

Ocean Sci. Discuss., author comment AC2
<https://doi.org/10.5194/os-2021-120-AC2>, 2022
© Author(s) 2022. This work is distributed under
the Creative Commons Attribution 4.0 License.

Reply on RC2

Katia Mallil et al.

Author comment on "The Levantine Intermediate Water in the western Mediterranean and its interactions with the Algerian Gyres: insights from 60 years of observation" by Katia Mallil et al., Ocean Sci. Discuss., <https://doi.org/10.5194/os-2021-120-AC2>, 2022

First of all, we would like to thank you very much for all your interesting remarks that helped us improve the paper.

Please find below the responses to each of the comments.

Best regards

Comment on os-2021-120

Anonymous Referee #2

Referee comment on "The Levantine Intermediate Water in the western Mediterranean and its interactions with the Algerian Gyres: insights from 60 years of observation" by Katia Mallil et al., Ocean Sci. Discuss., <https://doi.org/10.5194/os-2021-120-RC2>, 2022

General comments

The ms presents an analysis of an extensive amount of thermohaline data in the Algerian basin from the 60s to almost the present day. From this large dataset, Mallil and coauthors investigate the role of the Algerian Gyres in the transport of the Levantine Intermediate Water (LIW) throughout the basin. Dividing the basin into distinct zones, they estimate temperature and salinity trends in the LIW density classes over different time periods. From a cooling signal detected in the LIW during one of these periods, first off Sardinia and subsequently in the rest of the considered regions, they estimate LIW spreading time periods throughout the Algerian basin.

The ms is rigorous and the conclusions are well supported. It is also well organized and clearly written. The wording of some sentences seems odd to me, but this rarely happens. I urge the authors to revise the use of symbols and units throughout the manuscript (see comments).

In my opinion, this paper is a significant and relevant contribution to the research community, and deserves to be published once the following comments and corrections are taken into account.

Specific comments

L6. Indicate the values within the results section as well. It is stated on line 180 that the LIW is warmer and saltier in the eastern Algerian basin than in the Provençal basin, but the estimated values are not explicitly given there.

Thank you for pointing this out, the values have been added to the result section.

L6. Remove salinity units (practical salinity is unitless).

All salinity units have been removed, thank you.

L6-L7. Is the sinking not presumed produced by the regular presence of anticyclonic AEs coupled to the circulation of the Algerian Gyres (L270-L272)? I think it would be appropriate to clarify.

This part have been rephrased for more clarity, thank you.

L14-L31. I recommend restructuring this part of the introduction slightly and checking the wording to improve clarity, especially for a reader unfamiliar with the topic and area of study. All the necessary information is already included there, but I find a bit confusing the way it is structured.

For example, one option might be: after explaining the thermohaline functioning of the basin, the exchange across the Strait of Gibraltar and the MOW, one could then describe the LIW as an important constituent of the MOW (describing the origin, properties and general circulation pattern of the LIW in the Western Mediterranean), to conclude by indicating that the circulation of the southwestern region of Mediterranean has been relatively unexplored compared to other areas of the basin, especially regarding the LIW, even though the presence of the Algerian current and the generation of meanders and eddies are well known. Subsequently, in the next paragraph, proceed to describe the results of the MATER program in the region, and so on.

Indeed, as also pointed out by reviewer 1, this part needed reorganisation. It has been addressed, thank you for the suggestion.

L17. Relatively warm and fresh

This has been corrected, thank you.

L30-L31. LIW core is identified by an absolute salinity maximum and a relative temperature maximum.

It is indeed more precise with this formulation, thank you.

L41. 'AEs transport LIW from the vein flowing northward along the continental slope of Sardinia...'. In relation to the previous comment (L14-L31), I think it would be helpful to include a general description of the LIW circulation in the Western Mediterranean so that the reader can more easily follow the introduction. Perhaps (if possible), even include a simple schematic in Figure 1 to help the reader? A subplot/inset?

Thank you for the suggestion, reviewer 1 also suggested that. We will add a simple schematic figure to indicate the circulation features.

L64-65. Wording seems odd to me. Please, check it.

This sentence have been rephrased for more clarity, thank you.

L66-L70. I suggest indicating also here briefly what type of observational data will be used in the study.

A sentence have been added to this paragraph to mention the information, thank you.

Figure 1. Indicate in the caption the meaning of the background contour lines and specify units of the axes in the figure on the left. Also, use lowercase theta for potential temperature in the caption (correct this elsewhere in the manuscript and figures). Uppercase theta denotes conservative temperature.

The corrections have been implemented, Thank you.

L103. General comment on 'Removal of outliers': why don't you set an upper density threshold for outliers in the deepest layers (>2000 m)? In Figure 2, one can observe a profile (from the 80-90s approx.?) that reaches a maximum σ_{θ} value around 29.27 kg/m³, and which I assume corresponds to the deepest layers. I understand that these values are outside your region of interest in the T-S plane, but why is this profile in Figure 2 not considered an outlier?

An upper density threshold have already been applied, any profile that presented density larger than 29.2 kg/m³ from surface to 2000m, was considered an

outlier. This particular profile that appears on figure 2 started presenting bizarre values precisely at 2000m, therefore, the criteria did not apply. The criteria was tweaked in order to address the problem. Thank you for mentioning that.

Linked to this comment, I think it would be convenient to indicate somewhere in the manuscript the maximum depth of the basin, just to contextualize the depth range of the profile.

A mention to the maximum depth of the basin have been added in line 121.

L113. Since it has been indicated above (L107) that lowercase theta denotes potential temperature, you might use it here instead. At any rate, temperature and potential temperature are used interchangeably throughout the manuscript, therefore I recommend using one or the other consistently (if temperature is used, clearly state that it means potential temperature throughout the ms)

Thank you for mentioning that, it has been corrected throughout the manuscript.

L114. I suggest explaining here what these data will be used for.

The current measurements have been used to look for a signature of the Algerian Gyres reaching the deep layers. The information was added to the manuscript, thank you.

Figure 2. Remove salinity units (practical salinity is unitless), and replace uppercase theta (conservative temperature) with lowercase theta (potential temperature) as indicated above.

It has been sorted, thank you.

L129. General comment on 'Regions of interest': this subsection presents the distinct polygons defined from the different circulation features of the basin. The inclusion of a schematic in Figure 1 sketching those features as recommended before, would also greatly help the reader here.

An additional scheme will be added to help the reader understand our choices. Thank you again.

L131-L132. This sentence sounds strange to me. Check it and consider rephrasing for clarity.

The sentence have been restructured to clarify meaning (we chose the boxes to include temperature and salinity profiles being similar enough to characterize

one particular stage of circulation of LIW). thank you for the remark.

L137. Replace 'south of Sardinia' with 'south and west of Sardinia' since the polygon extends all over that region, and not only off south Sardinia.

It has been corrected throughout the manuscript, thank you.

L140. Replace 'along-slope LIW vein' with 'Sardinian along-slope LIW vein' for clarity.

It has been replaced throughout the manuscript, thank you.

L148-L152. I suggest explaining this part at the end of Section 2.1.

This part have been moved to the end of Section 2.1. as suggested, thank you

L163-L165. I recommend including this information in the explanation of the SOMBA-GE 2012 survey provided in Section 2.1.

This part belonged indeed in Section 2.1, it has been moved there. Thank you.

L165/Figure 4. Why do you only use layers from 1200 m to bottom (well beneath the LIW core depth range)?

We chose to look at layers from 1200m down to the bottom, because it is more stable than the above layers with dynamical structures which velocities might conceal the lower velocity of the Algerian Gyres.

L177. Check 'Western Algerian Gyre'. Do you mean the Eastern Algerian Gyre?

Yes this was a mistake, thank you for pointing it out

Figure 6. Indicate also in the caption what the white isoline denotes. Add the axes units.

Thank you, this has been addressed.

Figure 7. Add axes units. Replace 'density' with potential density anomaly. Check 'Western Algerian Gyre' (Eastern?)

Again thank you for pointing out the mistakes, they have been sorted.

L190. I wouldn't say 'overall increase' since that increase has a lot of uncertainty, only in 2/8 areas R2 is greater than 0.5. The general increase is much clearer in the case of salinity.

Thank you for pointing this out. Indeed, there is no significant trend for the full period according to the table. We thus rephrased to "The evolution of potential temperature of the LIW as seen in Fig. 8 is showing a slight overall increase over the 1960-2017 period, however not monotonous and significant only for Albo and AlgC regions (Table 1)."

As suggested by Refree 1, we will also reassess the significance of the trends. For that, we will use P-values to address the problem of large R² when there are few data points.

L197. Check wording.

We added some clarifications to the sentence, thank you.

L205. 'A brutal decrease'. Wouldn't it be better to use another word such as 'prominent'?

In fact, prominent or noticeable are better suited in this sentence. Thank you for the suggestion.

L212. Indicate that in this period, potential temperature trends present very low R2 values.

You are right, we should have referred to the trends in temperature with a comment on the low value of R2 for this period. Linked to the comment above (L190.), after including more information about significance, we will modify the text accordingly.

L214-L215. This is a bit difficult to observe in the graph. I recommend changing the vertical grid in Figure 8 so that each dotted vertical line corresponds to the beginning of each year.

Thank you for the suggestion, this will be fixed.

Figure 8. Since monthly means are used in the cross-correlation, I understand that the vertical bars refer to the average number of points in EACH polygon (not in ALL polygons). The right y axis label in Figure 8 is a bit confusing to me. I may be missing something.

Could you clarify this point?

In figure 8, the vertical bars represent the mean number of points used to compute the annual mean each year, independently of which polygon it is. We tried representing the number of data in each polygon, respecting the color code (8 bars every year), but it crowded the figure too much so we computed the mean value and represented it in grey. The bar plot is here to illustrate the increase of the observing capacities in the last 20 years or so, mainly due to the start of the Argo program.

Caption in Figure 8. Indicate that these are annual means.

The legend indicates that these are annual means, the information have been added to the caption as well. Thank you.

Table 1. Could you include the basin-averaged trend as well? Same for Table 2.

This is a very good suggestion. We will work to provide an estimate of the basin trend by merging the observation of relevant polygons (the regions Walg Ealg and MAIlg in the basin center are showing roughly the same pattern). The increase of points in the data set might improve the significance of the trend.

Table 2. Check MAIlg (NaNs in Period 1 and 2).

We will look at the code and fix this bug, thanks for the remark.

L266. I think the reference should be placed earlier in the sentence.

This will be checked carefully. Thank you for pointing this out

L270-L272. Just a comment: wasn't the presence of one of them captured during the SOMBA-GE 2014 survey?

Indeed an anticyclonic Algerian Eddy was captured during the SOMBA-GE2014 cruise, the surface signature of this AE is represented in fig.5, and the signature of its high velocities, even in the deeper layers, can be seen in fig.4. The East west section of the SOMBA-GE 2014 also shows a deepening of isotherms and isohalines at 600 km from point A on the panels (d) and (g) in fig.3. We added a

reference to this observation in the text.

L299. Clarify that the cross-shelf transport occurs over the Sardinian continental shelf.

Indeed, we also noticed that this sentence was not particularly clear so we rephrased: "In the transit time analysis, the last area to get the signal was the south Balearic one, likely because in this region the LIW comes mainly from the along-slope advection by currents at intermediate depth circling the whole Western Mediterranean Sea, and is not much influenced by the less efficient eddy-driven transport across the Sardinian shelf."

L309. Why 'some positive trends'? According to Table 1, all potential temperature trends are positive for the full period.

Indeed, thanks for pointing this out. We will modify.

We will also assess the significance of the trends using P-values instead of the R² coefficient to address the problem of large R² when there are few data points. We will modify the interpretation accordingly.

L.354. Explain why is it alarming.

We have expended this last sentence: "A closer monitoring of water mass properties need to be sustained. It is crucial to maintain and reinforce existing surveillance systems as they can assess the direct impacts of climate change in the Mediterranean hot-spot. In the future, we can expect important modification of the water masses properties with major consequences: increase of temperature, stratification, collapse of deep convection in the NW Mediterranean Sea (Parras-Berrocal, et al 2022), thus affecting its profound functioning and the rich but fragile ecosystems that is hosts. It is reported in Lacoue-Labarthe et al. (2016) that an increased warming is likely to result in mass mortality of seagrass *Posidonia oceanica* (which is a very important habitat in the Mediterranean, and constitutes an important carbon sink), invertebrates, sponges and corals ..etc. Invasive warm water species of algae, invertebrates and fish are increasing their geographical ranges. In addition to that, the proliferation of pathogens are expected, increasing the spreading of diseases."

Technical corrections

L8. Replace 'the signal' with 'a signal'

Sorted, thank you.

L15. Change 'is' to 'are'

Sorted, thank you.

L16. Preconditioning

Sorted, thank you.

L20. AEs acronym should be defined here, right after 'Algerian Eddies'

Sorted, thank you.

L23. water masses

Sorted, thank you.

L23. of the whole Mediterranean

Sorted, thank you.

L24. MOW acronym should be defined here, following 'Mediterranean Outflow Water'

Sorted, thank you.

L35-L36. Delete brackets in the coordinates

Sorted, thank you.

L41. Use AEs instead of 'Algerian Eddies' (also in L47)

Sorted, thank you.

L54. missing 'r' in further

Sorted, thank you.

L60. Sea

Sorted, thank you.

L68. broad

Sorted, thank you.

L109. Below

Sorted, thank you.

L119. Figure 1 must be referenced before Figure 2 (Figure 1 is referenced for the first time on L130. Section 2.3).

A reference to Figure 1 have been added to the first paragraph of Section 2.1, thank you.

L120. Indicate that the 'maximum values' are maximum values within the selected range

Sorted, thank you.

L144. Use MOW instead of Mediterranean Outflow Waters

Sorted, thank you.

Figure 3. Add axes units in (a) and colorbar units in (b), (c), (d) or indicate them in the caption.

Sorted, thank you.

Caption of Figure 5: helpS TO identify

Sorted, thank you.

L193. Replace 1969 with 1960.

Sorted, thank you.

Caption of Table 1. Replace 'temperature' with 'potential temperature'

Sorted, thank you.

L227. Replace 'along-slope circulation' with 'basin-scale along-slope circulation'.

Sorted, thank you.

L227. What do you mean by 'shear red'?

I intended to type sheer red, meaning partly transparent, but it turns out that sheer is a specific adjective for fabric, the word transparent was used instead, thank you.

Table 2. Delete '(unit)' in caption.

Sorted, thank you.

Figure 9. Correct 'PRincipal'. Add axes units.

Sorted, thank you.

Caption of Figure 9. L2. Replace 'were' with 'was'

Sorted, thank you.

L254. Replace 'right' with 'easternmost'

Sorted, thank you.

L264. Indicate that the LIW vein is that off Sardinia.

Sorted, thank you.

L283-L284. Specify after 'could be identified' that it was south/west of Sardinia.

Sorted, thank you.

L292. The anticyclonic

Sorted, thank you.

L317. Vargas-Yáñez (check the spelling). Also in L325.

Sorted, thank you.

L342. has

Sorted, thank you.

L343. replace `but` with `and`?

Sorted, thank you.

L359. conTributed

Sorted, thank you.