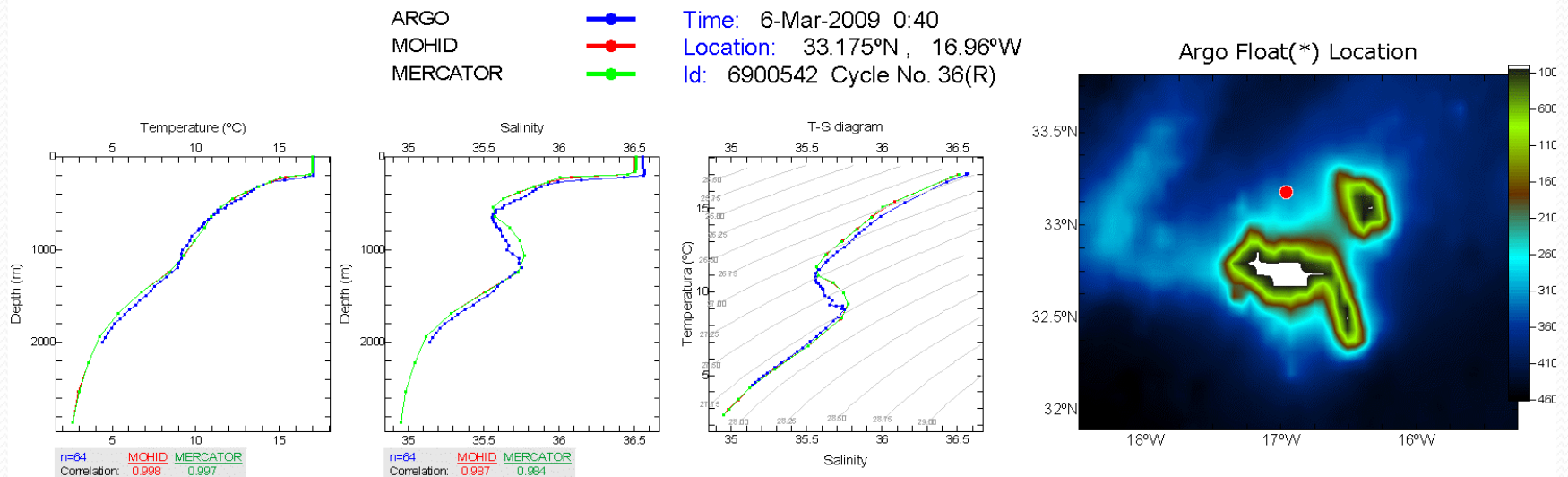


# Tarifa Tidal Gauge





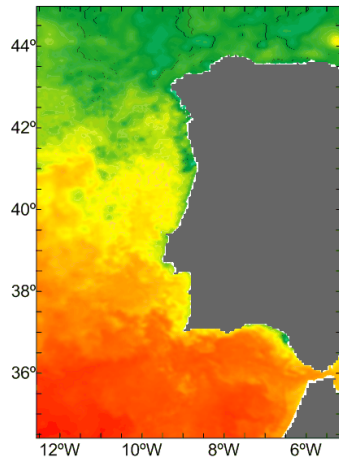
# Argos Buoys



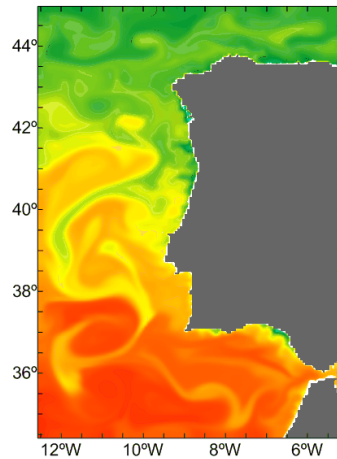


# Satellite Images

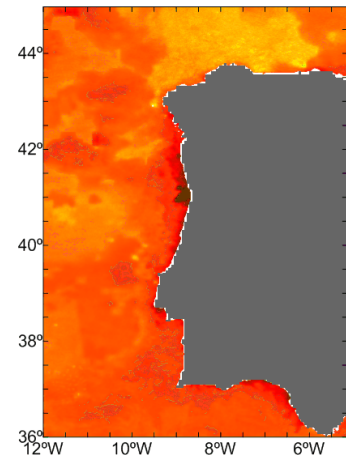
SST (°C) from satellite



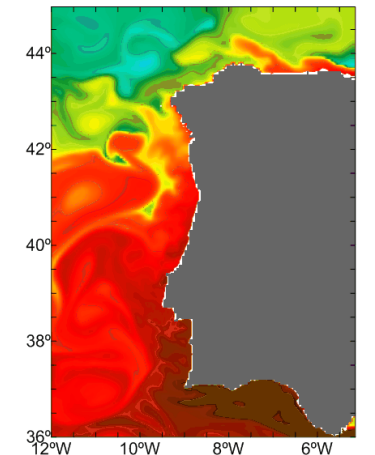
SST (°C) from MOHID



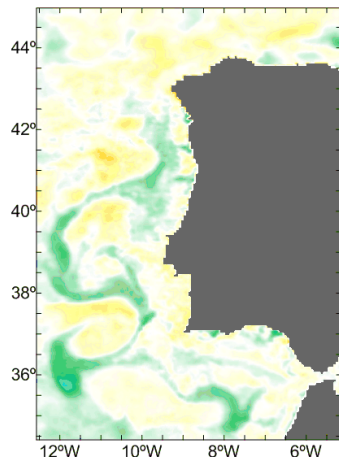
Chl\_a (mg m-3) from satellite



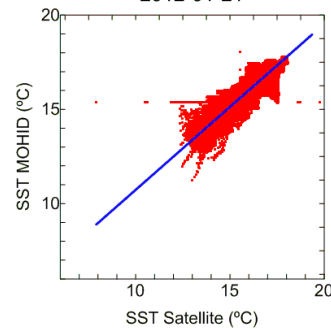
Phytoplankton (mg m-3) from MOHID



MOHID minus Observations

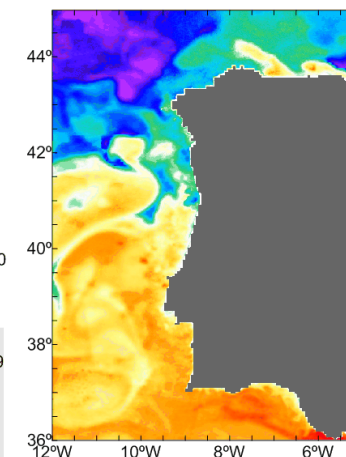


2012-01-21

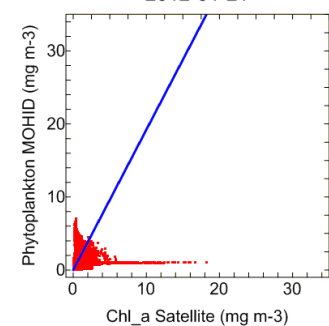


Linear Fit:  $Y = 1.932 + 0.88 * X$   
 Number of data points used = 128869  
 Average model data = 15.399 (°C)  
 Average obser data = 15.31 (°C)  
 Correlation (Pearson):  $R = 0.937$   
 Correlation (Pearson):  $R^2R = 0.878$   
 Bias = 0.089 (°C)  
 RMSE = 0.521 (°C)

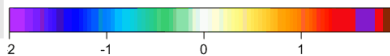
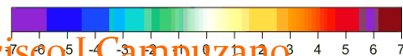
MOHID minus Observations



2012-01-21

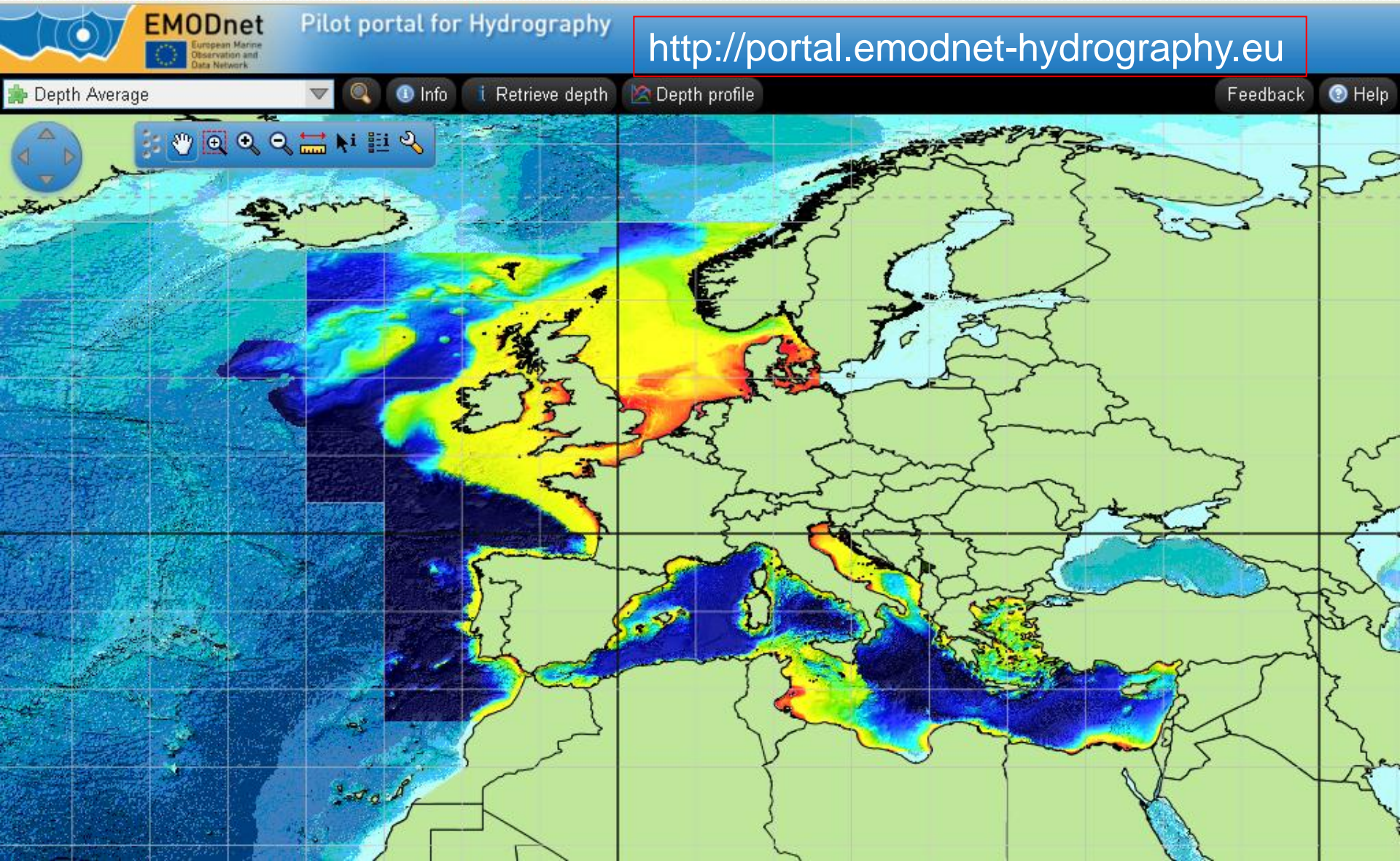


Linear Fit:  $Y = 0.004 + 1.92 * X$   
 Number of data points used = 238191  
 Average model data = 0.858 (mg m-3)  
 Average obser data = 0.324 (mg m-3)  
 Correlation (Pearson):  $R = 0.196$   
 Correlation (Pearson):  $R^2R = 0.038$   
 Bias = 0.534 (mg m-3)  
 RMSE = 1.155 (mg m-3)





# New resources for new bathymetries





# EASY-CO Project

Project Partners  
Study Area



*"Investing in our common future."*

METEOGALICIA

XUNTA DE GALICIA  
CONSELLERÍA DE PESCA  
E ASUNTOS MARÍTIMOS

intecmar  
INSTITUTO TECNOLÓGICO  
PARA O CONTROL DO  
MEDIO MARINO DE GALICIA



Puertos del Estado



Ifremer

Marine Institute  
Foras na Mara



Cefas

Mercator  
Ocean  
Ocean Forecasters



**easyco**

collaborative european atlantic water quality forecasting system



ATLANTIC AREA International Programme  
ESPACIO ATLÁNTICO Programa Internacional  
ESPACE ATLANTIQUE Programme International  
ESPACIO ATLÁNTICO Programa Internacional



MARINE ENVIRONMENT &  
RENEWABLE ENERGIES



European Union  
European Regional  
Development Fund





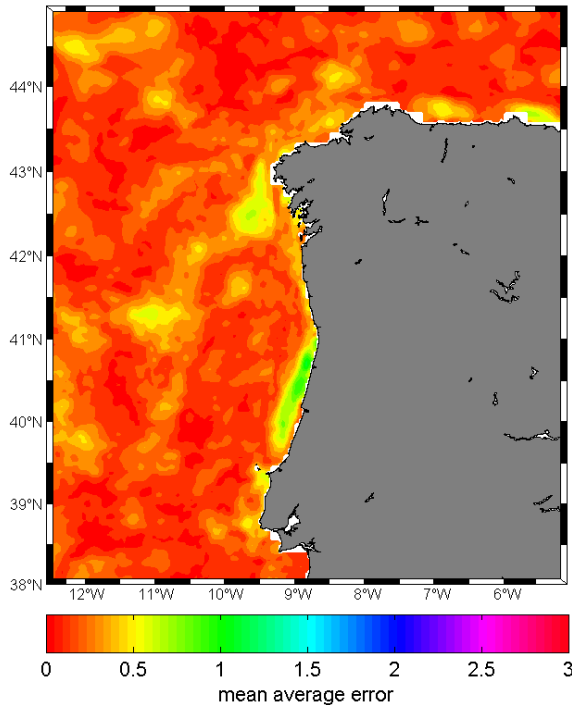
# model intercomparison tool via OpenDAP

- Data: THREDDS servers from EASYCO partners (IST, MeteoGalicia, Puertos del Estado, IMI, IFREMER, MERCATOR)
- Automatic Tool:
  - Runs daily
  - model images and comparison plots (absolute differences)
  - Results Published online:
- Semi-Automatic Tool:
  - On demand (user must define start and end period)
  - Model images and comparison plots (absolute differences)
  - Maps and time series with statistical analysis (MAE, RMSE, etc.)



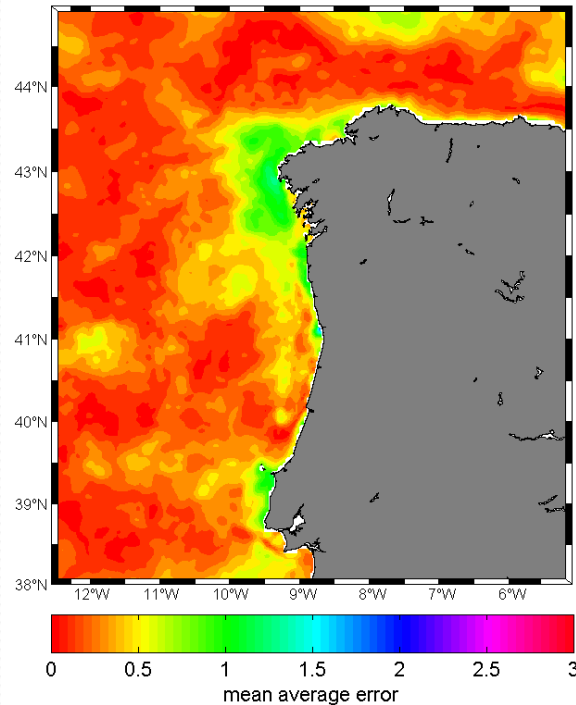
# NW Iberia – SST Mean Absolute Error (MAE) to ODYSSEA

SST mean average error: mercator nwiberia vs ODYSSEA



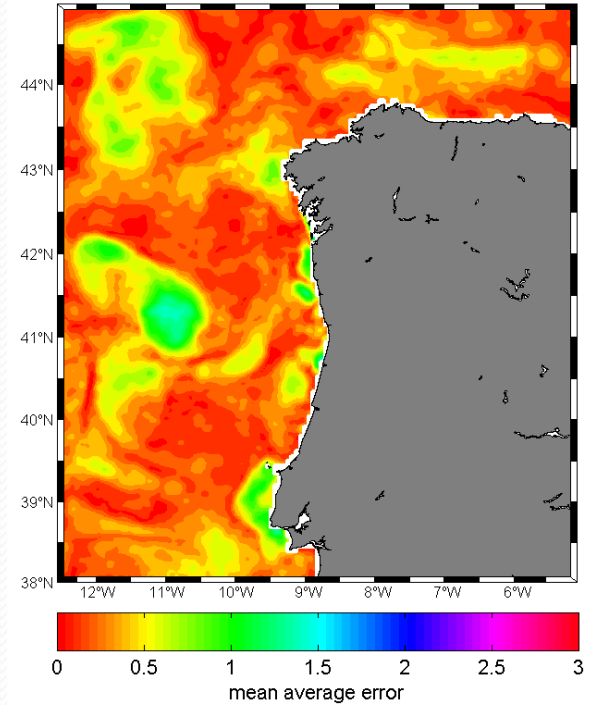
MERCATOR

SST mean average error: puertos nwiberia vs ODYSSEA



PUERTOS

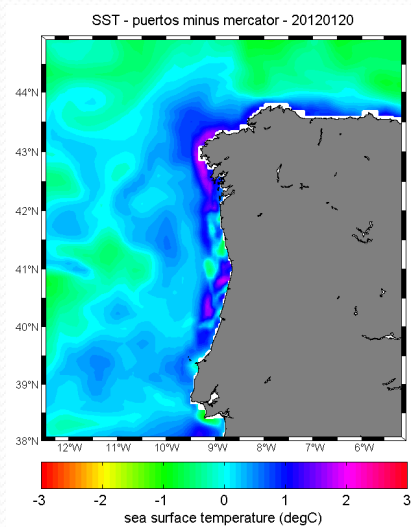
SST mean average error: ist nwiberia vs ODYSSEA



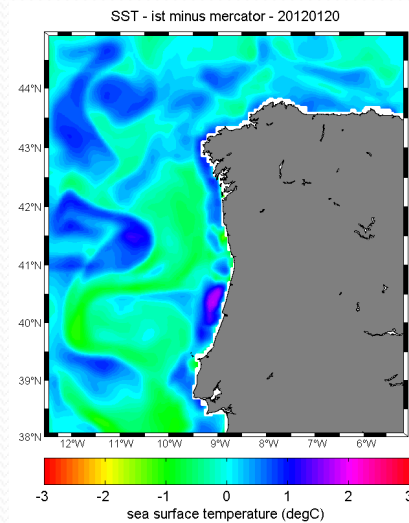
IST



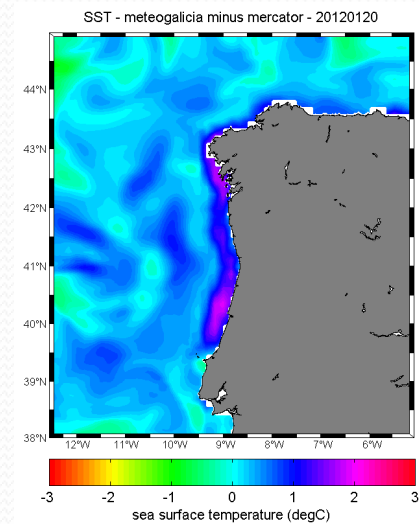
# NW Iberia – Instantaneous SST (model – Mercator)



PUERTOS



IST



METEOGALICIA

20 Jan 2012



# Next Steps

- Compilation in Matlab Compiler (allowing the tool to run in computers without Matlab license)
- Web Page for Automatic and Semi-Automatic (statistical analysis) intercomparison tools



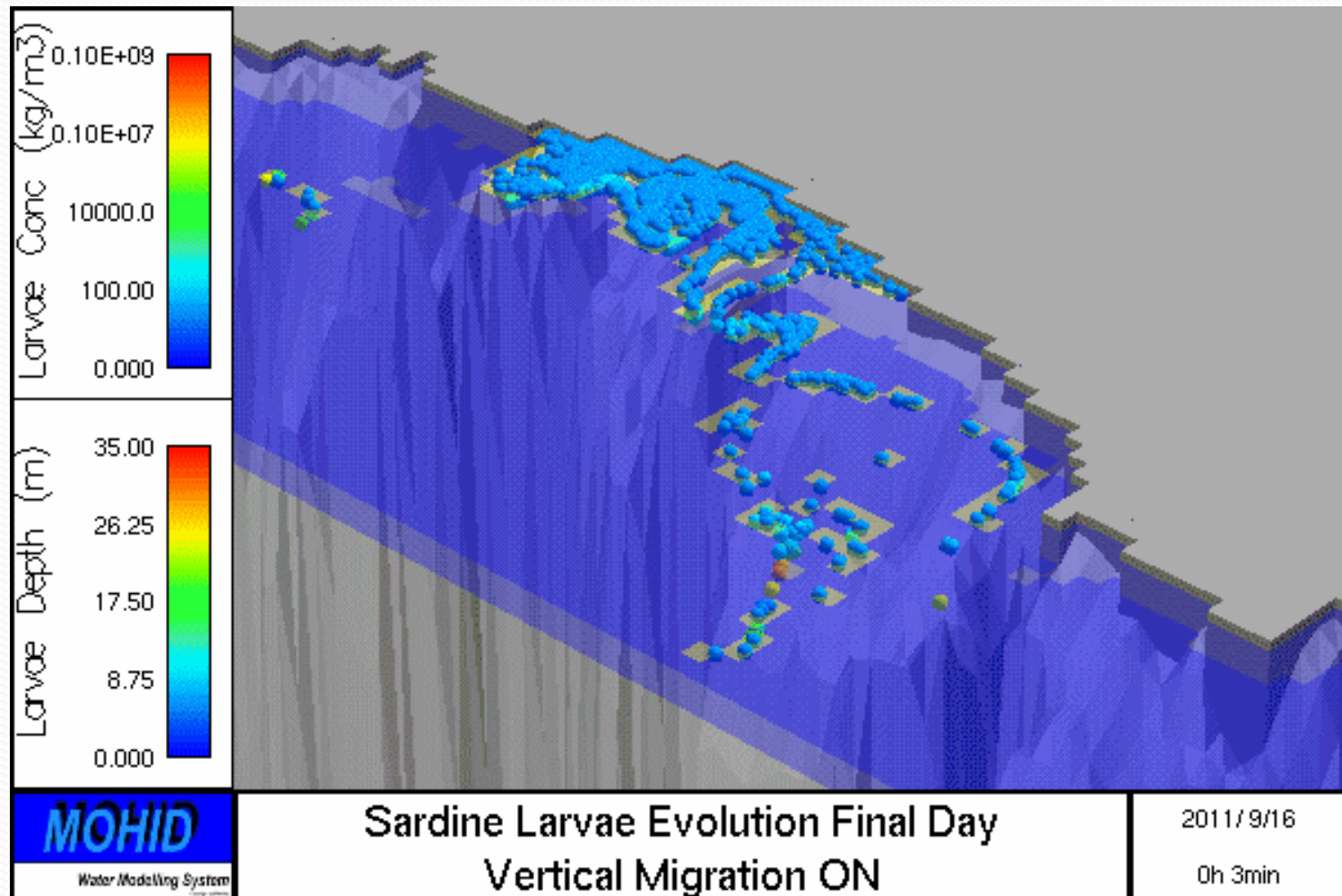
# Some applications

- Fish larvae
- Dynamic risk tool
- Oil spills
- Harmful algae blooms (HAB)



# Fish Larvae Simulation

Vertical Migration ON





History: Small boat (6 m)

30 Sep 2011 : 12h– Fishing at sea close to Terceira;

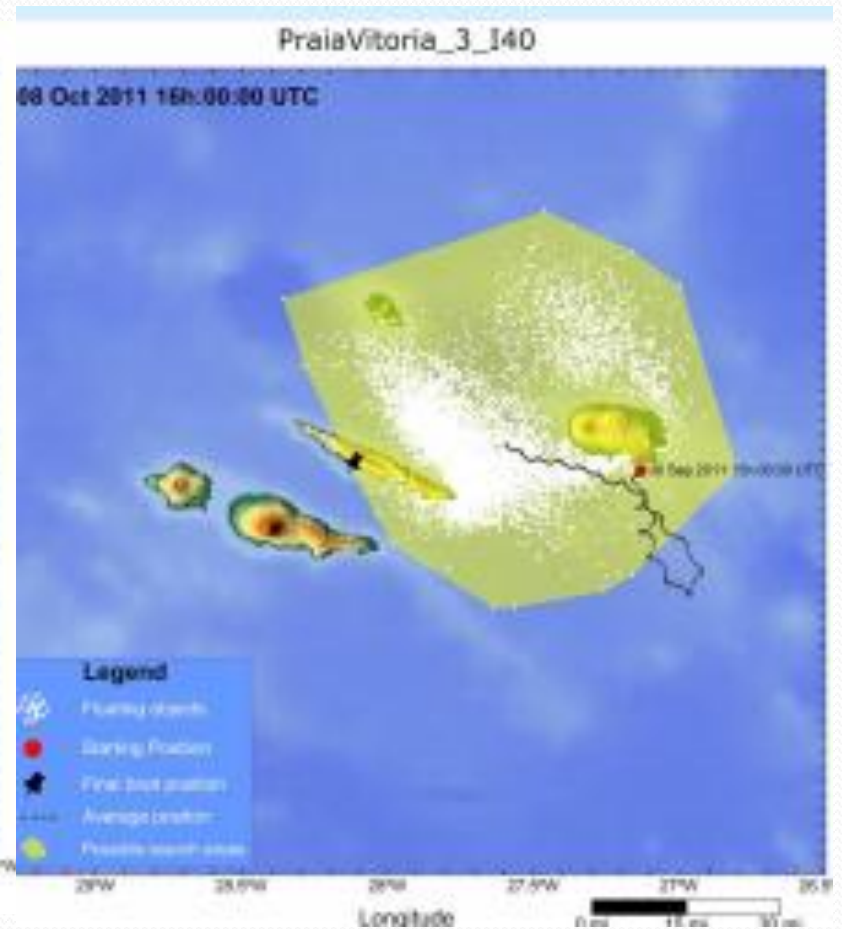
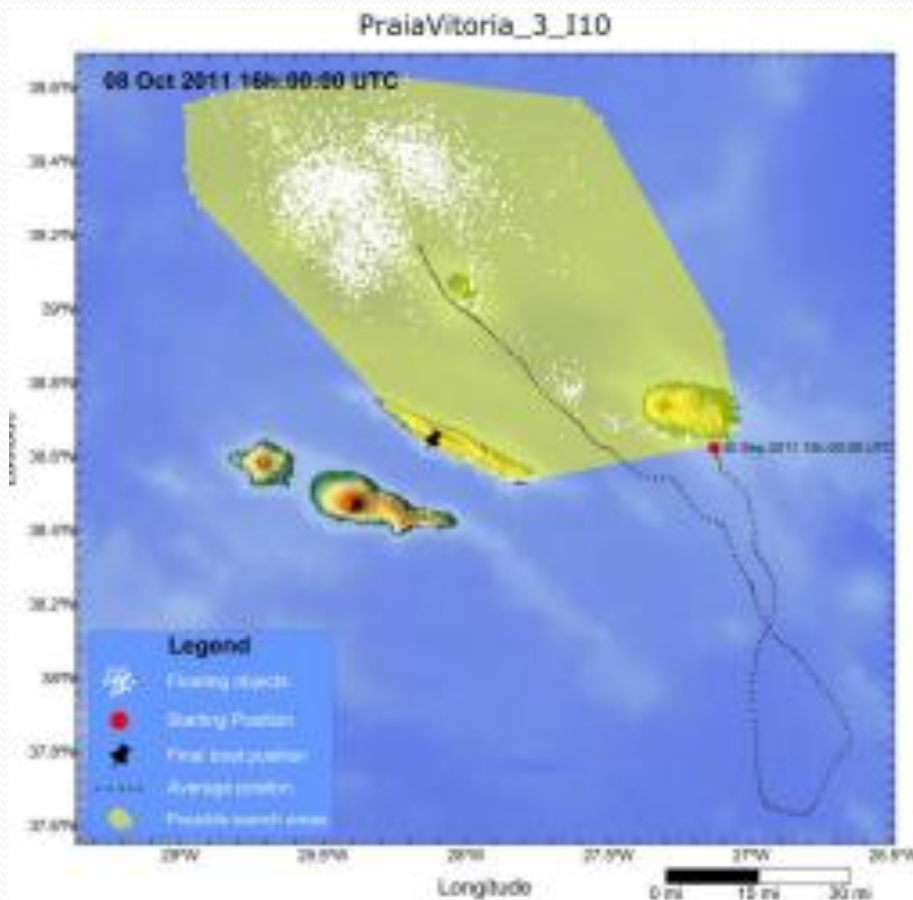
30 Sep 2011 : 14h – Seen for the last time;

11 Oct 2011 : 13h – Found dead in S.Jorge.





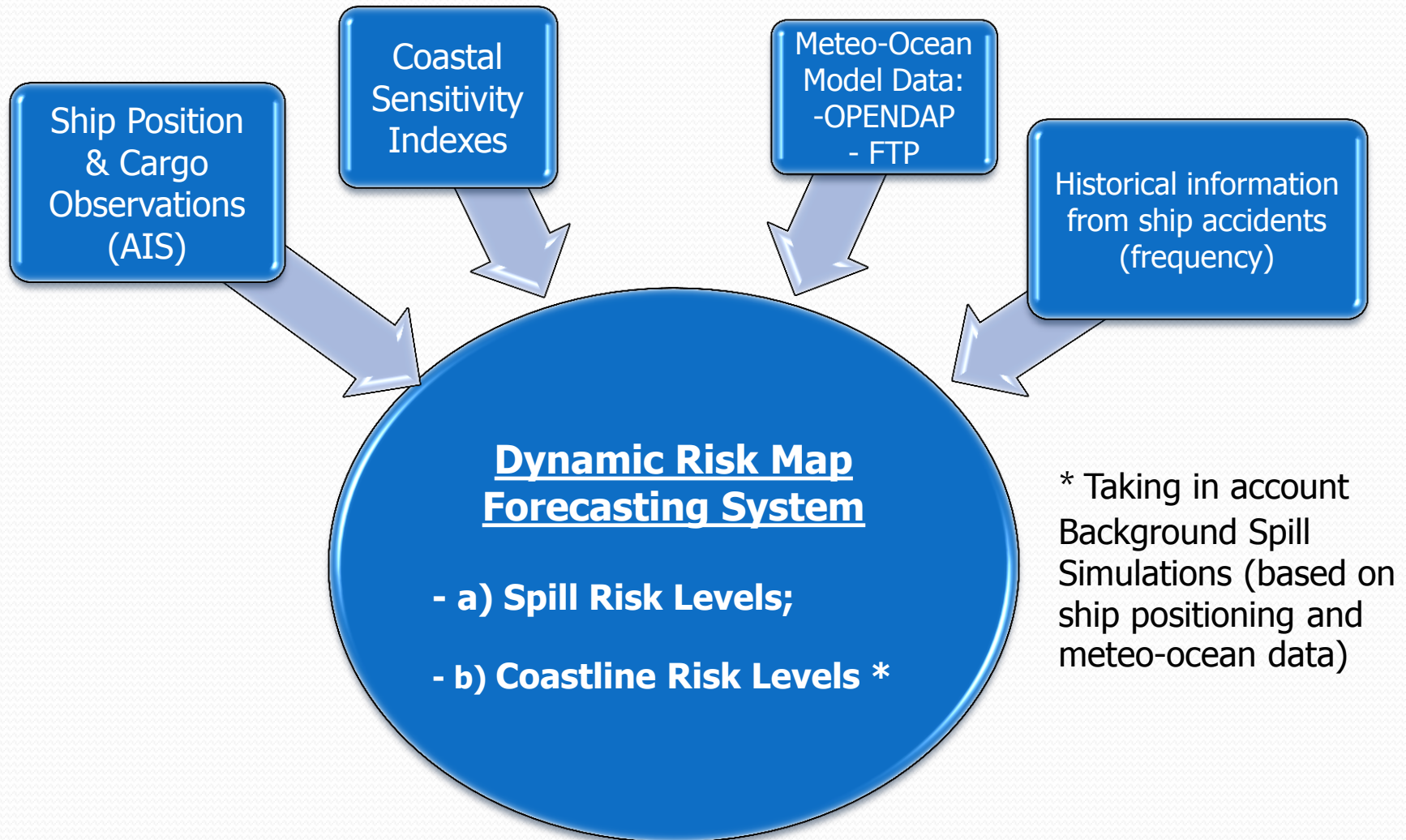
# Simulations





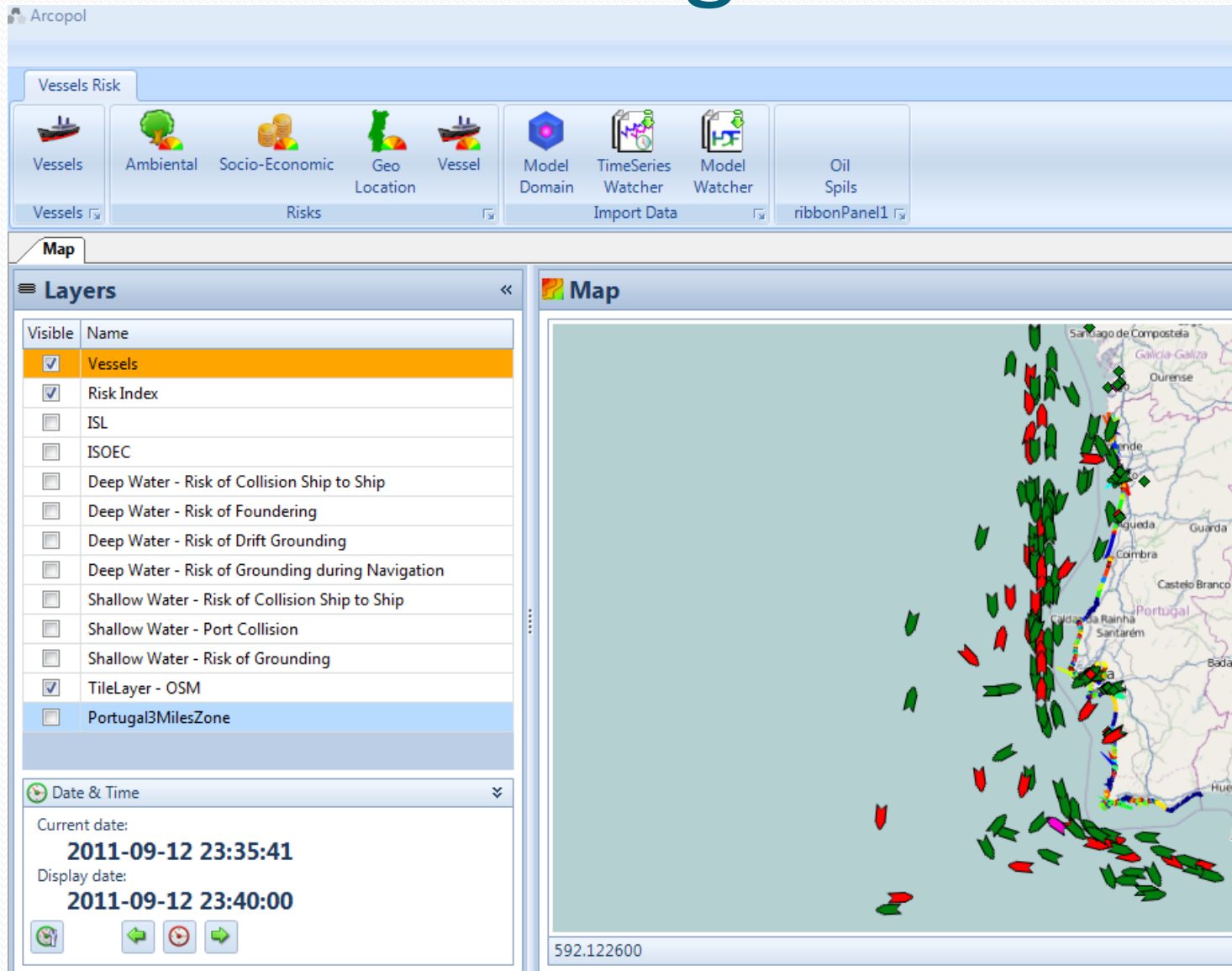
# Dynamic Risk Modelling Tool

“What is the environmental impact of a potential accident occurring with *that* ship, at *that* location under *those* weather conditions?”



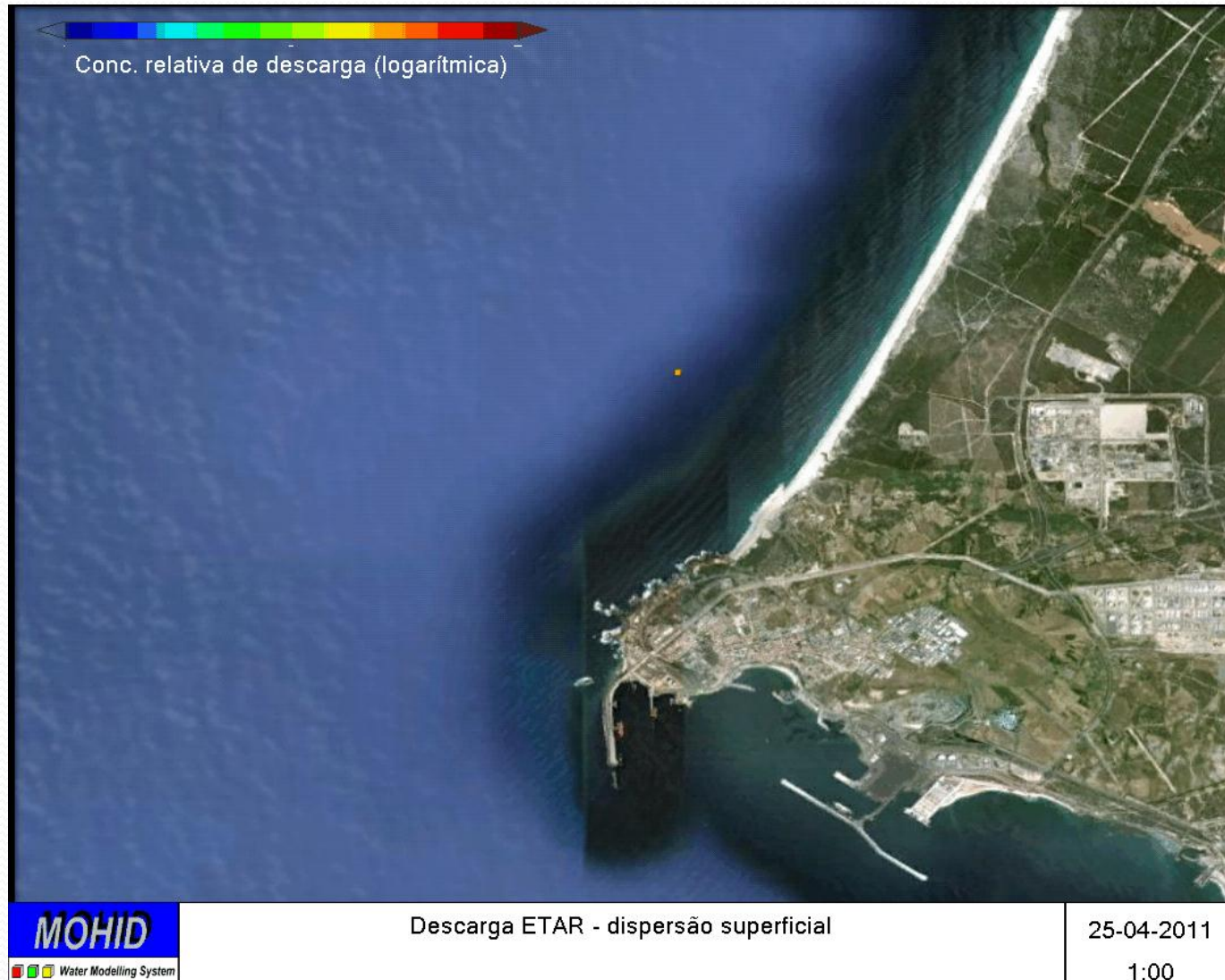


# Risk Index – Portuguese Coast





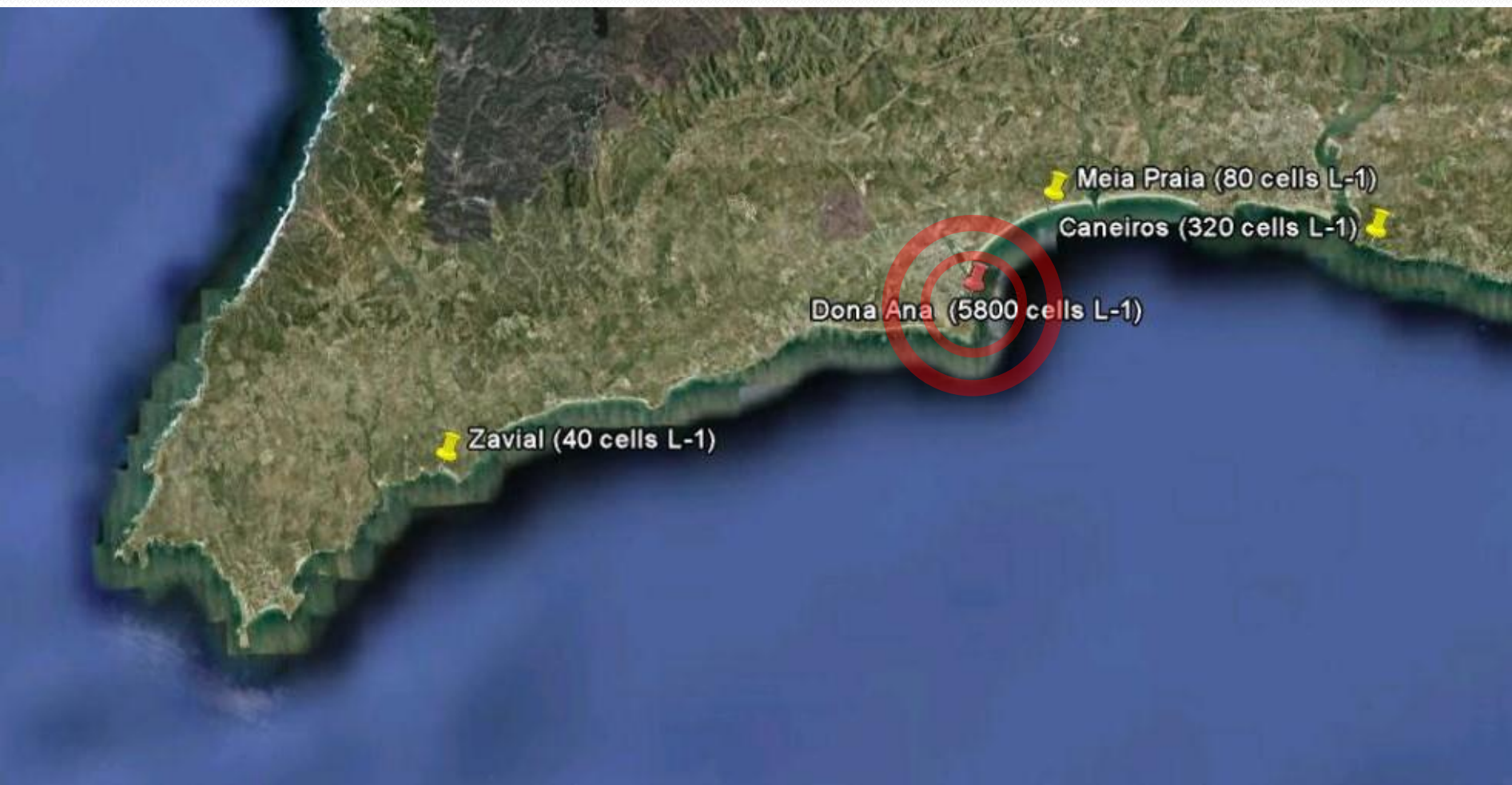
# Oil Spill in Santo André





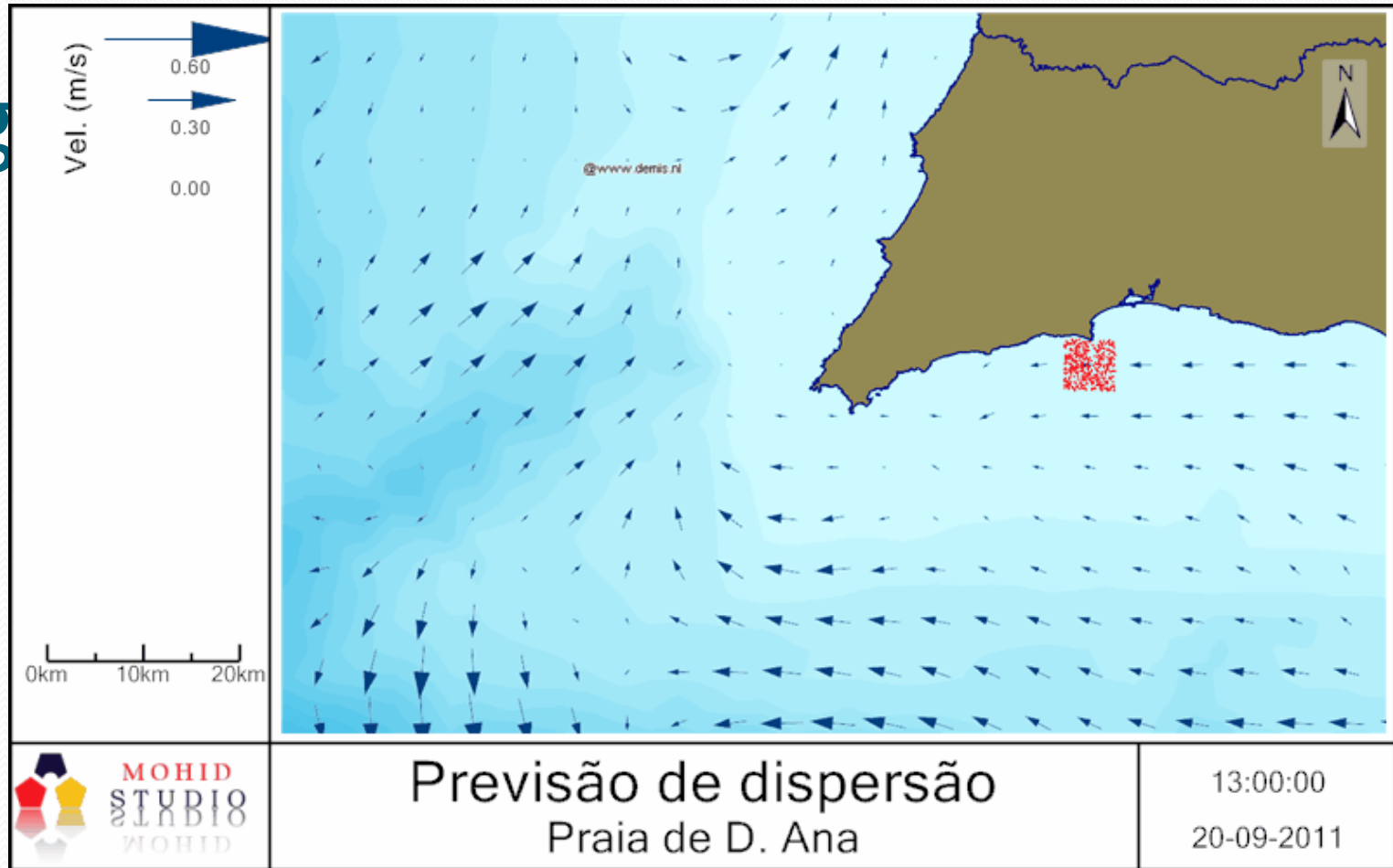
# Algarve September 2011

- 1<sup>st</sup> *Ostreopsis cf. siamensis* bloom: 21-23 September 2011 (Lagos, Algarve)





Alg



- Hindcast + nowcast + forecast (feed by the results from the operational model)
- Took about two hours to come up with the results



# Algarve 2011 – Closed beaches (impact)







# bi-directional tool

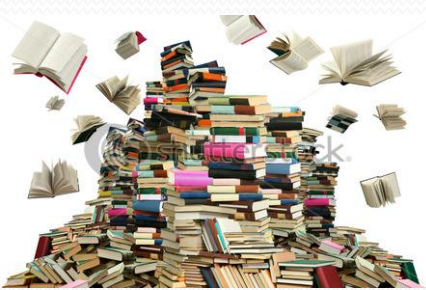
- Only for the forecast period
- Results published online
- Test period
- Access through webpage
- Free open access (no registration)

<http://www.project-easy.info/default.aspx>



# Library analogy

**Download  
manager**



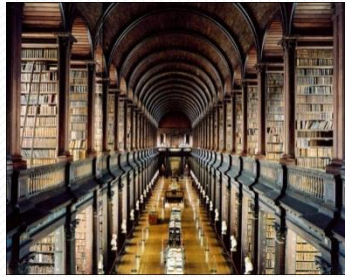
**Download from  
different providers  
files in netcdf CF**

**Netcdf  
converter**



**Normalize  
files**

**Files  
catalogue**



**Meta data base**

**Web client**



**Gives intuitive  
access to data**

**MOHID  
Lagrangian**



**Answer specific  
questions**





# Web client - functionalities

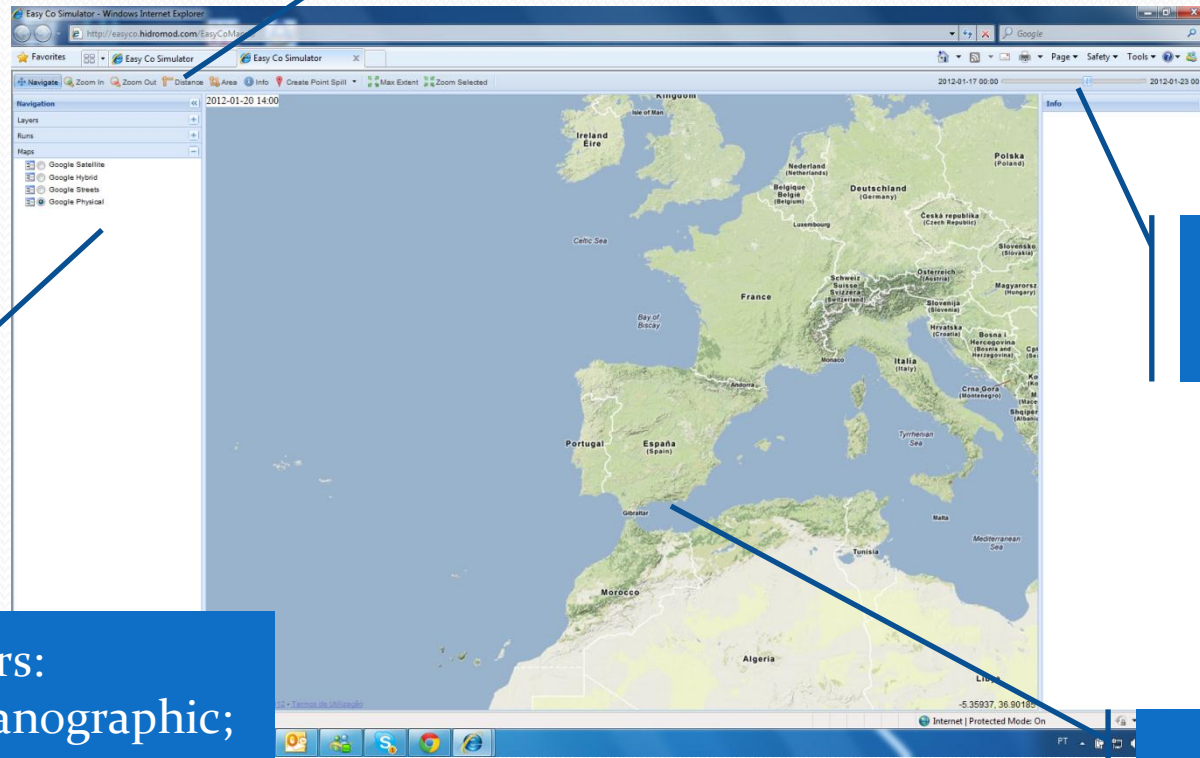
Standard GIS  
tool bar

Time slide bar

Layers:

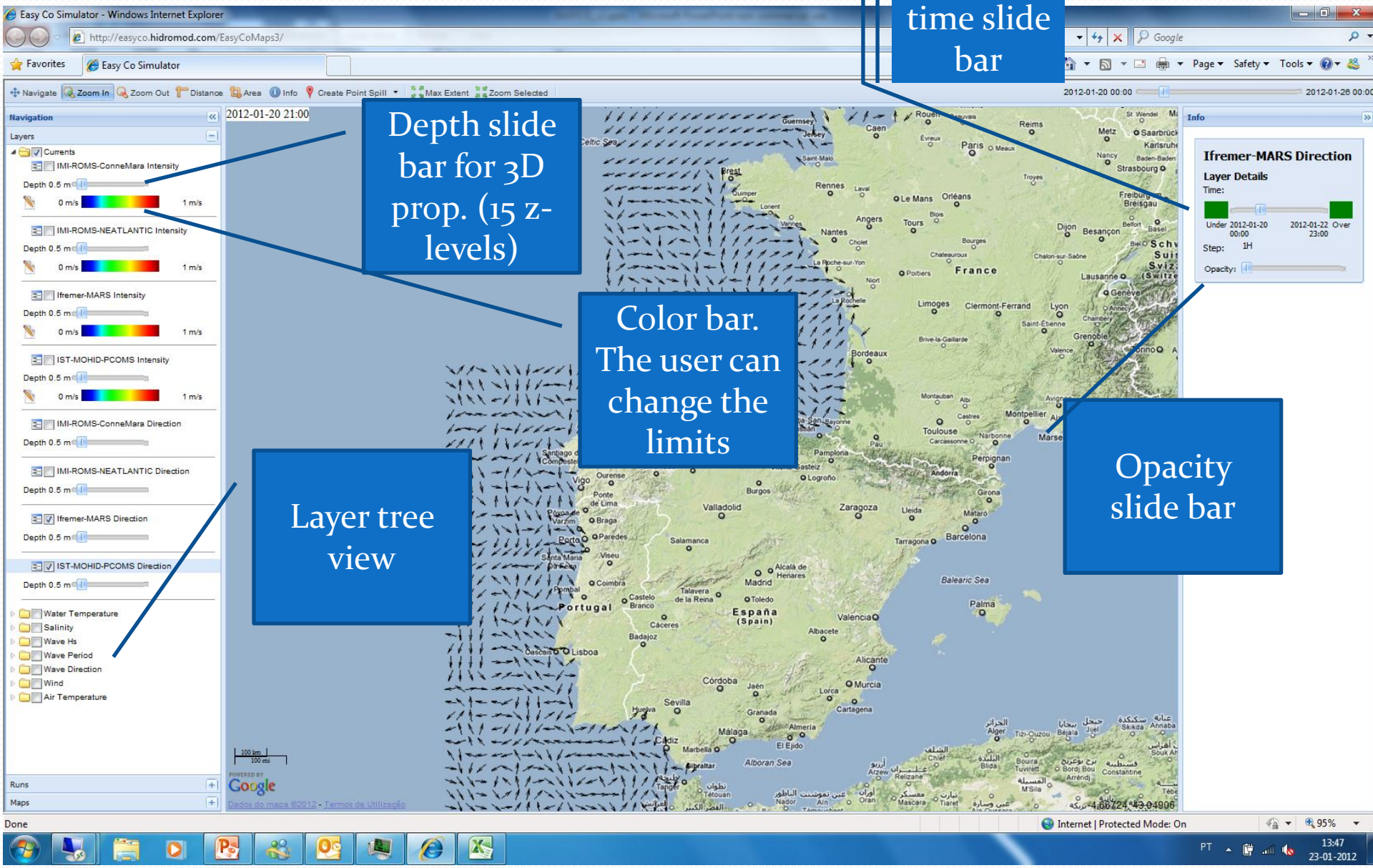
- meteo-oceanographic;
- Runs
- Background map

GIS view





# Web client – data layers





# Define a emission

Easy Co Simulator - Windows Internet Explorer

http://easyco.hidromod.com/EasyCoMaps3/

Navigation

Layers

- ☒ Currents
- ☐ IMI-ROMS-ConneMara Intensity
- ☐ IMI-ROMS-NEATLANTIC Intensity
- ☐ Ifremer-MARS Intensity
- ☐ IST-MOHID-PCOMS Intensity
- ☐ IMI-ROMS-ConneMara Direction
- ☐ IMI-ROMS-NEATLANTIC Direction
- ☒ Ifremer-MARS Direction
- ☒ IST-MOHID-PCOMS Direction
- ☐ Water Temperature
- ☐ Salinity
- ☐ Wave Hs
- ☐ Wave Period
- ☐ Wave Direction
- ☒ Wind
- ☐ NOAA-GFS Intensity
- ☐ MeteGalicia-WRF Intensity

2012-01-20 00:00

2012-01-26 00:00

Create Point Spill

Create Area Spill

Layer Details

Ifremer-MARS Direction

Time:

Under 2012-01-20 00:00

2012-01-22 23:00

Step: 1H

Opacity: 1.0

Create Spill

Spill Name: New Spill

Location

Longitude [°]: -10.398559569898

Latitude [°]: 41.397415070491

Radius [°]: 0.5

Create Delete Marker Close

100 km

50 km

Powered by Google

Dados do mapa ©2012 - Termos de Utilização

Internet | Protected Mode: On

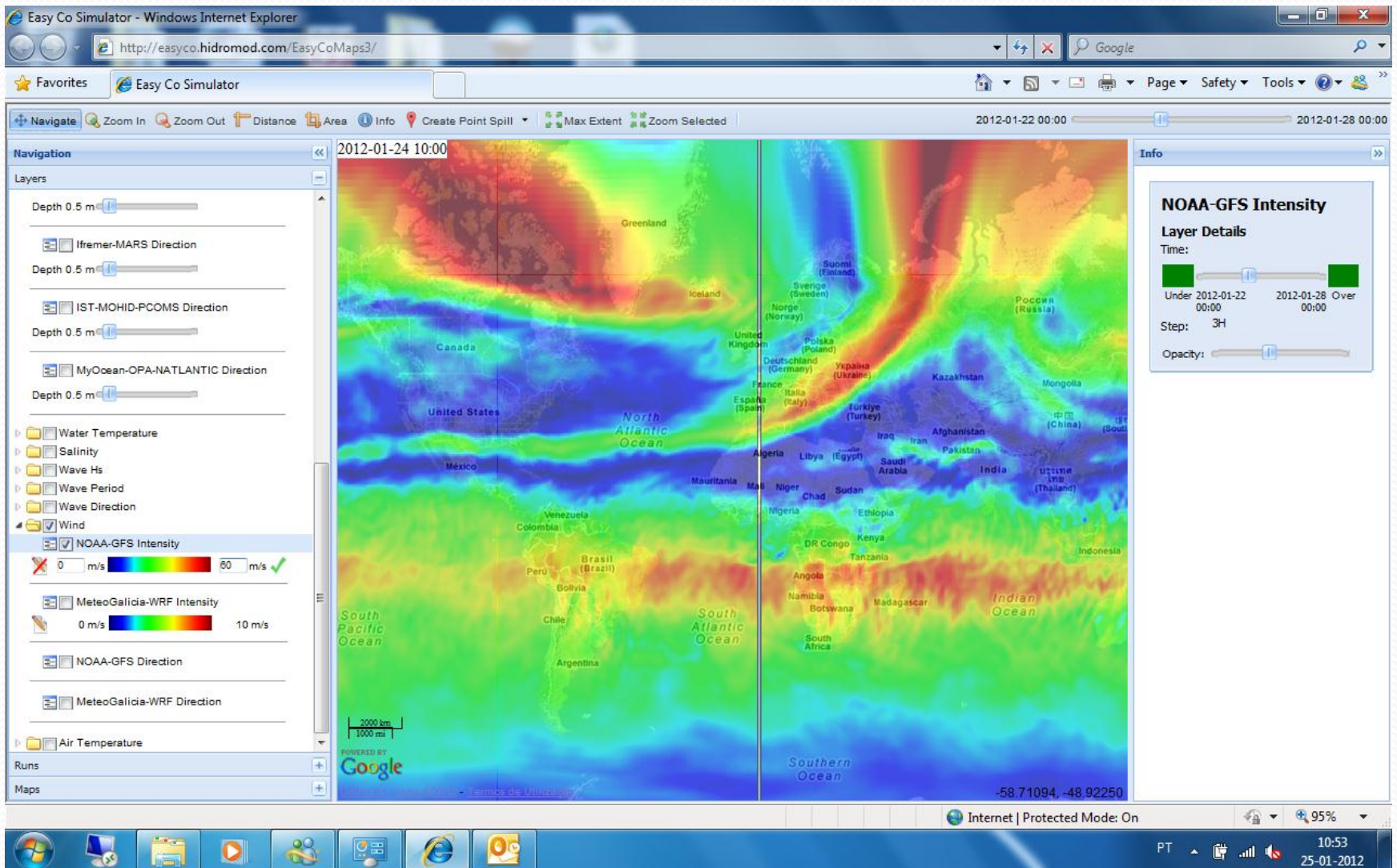
95%

14:05

23-01-2012

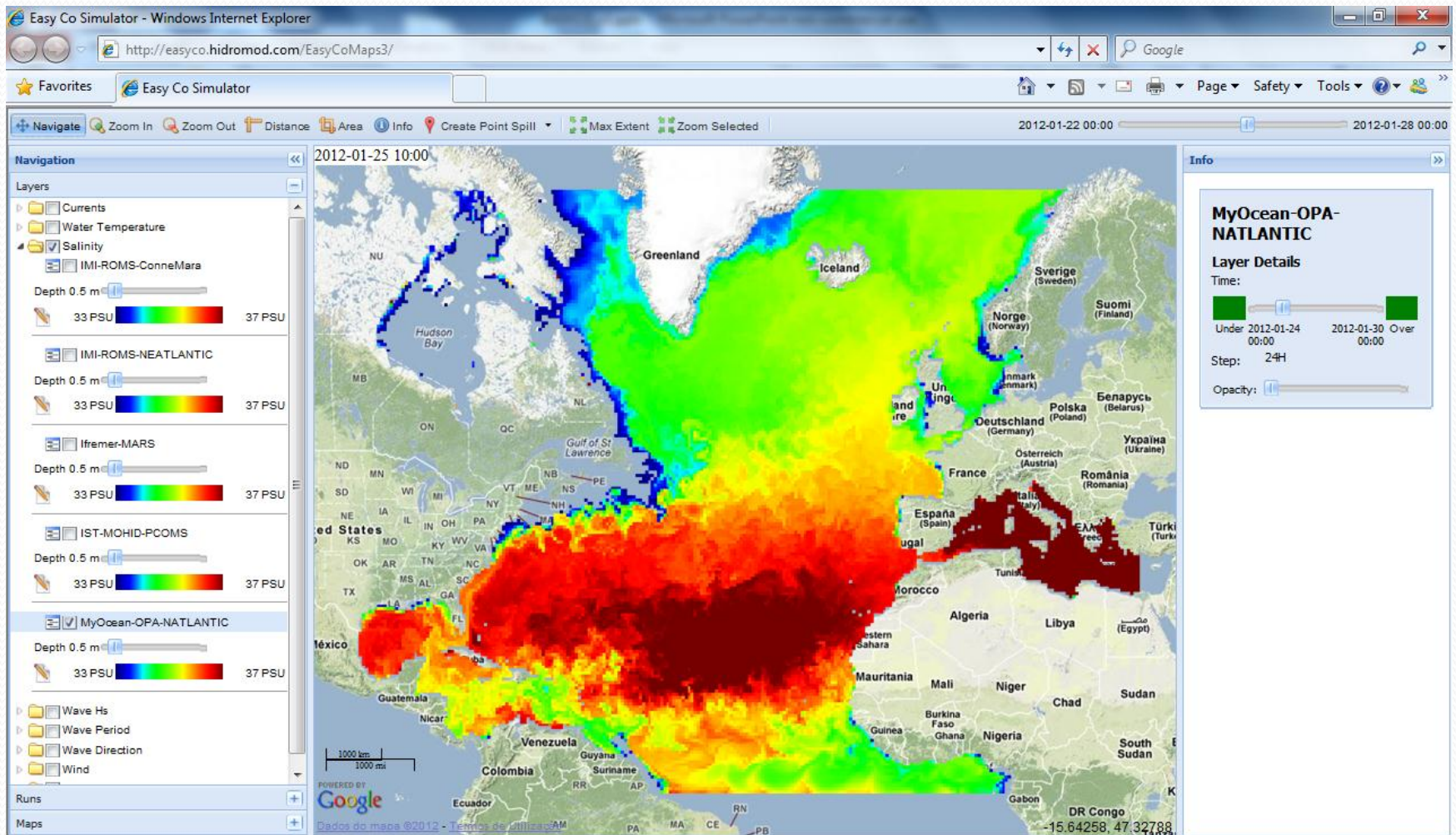


# Example - GFS





# Example - MyOcean





# Future Work

- Analysis of tidal forcing and atmosphere influence in the domain.
- Analysis of the role played by the Gibraltar Strait in the hydrodynamics and ecology of the domain.
- Continue model calibration-validation.
- Addition of main river discharges.
- Implement the described validation methods in operational mode.
- Provide operational results plots in the net.



- Thank you very much for your attention!!
- Muito obrigado pela vossa atenção!!
- Merci de votre attention !!
- ¡Muchas gracias por vuestra atención!
- Eskerrik asko zuen arretarengatik!!

and a proposal....

