



IH Jornadas 19-21 of June, 2018 Lisbon

Downscaling CMEMS IBI 3D hourly solution

Leitão, P., A. Silva, J. Rodrigues, S. Bartolomeu and J. Leitão

Overview

- Background
- Why downscale CMEMS IBI ?
- Proposed methodology
- Test case – Algarve coast
- Conclusions
- Ongoing work

Background

Hidromod forecast services (18 - signed contracts and 9 - demos)

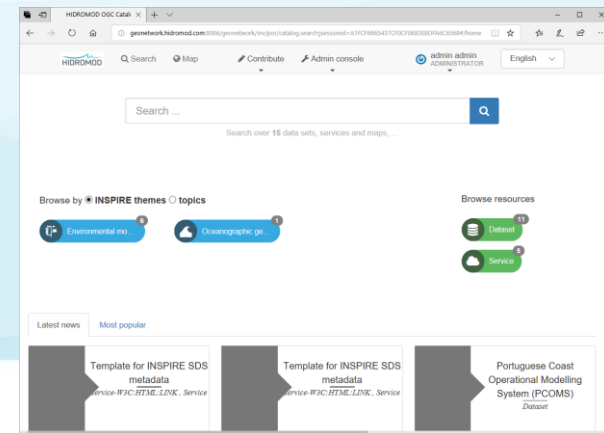
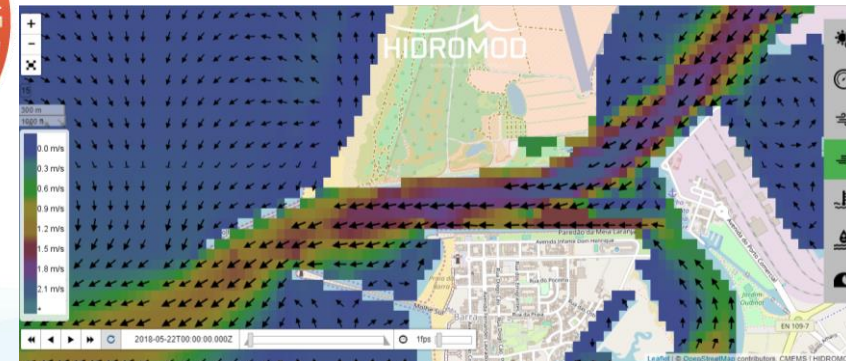
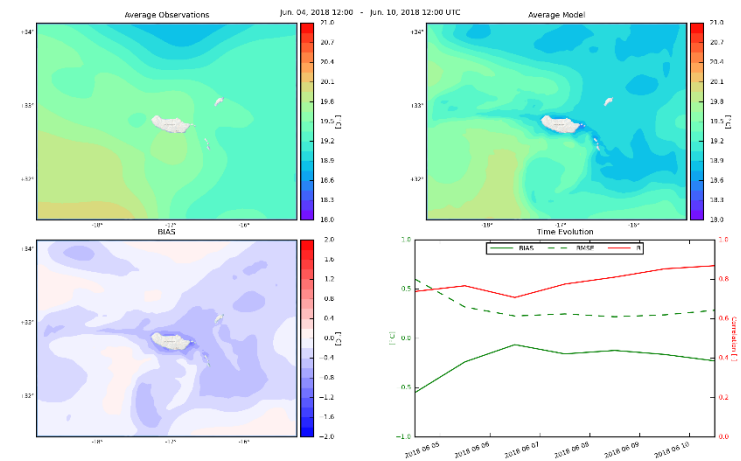


Background

- Marine Copernicus demonstration contracts



- Public validation
- WMS OGC 1.3 compliant (GeoServer)
- Metadata (GeoNetwork)
- Downscale CMEMS IBI 3D hourly solution



What is the CMEMS 3D hourly solution?

0.028 degree x 0.028 degree (50 depth levels)

From 2013-01-01 to Present

5 days forecast

Large scale circulation, meteorological, astronomic tide and rivers (climatologic)

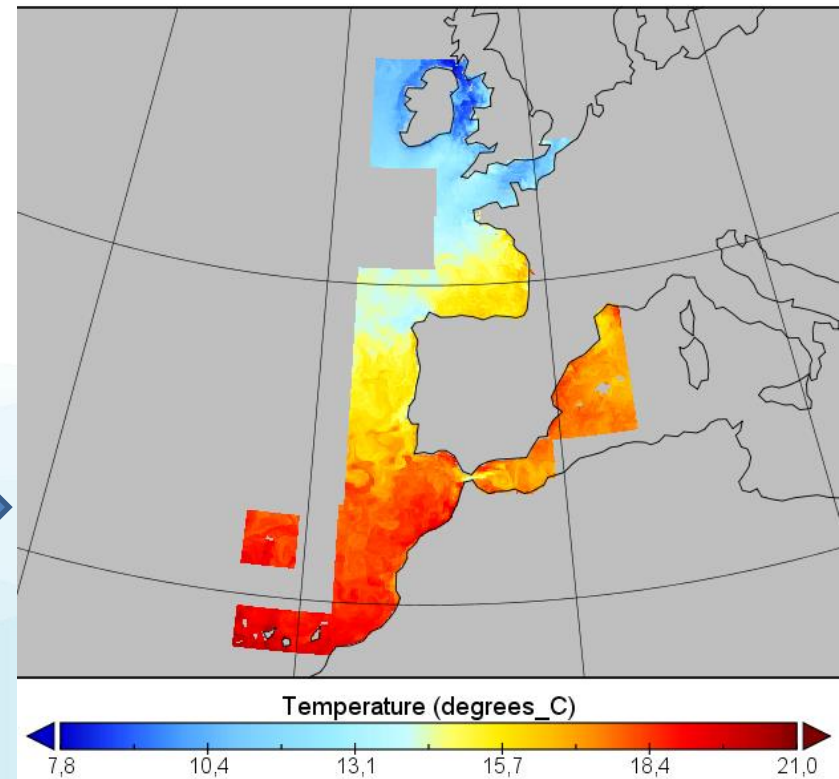
3D daily-mean entire domain
2D hourly-mean surface

3D hourly-mean near the coast (new output)



CMEMS IBI
Hourly 3D output

Temperature



HIDROMOD motivation

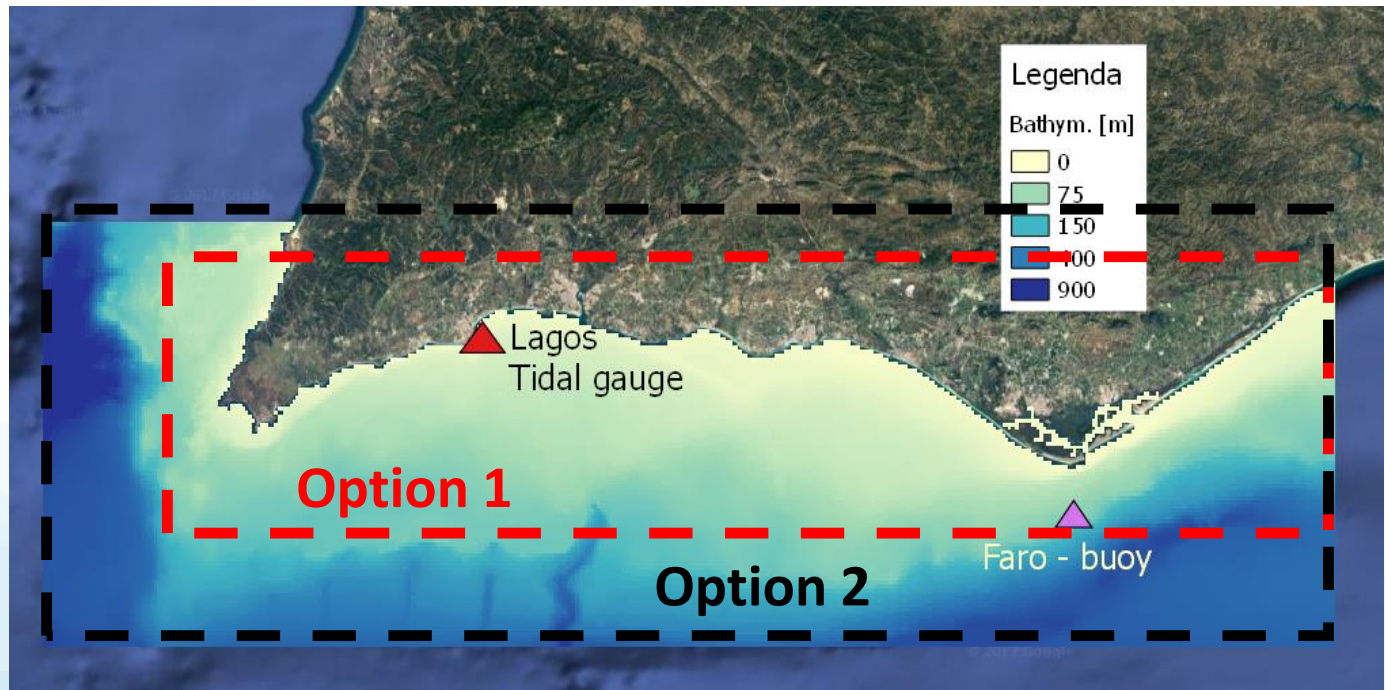
- HIDROMOD downscales the CMEMS global solution via MOHID model implementations for several sites located in the IBI area to support tailor forecast services: ports, utilities, emergency response, aquaculture, etc.
- The methodology proposed by HIDROMOD to downscale the CMEMS global solution is followed by several partners in the IBI area:
 - IST – PCOMS twin model of the one run by Hidromod for West Iberia (Mateus et al., 2012);
 - MeteoGalicia - covers the Galicia coast (Huhn et al., 2012);
 - Suez environment - French Bask country and Marseille (Delpey et al., 2014);
 - Algarve University – Algarve coast (Janeiro et al., 2017).

MOHID - Proposed downscaling methodology

- **Reference solution:** CMEMS IBI 3D Hourly solution
- **Open boundary conditions** (Leitão et al., 2005):
 - Sea level/barotropic flow – Flather radiation condition;
 - 3D velocity, temperature and salinity – flow relaxation scheme (or nudging)
- **Spin up**
 - **Initial condition:**
 - salinity/temperature = reference solution,
 - null velocity field
 - null sea level gradients;
 - **Forcing:** Slow connection of all forcing terms;

Algarve test case – December 2017

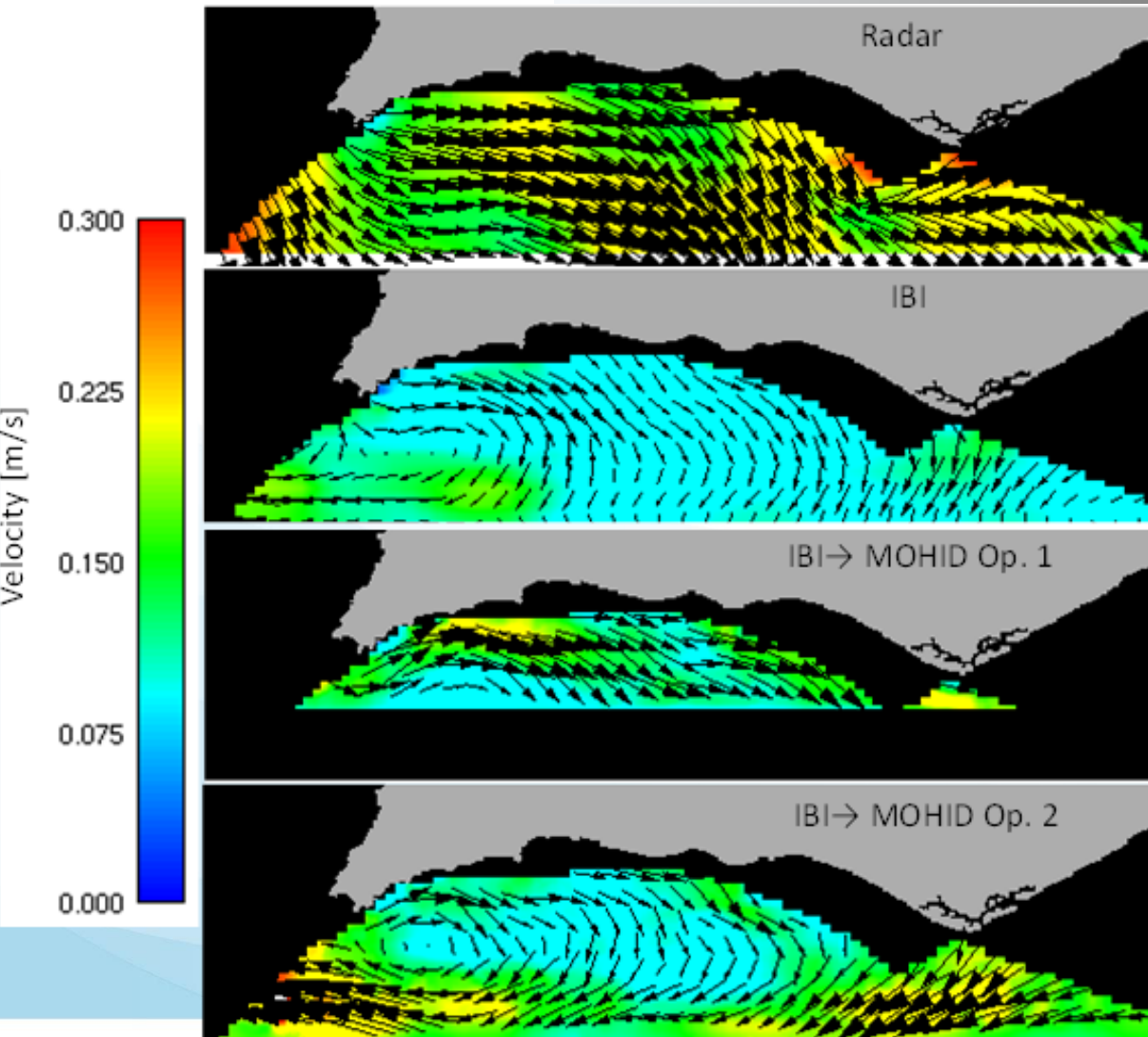
$dx \sim 400m$
Same vertical
discretization of
CMEMS IBI



Observations:

- HF radar – surface velocities (hourly);
- Faro buoy – sea surface temperature (every 10 minute);
- Lagos tidal gauge – sea level (every 5 seconds).

Results – average surface vel. – HF-Radar



9 to 22 of December of 2017

	RMSE U [m/s]	RMSE V [m/s]	Corr. U	Corr. V
IBI	0.17	0.13	0.34	0.33
MOHID Op.1	0.12	0.10	0.39	0.43
MOHID Op.2	0.21	0.11	0.42	0.40

Results – Model vs Observations

9 to 22 of December of 2017

Surface temperature - Faro buoy

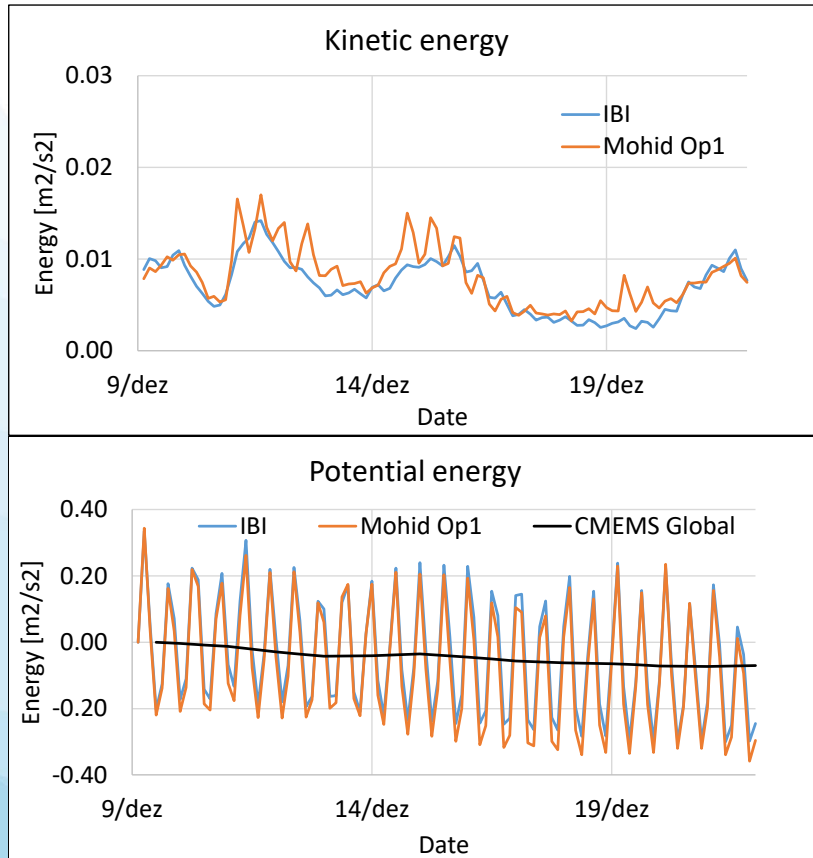
	IBI	MOHID Op.1	MOHID Op.2
Bias [°C]	-0.3	-1.0	-1.1
RMSE [°C]	0.5	1.1	1.2
Correlation	0.76	0.76	0.7

Sea level – Lagos tidal gauge

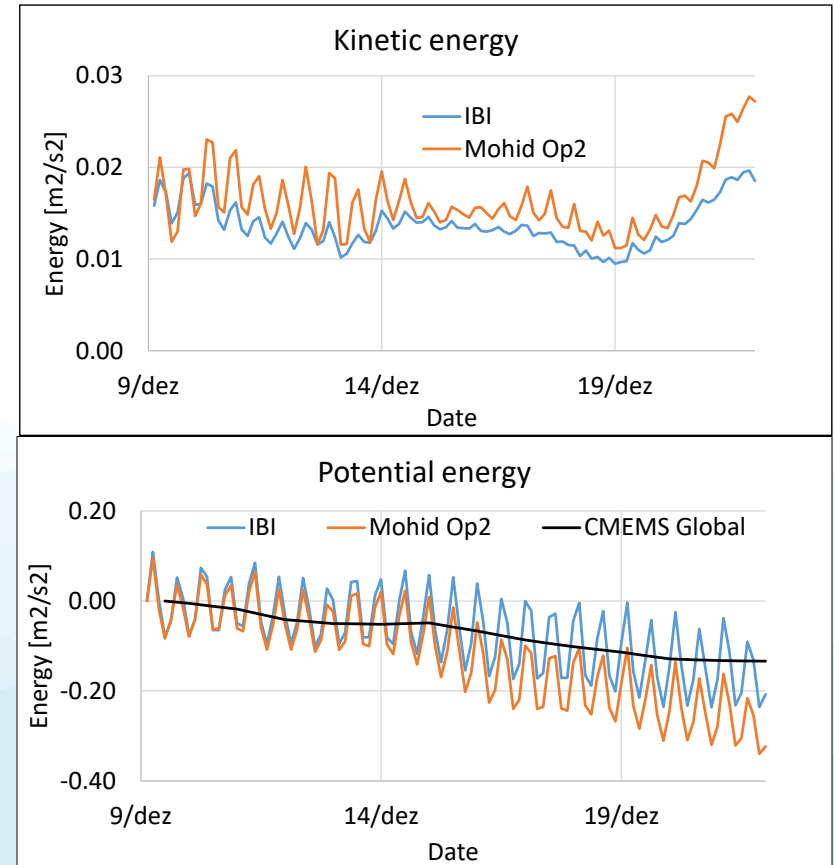
	IBI	MOHID Op.1	MOHID Op.2
Unbiased [cm]	8.4	9.3	10.4
Correlation [-]	0.99	0.99	0.99

Results – Energy evolution

Option 1



Option 2

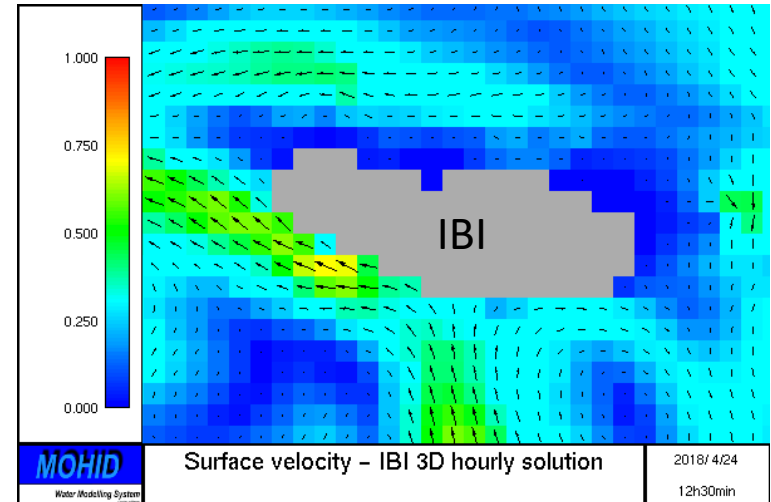
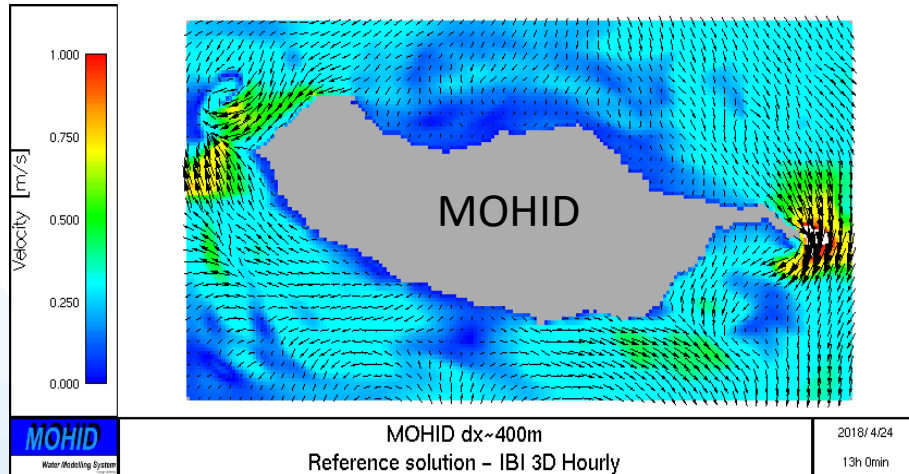


Conclusions – Algarve coast

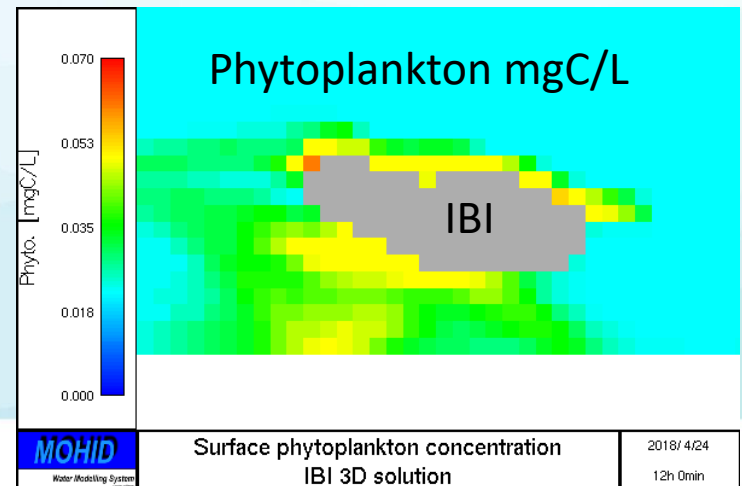
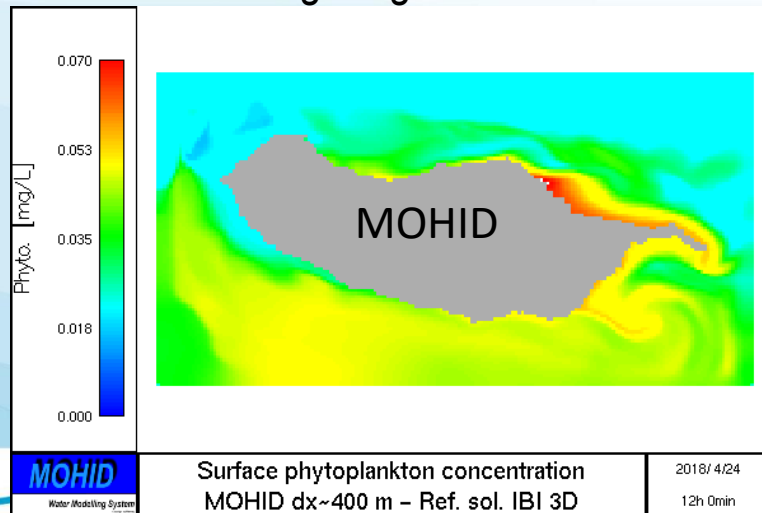
- MOHID is able to downscale with no limitations the 3D IBI hourly solution if the model domain is restricted to the continental shelf;
- A way of overcoming the problem faced by Option 2 is to implement a spectral nudging in the MOHID source code similar to the one used in the CMEMS IBI solution (Katavouta and Thompson, 2016):
 - 2D Fourier transform;
 - Salinity and temperature;
 - Strong nudging in the deepest areas and free on the shelf;
- Dissemination actions done:
 - Detail report disseminate in the CMEMS IBI and MOHID users community

Ongoing work

- Downscaling IBI solution for Madeira Island



- Downscaling Biogeochemical IBI solution



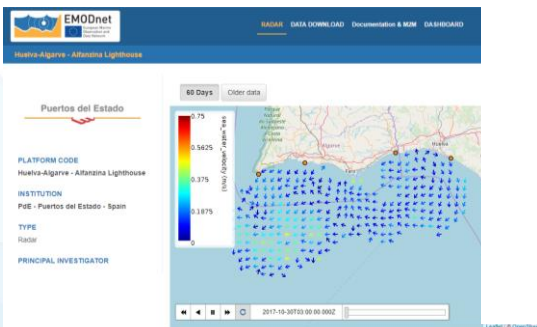


OBRIGADO!



paulo.chambel@hidromod.com

Average field (m/s)



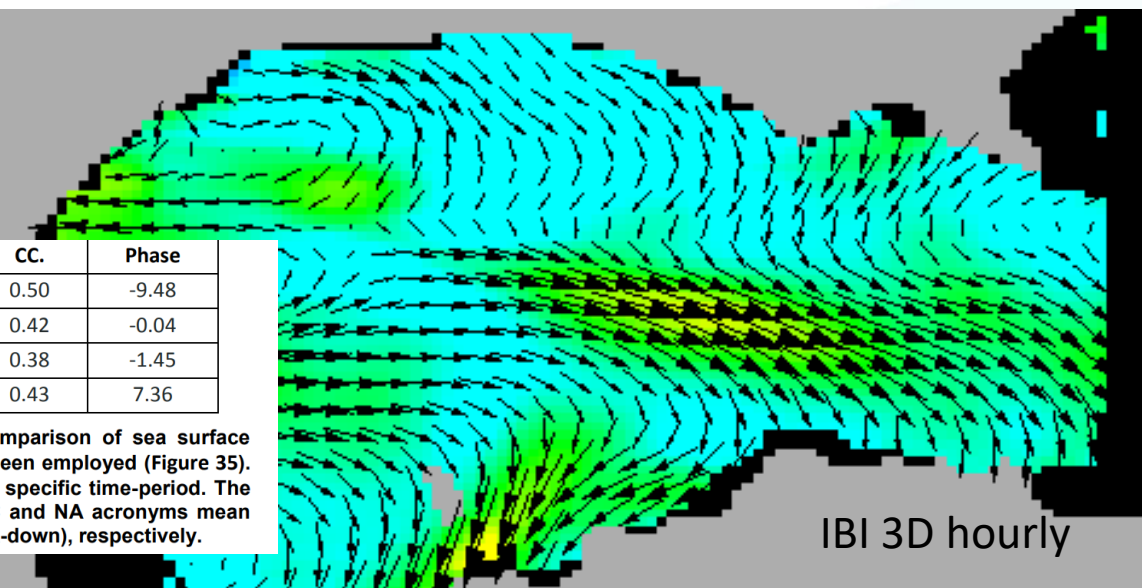
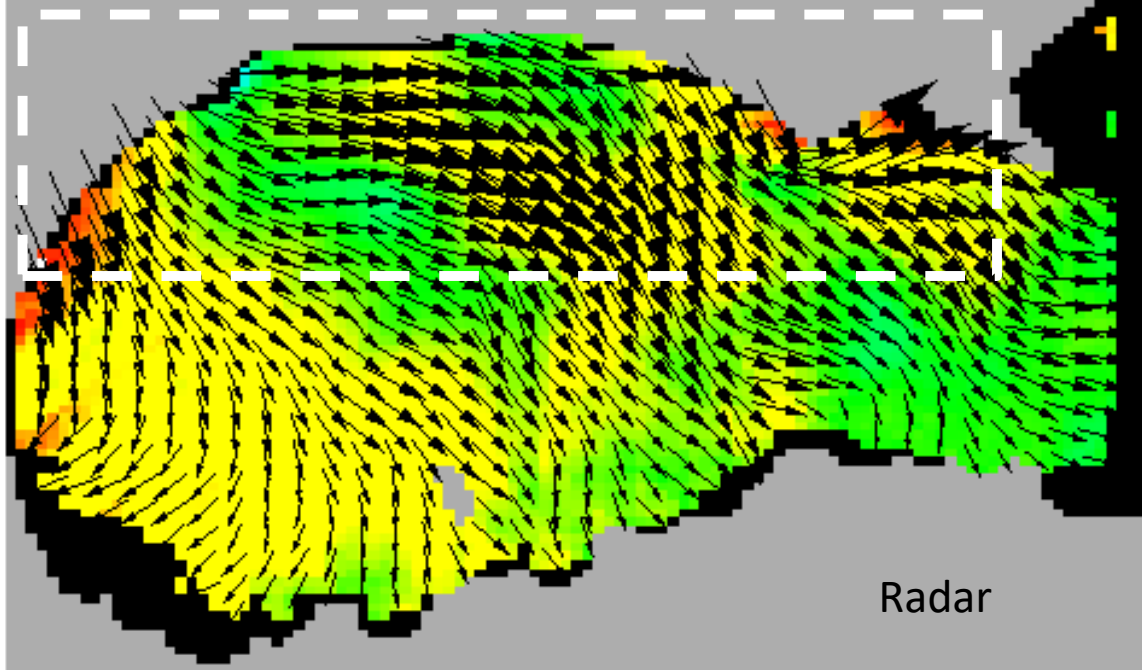
EMODNET

CMEMS-IBI-QUID-005-001.pdf

HUELVA-ALGARVE	RMSE U	RMSE V	Corr. U	Corr. V	CC.	Phase
Winter	0.07	0.12	0.48	0.37	0.50	-9.48
Spring	0.11	0.07	0.26	0.49	0.42	-0.04
Summer	0.09	0.10	0.33	0.43	0.38	-1.45
Autumn	0.12	0.12	0.35	0.42	0.43	7.36

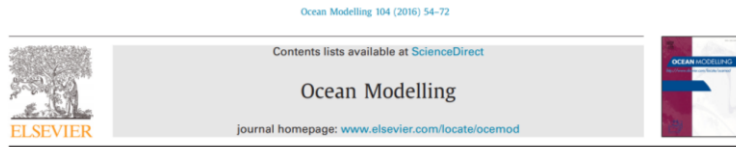
Table 11: Statistical metrics derived from IBI-HF radar seasonal comparison of sea surface currents during 2016. Four different HF radar systems (in blue) have been employed (Figure 35). The values have been averaged over each HF radar domain and each specific time-period. The units of RMSE and phase are m/s and degrees, respectively. The CC and NA acronyms mean "Complex Correlation" and "Not Available" (as a result of a radar break-down), respectively.

0.225
0.150
0.075
0.000



RMSE U	RMSE V	Corr U	Corr V
0.16	0.11	0.38	0.43

Relevante references



Downscaling ocean conditions with application to the Gulf of Maine, Scotian Shelf and adjacent deep ocean

Anna Katavouta*, Keith R. Thompson

Department of Oceanography, Dalhousie University, Halifax, Nova Scotia, Canada



ARTICLE INFO

Article history:
Received 1 December 2015
Received in revised form 17 April 2016
Accepted 22 May 2016
Available online 24 May 2016

Keywords:
Dynamical downscaling
Regional ocean model
One-way nesting
Spectral nudging

ABSTRACT

Spectral nudging

global prediction system and shelf and adjacent deep ocean. Its predictions using observation and sea level, CTDs, predicts more realistic fields than the global system on the shelf because it has higher resolution and includes tides that are absent from the global system. However, in deep water the regional model misplaces deep ocean eddies and meanders associated with the Gulf Stream. This is not because the regional model's dynamics are flawed but rather is the result of internally generated variability in deep water that leads to decoupling of the regional model from the global system. To overcome this problem, the next step is to spectrally nudge



Atlantic -Iberian Biscay Irish- IBI Production Centre
IBI_ANALYSIS_FORECAST_PHYS_005_001_b

IBI validation

Issue: 3.0

Contributors: Marcos Sotillo, Bruno Levier, Pablo Lorente

Approval date by the CMEMS product quality coordination team: dd/mm/yyyy

5th Jornadas de Engenharia Hidrográfica

Lisboa, 19 a 21 de junho de 2018

Downscaling CMEMS IBI 3D hourly solution

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

(1) HIDROMOD, Rua Rui Teles Palhinha, N.º 4, 1.º floor, 2740-278, Porto Salvo. paolo.chambel@hidromod.com.

Abstract: The IBI 3D hourly solution was tested as an alternative initial and open boundary condition to the present methodology used by Hidromod based in the CMEMS global forecast. The tests were done for resolution: Faro buoy, conclusion present at is located methodology used in the IBI solution. In this methodology, some salinity and temperature (spectral nudging) sinks/sources terms are added to force the density field to converge outside of the shelf to the CMEMS global solution.

Key words: Downscaling, hydrodynamic model, spin-up, nudging, CMEMS, MOHID, Algarve

Algarve downscaling results

5th Jornadas de Engenharia Hidrográfica

Lisboa, 19 a 21 de junho de 2018

Serviço de previsão para suporte a estabelecimentos de culturas marinhas

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

(1) HIDROMOD, Rua Rui Teles Palhinha, n.º 4, 1.º, 2740-278, Porto Salvo. soufia.bartolomeu@hidromod.com

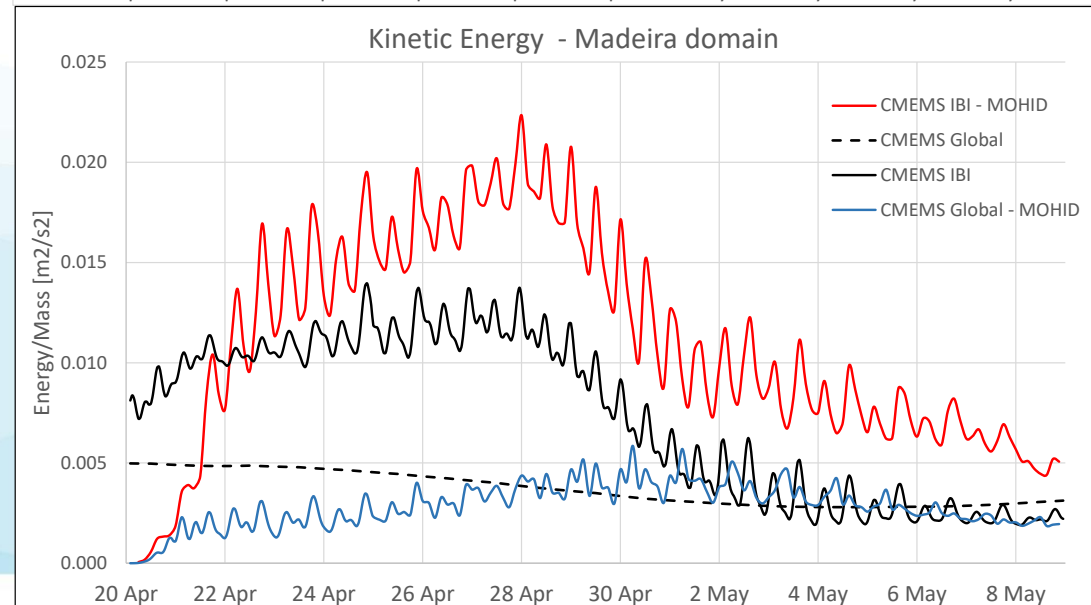
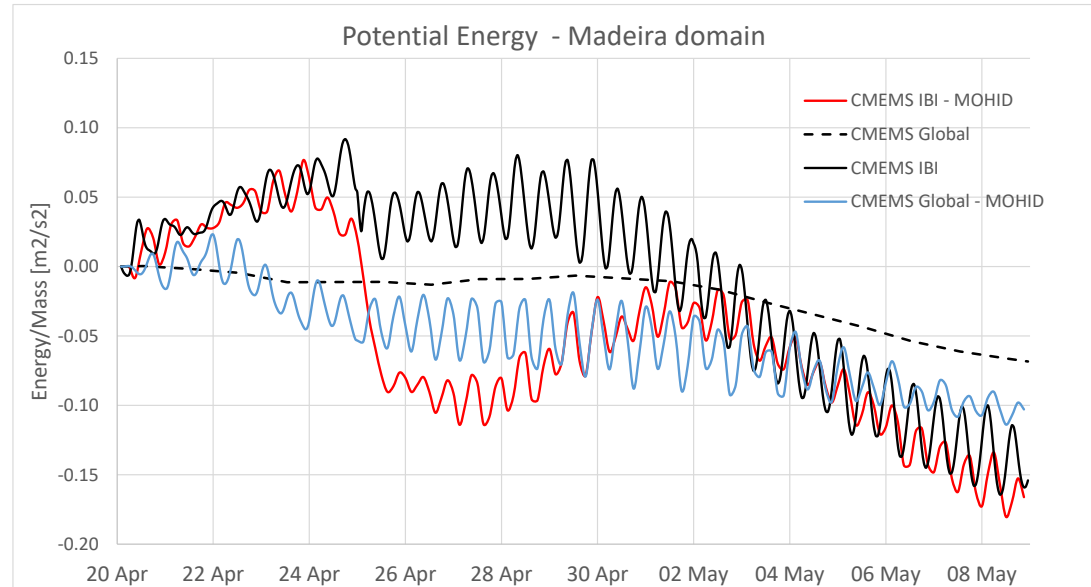
Resumo: A aquacultura é um sector que tem vindo a aumentar significativamente nos últimos anos em Portugal. Para uma vez que se re modelos encaixada escala dos quilómetros plumas de estuário que fornece previsões tridimensionais por processos de alta resolução de alimento necessário ambiente.

Sea surface temperature Sines – CMEMS, MOHID

Palavras-chave: Aquacultura, MOHID, Temperatura da água

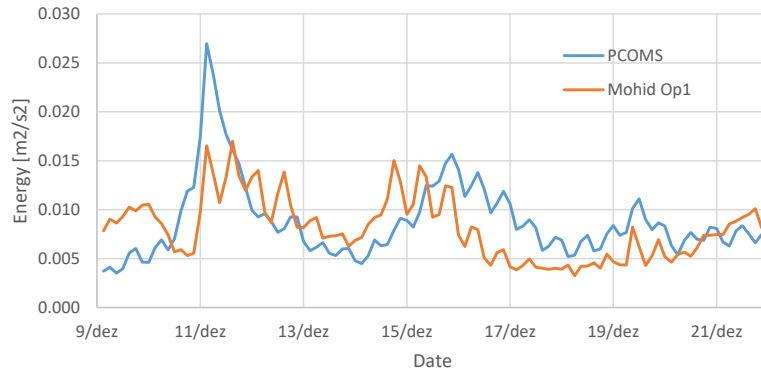
Future and ongoing work

- Downscaling : IBI vs Global + FES2012 (MOHID Standard method)

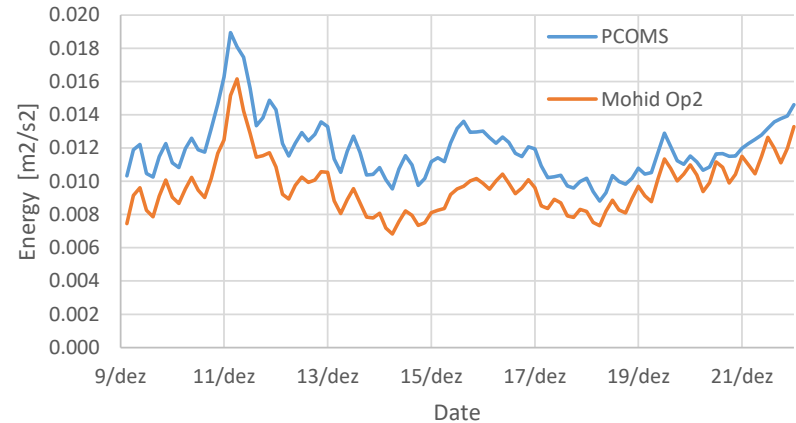


Downscaling PCOMS - Energy - Op. 1 vs Op.2

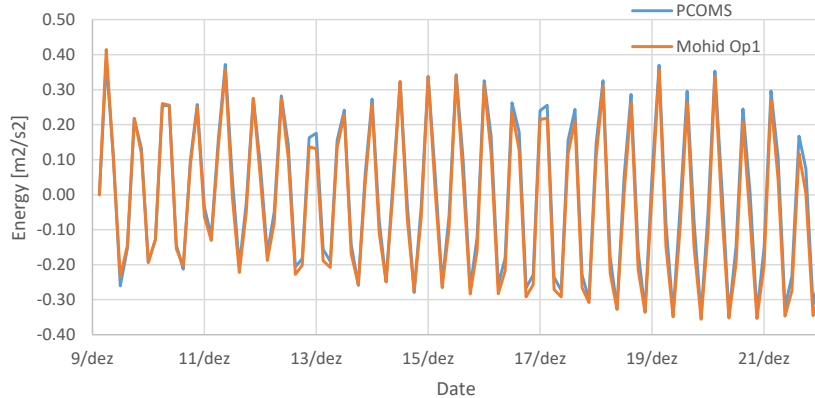
Kinetic energy



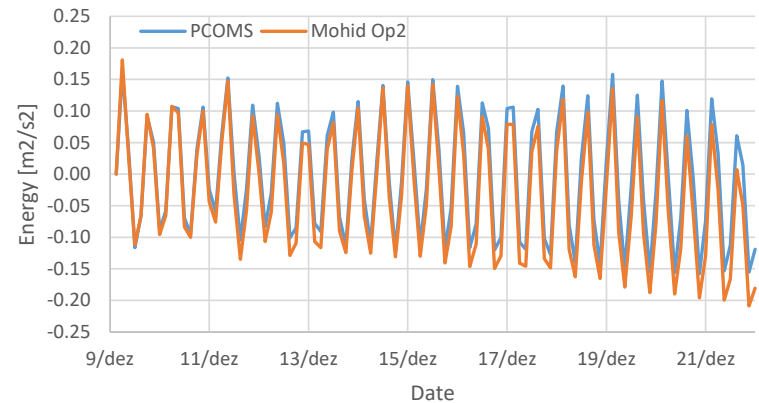
Kinetic energy



Potential energy

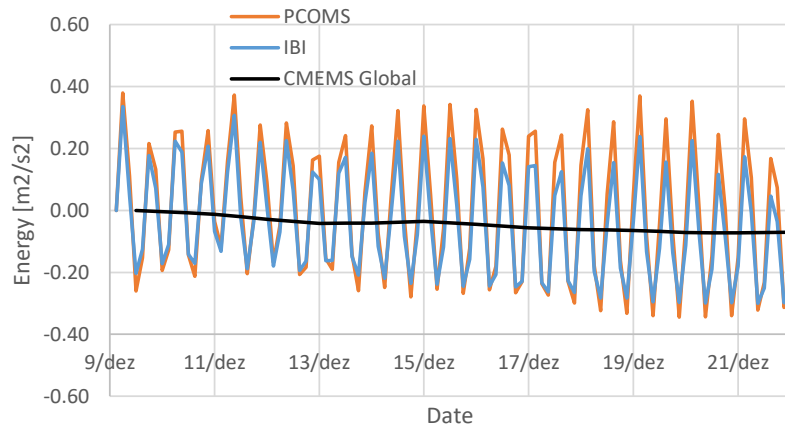


Potential energy



Energy – PCOMS vs CMEMS IBI vs CMEMS Global

Potential energy - Domain Option 1



Potential energy - Domain Option 2

