

GENERAL COMMENTS

In this contribution, the authors describe the operational implementation of a very high-resolution coastal ROMS-based model, nested to CMEMS-IBI regional system, in order to monitor water quality within Alfacs Bay (NW Mediterranean Sea). 1-year validation exercise is presented along with two numerical simulations to analyze the impact of proposed interventions. This work addresses an interesting topic. I particularly appreciate the development of tailored CMEMS downstream services in coastal and port-approach areas with subsequent societal benefits. The paper is mostly well written and organized, just a few English slips, and will be of interest to readers of this journal. The results of water residence times are consistent and nicely interpreted. However, the overall impression is that the paper, although adequately conceived, is too short in some sections. My main concern is that sections 2.2 (Observations) and 2.4 (Validation) are not well resolved and therefore should be improved. In summary, I believe that the paper can be made acceptable for publication **upon minor revision**. In the following lines I provide some comments, which should hopefully strengthen the manuscript.

Dear Referee, Thank you very much for your insightful comments and suggestions. These are very valuable and helpful for revising and improving our paper. A revision has been made to our manuscript in accordance with these recommendations. The response to each one of the reviewer's comments and the corresponding correction to the paper are explained in detail. Once again, thank you very much for all your help in reviewing our paper. Kind regards,

SPECIFIC COMMENTS

-Section 2.2: Observations

1. I definitively do not understand why the first paragraph was placed in this section. It should be better moved to other section, perhaps to "Results".

Thanks, we agree with the referee that the way it is written and placed could lead to confusion. We have moved the text to the study area description.

2. I miss a brief description of the most basic technical features of the in situ and remote-sensing instrument used in this work: CTD, moored buoy, HFR, etc... Maybe a table summarizing those details would be useful (together with the time periods used in the validation exercise), similar to Table 1 where information about the different simulations was gathered.

OK, we agree. We have added a table summarizing all the instrument used for the validation. (Table 1). A sentence have been added in page 4: *All the observations are summarized in Table 1*

3. Most of the audience will not be familiarized with HFR shore-based technology. Please add a brief paragraph describing basic characteristics: frequency at which it operates, time sampling (1 hour?), horizontal resolution of the grid, spatial coverage, number of radar sites, date of deployment, sources of uncertainties in the remotely-sensed observations, etc.

Ok, we have added a brief paragraph with some more information about the HFR (as well as some new references):

“The HF-R (CODAR SeaSonde Standard-range) was deployed at the Ebro delta in 2013 within the framework of the RIADE (Redes de Indicadores Ambientales del Delta del Ebro) project. The network consists in three remote shore-based sites providing hourly radial measurements with a cut-off filter of 100 cm s⁻¹ and representative of current velocities in the upper first meter of the water column. The total current vectors are hourly averaged on a predefined Cartesian regular grid with 3 × 3 km horizontal resolution (Lorente et al. 2015).”

Lorente, P., Piedracoba, S., Soto-Navarro, J., and Alvarez-Fanjul, E.: Evaluating the surface circulation in the Ebro delta (northeastern Spain) with quality-controlled high-frequency radar measurements. *Ocean Science*, 11(6), 921-935, 2015.

4. Likewise, no information about the data treatment was provided. There were gaps in observational time series? If so, small gaps (let's say, < 6 hours) were linearly interpolated?

Ok, we have added some information about the data treatment:

“Validation is performed for the entire 2014 and the gaps in the HF-R data are not considered (it represents less than 15% of raw data).”

- Section 2.4: Validation

1. As previous step to validate your model, you must be sure that the parent system is consistent and accurate enough, able to provide coherent open boundary conditions to the nested system you are implementing. In this context, has CMEMS-IBI system been previously validated in Ebro Delta area using a multi-platform approach? If so, please add the reference and briefly mention the statistical results derived from IBI validation in this coastal area.

OK. We have added a paragraph addressing this question:

“The parent model (CMEMS-IBI) has been validated in Region using HF-R in Sotillo et al. (2015). Their results shows zonal and meridional RMSE (correlation) values in the range of 6–10 cm/s (0.4–0.8) over central areas of HF-R radar domain, with higher errors detected in far edges of the radar spatial coverage (Sotillo et al. 2015).”

2. The validation is performed on a very basic level, only from a qualitative perspective. The conclusions are drawn according to the visual resemblance of time series. I miss the number of hourly observations and some skill metrics such as the (relative) bias, (normalized) root mean squared error (RMSE), temporal correlation, complex correlation, mean percentage error, scatter and quantile-quantile plots, current roses, Taylor diagrams, percentiles, etc. in order to provide a quantitative perspective of the model performance. I am not asking to compute all of them, but a deeper insight should be welcome. You could add some skill metrics to Figures 2 and 3, for instance.

Ok, we agree. For that reason, we have modified Figure 2 and 3 adding some skill scores.

3. Why both SST and SSS validations were performed on an annual basis (2014), but the validation against the HFR was only performed from approximately mid-January to end of March? Please provide an explanation. There was a radar break down?

It is only a graphical recurse. Using all the data for 2014 for Figure 3 does not allow to correctly see the fitting between the model and the data. The validation (statistical values) have been done for the entire 2014. In the text now is reflected that validation is done for the entire 2014.

4. A specific HFR grid point was selected to conduct the comparison against modeled currents. Which one? Please provide longitude and latitude. Why this grid point was selected and no other one? Maybe because the data temporal coverage was optimal? If so, explain it please.

Ok. Longitude and latitude are now provided in the Figure 1 caption. This point was selected because the data temporal coverage was optimal and also it is located close to the Ebro Delta but far from the coast to avoid land-mask effects. We have added a sentence explaining it:

“Validation is performed for the entire 2014 in one point close to the bay and with optimal temporal coverage (more than 85% of 2014 with data). The gaps in the HF-R data are not considered.”

5. The time series of zonal and meridional currents shown in Figure 3 (a-b) were raw or low-pass filtered?

Raw data, without filtering.

6. As far as I know, the HFR deployed in Ebro Delta operates at a nominal frequency of 13.5 MHz and provides hourly current estimations which are representative of the first meter of the upper water column. In this context, the current meter installed in PdE buoy provides in situ measurements of currents at which depth? This was not explicitly described in the manuscript and could partially explain some of the HFR-model discrepancies observed. I think it is worthwhile mentioning this in the Discussion section.

We are sorry but we believe there is a misunderstanding here. Data from PdE buoy is used here only to compare it with SST with data from Ebro River and discharge channels. The PdE buoy is located outside the CSTDEL domain, so no validation is possible to realize.

Conclusions

1. Future prospects are not provided in the conclusions.

Ok, we agree. In this sense we have added the following text:

“Future works should include the analysis of the wave effects on water the circulation, as well as the consideration of different initial conditions and met-ocean conditions on the determination of water renewal in Alfacs Bay.”

2. Besides, in “future work” section I miss a mention to the inter-comparison of the high-resolution coastal model against its parent regional system (IBI) in order to

thoroughly quantify the potential added value of the dynamical downscaling approach adopted.

Yes, we agree and we have added a sentence in the discussion to this end.

Figures

1. I suggest splitting Figure 3 into two different Figures, adding also the skill metrics derived from the comparison.

We prefer to keep the figure as it is (not splitting). However, we have added the skill metrics following the reviewer suggestion.

2. It could be useful to show the mean surface circulation patterns in D-B domain during inflow/outflow phases. This is also partially related to the residual and mean circulation (last paragraph, page 6) you mentioned in the text: since only six figures were provided in the manuscript, an additional image showing this could enrich the work.

We agree with the reviewer that the residual (mean circulation) is important and could improve the knowledge of the bay. For that reason, we have added the reference of an article (just published, Cerralbo et al. 2019) where the subtidal and mean circulation of Alfacs Bays is analyzed in detail. However, we prefer not to add any new figure in this article in order to not blur the main results and scope of this manuscript.

TECHNICAL CORRECTIONS:

I am fully aware that the authors are not English native speakers (neither am I) and therefore I appreciate the considerable effort made to write down a research paper. However, I would suggest some professional English editing to improve the quality of the manuscript.

OK, we have done some English-editing.

Abstract

- For consistency reasons, please replace “Delta Ebro” by “Ebro Delta”

Ok, done.

- Replace “leading high rates” by “leading to high rates”

Ok, done.

- For consistency reasons, please replace “modelled” by “modeled”

Ok, done

1. Introduction:

- Wrong definition of CMEMS acronym: it should be “Copernicus Marine Environment Monitoring Service” instead of “Copernicus Marine Environment Monitoring System”.

Ok, thank you.

2.3. Numerical model

- Please specify the atmospheric model, implemented by AEMET, used to force the coastal ocean model: HIRLAM, HARMONIE-AROME, etc?

Ok. Done. The model used has been HARMONIE

2.4. Validation

- Replace “Ebro plume” by “Ebro River plume”.

Ok. Done.

- “HF-radar” and “High-Frequency radar” are found in the text, “HF” in Figure 1-b. Please use an unified nomenclature: Define firstly “High-Frequency radar (HFR)” and use the acronym afterwards.

Ok, Done.

- Please define the acronym IRTA in the text since it was only previously described in the list of institutions involved in the present manuscript.

Ok, Done.

4. Discussion:

- For consistency reasons, please replace “modelled” by “modeled”

Done.

5. Conclusions:

- It should be “effectiveness in increasing” instead of “effectiveness in increase”.

OK.

- Replace “related to water temperature peaks during some days” by “related to occasional extremely high temperatures”

OK.

- Replace “allowed for the first time” by “allowed for first time”

OK.

Figure 1, caption:

- For consistency reasons, please replace “Delta Ebro” by “Ebro Delta”

OK

- Replace “Pde” by “PdE”

OK

- Replace “Data from High frequency Radar used to...” by “Location of the HFR grid point used to...”

OK

Figure 2, caption:

- You mention “Puertos del Estado” and define here the acronym PdE. Such acronym, used several times along the document, should be defined in the main body of the text, not in a Figure caption.

OK. Done

Figure 3:

- In the text, you defined CMEMS-IB but in the legend “IBI-CMEMS” is shown. Please correct this inconsistency.

Ok, done

- Specify that model (red line) represent DA model

Ok, done

- Which is the frequency of observations (blue dots)?

Hourly. It has been added in the Figure 3 caption.

Figure 4, caption:

Replace “a) Shows the time-evolution” by “a) Time evolution”

OK, done.

Figure 6:

Please redefine the color palette (maybe from -0.5 to 0.5) because the details can not be readily inferred.

Ok, we agree. Thanks for the suggestion. It has been redefined.