Comment on egusphere-2022-1337

Anonymous Referee #3

Referee comment on "The Mediterranean forecasting system. Part I: evolution and performance" by Giovanni Coppini et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-1337-RC2, 2023

Comments of the Referee are in black while the authors' reply is in red.

The paper is of great interest to the oceanography community in the Mediterranean and not only, providing the up today updates of the three components of the MFS, i.e., the hydrodynamical, wave and biogeochemistry modelling systems, as well as of the DA. These three modules consist the Copernicus Mediterranean monitoring and forecasting system (CMEMS Med MFC). The quality assessment of the reanalysis's products of the CMEMS Med MFC between 2018-2020 was evaluated based on in-situ and satellite remote sensing data using well accepted statistical indexes.

The paper is very useful also to the Mediterranean teams operating the national operational coastal forecasting system, downscaling from the CMEMS Med MFC.

I recommend the publication of the ms, after minor modifications, proving the clarifications and additions mentioned here below, as well as to consider the comments from the two anonymous referees.

Why is needed 141 vertical levels in the hydrodynamical model? What is the benefit comparing to a 100 vertical levels? What are the criteria to use 141 and not less vertical levels?

The choice of the number of vertical levels has been made after performing several sensitivity experiments comparing vertical discretization with 91, 121 or 141 vertical levels. The configuration with 141 levels provided the best results and allowed us to have a quite large number of levels with limited thickness for a proper representation at the thermocline, but also for representing the Levantine Intermediate Water and guarantee a reduced last vertical layer thickness in deep areas.

Clarify, why the need to use two different waves models? WW3 and WAM? If indeed is necessary, then, are there any inter-comparison between the results of the 2 wave models used?

The presence of two different wave models, results from two different objectives and scientific developments.

From one side, the NEMO-WW3 coupled system has been specifically designed to improve the NEMO model physics in terms of surface drag coefficient (evaluated by the wave model) and in the future to account for the wave impact on the vertical mixing.

On the other hand, considering the state of the art of wave modelling and current operational requirements for wave products, the WAM implementation is intended to provide the Copernicus Marine analysis and forecast wave product for the Mediterranean Sea. It thus considers additional modules and a more complex setup. At the same time, WAM is forced with surface currents stemming from the NEMO model to compute the wave refraction. Such a modelling approach can consider various modules and benefit from continuous modeling developments such as:

- open lateral boundaries in the Atlantic in order to obtain a better representation of swell in the Alboran Sea and further east along the north African continental shelf area

-data assimilation of available satellite observations such as altimetry and wave spectra (in the future) within and outside the Mediterranean basin

-extensive calibration of tunable parameters in the wind source and dissipation terms in order to increase the accuracy of the wave product

-wave ensemble prediction to provide uncertainties and improve accuracy at various lead times

An inter-comparison between the two wave models (WW3 and WAM) against the same buoy measurements for a one-year-long period (2018) revealed that WAM slightly underestimates Hs (mainly for high percentiles), displaying an RMSD of 0.22m and Bias -0.007m, whilst WW3 systematically underestimates Hs exhibiting lower quality metrics compared to WAM (bias= -0.126m and RMSD=0.275m). For the latter, model underestimation becomes more profound for wave heights larger than 3m. Regarding the mean wave period, the one-year evaluation suggested a systematic mean wave period overestimation by WW3 (bias = 0.431 s), as opposed to the model underestimation by WAM (bias = -0.297 s). RMSD against mean wave period observations for WW3 is equal to 0.879 s (which again is higher than the one obtained by WAM (0.642 s). Despite discrepancies in PQ metrics between the two models for Hs and Tm, the quality of WW3 (although not as high as the one obtained for the operational wave component), is still deemed to be acceptable, as it fulfils the purpose of estimating the neutral drag coefficient for the physics components and improving the model hydrodynamics, as shown in Clementi et al. (2017a).

Cited references

Clementi, E., Oddo, P., Drudi, M. et al. Coupling hydrodynamic and wave models: first step and sensitivity experiments in the Mediterranean Sea. Ocean Dynamics 67, 1293–1312 (2017). https://doi.org/10.1007/s10236-017-1087-7

Before mentioning that " Sea ice coverage fields are also obtained from ECMWF" clarify that this parameter (sea ice) concerning the North Atlantic domain used for the lateral boundaries of the biogeochemical model. The reader is confusing as it is appeared in the current text without any prior explanation.

Sea ice coverage fields (obtained from ECMWF IFS) are used for the North Atlantic wave model (wave energy in the WAM model is dissipated due to the presence of ice) that provides lateral boundary conditions to the WAV system. Following the reviewer's comment, the text in Lines 191-192 will be changed as follows: " Sea ice coverage fields used by the North Atlantic wave model are also obtained from ECMWF"

Provide a paragraph or sub-section describing the cal/val of the surface forcing used in the CMEMS Med MFC, provide a relevant plot if available.

We appreciate the suggestion of the reviewer and we propose to add the following paragraph:

"A calibration/validation system of the ECMWF forcing fields used by the Med-MFC operational systems has been developed using in-situ ground meteorological observations (METAR stations) and numerical model data from ECMWF. Four well-established statistical indices for validating 2m temperature, dew point temperature, air pressure and wind speed have been defined: (a) Bias, (b) RMS Error, (c) Nash-Sutcliffe Model Efficiency Coefficient, (d) Correlation Coefficient.

The atmospheric forcing Cal/Val system will become publicly available and an example of this validation is provided in figure xx showing daily mean wind speed time series from a METAR station (blue line) and ECMWF (red line) in the area of the Gulf of Lion during the year 2019 as well as time series of main skill metrics."

The following figure will be added:

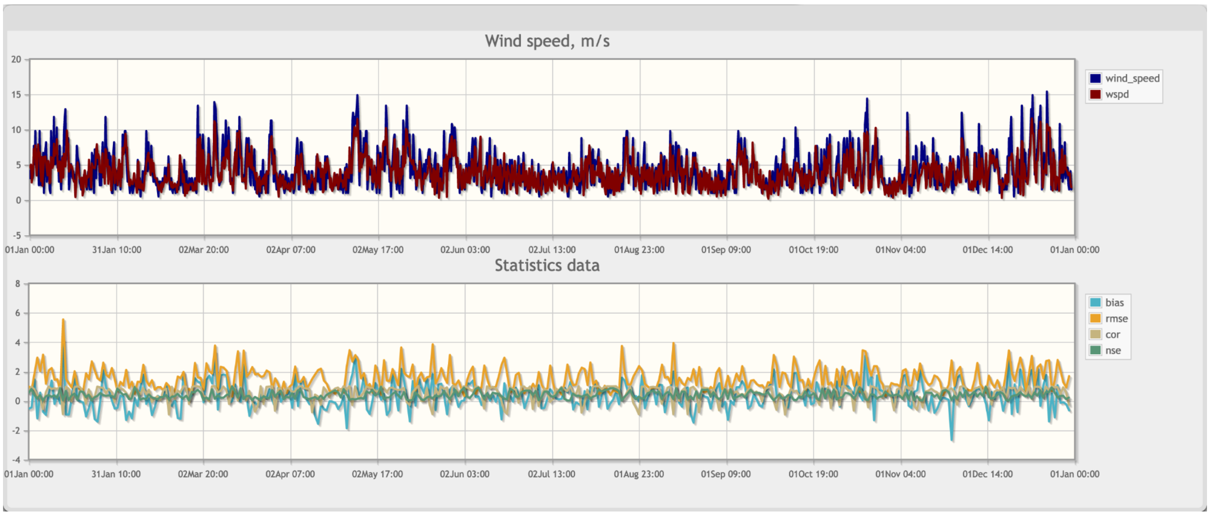

Figure xx: Example of ECMWF wind speed validation with respect to METAR ground observations in 2019 in the area of the Gulf of Lion. Top panel: time series of daily mean wind speed time series from METAR station (blue line) and from ECMWF (red line). Bottom panel: time series of main skill metrics (bias, RMS Error (RMSE), Correlation Coefficient (cor), Nash-Sutcliffe Model Efficiency Coefficient (nse).

There is no information what will be included in the Part II of the ms. Due to the fact that the CMEMS Med MFC products are used for operational downscaling and down-streaming in the Med-Sea, provide a paragraph mentioning the most known Mediterranean national operational downscaled coastal forecasting systems using the CMEMS Med MFC, as well as few successful down-streaming applications where the CMEMS Med MFC and the downscaled coastal systems were used (2 sound examples).

As far as it concerns Part II of the paper we propose to add the following after line 74:

“The Part II of the paper will be showing the capacities of the Med-MFC components in describing the Medicane effects on the ocean. In particular the Med-MFC physics, biogeochemistry and waves components will be used to describe the effects of Medicane Zorbas (27-30 September 2018) on the ocean variables.“

Then, we thank the reviewer for the supportive comment on Med-MFC value. Indeed, the Med-MFC products are used for operational downscaling and down-streaming in the Med-Sea. Among the operational coastal forecasting systems in the Mediterranean Sea, the following paragraph describes few successful down-streaming applications where the Med-MFC outputs are used.

We propose to add the new paragraph after line 554:

"The value and reliability of the Med-MFC systems is demonstrated by the several downscaling coastal model systems and downstream applications that use its outputs operationally. The CYCOFOS – Cyprus Coastal Ocean Forecasting and Observing System (Zodiatis et al 2003), which is a sub-regional forecasting and observing system in the Eastern Mediterranean Levantine Basin, uses the Med-MFC output to set its boundary conditions. The Med-MFC outputs are used for initial and lateral boundary conditions by the physical and wave ocean system MITO, which provides 5-day forecasts at resolution up to 1/48° (Napolitano et al., 2022). The Southern Adriatic Northern Ionian coastal Forecasting System (SANIFS), which is a coastal-ocean operational system providing short-term forecasts since September 2014 (Federico et al, 2017). It is built on the unstructured-grid finite-element three-dimensional hydrodynamic SHYFEM model and is based on a downscaling approach starting from the large-scale system Med-MFC which provides the open-sea fields.

The CADEAU physical-biogeochemical forecast system of the Northern Adriatic Sea (Bruschi et al., 2021) is based on a high resolution (up to 700m) application of the MITgcm-BFM model (Cossarini et al., 2017) targeting water quality and eutrophication and uses the daily Med-MFC products for initialization and to constrain the southern boundary.

Finally, the GUTTA-VISIR system, which can be defined as a tactical, global-optimization, single-objective, deterministic model system for ship route planning (Mannarini et al., 2015 and 2016, Mannarini and Carelli, 2019), uses the analysis and forecast wave and current fields from the Med-MFC in conjunction with wind fields from ECMWF."

Cited References:

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Napolitano, E., Iacono, R., Palma, M., Sannino, G., Carillo, A., Lombardi, E.,et al.: MITO: A new operational model for the forecasting of the Mediterranean sea circulation, Frontiers in Energy Research, 1296, 2022.

Federico, I., Pinardi, N., Coppini, G., Oddo, P., Lecci, R., and Mossa, M.: Coastal ocean forecasting with an unstructured grid model in the southern Adriatic and northern Ionian seas, Natural Hazards and Earth System Sciences, 17(1), 45-59, 2017.

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Cossarini, G., Querin, S., Solidoro, C., Sannino, G., Lazzari, P., Di Biagio, V., and Bolzon, G.: Development of BFMCOUPLER (v1. 0), the coupling scheme that links the MITgcm and BFM models for ocean biogeochemistry simulations, Geoscientific Model Development, 10(4), 1423-1445, 2017.

Mannarini, G. and Carelli, L.: VISIR-1. b: Ocean surface gravity waves and currents for energy-efficient navigation, Geoscientific Model Development, 12(8), 3449-3480, 2019.