ODYSSEA

Creating products and knowledge for the Mediterranean

HIDROMOD
modelação em engenharia

ODYSSEA - HYDRODYNAMIC MODELING RESULTS ALONG THE MOROCCAN COASTS

ATELIER DE VALIDATION DE LA PLATEFORME DE DONNEES PAR LES UTILISATEURS ET DE FORMATION A L'OCEANOGRAPHIE OPERATIONNELLE

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HIDROMOD

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727277

Overview

ODYSSEA

- Odyssea coastal model rational;
- What is downscaling?
- Questions that downscaling can answer;
- Implementation of coastal model in forecast mode (Morocco Observatory example).

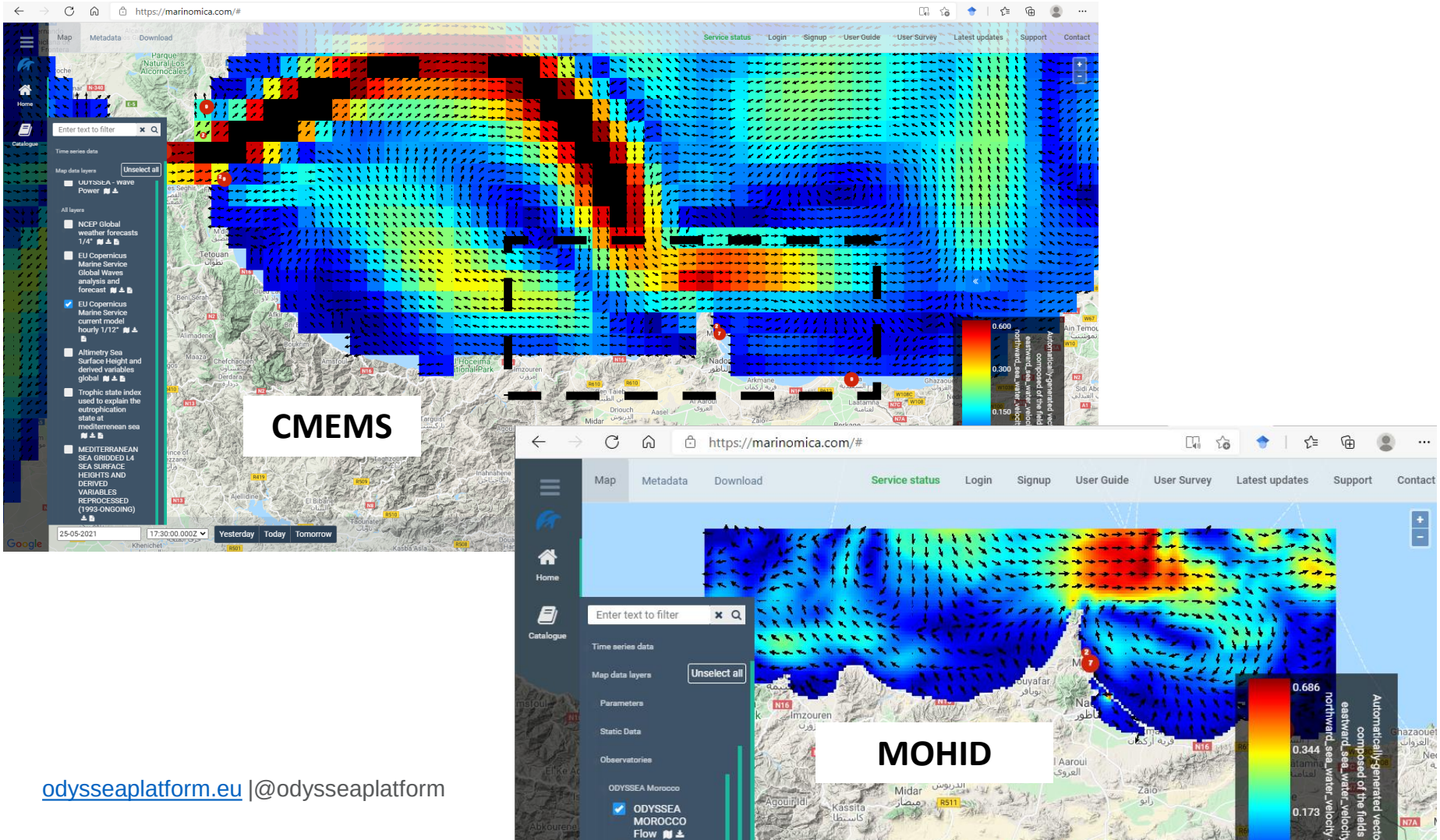
Rational

- Datasets, data sources, models and algorithms under consideration for each observatory

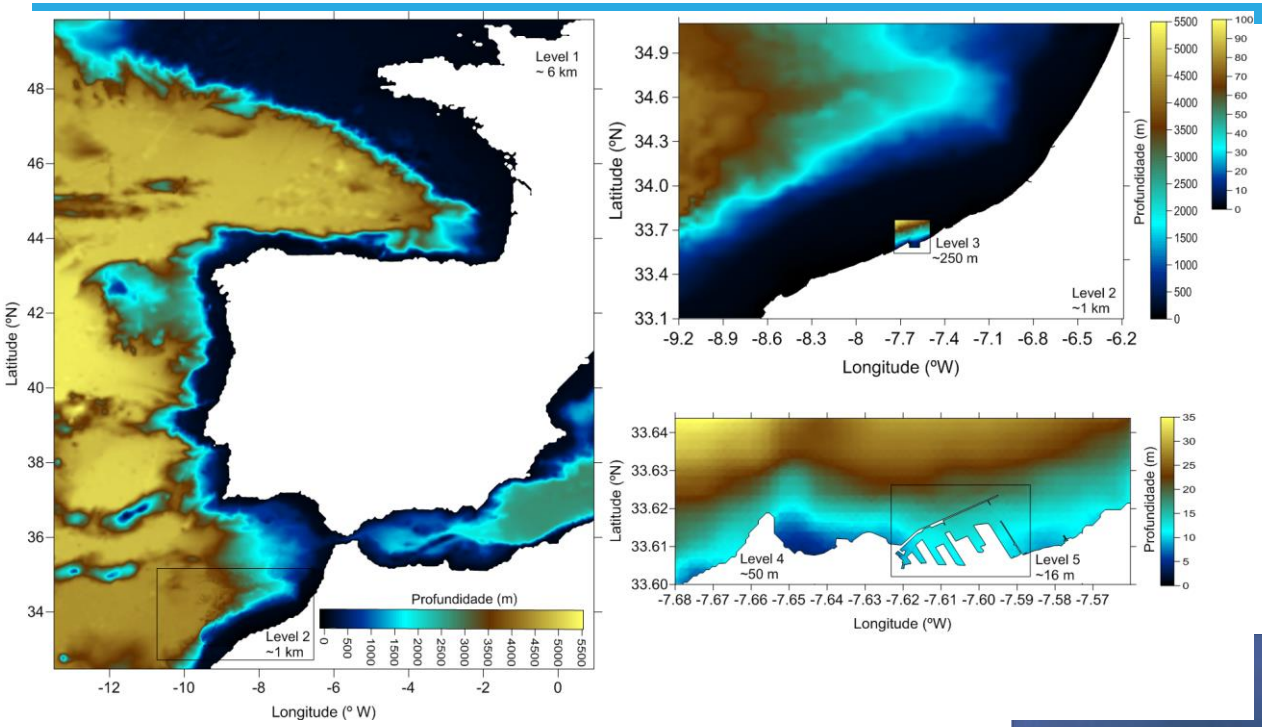
Downscalling

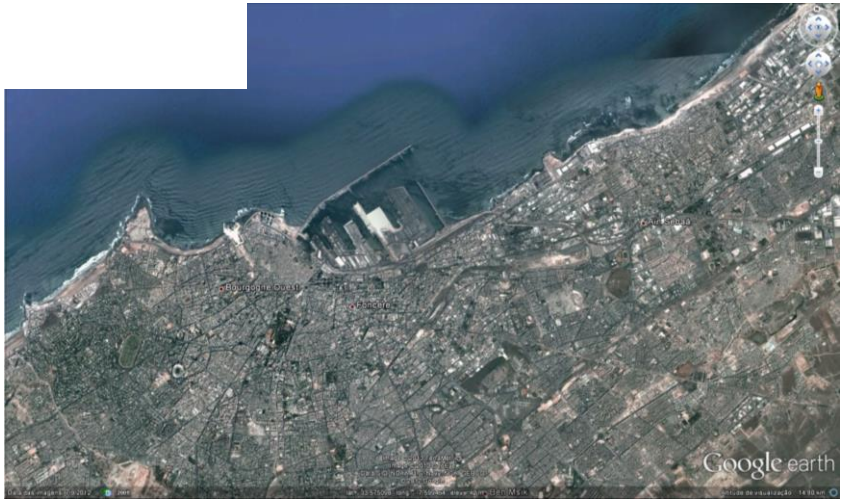
	In-situ measurements	Coastal models	External Earth Observation datasets	Citizen Science	Algorithms
DESCRIPTION	At the ODYSSEA Observatories new in-situ monitoring devices (fixed bottom and surface sensors, and gliders) are deployed measuring standard physical and biogeochemical variables, as well as novel measurements (e.g. microplastics, acoustic signal, etc.)	**At the ODYSSEA Observatories high-resolution three-dimensional coastal models are setup to simulate hydrodynamics**, wave conditions, water quality, oil spill (in selected observatories), jellyfish (in selected observatories), and ecosystem composition	Covering the entire Mediterranean Sea basin ODYSSEA collects and provides easy access to external databases containing in-situ measurements, satellite data, and model outputs	ODYSSEA collects and makes use (e.g. visualizes) of data provided by citizens through social media and dedicated citizen science apps	Using algorithms to merge, fuse, and transform the primary data products, ODYSSEA generates secondary variables that are not provided by any other data sources
OBSERVING/MODELLING PLATFORM	- Develogic Modular Surface Sensor (fluorometer + hydrophone + submerged camera + microplastics sensor) - Develogic Deep Water Sea Lander - Alseamar SeaExplorer glider: • Payload 1: GPS, CTD, DO, Phyto, CDOM, Turbidity, • Payload 2: Passive Acoustic Monitoring (hydrophone), • Payload 3: CTD and microplastics	- **Hydrodynamic model: Delft3D-FLOW, MOHID** - Wave model: Delft3D-WAVE, SWAN - Biogeochemical model: Delft3D-WAQ, MOHID - Oil spill model: MEDSLIK-II - Mussel farm model - Ecosystem model: ECOPATH - Jellyfish model: Delft3D-PART, OpenDrift	- **CMEMS** - GEOSS - **EMODnet** - NOAA - **ECMWF** - GOOS - MonGOOS - **SeaDataNet** - UNEP-WCMC	- Twitter - Marine LitterWatch App - Pangaea	- Algorithm for Eutrophication Index in sea water - Algorithm for TRophic IndeX in sea water - Algorithm for UNscaled TRophic IndeX in sea water - Algorithm for Efficiency Coefficient in sea water - Algorithm for wave power

Downscaling – Morocco observatory



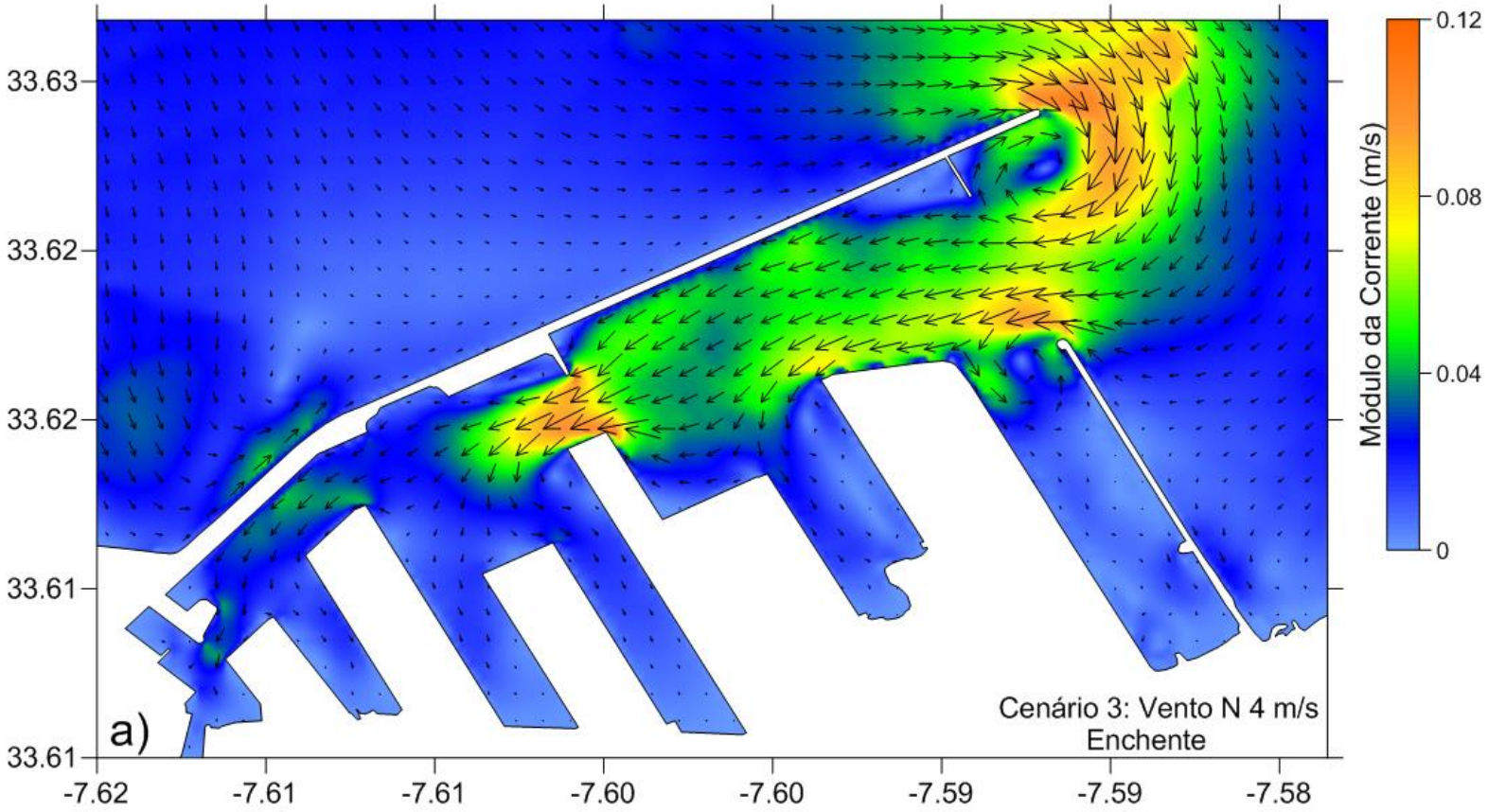
Downscale to local scale
Casablanca





Downscale to local scale
Casablanca

- Spring tide, flood – North wind 4 m/s;



Questions that downscaling can help

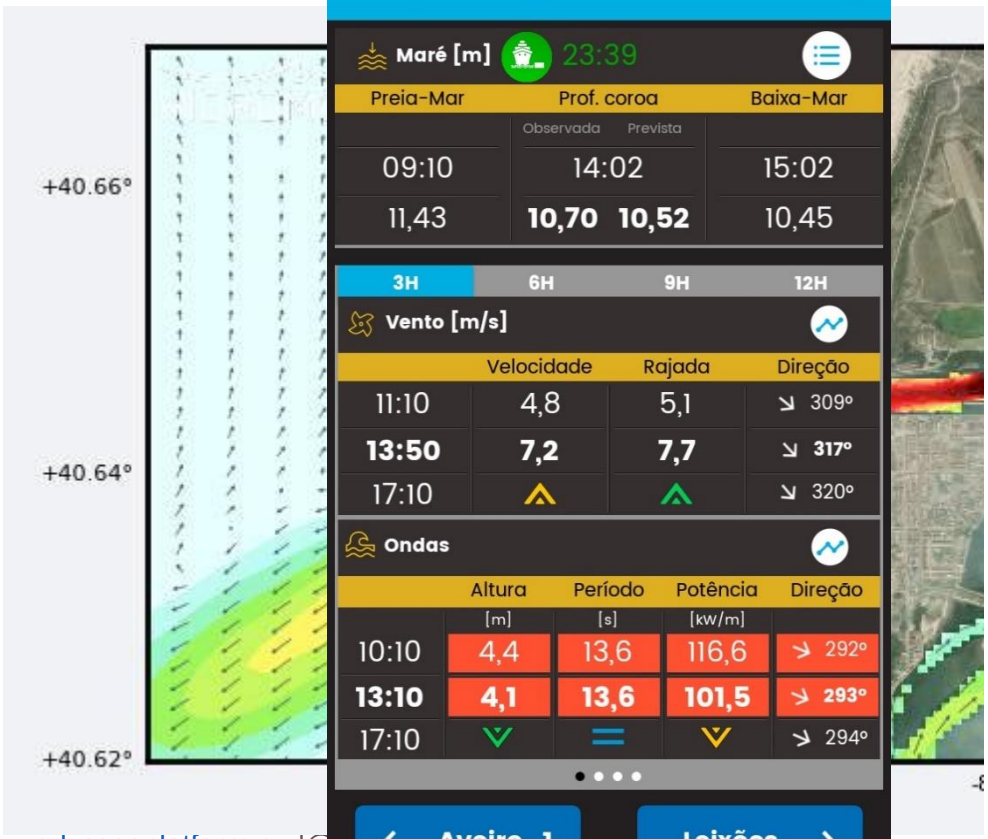
ODYSSEA

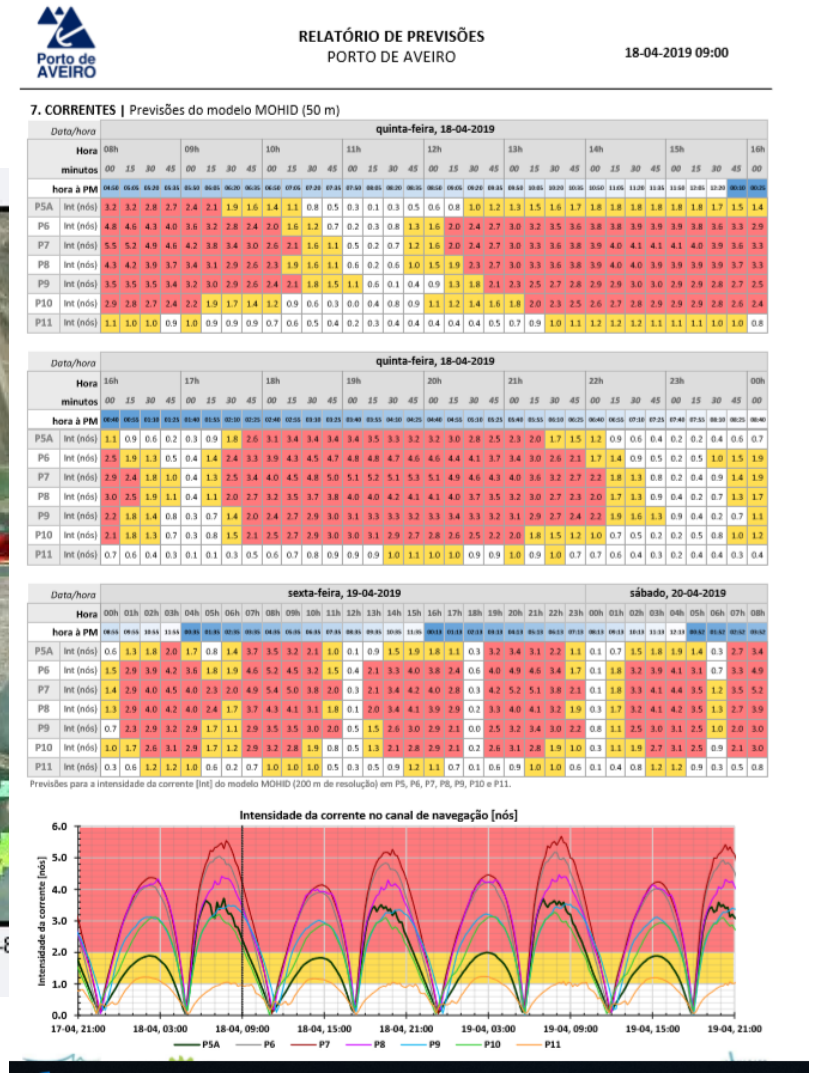
- Usually users are interested in the local scale;
- You need to define the model purpose?
- Downscaling can be useful for:
  - Support operations: ports, aquaculture,…;
  - Emergence response: Oil spill, search and rescue;
  - Bathing water quality forecast;
  - Storm surge forecast;
  - Consultancy;
  - Litter trajectory;
  - …

Ports operation

ODYSSEA

- Aveiro/Portugal

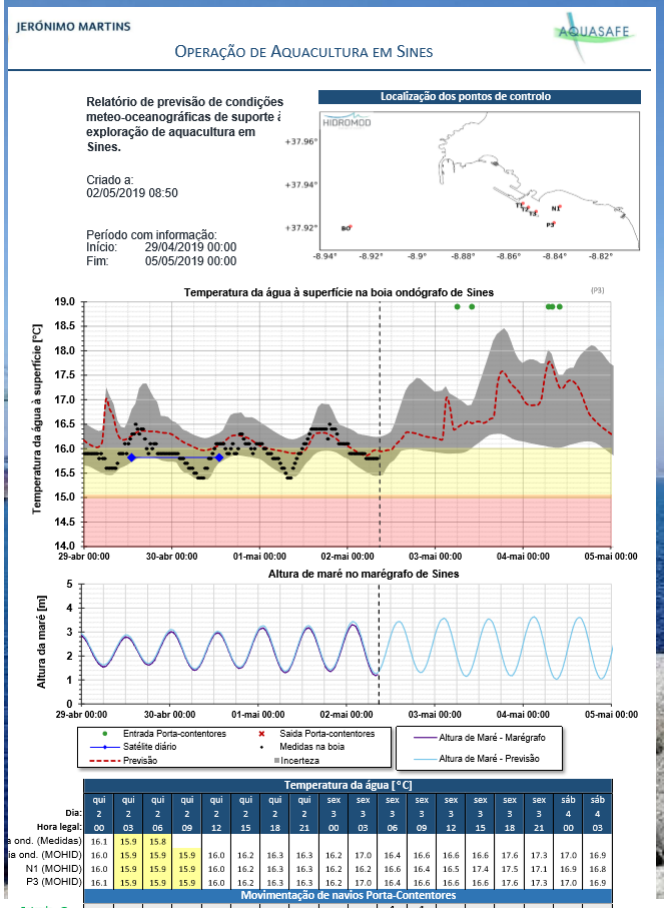


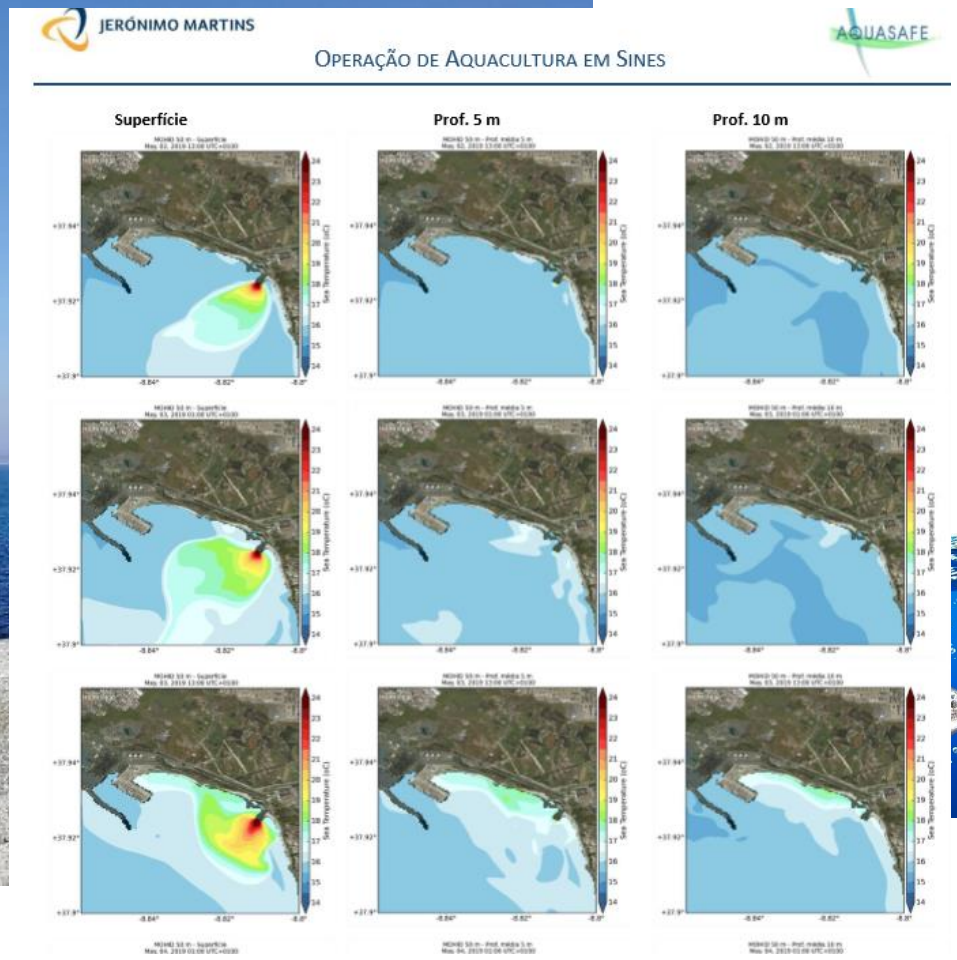


Aquaculture operation

ODYSSEA

- Sines/Portugal – fish feeding optimization





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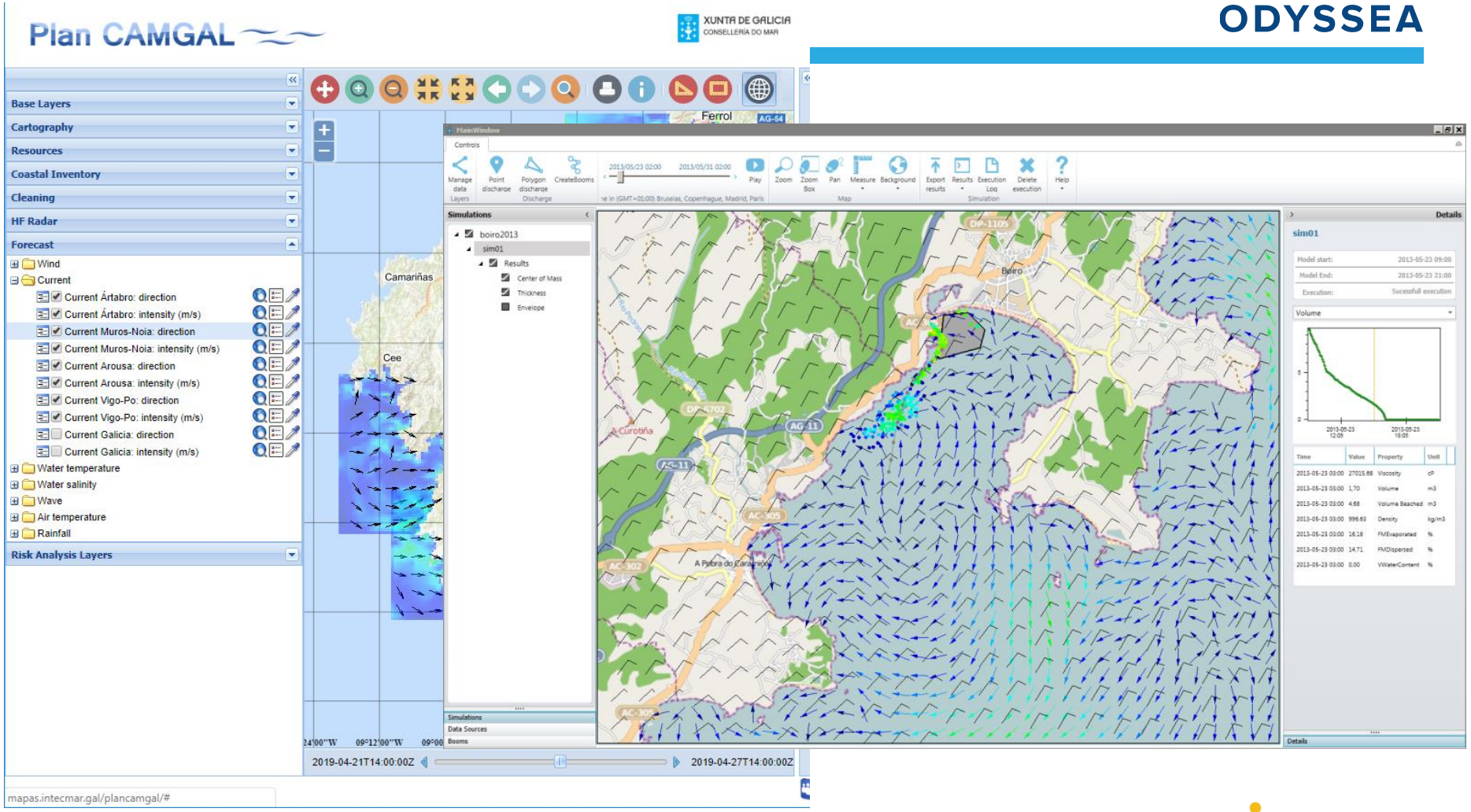
Emergence response – Oil spill

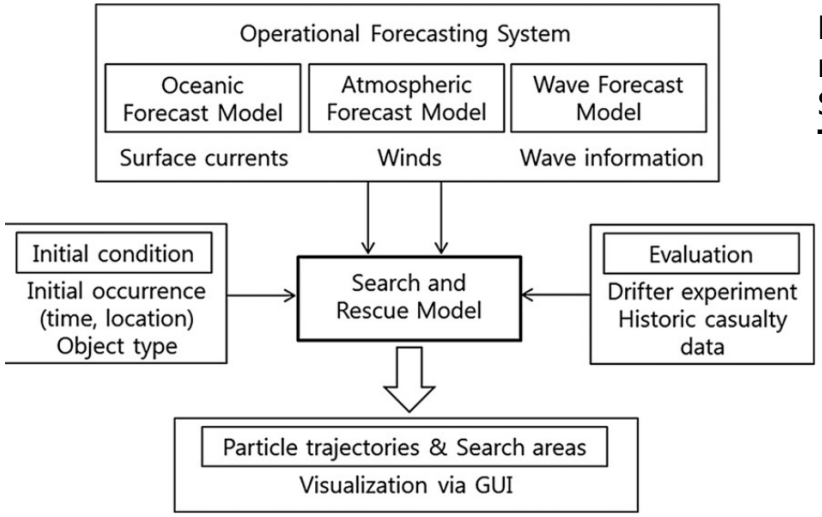


ODYSSEA

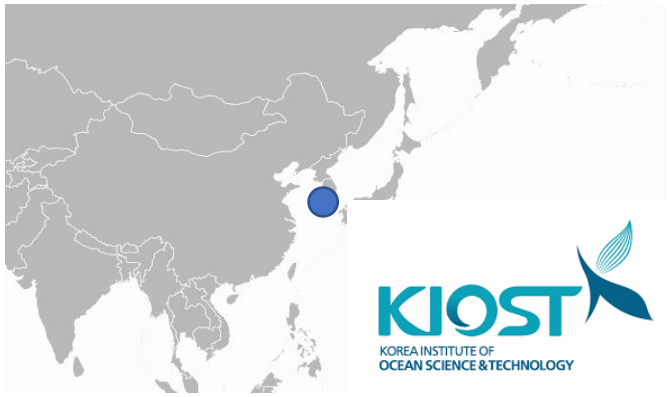
meteogalicia

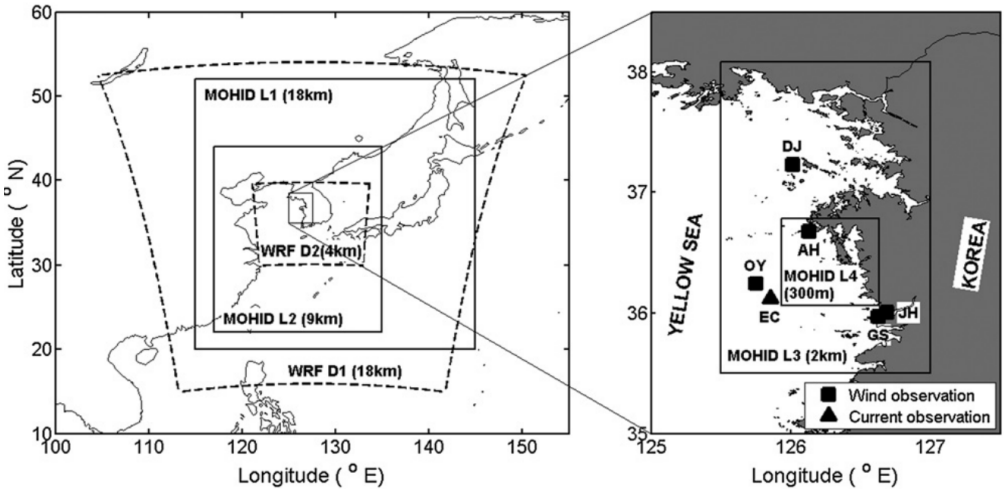
intecmar
INSTITUTO TECNOLOXICO PARA O CONTROL DO MEDIO MARIÑO DE GALICIA

KIOST (Korea) Emergence response – search and rescue



Cho K-H, Li Y, Wang H, Park K-S, Choi J-Y, Shin K-I, Kwon J-I. Development and validation of an operational search and rescue modeling system for the Yellow Sea and the East and South China Seas. **Journal of Atmospheric and Oceanic Technology**. 2014; 31: 197–215





Bathing water quality forecast

ODYSSEA

- Santos/Brazil – Water utility – Faecal contamination

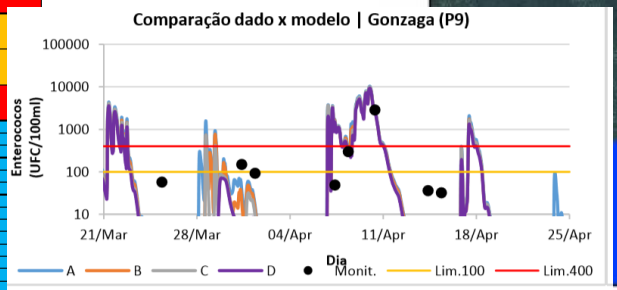
UNISANTA UNIVERSIDADE SANTA CECÍLIA

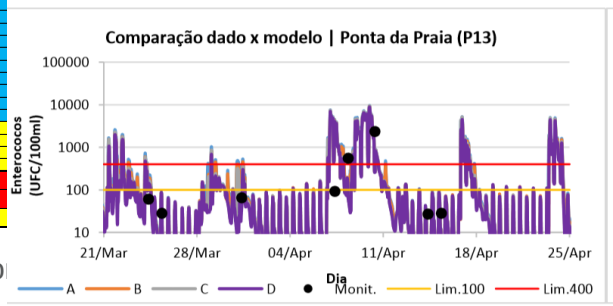
Concentração de Enterococos
Previsão 4/25/2019

NPH NÚCLEO DE PESQUISAS HIDRODINÂMICAS UNISANTA

UFC/ 100ml	Classificação
<25	Excelente
25-50	Muito boa
50-100	Satisfatória
100-400	Ruim
>400	Péssima

Cidade	Ponto	Nome	Cenário	Previsão: máxima concentração de enterococos (UFC/100ml) 25/04 (Thu.) Manhã	Tarde	Noite	26/04 (Fri.) Manhã	Tarde	Noite	27/04 (Sat.) Manhã	Tarde	Noite
São Vicente	1	Prainha	-	188	184	18	111	119	29	196	156	131
	2	Gonzaguinha	-	358	347	32	254	285	70	55	242	156
	3	Milionários	-	203	228	15	14	125	16	95	83	100
	4	Ilha Porchat	-	12	7	21	51	54	323	172	38	36
	5	Itararé	-	101	167	442	112	453	206	8	13	22
	6	Divisa	-	20	6	1	0	0	0	0	0	0
	REIS	Canal dos Barreiros	-	696	377	384	769	477	127	236	497	405
	SV1	Canal de São Vicente 1	-	1957	2381	284	135	337	259	158	437	
	SV2	Canal de São Vicente 2	-	573	471	378	175	327	410	65	77	
	SV3	Canal de São Vicente 3	-	2976	1992	3863	2766	2591	2476	4509	3543	
Santos	7	José Menino (R.Frederico Ozanan)	A	0	0	0	0	0	0	0	0	
			B	0	0	0	0	0	0	0	0	
			C	0	0	0	0	0	0	0	0	
			D	0	0	0	0	0	0	0	0	
	8	José Menino (R.Olavo Bilac)	A	0	0	0	0	0	0	0	0	
			B	0	0	0	0	0	0	0	0	
			C	0	0	0	0	0	0	0	0	
			D	0	0	0	0	0	0	0	0	
	9	Gonzaga	A	0	0	0	0	0	0	0	0	
			B	0	0	0	0	0	0	0	0	
			C	0	0	0	0	0	0	0	0	
			D	0	0	0	0	0	0	0	0	
	10	Boqueirão	A	3	2	1	0	0	0	1	0	
			B	0	0	0	0	0	0	1	0	
			C	0	0	0	0	0	0	1	0	
			D	0	0	0	0	0	0	1	0	
	11	Embaré	A	5	2	1	1	0	1	1	1	
			B	0	0	0	0	0	1	1	1	
			C	0	0	0	0	0	1	1	1	
			D	0	0	0	0	0	1	1	1	
	12	Aparecida	A	4	2	1	1	1	2	3	19	
			B	1	1	1	1	1	2	3	20	
			C	1	1	1	1	1	2	3	19	
			D	1	1	1	1	1	2	3	20	
	13	Ponta da Praia	A	73	8	33	65	12	12	42	118	
			B	75	8	31	68	13	13	43	120	
			C	73	7	32	64	12	12	42	125	
			D	72	7	32	64	12	13	42	126	
	ST1	Canal de Santos 1	-	1480	1674	1282	3449	2219	1558	1813	273	
	ST2	Canal de Santos 2	-	7448	1517	5586	5114	3824	5018	3567	3996	
	ST3	Canal de Santos 3	-	23	79	80	13	2	51	4	1	

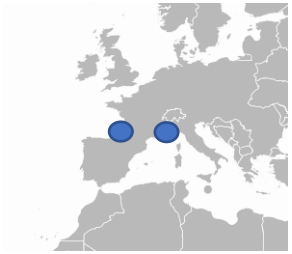




Bathing water quality forecast France – Since 2008

ODYSSEA

suez environnement



JGR Oceans

Research Article | Free Access

Effects of waves on coastal water dispersion in a small estuarine bay

M. T. Delpey, F. Ardhuin, P. Otheguy, A. Jouon

First published: 13 December 2013 | https://doi.org/10.1002/2013JC009466 | Citations: 24

ELSEVIER

International Journal of Hygiene and Environmental Health

Volume 222, Issue 4, May 2019, Pages 695-704

Differential decay and prediction of persistence of *Enterococcus* spp. and *Escherichia coli* culturable cells and molecular markers in freshwater and seawater environments

Maialen Sagarduy [a], Sophie Courtois [b], Andrea Del Campo [c], Joxe Mikel Garmendia [c], Agnès Petrau [a]

[a] Rivages Pro Tech, 2, Allée Théodore Monod, 64210, Bidart, France
[b] Suez, CIRSEE, 38 rue du président Wilson, 78230, Le Pecq, France
[c] AZTI Tecnalia, Herrera Kaia – Portualdea z/g, E-20110, Pasaia, Spain

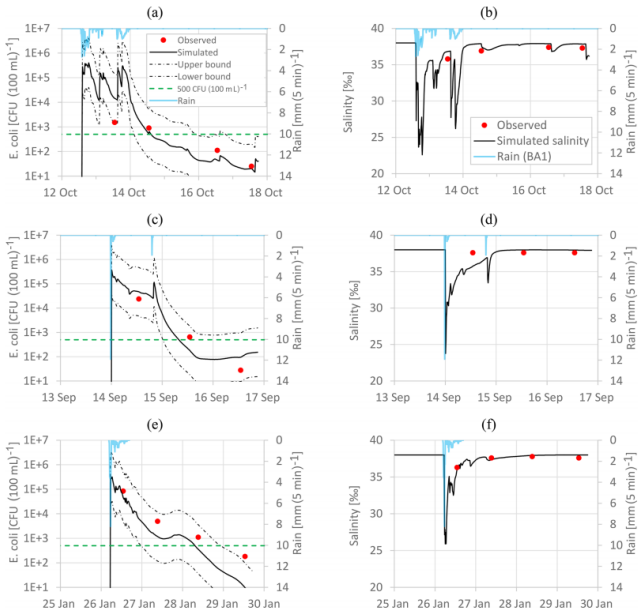
Bathing water quality forecast
Spain/Barcelona since 2007

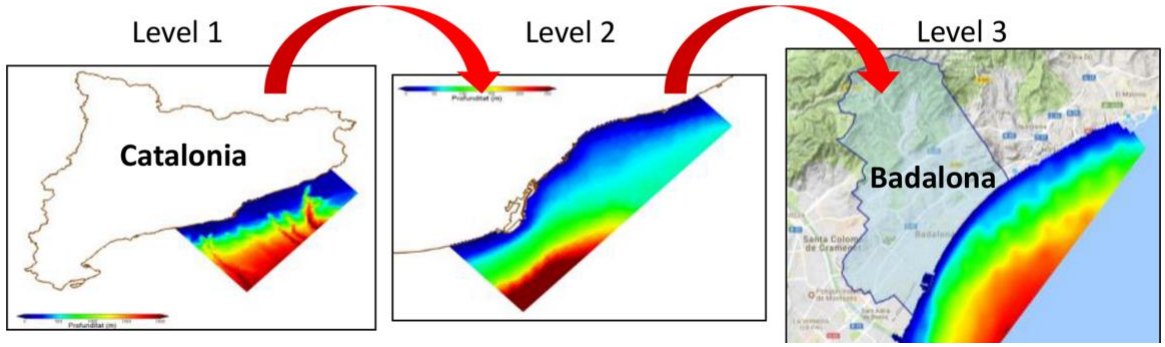
ODYSSEA

suez environnement

L. Locatelli et al.: Modeling of *E. coli* distribution for hazard assessment of bathing waters

Locatelli et al.: Modeling of *E. coli* distribution for hazard assessment of bathing waters





Nat. Hazards Earth Syst. Sci., 20, 1219–1232, 2020
https://doi.org/10.5194/nhess-20-1219-2020

Natural Hazards and Earth System Sciences
Open Access
EGU

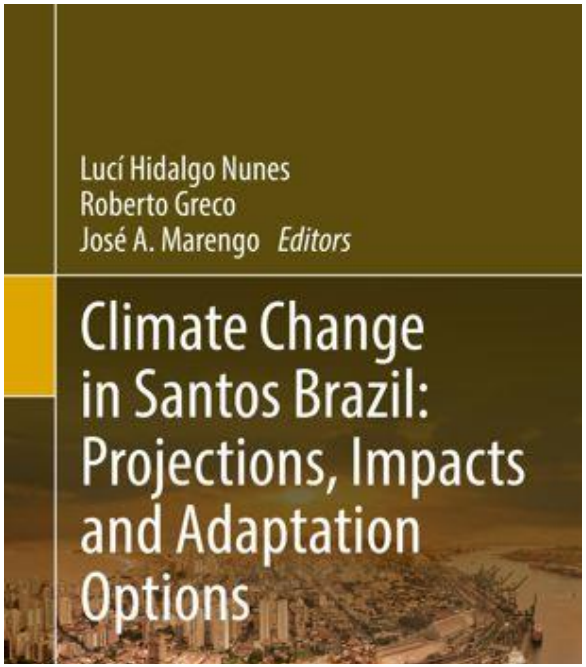
Modeling of *E. coli* distribution for hazard assessment of bathing waters affected by combined sewer overflows

Luca Locatelli[1], Beniamino Russo[1,2], Alejandro Acero Oliete[2], Juan Carlos Sánchez Catalán[2], Eduardo Martínez-Gomariz[3], and Montse Martínez[1]

[1]AQUATEC – Suez Advanced Solutions, Ps. Zona Franca 46-48, 08038, Barcelona, Spain
[2]Group of Hydraulic and Environmental Engineering (GIHA), Technical College of La Almunia (EUPLA), University of Zaragoza, Mayor St. 5, 50100, Zaragoza, Spain
[3]Cetaqua, Water Technology Centre, Environment, Society and Economics Department, Cornellà de Llobregat, 08940, Spain

Storm surge forecast

ODYSSEA



geosciences

MDPI

Article

Improvement of an Operational Forecasting System for Extreme Tidal Events in Santos Estuary (Brazil)

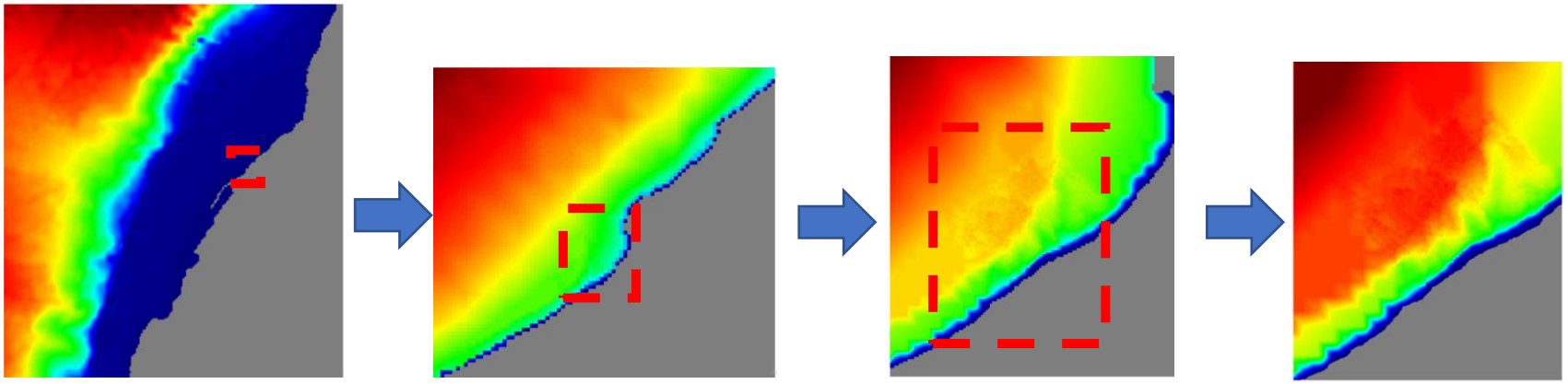
Joana Mendes [1], Paulo Leitão [2], José Chambel Leitão [2], Sofia Bartolomeu [2], João Rodrigues [2] and João Miguel Dias [1,*]

1 CESAM, Departamento de Física, Universidade de Aveiro, 3810-193 Aveiro, Portugal; joanaamendes@ua.pt
2 Hidromod, Rua Rui Teles Palhinha, n° 4, 1°. 2740-278 Porto Salvo, Portugal; paulo.chambel@hidromod.com (P.L.); jcleitao@hidromod.com (J.C.L.); sofia.bartolomeu@hidromod.com (S.B.); joao.rodrigues@hidromod.com (J.R.)

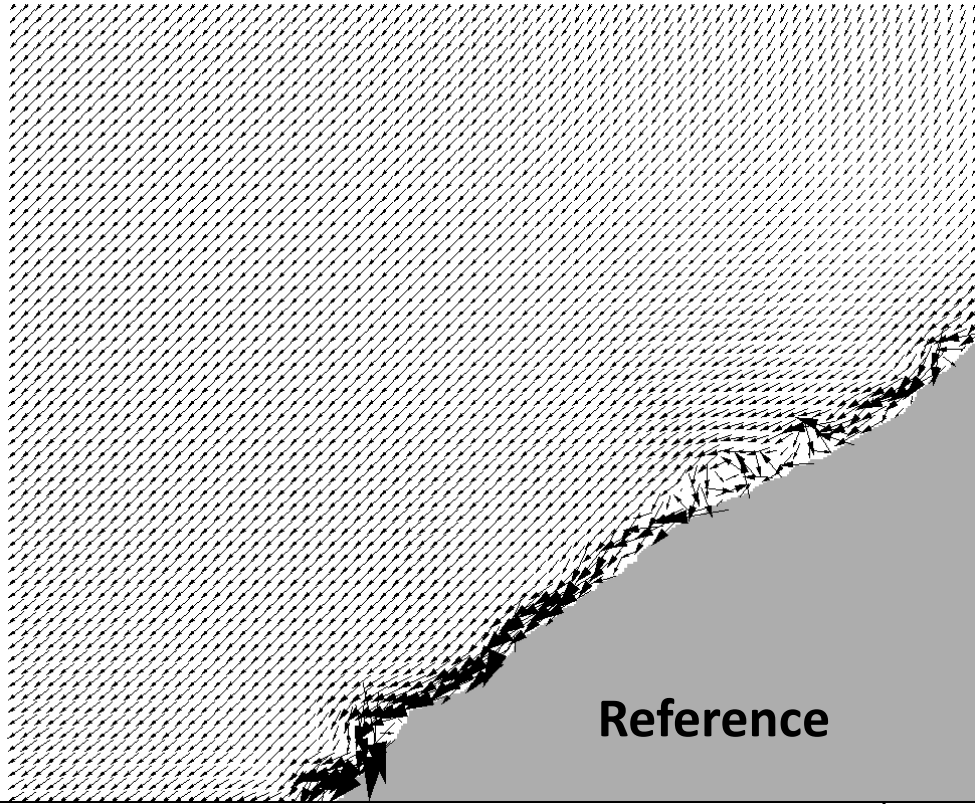
Fig. 7.19 Page in the local newspaper showing an article praising the preventative work in Santos. Source: Jornal A Tribuna from 16 September 2016)

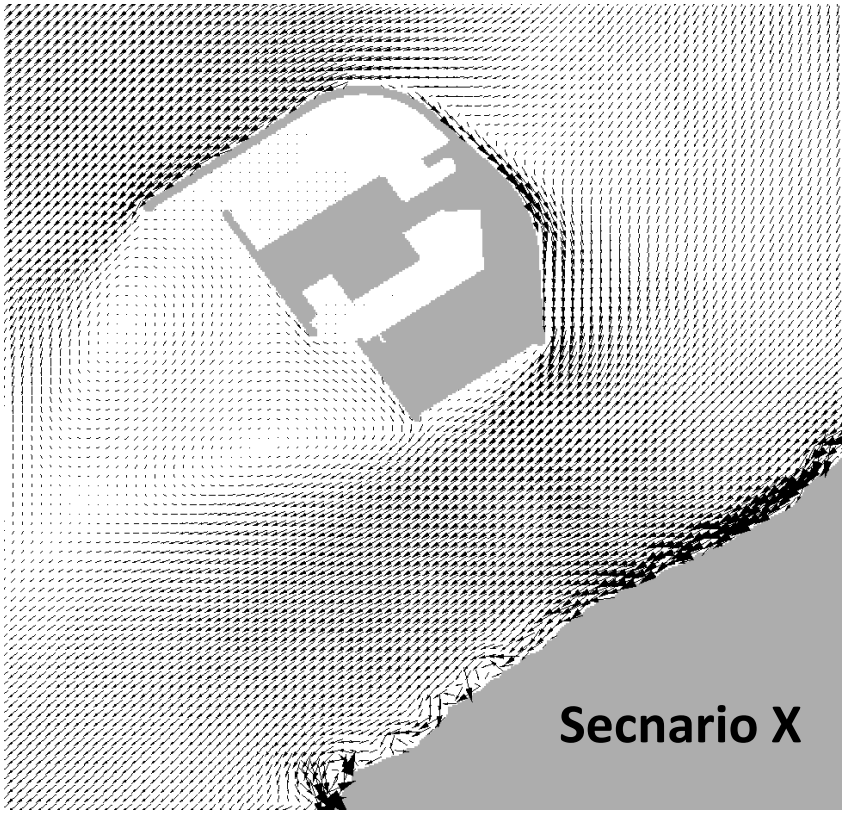
Consultancy Dakhla

ODYSSEA



Downscale to local scale
Dakhla – port scenarios





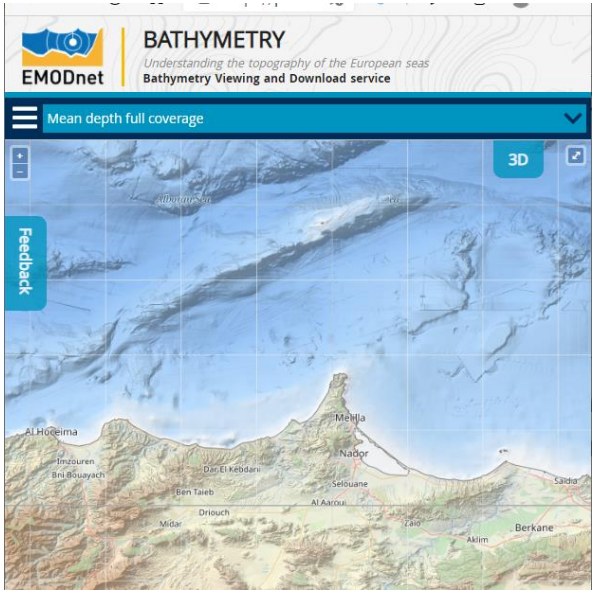
Implementation of coastal hydrodynamic model in forecast mode
Morocco Observatory

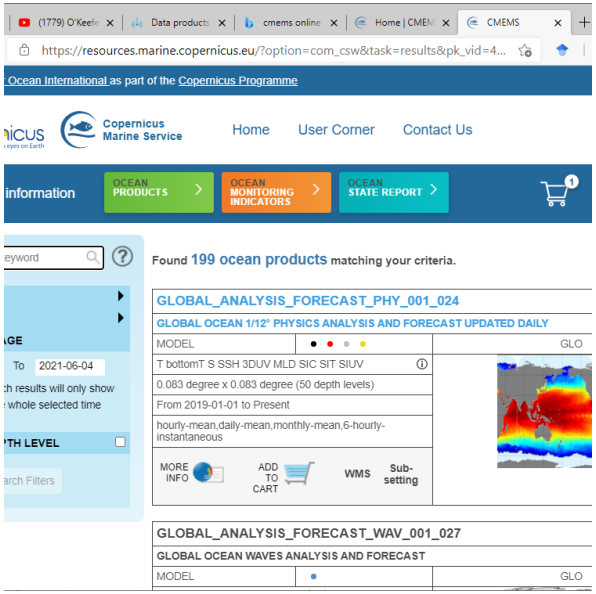
ODYSSEA

- Initial and boundary conditions:
  - Earth Observation datasets;
- Spatial discretization;
- Outputs (Marinomica platform);
- Validation.

External Earth Observation datasets

ODYSSEA





Emodnet

Bathymetry

CMEMS + FES2014

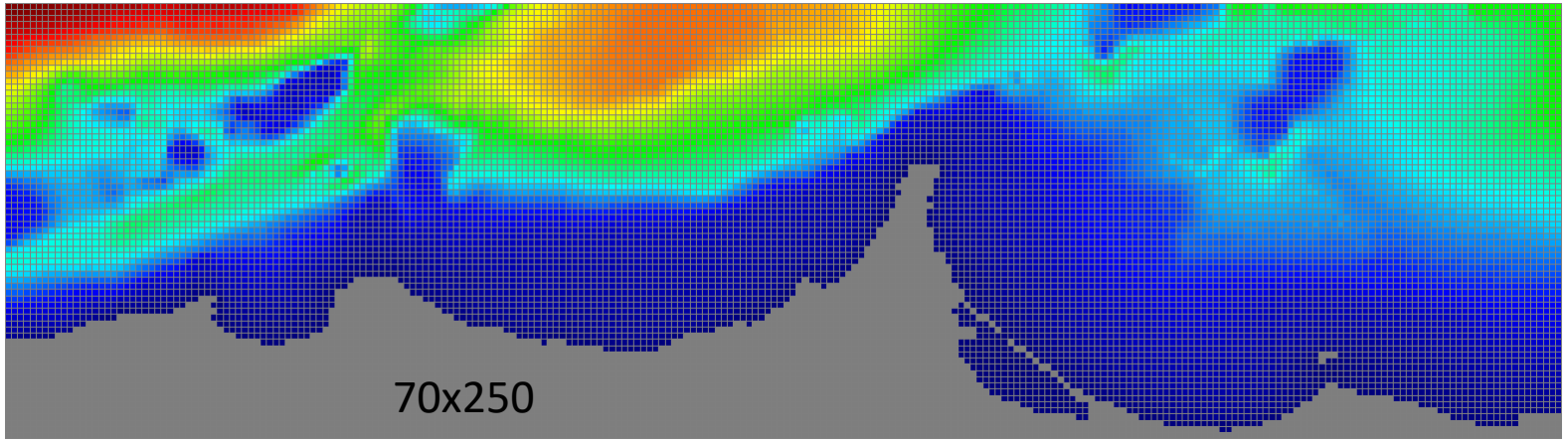
Large scale hydrodynamics forecast

ICON

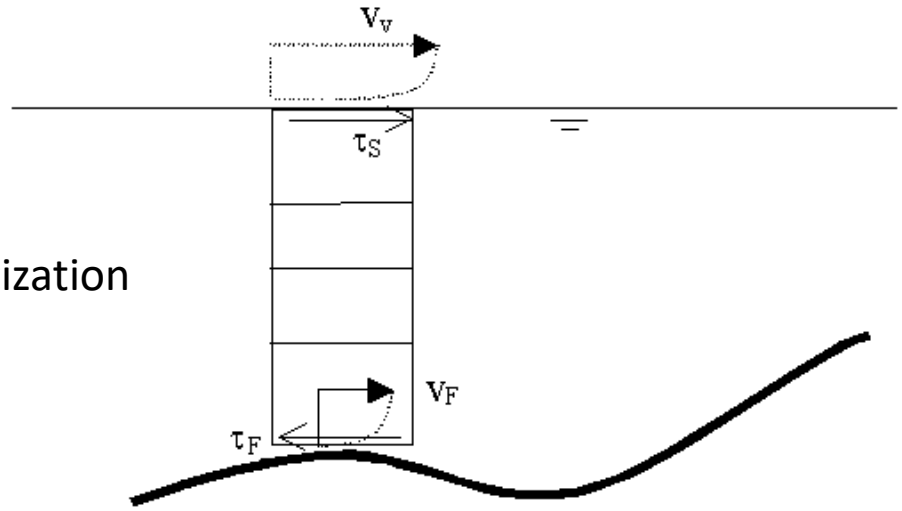
Weather forecast model

Spatial discretization & running cycle
Morocco Observatory

ODYSSEA

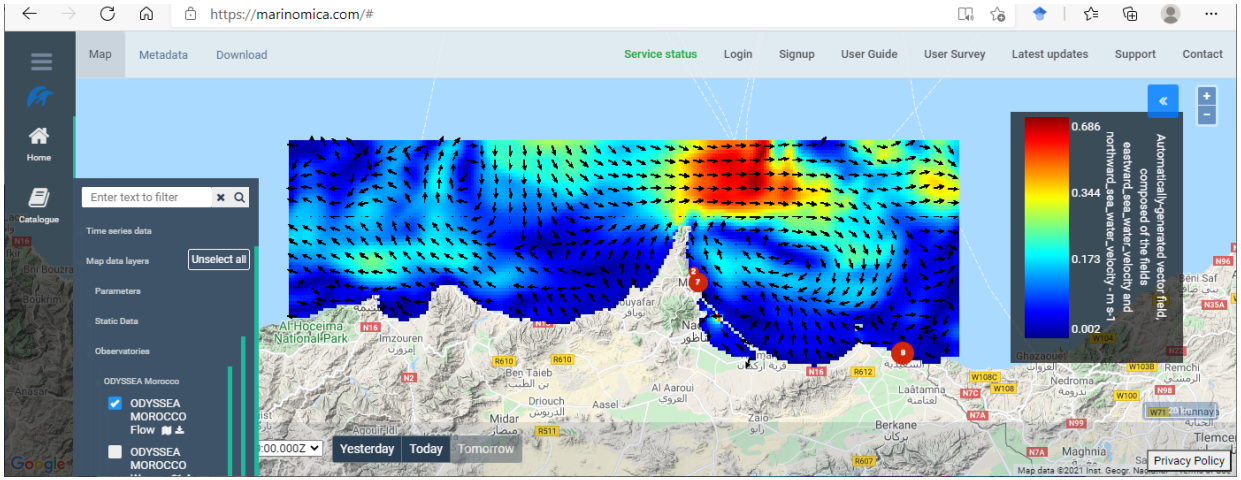


75 layers - Z level vertical discretization



Morocco Observatory – Output

ODYSSEA



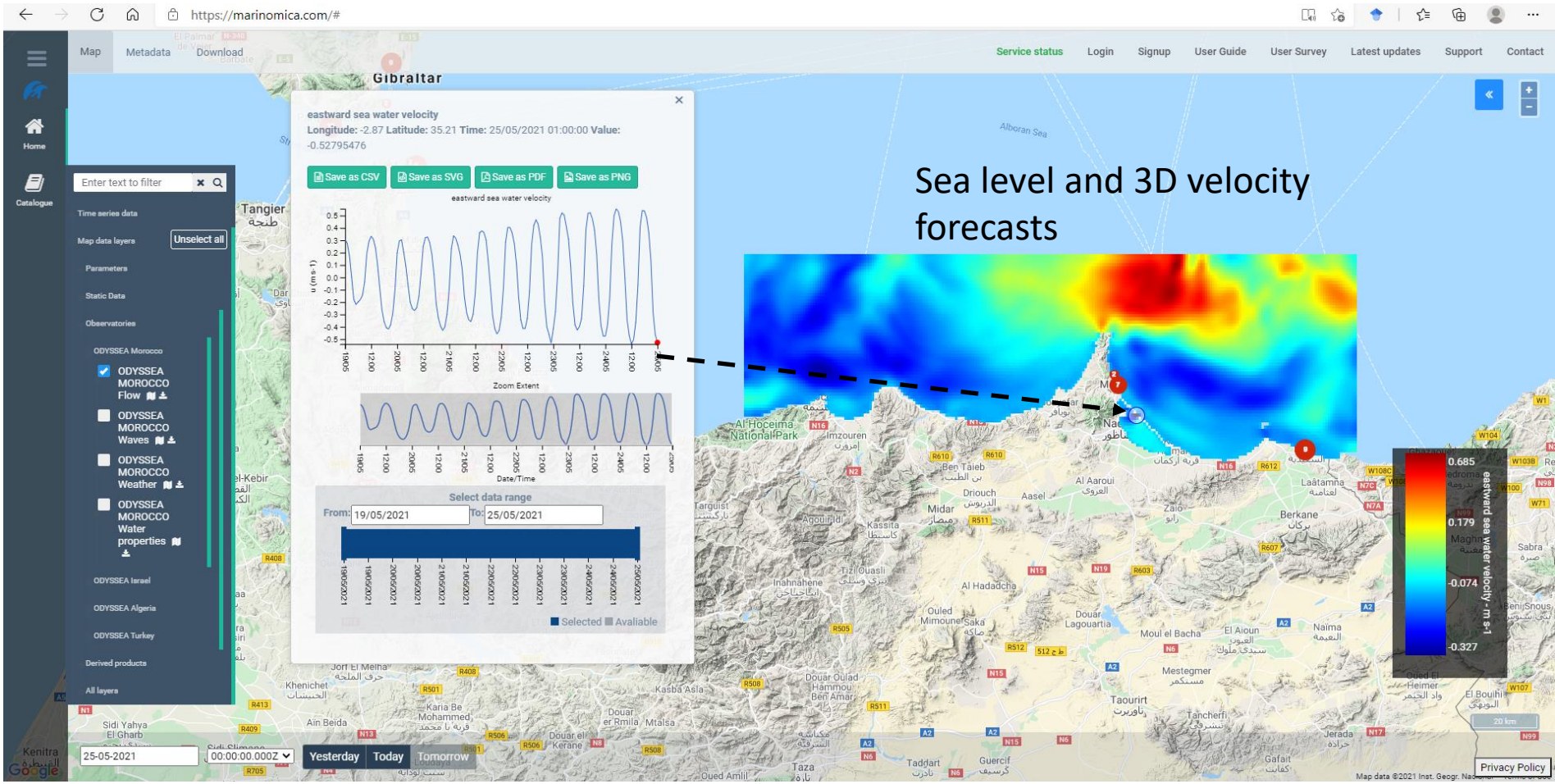
- Biogeochemical model: Delft3D-WAQ
- Oil spill model: MEDSLIK-II
- Mussel farm model
- Ecosystem model: ECOPATH

- Jellyfish model: Delft3D-PART, OpenDrift

- Local scale high-resolution hydrodynamic models to support services

Morocco Observatory – Output

ODYSSEA

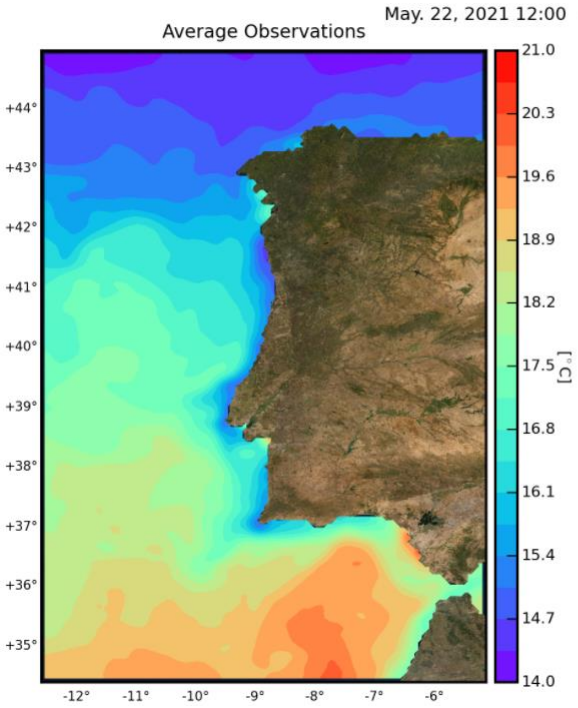


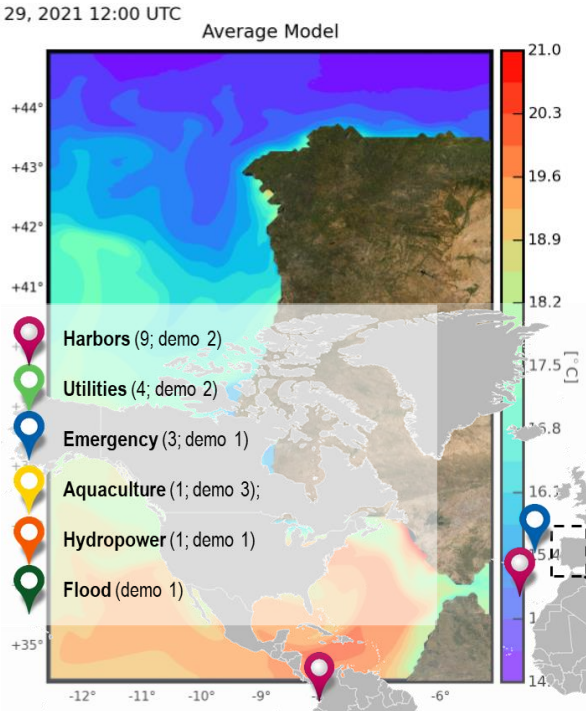
Validation

ODYSSEA

- Validation is a critical task in running models in forecast mode to support activities;
- Users want to know the uncertainty of forecasts;
- Implement a coastal model run in forecast mode without validation can take a couple of days. However, a good **validation can take years;**
- Validation is complex process because:
  - The present volume of observations (satellite & in situ) is quite large;
  - Number of observations grows continuously due to new satellite missions and the deploy of new in situ platforms;
  - Models have several calibration parameters that need to be tunned (e.g. bottom drag coefficient, surface drag coefficient, parameters of the horizontal and vertical turbulence models, etc.);
  - Models are always being improved for each relevant new version a new implementation need to be done and the validation procedure need to be repeated;
  - End users looking to the forecasts in a daily base find regulary new deficiencies that need to be tackle;
  - It is a non stopping procedure and very time consuming;

Validation

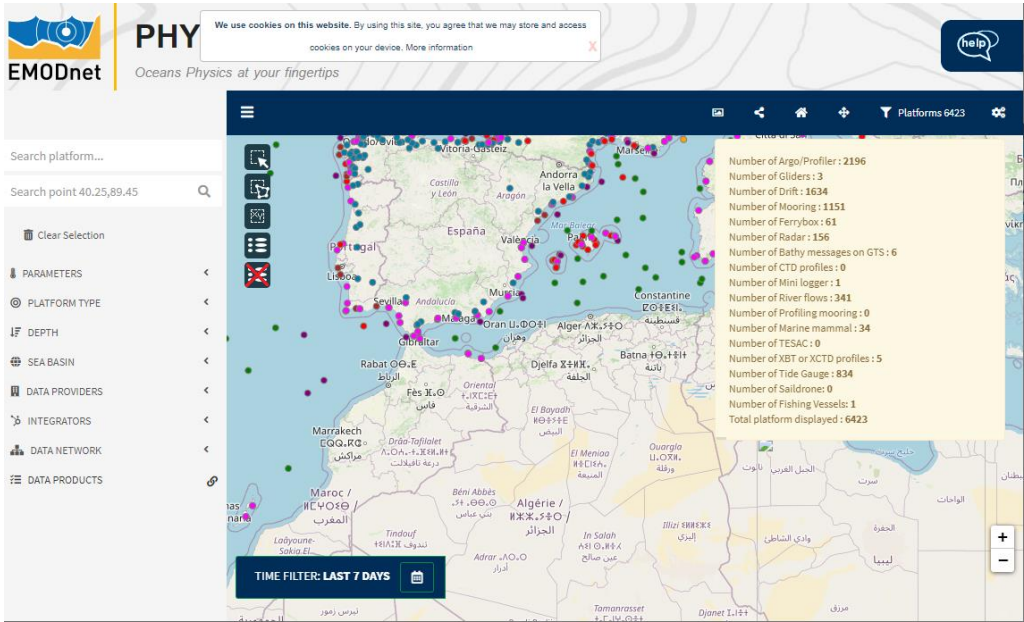

May. 22, 2021 12:00 - May. 29, 2021 12:00 UTC
Average Observations
+44°
+43°
+42°
+41°
+40°
+39°
+38°
+37°
+36°
+35°
-12°
-11°
-10°
-9°
-8°
-7°
-6°
21.0
20.3
19.6
18.9
18.2
17.5
16.8
16.1
15.4
14.7
14.0
[°C]


Average Model
+44°
+43°
+42°
+41°
+35°
-12°
-11°
-10°
-9°
-6°
21.0
20.3
19.6
18.9
18.2
17.5
[°C]

Harbors (9; demo 2)
Utilities (4; demo 2)
Emergency (3; demo 1)
Aquaculture (1; demo 3);
Hydropower (1; demo 1)
Flood (demo 1)

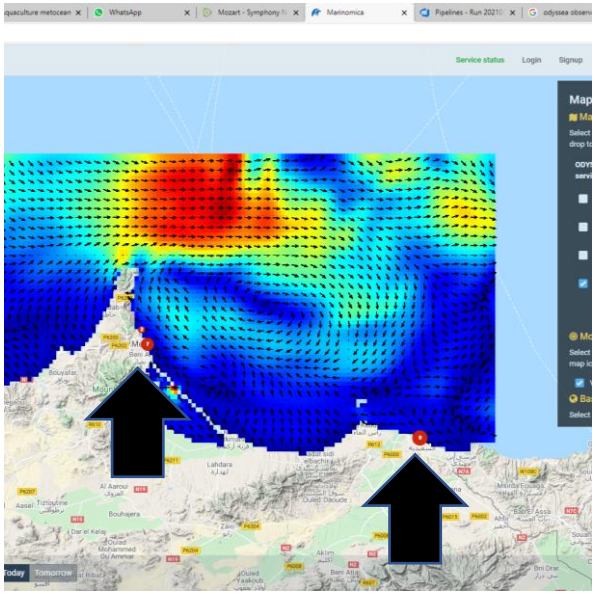
Validation – coastal models

- sea level - **Tidal gauges**,…;
- temperature – **Satellite**, buoys, gliders, … ;
- currents – **ADCP, HF-Radar, drifters**,..;
- salinty – buoys, gliders, …;
- …



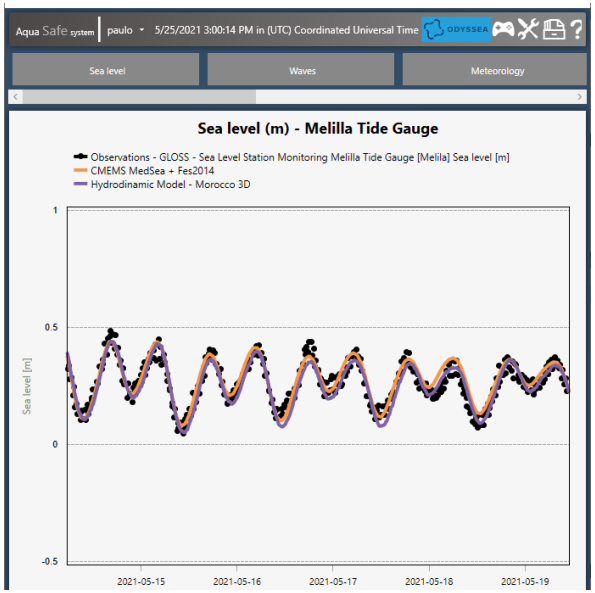
Tidal gauge – Morocco Obs.

Preliminary validation – March-May 2021

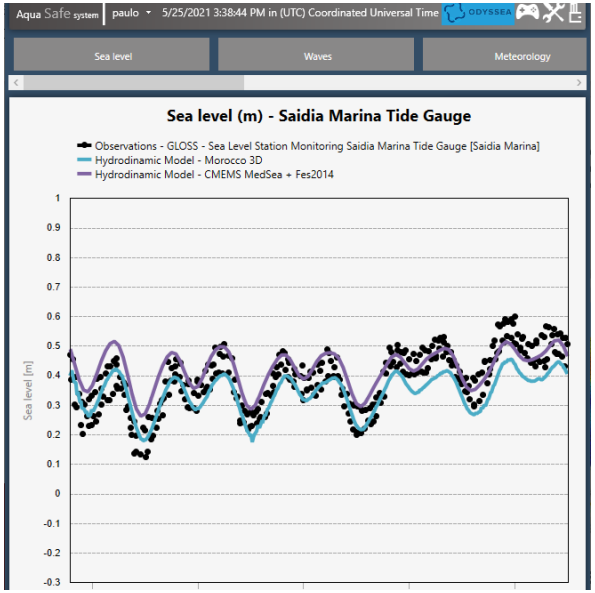


Sea level

Tidal gauges



Melilla



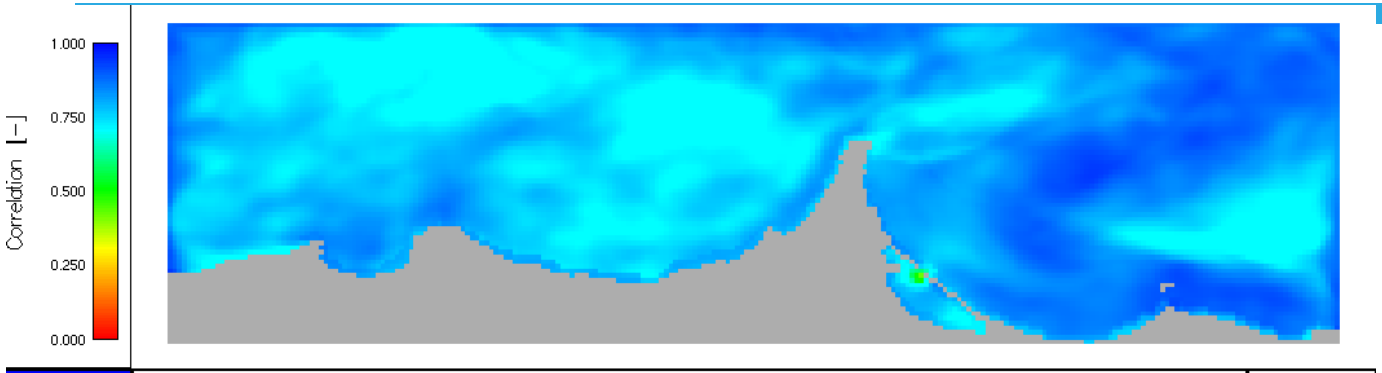
Saidia Marina

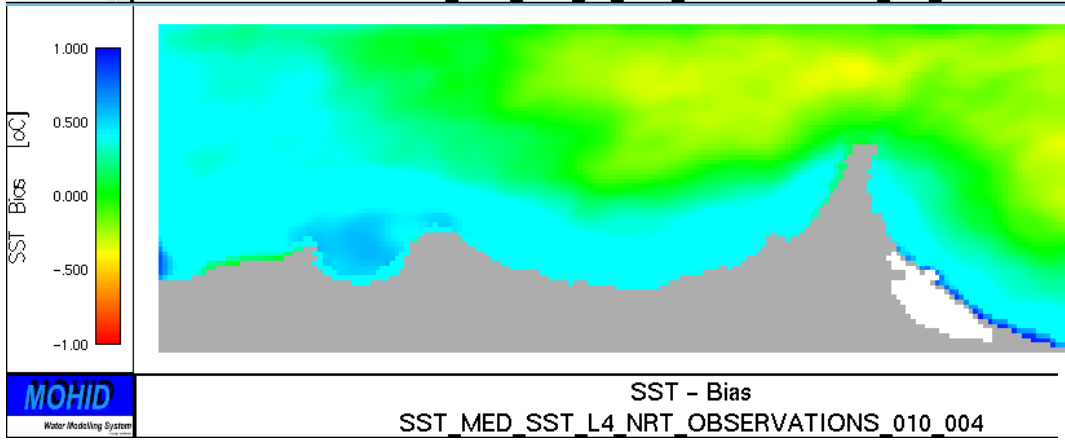
BIAS [m]	**0.01**
RMSE [m]	**0.07**
Normalise RMSE [%]	**14**
Unbias RMSE [m]	**0.07**
Normalise unbias RMSE[%]	**14**
R	**0.83**

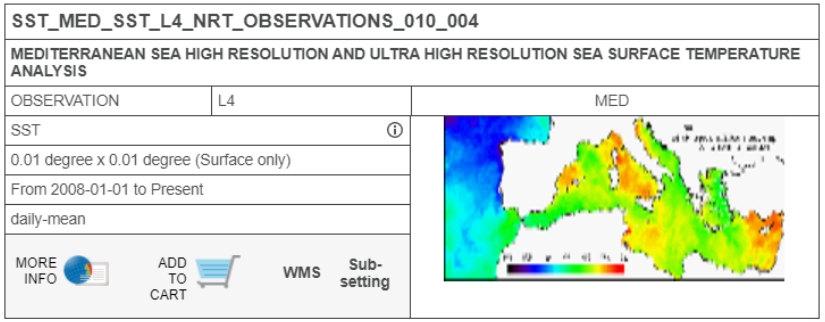
Satellite – temperature – Morocco Obs.

Preliminary validation – May 2021

ODYSSEA





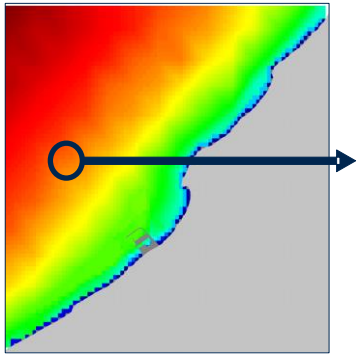


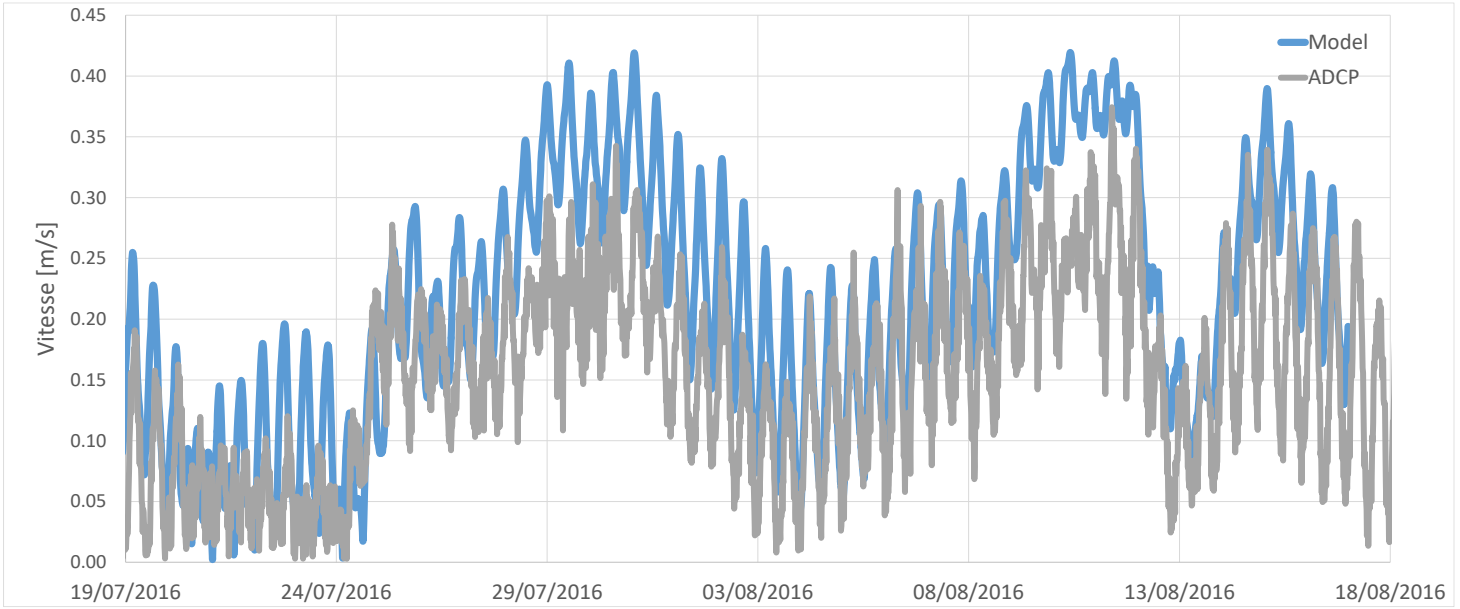
Copernicus Europe's eyes on Earth

Copernicus Marine Service

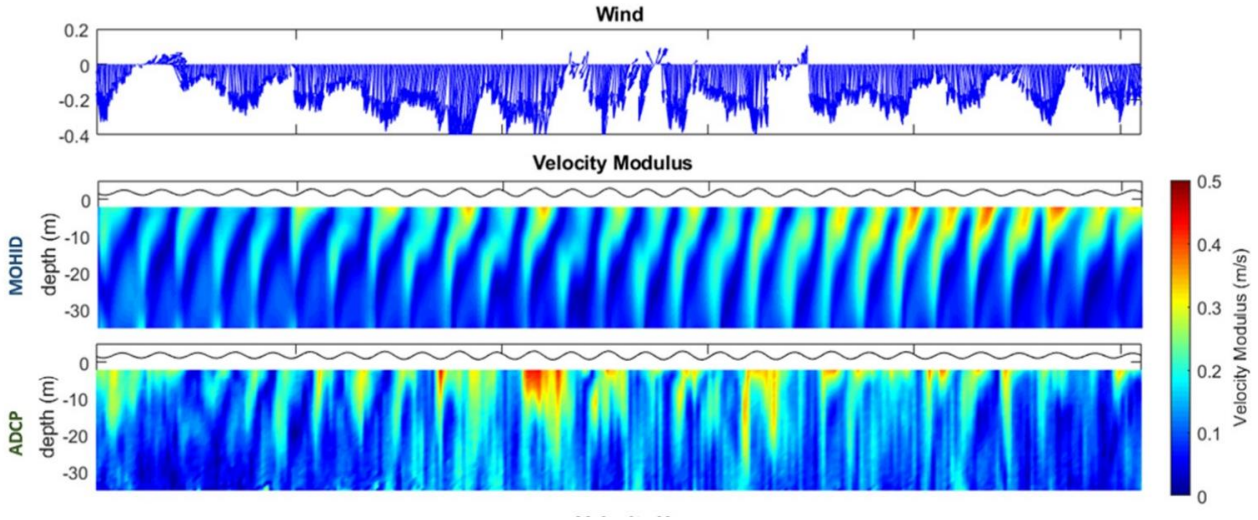
Validation - ADCP
Dakhla/Morocco

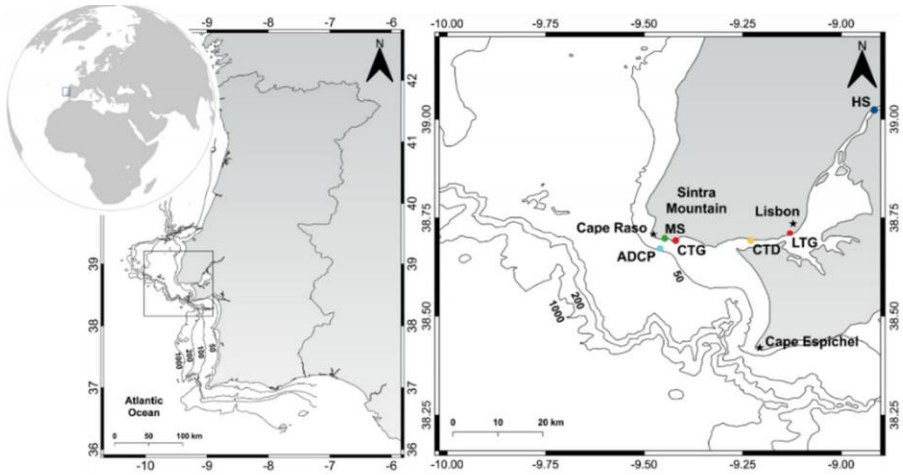
ODYSSEA





Validation - ADCP
Lisbon/Portugal





Validation – Drifters Korea

Hindawi
Discrete Dynamics in Nature and Society
Volume 2018, Article ID 6848745, 15 pages
https://doi.org/10.1155/2018/6848745

Hindawi

Research Article

Prediction of Drifter Trajectory Using Evolutionary Computation

Yong-Wook Nam and Yong-Hyuk Kim

Department of Computer Science, Kwangwoon University, 20 Kwangwoon-ro, Nowon-gu, Seoul 01897, Republic of Korea

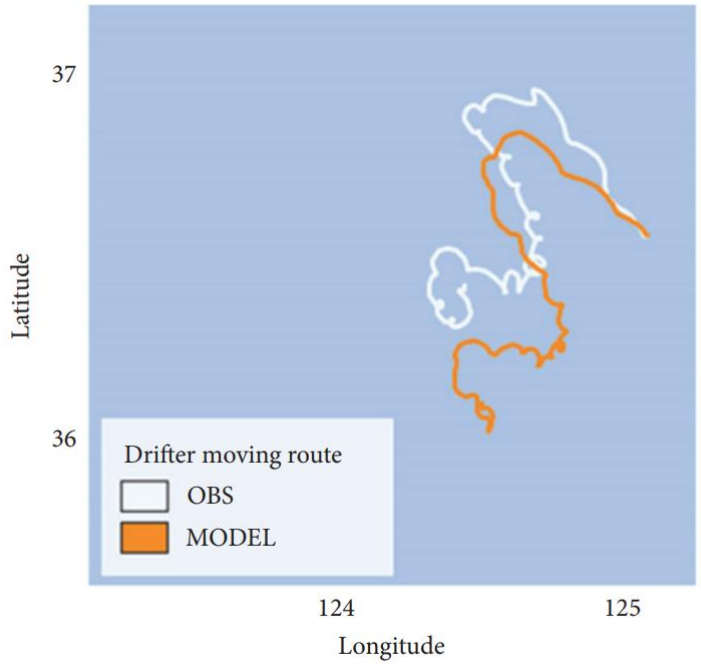
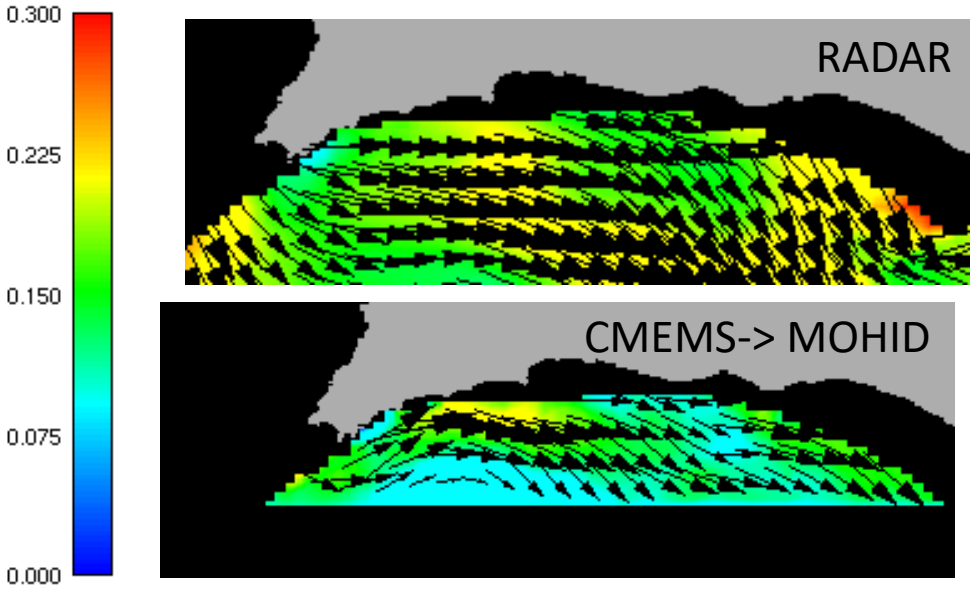
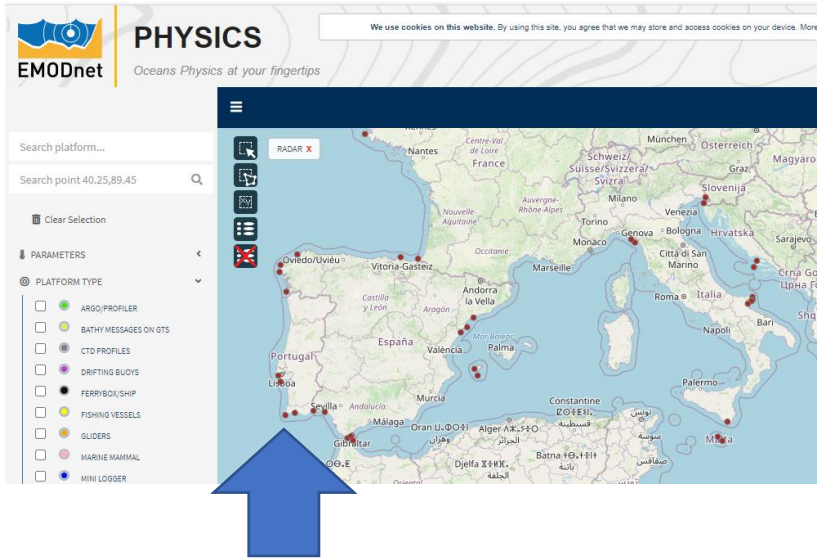


FIGURE 3: Observed trajectory of drifter (OBS) and predicted one of MOHID model to be compared with our predicted models (Case 1).

Validation – HF-Radar
Algarve/Portugal

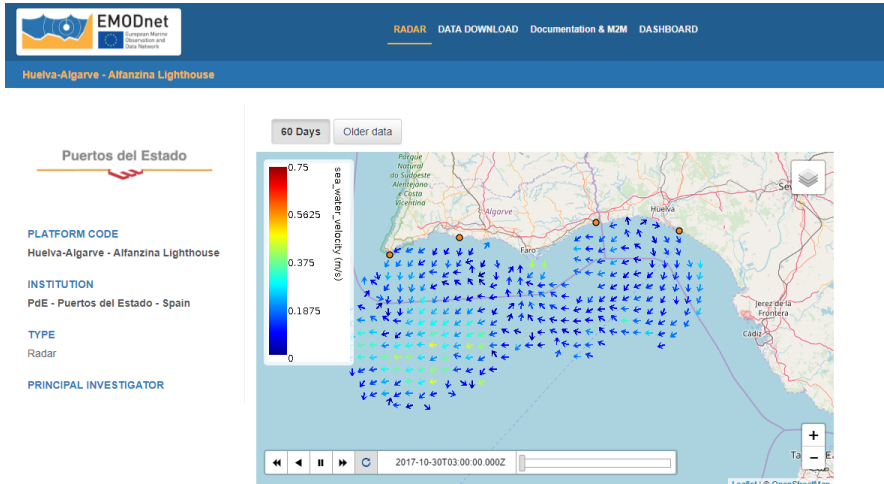




Downscalling CMEMS IBI 3D hourly solution

Leitão P. (1), A. Silva (1), J. Rodrigues (1), S. Bartolomeu (1) and J. Leitão (1)

(1) HIDROMOD, R. Rui Teles Palhinha, Nº4, 1º, 2740-278,Porto Salvo. E-mail: paulo.chambel@hidromod.com



Conclusions

ODYSSEA

- CMEMS forecasts can be downscale to support services at the local scale;
- Before implementing a complex downscale process it is necessary to **define the question to answer;**
- Validation is a critical component of any service. The end user needs to know the forecasts uncertainty.

ODYSSEA

Creating products and knowledge
for the Mediterranean

THANK-YOU

Paulo Leitão

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