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Ocean Science
Discussions

Interactive comment on "A nested Atlantic-Mediterranean Sea general circulation model for operational forecasting" *by* P. Oddo et al.

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Anonymous Referee 1

General Comments: "A nested Atlantic-Mediterranean Sea general circulation model for operational forecasting" by Oddo, et al., presents the results of comparing a Mediterranean twin experiment. One member utilized open boundaries in the outer Atlantic model while the second utilized climatological nudging with closed boundaries for the outer Atlantic model. Hence, the two "twins" were identical models run with different open boundary forcing. The surface forcing was consistent between the two. The results of the experiment were interesting for two reasons: 1) the salinity from the "open"

Atlantic simulation was increased across Gibraltar and 2) the sea surface state variability was dramatically increased by the same Atlantic simulation. The authors do a sufficient job of detailing the results and I recommend its publication with minor revisions as described below. The comparisons performed between the sea surface height solutions and observations were well thought out, and a significant part of the paper.

Specific Comments:
1. There are a couple of instances in which generalities are stated as definitive without data or reference to back them up. For instance, pg 1100:29, "...we argue that this is due to the coarse...resolution..." This is no argument at all but a supposition. Provide an explanation or data as to why you make such an "argument."
We thank the Reviewer for this comment. We agree that the proposed explanation was actually just a supposition; the sentence will be modified as follows:
"The only remarkable difference between simulated and observed values regards the amplitude of the seasonal cycle and we argue that this is due to the different length of the time-series used to compute climatologies (4 years for MFS and 40 years for NCEP)"

2. It would seem that with constant temperatures and increased salinity (0.2) that there would be a density issue. Could you comment on this? For instance, why in figure 4, with such a significant increase in salinity that propagates into the Atlantic, we do not see a deepening of this salinity difference where the denser water sinks into the fresher Atlantic? A simple statement or description of the density as a whole would suffice.
The surface salinity differences observed between the two model simulations (0.2) are due to the different surface fluxes over the Atlantic (as explained in Section 4.1). So MFS-V2.2 is able to produce more realistic surface Atlantic waters that intrude in the Mediterranean Sea. For what concern the Mediterranean outflow a 0.05 increase in salinity has been observed with respect to V2.1. In both cases these differences in salinity are not enough to modify the vertical stability of the water column. The following sentence has been added to the text (1100:26):

"The increased salt content of the incoming Atlantic waters is not sufficient to strongly modify the stability of the water column. In the Atlantic side, the vertical stability is ensured by the combination of the large temperature gradient, the effect of the pressure and the salty Mediterranean outflow. In the Mediterranean Sea, where vertical gradients of temperature are less pronounced, the saltier Atlantic waters simulated by MFS-V2.2 are still fresh enough to be buoyant."

3. Similarly, a confusion is created by your statements regarding the volume conservation on pg. 1104:25. You state that the water surface fluxes are different by the volume conservation; however, in the previous section went to great length (including Fig. 3) that the surface fluxes were identical between the two solutions and that the results were due to the advection across Gibraltar.
In the paper is stated that surface fluxes are identical over the Mediterranean Sea (1100:12), but they are different in the Atlantic due to the salinity correction factor of V2.1. We have modified the sentence (1104:25) making clearer this point.

4. There are significant variations in the transport across Gibraltar between the two twins; however, advection is eliminated as a possible mechanism for any temperature variations. Why is this? The only mechanism that is stated that could account for it is air/sea flux, which leads us back to point 3. Please explain these seeming disconnects.
The Reviewer is right and we thank him/her for this important comment. The sentence (1104:14) as been rephrased as follows:
"In Fig.08 the mean temperature (A) and salinity (B) of the Atlantic water entering into the Mediterranean at the Gibraltar Strait are shown. The mean temperatures (Fig.08 A) of the Atlantic water are very similar, with a clear and strong seasonal cycle. This is due to the fact that the Atlantic waters entering into the Mediterranean Sea are surface waters and the air-sea fluxes totally determine their temperature. However the amount of the inflowing Atlantic water is different between the two simulations (Fig.06), thus the water masses can be differently advected producing the small differences in

temperature observed within the Mediterranean Sea (Fig. 07)."

5. PCC. When performing pattern correlation on anomalies, it is most often referred to as ACC, and when using anomalies, you must remove the same climatological mean from both fields; otherwise, you can easily make any two fields appear well correlated. Ideally, one would use a Levitus or other "observed" mean removed from both to do the comparison.
The PCC has been computed in several ways, subtracting different means from the fields. We have computed the PCC subtracting: the same climatological field (MedAtlas); observed monthly values (from ARGO) and the one presented in the paper. The results obtained with the different methods were very similar indicating that the model is able to reproduce both seasonal signal and anomalies. Moreover we have added a sentence on pg1103:3 explaining this point.

Technical Comments:

1. A number of sentences contain an introductory clause without the trailing comma, (e.g., "In the past ten years operational oceanography...") should have a comma after years.
Text modified accordingly.

2. Typo "cantered" should be "centered" at pg 1098:2.
Text modified accordingly.

3. Define "MUSCL"
MUSCL defined.

4. Many of the figures or captions need work. Fig.2, the deviations in salinity: though they look significant in the figure, the differences are 0.02% of the total. I'm not sure that the axes are chosen in such a way to properly convey the information.

Axes limits modified.

Fig. 4c, the color scale is cut-off below the level of many of the data (many of the values are > 0.2).
Reviewer is right, moreover we have tried several color scales and we think that the current scale is the more appropriate in order to highlight the information we want to provide.

The caption for Fig. 7 should be rewritten as it is confusing.
Caption rewritten as follows: "Upper panels: Temperature and Salinity RMSE (A), ME (B) and pattern correlation coefficient (C) vertical profiles for MFS-V2.1. Bottom panels: RP vertical profiles for RMSE (D) ME (E) and pattern correlation coefficient (F). Black lines indicate Temperature, red lines indicate salinity data."

Fig. 9 requires changes: the caption and figure legends do not match and there is a large discontinuity in the red line (not sure if it is obs or MFS-V2.2) at 150m.
Caption and figure modified in order to make it clearer. We do not see any discontinuity in the red line at 150m, at that depth green and red lines overlap.

Fig. 10, remove last sentence of caption, it is repeated.
Sentence removed

Fig. 11, redo the color scale for the lower panels: it is black from 0.1 to 0.15–use color.
Done.

5. Pg. 1106:29, the sentence that begins, "To understand the difference–similarities..." reads very awkwardly.
Sentence modified as follows: "In order to better understand the differences and similarities between simulated and observed surface elevation, the power spectrum of the three time-series is shown in Fig.10 B."