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Interactive comment on "Mesoscale variability in the Arabian Sea from HYCOM model results and observations: impact on the Persian Gulf Water path" *by* P. L'Hégaret et al.

Anonymous Referee #1

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This manuscript describes a single regional mesoscale-resolving simulation of the Sea of Oman and Arabian Sea region, carried out for 11 years, with repeating 2011 forcing. The results for the last 6 years of simulation are compared with observations, and analysis focuses on the mesoscale eddies and the Persian Gulf outflow water. There are many interesting features in the results which warrant publication. However, the analysis, particularly of the Persian gulf outflow water, and its modification by the eddies, could be much more thorough and illuminating. I therefore recommend major revision, as detailed below.

Major recommendations

1. Connect properties of Persian Gulf water to mesoscale eddy activity

In the conclusions, (p515, lines 6-13), it is stated that the characteristics of the PGW are modified by the eddy behaviour. However, in section 5, little direct evidence of the effect of eddy activity on the PGW properties is actually given. The main evidence shown is for the different pathways of PGW in different seasons, which is a function of different mesoscale circulations. Can you show evidence for fragmentation of PGW by mesoscale eddies, or the different evolution of PGW inside an eddy core as compared to an eddy filament? For example, what is the thermohaline signature of the eddy merger events described in section 4 at the PGW level?

2. More details of physical processes acting on PGW outflow

While the authors have shown the depth, thickness and width of the PGW outflow, along with the evolution of the temperature and salinity, there is little effort to determine what this information tells us about the mixing which is taking place, the net entrainment etc. One missing quantity would be the integrated transport across the outflow - does this increase when the thickness increases, indicating entrainment? Does the outflow reach a neutral buoyancy level, at which point mesoscale eddy stirring might be expected to dominate over entrainment? Does the PGW detrain from the boundary? Can you identify dilution due to (parameterized) vertical mixing in a downslope flow from mixing associated with the mesoscale eddy fragmentation processes?

3. More details of the numerical simulation

Several important details of the numerical simulation were missing. What is the domain over which the simulation is carried out - is it as shown in figure 1, or is it much larger? What lateral boundary conditions are used? What is the vertical mixing scheme used in the implementation of Hycom? How might this impact the dilution of the PGW outflow?

4. Comparison between observations and model

While the model is run with forcing from 2011 cycled 11 times, the observations span

the periods 2002 to 2004 (floats) and 1992-2014 (AVISO). In your discussion of the differences between model and observations, I did not notice any consideration of the impact of examining different time-periods. How can you account for any trends which may confuse this comparison between model/data at different time periods?

Specific concerns

Abstract: p494, line 10-11: "with a higher resolution" - At first I thought you meant that you did some followup simulations at a higher resolution than your initial simulation. But I think you mean higher resolution than possible from the observations - please clarify.

Figure 1: It would be helpful to the reader to label the Sea of Oman in figure 1.

Section 1, p496, line 6: "this was observed" - please include citations for statements like this.

Section 1, p497, lines 7-8: It is not really correct to label the simulation years 2016 to 2021, when the forcing is always 2011. Instead label them "model year 5-11", so the reader understands you are not referring to actual calendar years 2016-2021.

Section 1, p497, line 13 "better results" - better than what?

Section 1, p497, line 25-26: The sentence "Nevertheless, the calculations of derivatives, as the wind stress can still present strong horizontal gradients" does not make grammatical sense.

Section 1, p497, line 1: "Fonction's" should be "Functions".

Section 3.2, p499, line 2: The acronym "MADT" is used for the AVISO altimetric data - what is it an abbreviation for?

Section 3.2 p499, line 3, and elsewhere: When you use "anomaly" in this context, what is it an anomaly relative to? Is it relative to the time-mean over the entire measurement period? Or relative to the spatial mean? Please clarify.

Section 3.2, p500, line 15-17: The third EOF in the Hycom simulation looks very different from that in the observations - can you speculate why?

Section 3.3, p500, line 25-27: Can you show the two different regions over which you examine the water mass properties on the map? (e.g. Figure 1)

Section 3.3, p501: When discussing the comparison between model and obs, please make it clear when you are talking about the observations, and when you are talking about the model. e.g. line 2 "Several profiles present fresher water" - this is in the observations; line 26 "the stronger salinities that are found in the northwestern part of the basin" - this is in the model results.

Section 4, p502, line 15-16: Give the Rayleigh Kuo criterion in terms of the two quantities evaluated, to refresh the reader's memory.

Section 4.1, p504, line 14: "The Rossby waves deform over the sea mount" - the sea mount is not marked in figure 9, so it is hard for the reader to determine if this is true. I suggest showing the location of the sea mount on figure 9a.

Section 4.3.1, p506, line 1-2: Rewrite this sentence as "Two eddies of the same polarity can merge if they approach close enough that the distance between their centers is smaller than 4 times their radius."

Section 4.3.1, p506, line 8: Delete "and".

Section 4.3.2, p508, line 23-27, and elsewhere: Replace "slope" or "slopes" (which imply a spatial gradient) with "tendency" or "tendencies" (which imply a temporal gradient).

Section 4.3.3, p509, line 14: "have" should be "has".

Section 5.1, p511, line 22: "a PGW" should be "of PGW".

Section 5.1, p511, line 26: "equilibirum" should be "equilibrium".

Section 5.1, p511, line 27: Add a comma after "salinity".

Section 5.1, p512, line 8: Add a comma after "56 E".

Section 5.1, p512, line 9: Insert "an" before "anticyclonic lee eddy".

Section 5.2, p513, line 17: Are decreases in thickness of the outflow associated with detrainment (e.g. fluid at its neutral buoyancy level is mixed into the ambient flouid) or due to widening or acceleration?

Section 6, p515, line 6: Delete "on" before "its pathway".

Figure 3: Mention that these fields are for 2011. Include " and left to right" after "top to bottom".

Figure 4: Instead of "MADT anomaly" use the name of the physical variable (e.g. "dynamic topography anomaly" ?). Is the x-axis of the amplitude plots time in months? Label axes.

Figure 7: Is this observations or model?

Figure 8, especially at right: black contour lines are too thick, obscuring the color signal, even when the figure is expanded 200%.

Figure 9: Show the sea mount location in panel (a). All panels are lacking axes labels. What is the contour spacing?

Figure 11: The interpolation in the salinity section looks peculiar. The density section goes down to 1000m, not 1200m.

Figure 15: Again, change "slope" to "tendency".

Figure 16 and 17: Is the whole domain shown? If not, indicate the full size of the model domain. Specify the model used in the caption (ROMS?).

Figure 19: Again, is the x-axis time (units?) on the amplitude plots?

Figure 20 and 21: Are these quantities calculated for each of the 4 months averaged over the 6 years of analysis? How different do the different years look?

Figure 21: Add outflow transport to this figure. Also, instead of plotting temperature and salinity on the same scale (which leaves most of the panel blank, and puts the interesting signal at the top or bottom) use different axes for each field, so that the signal takes up the maximum space. I found it very difficult to see any significant difference in the end point salinity or temperature in these plots.

Interactive comment on Ocean Sci. Discuss., 12, 493, 2015.