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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Hydrodynamic modeling of coastal seas: the role of tidal dynamics in the Messina Strait, Western Mediterranean Sea" *by* A. Cucco et al.

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Dear Editor

The paper has been modified following the reviewers suggestions and comments. Several modifications were made to improve the clarity of the text. The English grammar was revised. The general structure of the paper was slightly changed following the recommendations of the reviewers. The quality of the figures was improved and figure 2 was deleted as requested by reviewer #2.

In the following we pointed out the answers to the main comments and questions of the reviewer #2.

ANSWERS TO REVIEWER #2

Reviewer #2 main comment: "Figure 2 (and its description in page 10) does not provide a complete picture of the tidal flow in the region and does not contribute in the overall discussion since the paper is not focusing on identifying the tidal signal. The results of TDO are only compared to observations/previous work only for validation purposes."

We modified the text and deleted figure 2.

Reviewer #2 main comment: "Section 4.2.2, on the thermohaline features, needs more discussion on the processes involved in modifying the fluxes and T/S fields, due to tidal flow variability. "

We agree with the reviewer that the increase in the discussion of the results is always better. Nevertheless the focus of the paper is the determination and quantification of the role of modeling the tidal dynamics in modifying the reproduction of the general circulation in the Strait, and not the analysis of the general circulation itself. In this latter case, a more robust evaluation of the seasonal variability of the TS would be desirable and necessary, but, for the specific objective of the paper, we considered the obtained results as satisfactory. Furthermore, due to the scarcity of TS data in the Strait and in the surrounding coastal zone, further analyses and insights of the model results could lead only to speculations.

Reviewer #2 main comment: "I believe that the Section 4.2.3 does not contribute to the overall focus points of the paper and does not add significant information to the results presented in previous sections and should be omitted. If the authors want to connect this work with operational needs (e.g. advection/diffusion of tracer), an operational setup of the modeling system should be considered."

We partially agree with the reviewer. The added value due to the computation of the ETTS and the consequent role of the tides in modifying it, is negligible and probably redundant. That is why we deleted all the contents related to the ETTS. On the

other hand, we believe that the analyses on the transport processes in the MS and the approach we followed to identify the differences between the scenarios, are very interesting and decisive for the scope of this study. In fact, the obtained results provide an intuitive overview of the "errors" that are done when skipping the tidal contribution from the modeling of the MS general circulation. As an example, the analyses of the transport results, considering the temporal integration of the tracer concentration provide an alternative evaluation of the impact of tidal contribution to the computation of the general circulation in the area Furthermore, the differences between the two scenarios results as obtained from hyndcast simulations are absolutely representative of the ones we will have from operational run. In fact, in both forecasting and hindcasting modes, the model setup and the boundary conditions are the same, technically speaking, and, there is no reason why the role of the tides should be different in the two cases.

Reviewer #2 main comment: "How do you define the length of the strait?."

The Strait is comprised between 37.9°- 38.3° North and 15.3°-15.8° East, considering the hydrological area with its Southern border aligned with Capo dell'Armi (Calabria) and Capo d' Ali (Sicily) and its Northern Border with Capo Rasocolmo (Sicily) and the Calabria coastline. We considered the area included by the set of sections used by Defant (1940) for his hydrological and morphological analyses.

In the text, page 3, line 5: " The Strait is comprised approximately between 37.9°- 38.3° North and 15.3°-15.8° East, it is about 40 km long, and around 10 km wide with the narrowest passage of about 3 km width."

Reviewer #2 main comment: "Are the full slip conditions appropriate for the regional dynamics?"

The full slip conditions were considered as adequate being the lowest size of the mesh on the domain borders around 50 m. For these spatial scale, in the case the element depth is shallow, the wall effects are negligible if compared to the reduction of the flow induced by the bottom friction. On the contrary, for deeper elements the wall effect is

not a realistic forcing being, in SHYFEM, the water depth treated as constant for all the element surface. The no sleep condition is more appropriate in the case the mesh size resolution is adequate and in the case the objective of the study is focused on the small scale dynamics generated by the horizontal diffusion of the momentum, which is not the case of this work.

Reviewer #2 main comment: "The tidal model validation seems incomplete (important constituents are missing). The authors should explain where data are available and where bibliographic values are used. The authors should also provide an overall estimation of the error and some indication for the accepted level of accuracy for the model."

We considered the 7 major diurnal and semidiurnal components of the tides in the Mediterranean Sea as stated by many authors and adopted in numerous studies (as an example, see all the applications of SHYFEM model to the Adriatic Sea and Venice lagoon, https://sites.google.com/site/shyfem/list-of-publications). Regarding the compound tides and the shallow water tides, we considered only the M4 wave, being the most intense and its amplitudes and phases well documented by direct observations. The source of observed amplitudes and phases for each station and for each component is well documented in the text.

In the text at page 7, line 20: " The main harmonics observed amplitudes and phases were estimated by Vercelli, (1925) during the homonym Oceanographic cruise in 1922, and more recently reported by Brandolini et al., (1980) and Androsov et al., (2002a). In this work we refer to the values from Brandolini et al., (1980) for stations from 1 to 6 and from Androsov et al., (2002a) for stations from 7 to 10."

In the text, the table 2 allow a direct comparison between model results and observation for each tidal wave and for each station. In the text at page 7-8 the model accuracy in reproducing the major semidiurnal, diurnal and compound tide is discussed. We also estimated the overall accuracy of the model results considering the whole set of

stations and all the tidal components.

In the text at page 8 line 19: " On average, considering the whole set of stations and tidal components, the model results reproduced the observed amplitudes with a RMSE of 0.78 cm which is fair and acceptable for this type of analysis."

Reviewer #2 main comment: "You should define winter and summer period used, explain the reason why you are using only 45 days for estimating the mean seasonal characteristics."

We clarified the method followed to analyze the model results.

In the text at page 10, lines 16: "In figures 4 and 5 the residual currents computed for winter and summer seasons as the algebraic averages of the three-dimensional hourly current speeds obtained for winter (January, February and March) and summer months (July, August and September) during the 2 years of simulation are reported for both scenarios."

In the text at page 11, lines 21-22:" Water fluxes through section CD were computed during both winter and summer months from the THO and TTC scenarios results. The winter period included January, February and March, whereas the summer period included the months of July, August and September of both simulated years. As an example, in figure 6 the time series of the computed fluxes are reported, for reason of clarity, only for 45 days during both summer and winter 2015 and for the THO and TTC scenarios. "

Reviewer #2 other comments

Figure 7 now includes the dates.

Caption of table 3 now describes clearly all the contents.

In the text, caption table 3:" Table 3: Water, salt and heat fluxes through section CD computed for winter and summer periods from THO and TTC scenario results and dif-

ferences (TTC-THO). Water and salt fluxes are expressed in Sv, heat fluxes in 107 Watt. The South Flux and North Flux are considered as absolute values. The Net Flux (N-S) values are obtained as the differences between North Flux and South Flux values. Positive values indicate a northward net flux, negative values indicate a southward net flux. "

Smaller comments have been integrated silently into the manuscript

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