HIDROMOD

MOHID meeting 7-8 of June, 2018 Lisbon

Downscalling CMEMS IBI 3D hourly solution

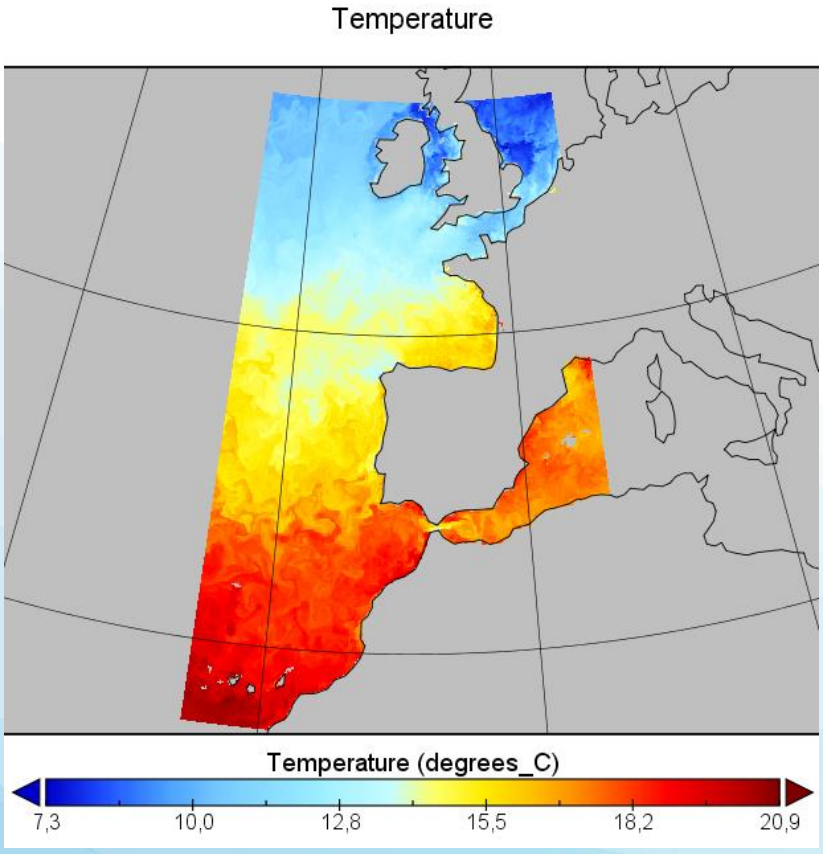
Paulo Leitão

Overview

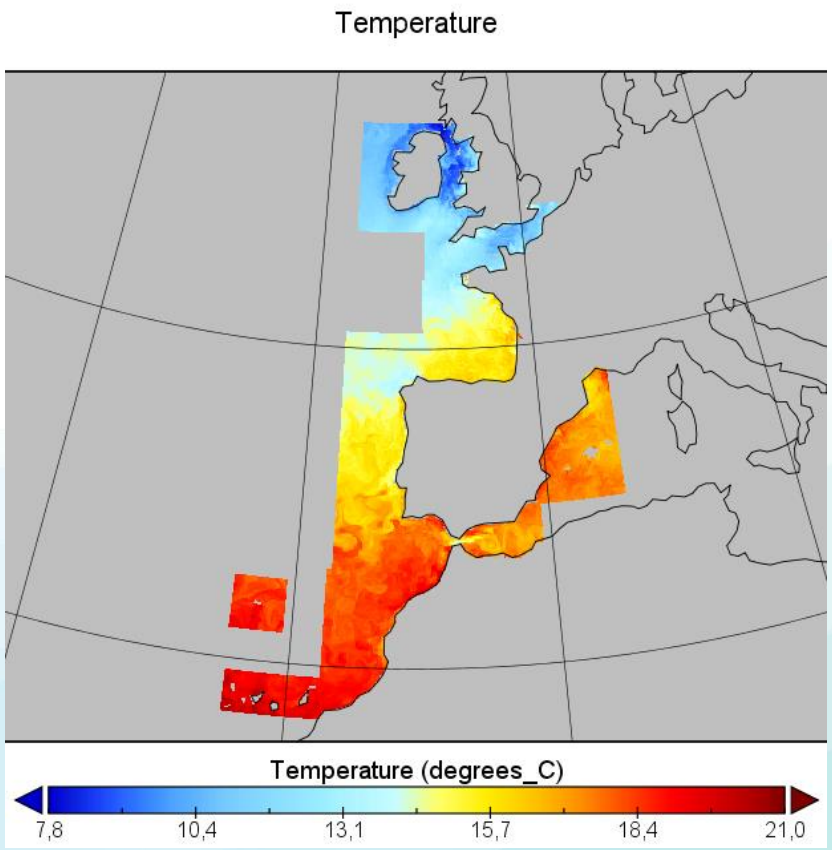
- What is the CMEMS 3D hourly solution?
- HIDROMOD motivation
- Proposed downscalling methodology
- Test case – Algarve coast
- CMEMS IBI vs PCOMS – Algarve coast
- Conclusions
- Future / Ongoing work – Madeira Island

What is the CMEMS 3D hourly solution?

Daily 3D – Standard output



Hourly 3D – New output



What are the advantages relatively to the global solution ?

Global	IBI
3D daily	3D hourly near the coast
0.08º	0.02778º
Large scale circulation and meteorological tide	Large scale circulation, meteorological and **astronomic tide**

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, emergence 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 (Delpey et al., 2014);
  - Algarve University – Algarve coast (Janeiro et al., 2017).

MOHID – Motivation

HIDROMOD's tailored forecast services (with signed contracts (18) or R&D demos (9))

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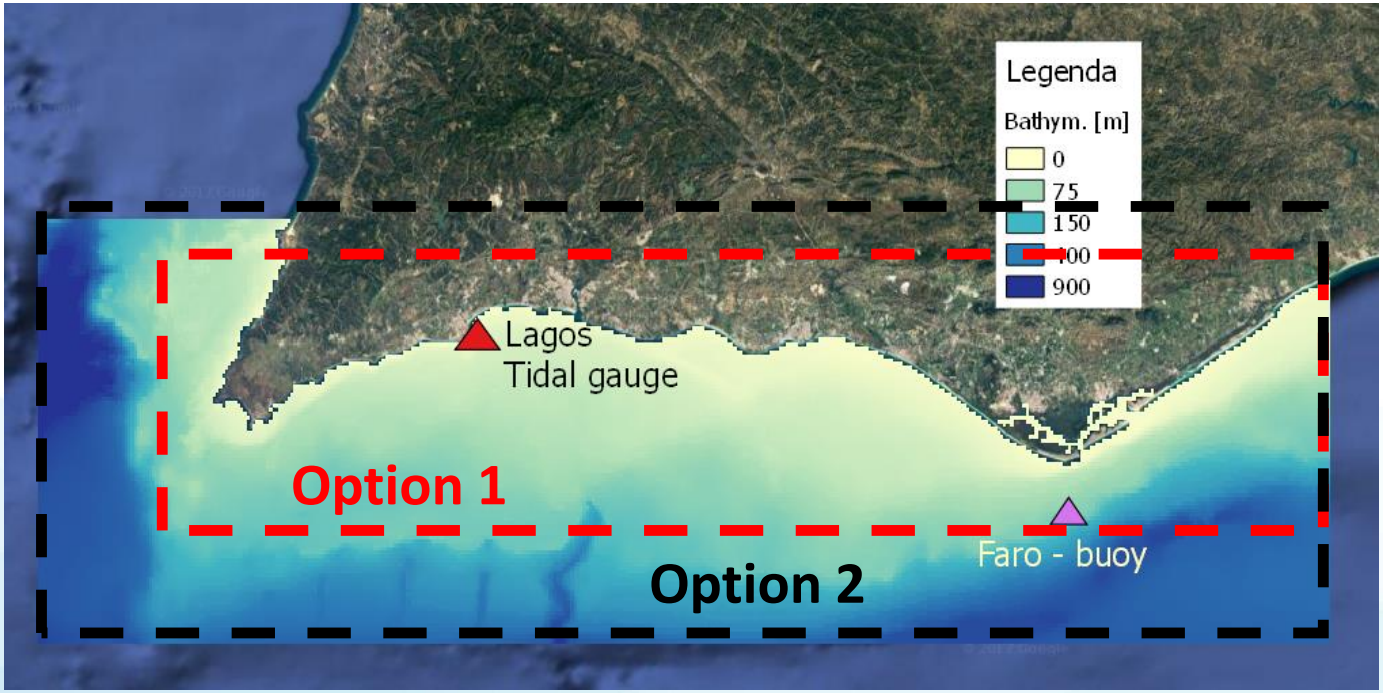
MOHID - standard downscalling methodology

- **Reference solution**: CMEMS global solution+ FES2012 + inverted barometer approximation
- **Open boundary conditions** (Leitão et al., 2005):
  - Sea level/barotropic flow – Flather radiation condition;
  - 3D velocity, temperature and salinity - boundary relaxation scheme
- Spin up
  - Method 1:
    - **Initial condition**: sea level, velocity, salinity and temperature = reference solution;
    - **Forcing**: no restrictions;
    - **Limitations**: can only be used is shallow depths (< 300 m depth);
  - Method 2 :
    - **Initial condition**:
      - salinity/temperature = reference solution,
      - null velocity field
      - null seal level gradients;
    - **Forcing**: Slow connection of all forcing terms;
    - **Limitations**: long spin up periods.

Algarve test case – December 2017

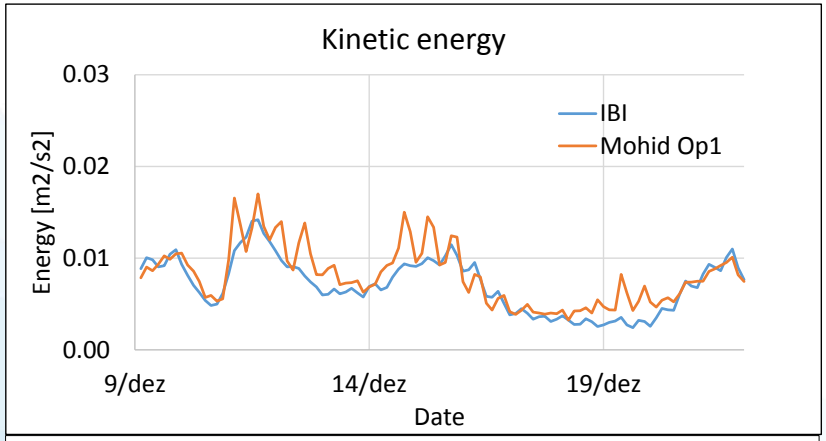


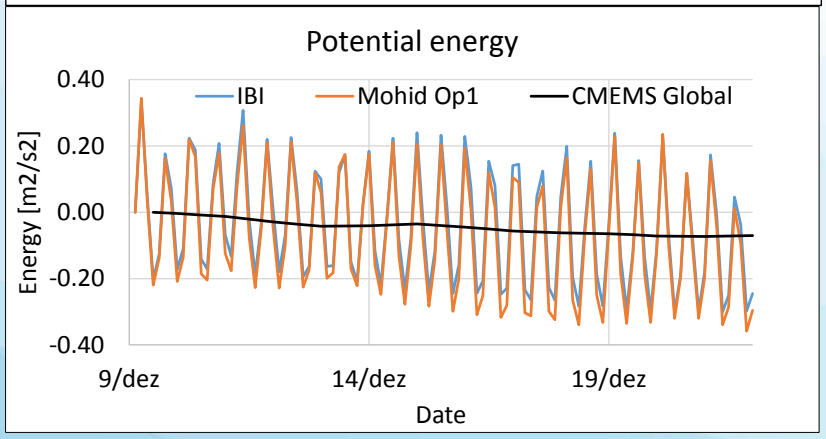
Observations:

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

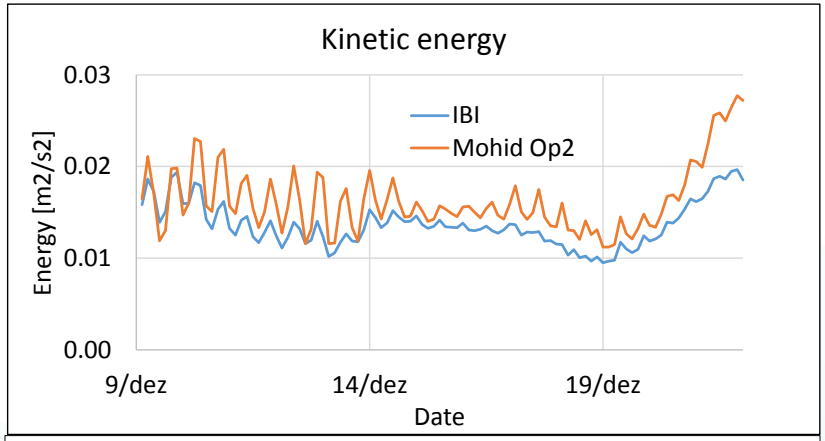
Results – Energy evolution

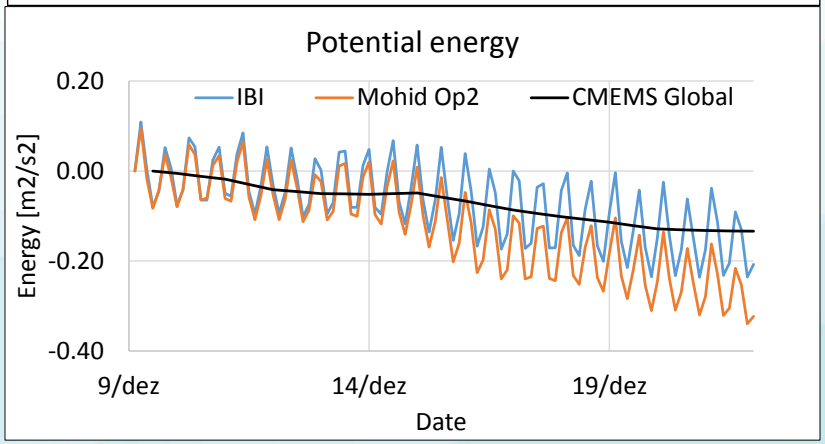
Option 1



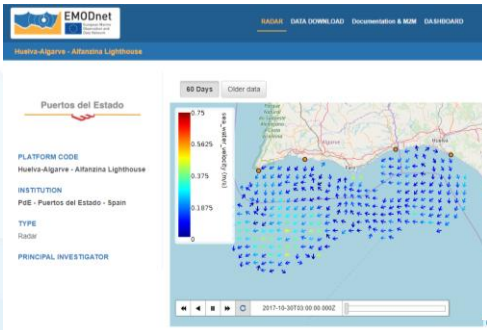


Option 2

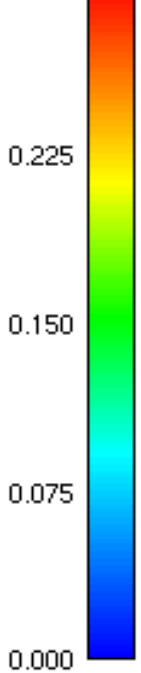


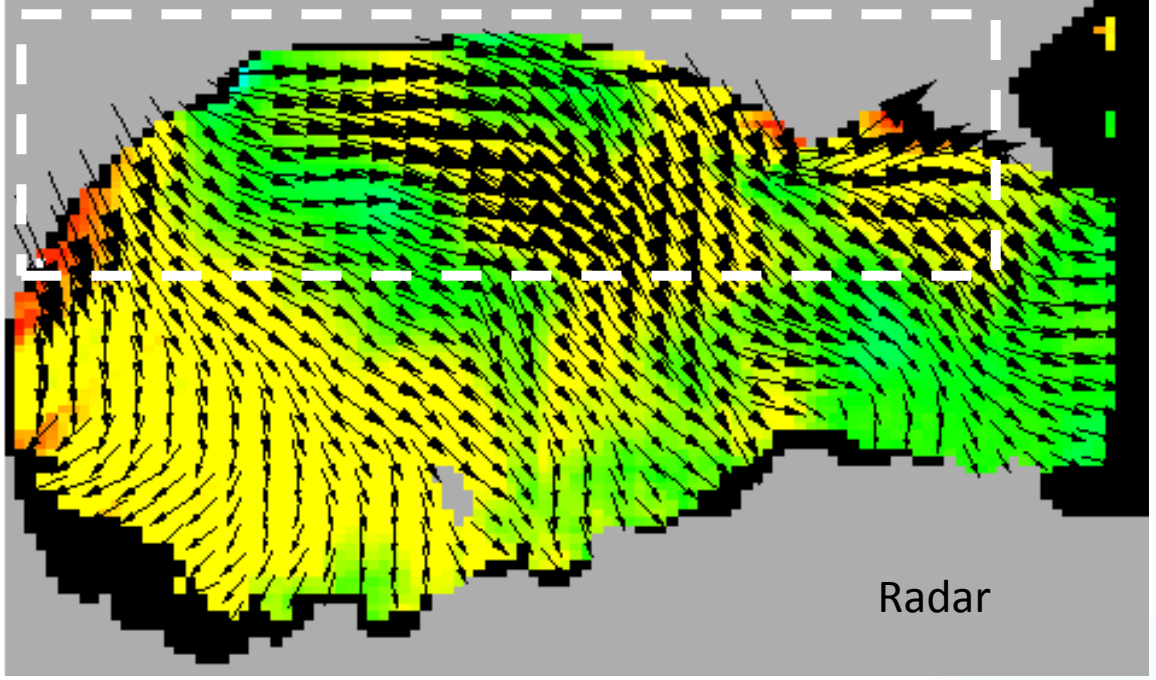


Average field (m/s)



EMODNET

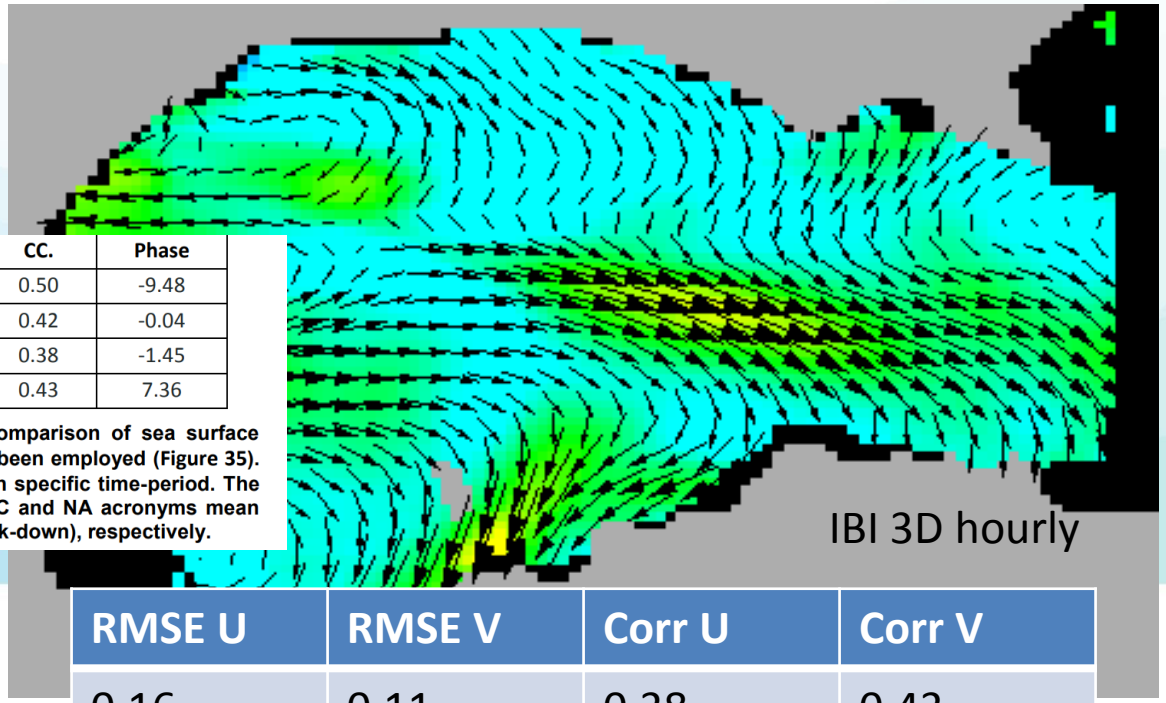




CMEMS-IBI-QUID-005-001.pdf

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.



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

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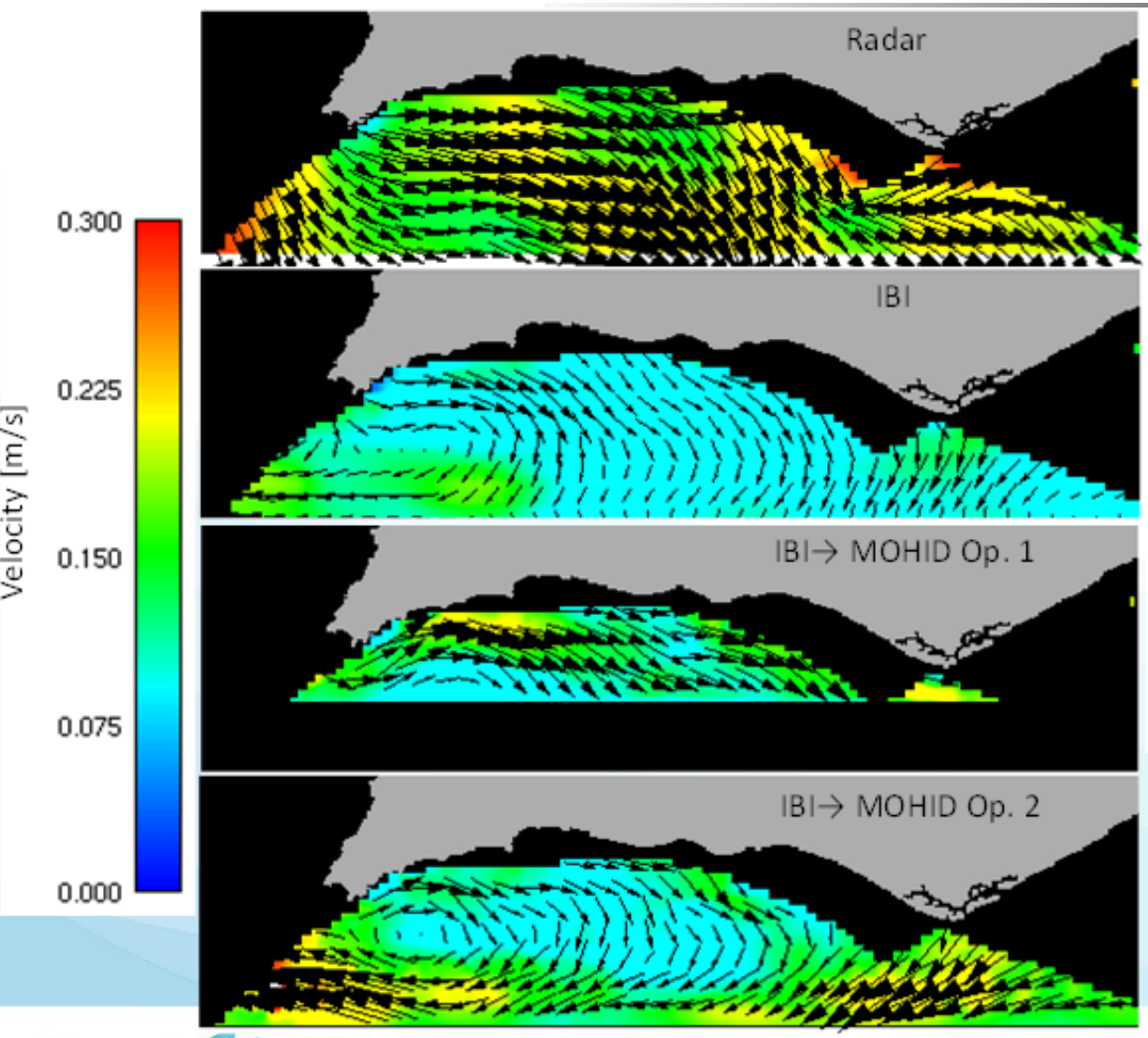
Results – Model vs Observations – HF-Radar



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 [ºC]	-0.3	-1.0	-1.1
RMSE [ºC]	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

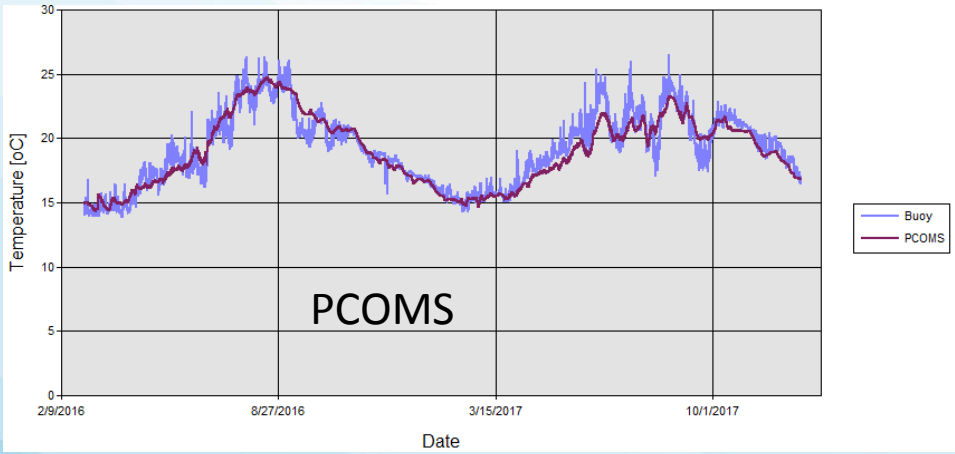
IBI vs PCOMS – December 2017 / Algarve coast

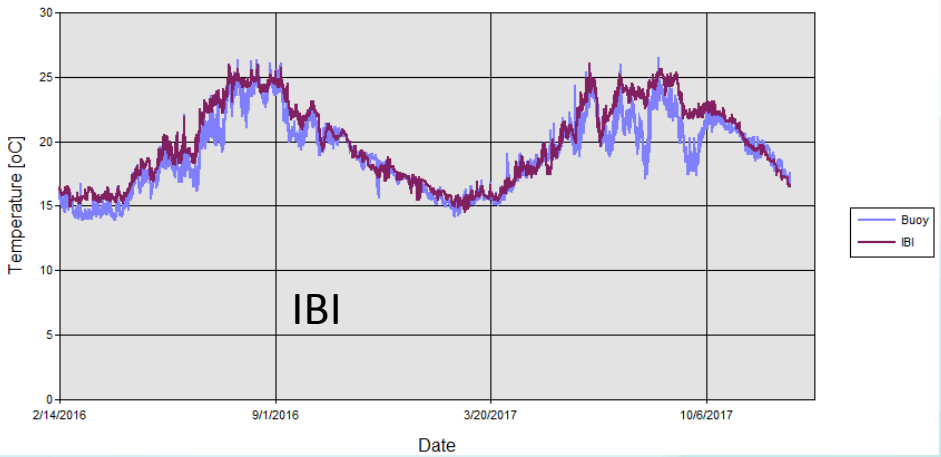
- Similar results
  - Surface temperature - Faro buoy
  - Sea level – Lagos tidal gauge

- PCOMS is better
  - Surface currents – HF-radar.

Faro buoy – surface temperature March 2016 – December 2017

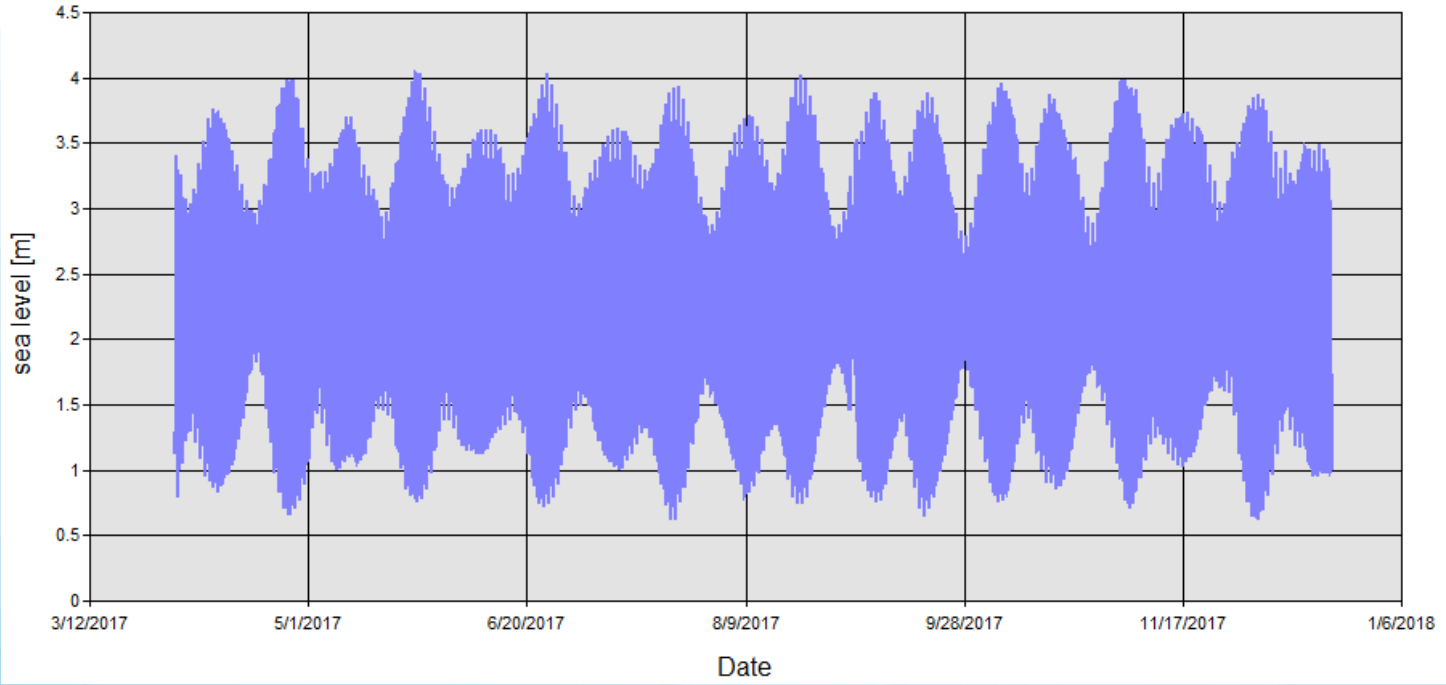
	PCOMS	IBI (CMEMS online catalogue)
Bias [oC]	-0.2	0.8
RMSD [oC]	0.9	1.3
Correlation	0.95	0.94



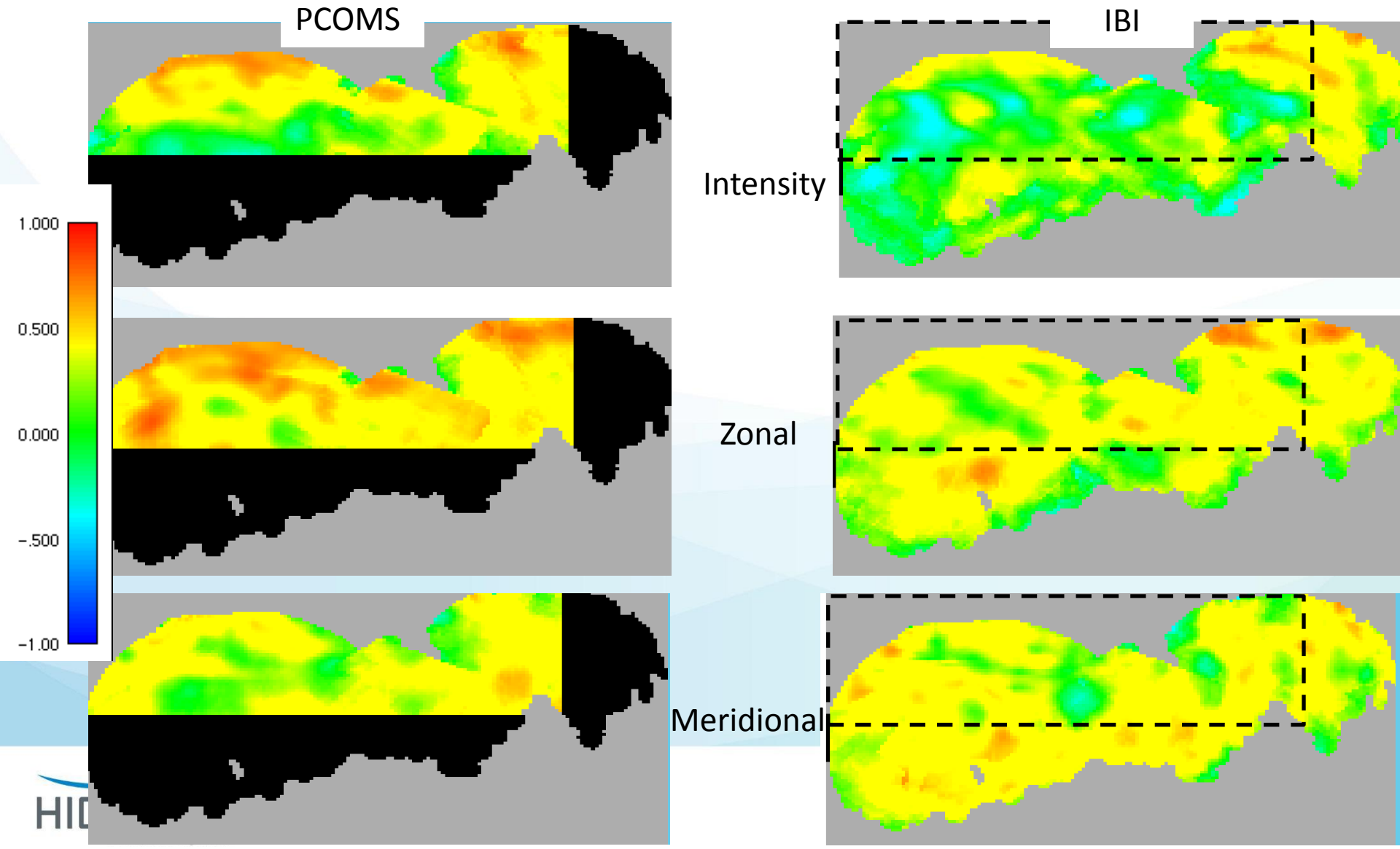


Lagos tidal gauge – Sea level
April 2017 – December 2017

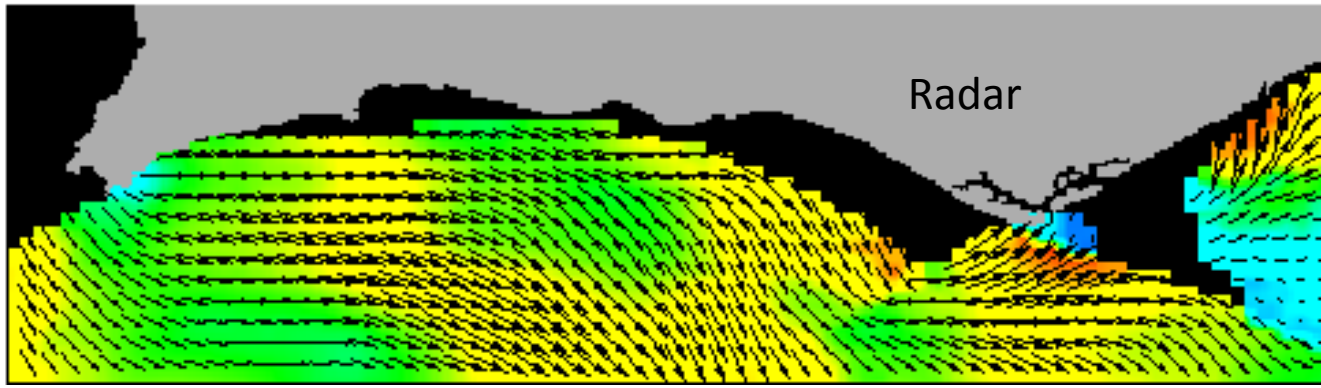
	PCOMS	IBI (CMEMS online catalogue)
Unbias RMSE [cm]	6.5	7.2
Correlation	1.00	1.00

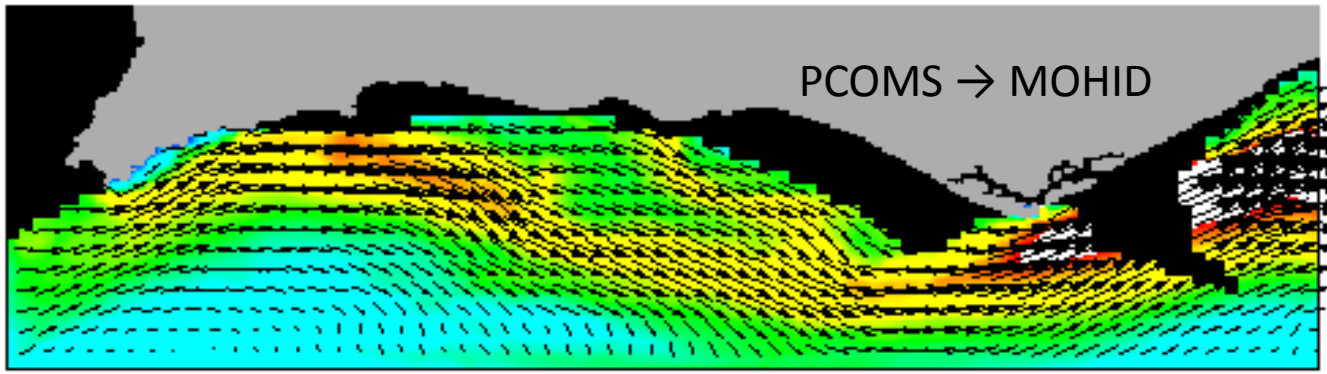


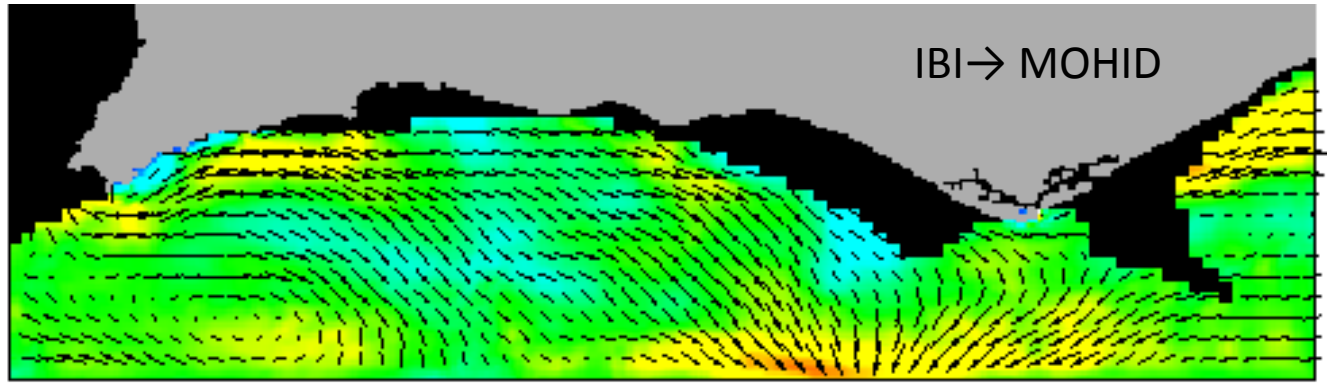
Radar – current correlation

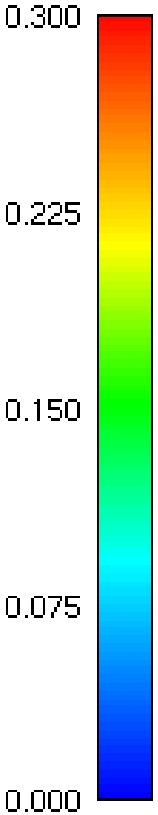


Radar – average field (m/s)

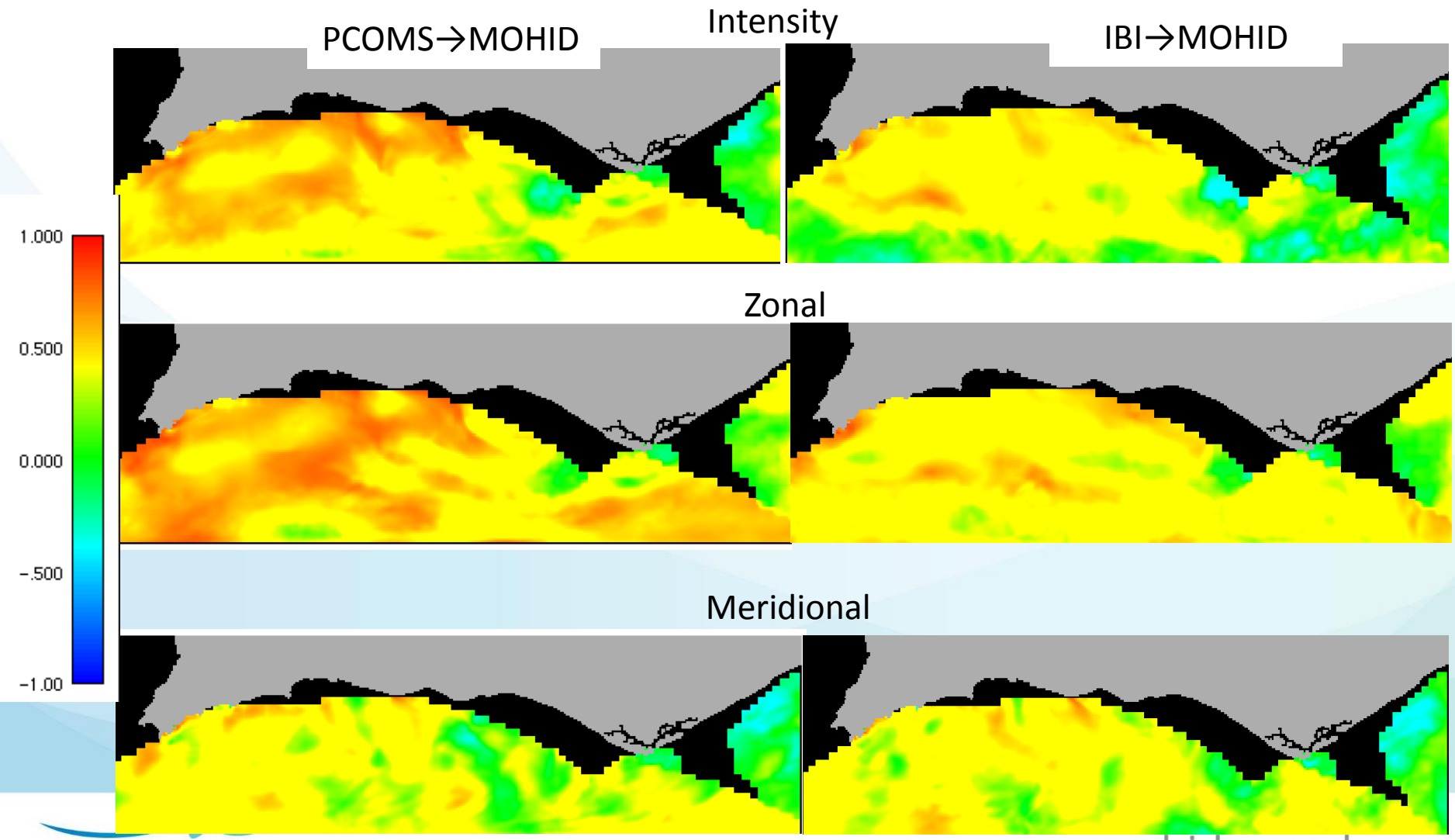








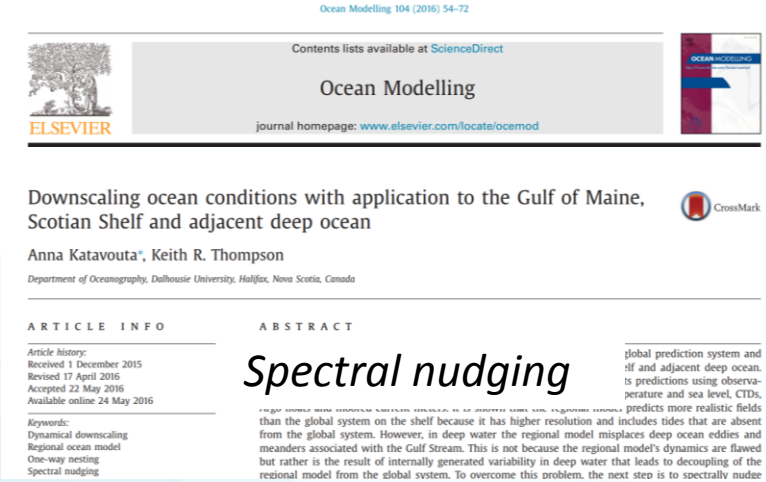
Radar – current correlation



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 IBI solution (Katavouta and Thompson, 2016):
  - 2D Fourier transform;
  - Salinity and temperature;
  - Strong nudging in the deepest areas and free on the shelf.
- For now it is advised to use the PCOMS solution as the reference one instead of IBI 3D hourly solution.

Relevante references



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

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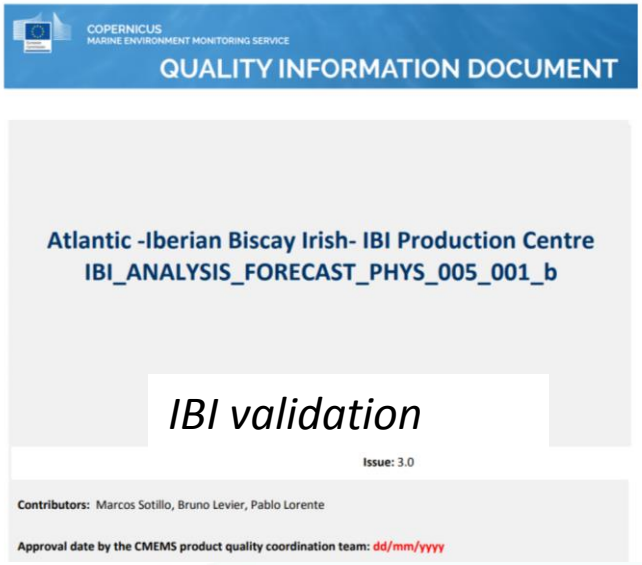
Spectral nudging

ABSTRACT

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

Spectral nudging



COPERNICUS
MARINE ENVIRONMENT MONITORING SERVICE

QUALITY INFORMATION DOCUMENT

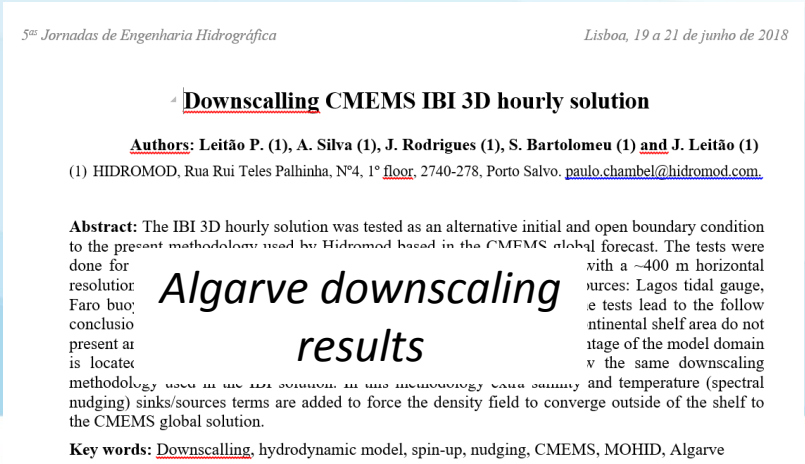
Atlantic -Iberian Biscay Irish- IBI Production Centre
IBI_ANALYSIS_FORECAST_PHYS_005_001_b

IBI validation

Issue: 3.0

Contributors: Marcos Sotillo, Bruno Levier, Pablo Lorente

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



5as Jornadas de Engenharia Hidrográfica *Lisboa, 19 a 21 de junho de 2018*

Downscalling CMEMS IBI 3D hourly solution

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

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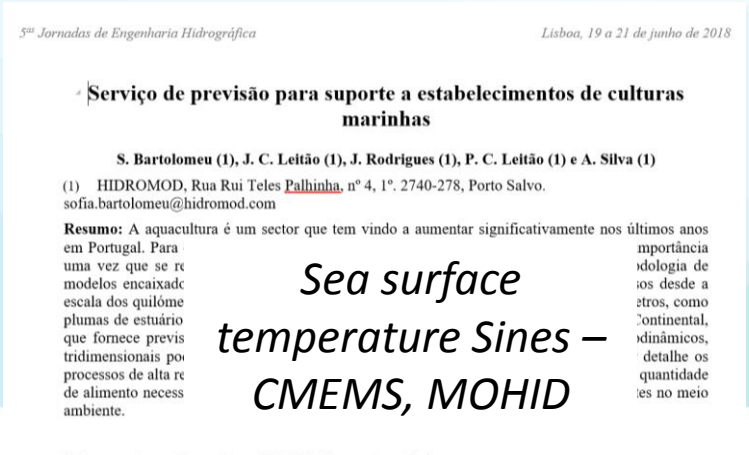
Abstract: The IBI 3D hourly solution was tested as an alternative initial and open boundary condition to the present methodology used by Hidromod based in the CMEMS global forecast. The tests were done for with a ~400 m horizontal resolution ources: Lagos tidal gauge, Faro buo e tests lead to the follow conclusio ntinental shelf area do not present ar tage of the model domain is locate v the same downscaling methodology used in the IBI solution. In this methodology extra 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.

Algarve downscaling results

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



5as 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)

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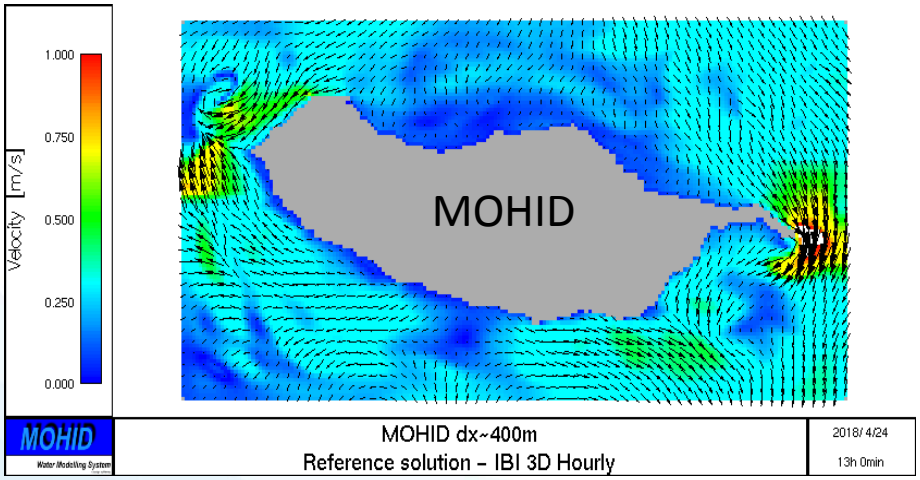
Resumo: A aquacultura é um sector que tem vindo a aumentar significativamente nos últimos anos em Portugal. Para mportância uma vez que se re dologia de modelos encaixadc os desde a escala dos quilóme etros, como plumas de estuário Continental, que fornece previs dinâmicos, tridimensionais po detalhe os processos de alta re quantidade de alimento necess es no meio ambiente.

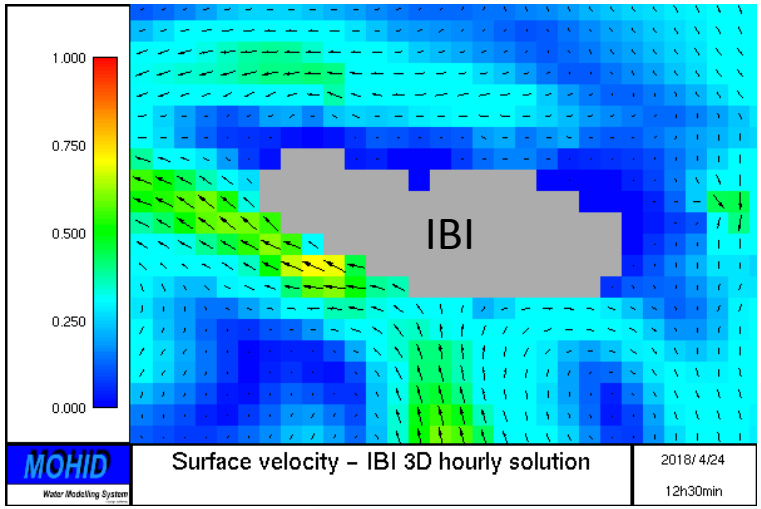
Sea surface temperature Sines – CMEMS, MOHID

Palavras-chave: Aquacultura, MOHID, Temperatura da água

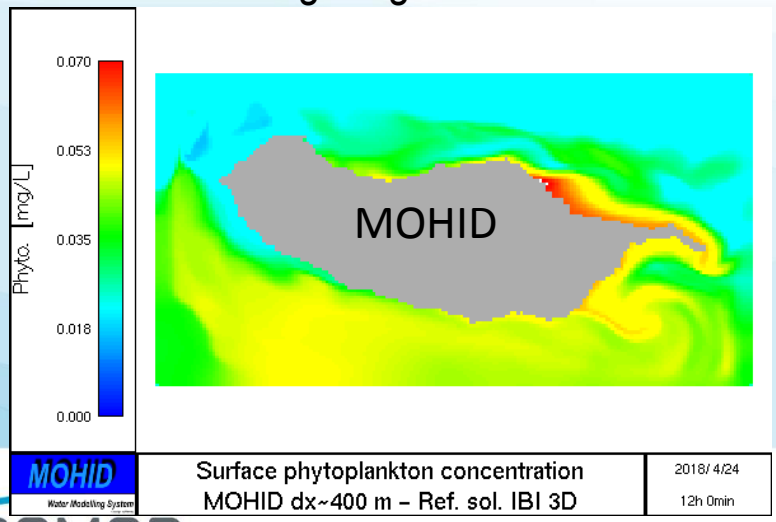
Future and ongoing work

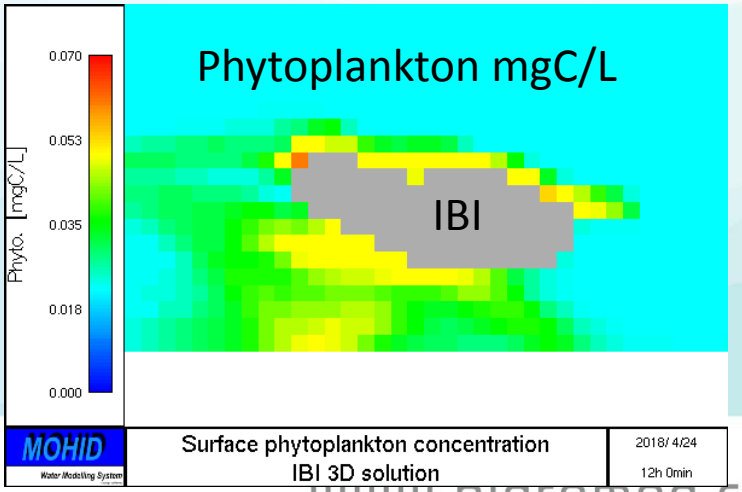
- Downscalling IBI solution for Madeira Island





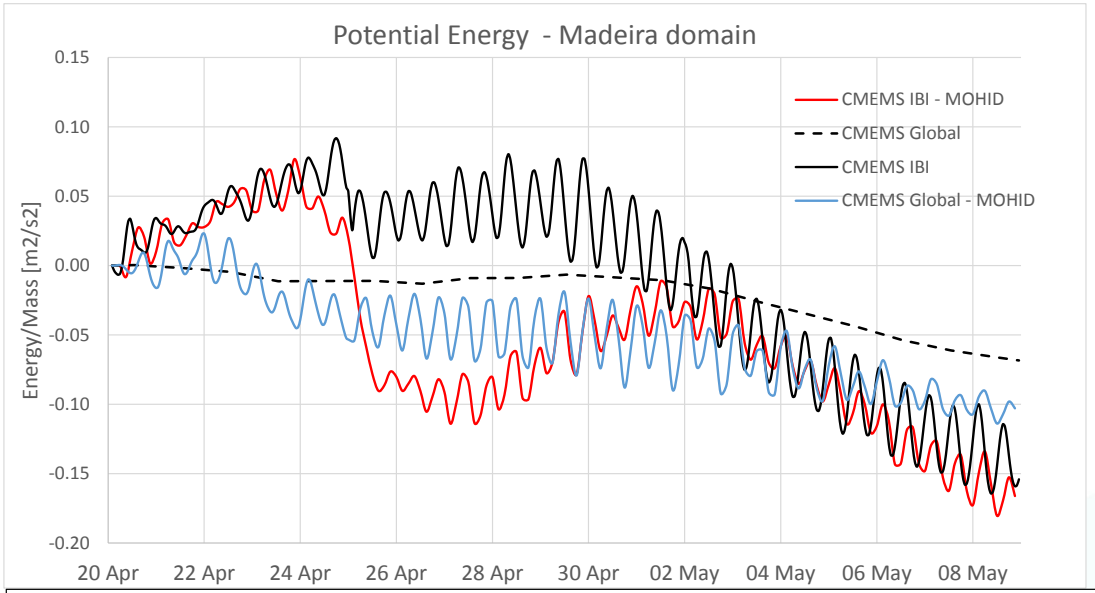
- Downscalling Biogechemical IBI solution

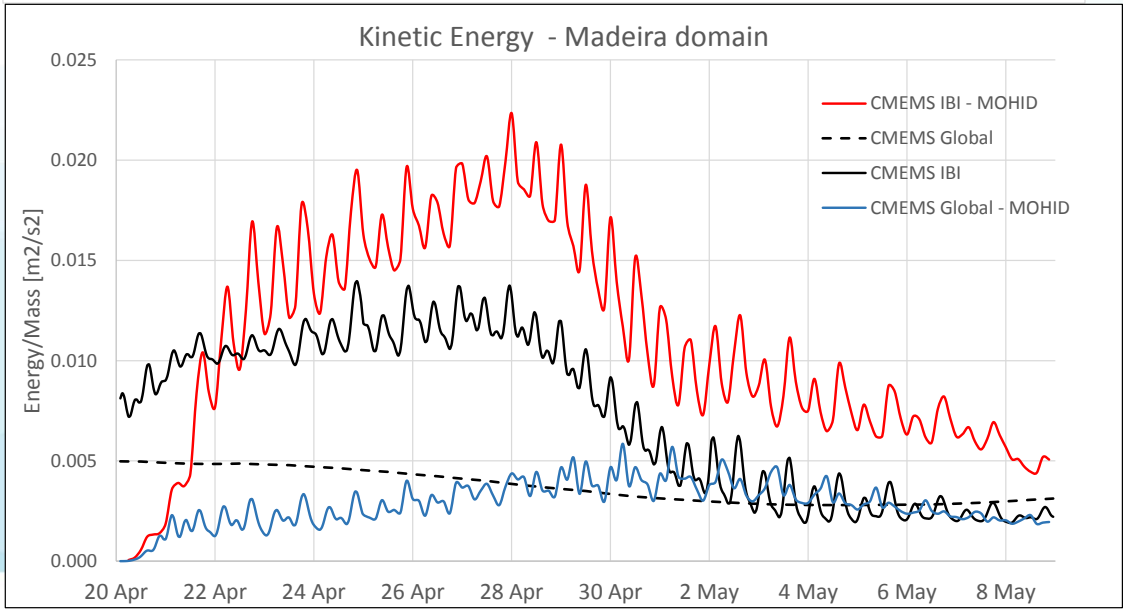




Future and ongoing work

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





OBRIGADO!

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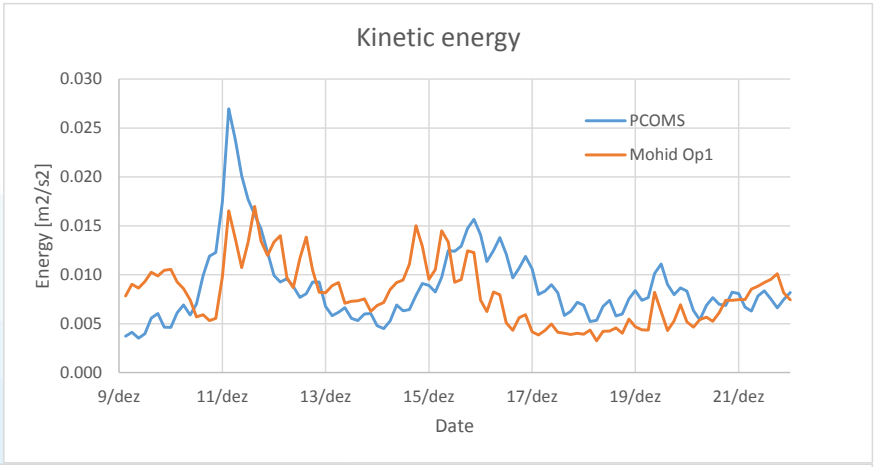
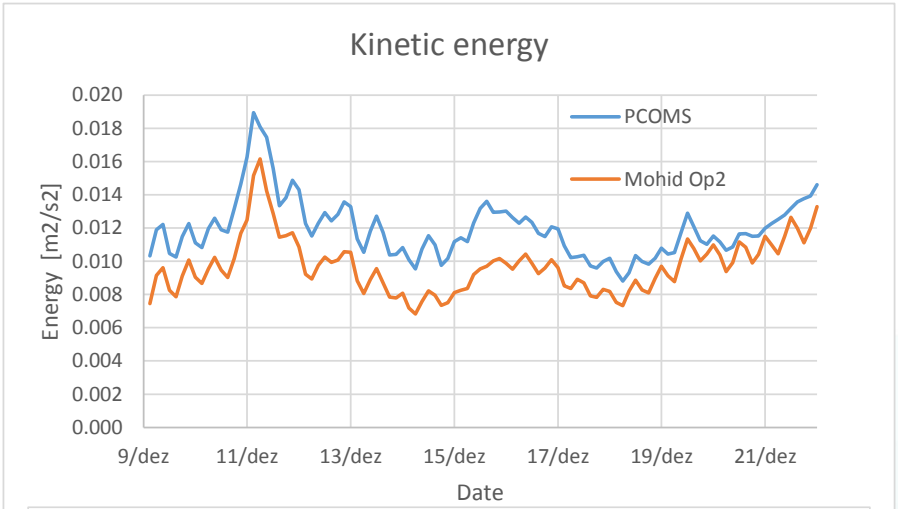
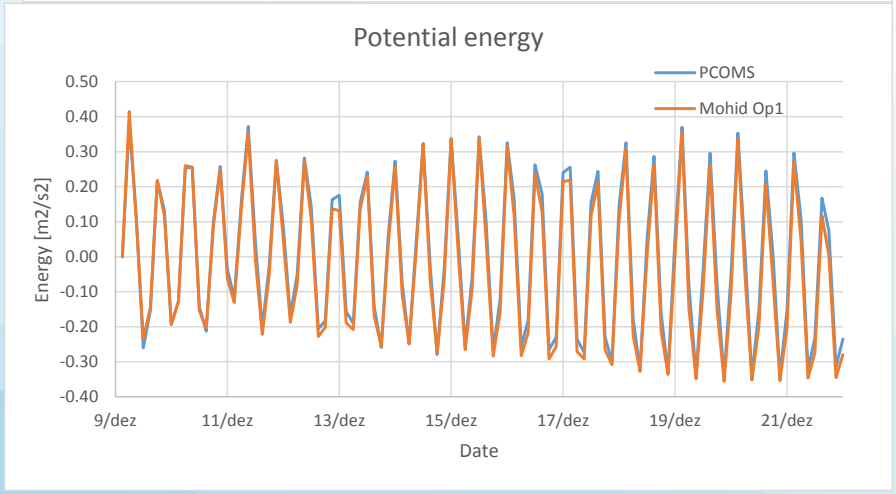
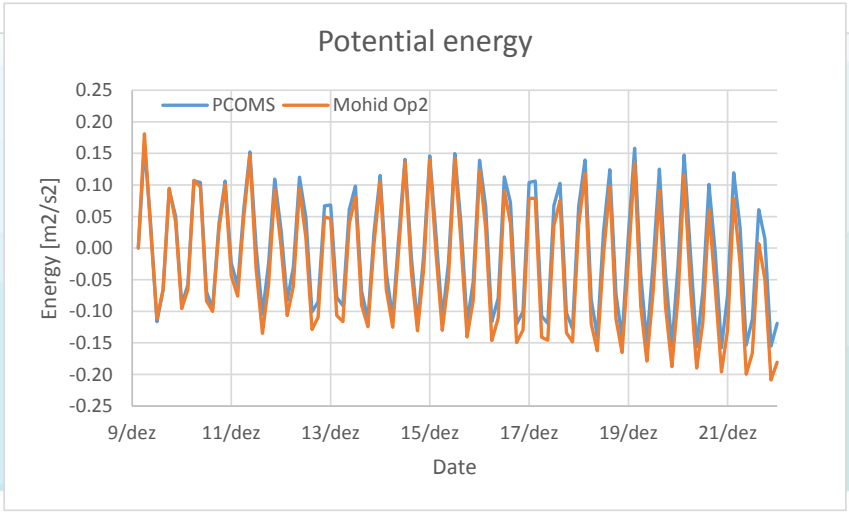
Downscalling PCOMS - Energy - Op. 1 vs Op.2









Energy – PCOMS vs CMEMS IBI vs CMEMS Global