Ocean Science Discussions

Ocean Sci. Discuss., author comment AC3
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Reply on RC2

Giusy Fedele et al.

Author comment on "Characterization of the Atlantic Water and Levantine Intermediate Water in the Mediterranean Sea using 20 years of Argo data" by Giusy Fedele et al., Ocean Sci. Discuss., https://doi.org/10.5194/os-2021-68-AC3, 2021

AUTHORS' ANSWERS

We thank the reviewer for the comments, which contributed to improve the quality of this paper. A detailed answer to the reviewer is provided below. In bold the reviewer's comment are shown. The updates in the manuscripts are in red font.

Title could better reflect the content of the paper: Please, consider revising it to highlight the use of 20 years of data from the last decades since the use of long-term timeseries constitutes, from my viewpoint, the main strength of this work to determine trends, which have often been based of very few data)

- **Suggestion 1: Characterization of the Atlantic Water and Levantine Intermediate Water in the Mediterranean Sea using last two decades of Argo Float Data**
- **Suggestion 2: Characterization of the Atlantic Water and Levantine Intermediate Water in the Mediterranean Sea using last 20 years of Argo Float Data**

We thank the reviewer for this suggestion and update the title with the following:

"Characterization of the Atlantic Water and Levantine Intermediate Water in the Mediterranean Sea using 20 years of Argo Data".

Answers to points 2-3-4-5 are provided below:

- **Authors are requested to explain how this approach, based on min/max salinity peaks, is considering the positive trend due to climate change for tracking the AW and LIW. The use of geometry-based method is recommended to better detect the water masses instead of the traditional criterion based on predefined temperature and salinity ranges, as concluded by Juza et al., 2019; Vargas-Yáñez et al., 2020). In addition, they mentioned that the use of pre-determined temperature and salinity ranges does not allow to detect and track spatio-temporal changes in water mass properties and may lead to erroneous characterizations and interpretations.**

- **Authors are asked to justify the use of the minimum difference value of 0.01 for the definition of the peak.**
- **Authors are invited to provide an explanation about the effect of the lower percentages of effective profiles related to the total number in Levantine (for AW and LIW) and in the Adriatic (for LIW) in the final results.**
- **Authors are requested to further explain how the exclusion of profiles where no peaks were found (due to intense vertical mixing) could interfere in the interpretation about the stratification trend.**

The method previously shown aimed to capture the AW and LIW cores, reducing the "noise" provided by external factors. The method considered a unique threshold for each profile and basin, provided by the prominence value 0.01. We agree with the reviewer that using different prominence values for each basin would impact less on the number of profiles considered and as consequence on the results, but the definition of the best prominence for each region would need a more in-depth study, which is not the purpose of this paper. Therefore, we choose that arbitrary value, which excluded the profiles with a less clear minimum/maximum salinity value for the AW and LIW respectively, rejecting a smaller number of profiles than other prominence values. Nevertheless, we agree that this method is too arbitrary and less robust. Therefore, we decided to modify the method, following a new strategy, discussed below. The manuscript has been updated as follows. Please see lines L183 – L213.

"A preliminary step in this analysis was the post-processing: we first applied a time sub-sampling on each profiler to obtain a more homogeneous dataset (Notarstefano and Poulain, 2009). This is applied to each float as follows: if the cycling period is 1 day or less, the profiles are sub-sampled every 5 days; if the period is 2 or 3 days, they are sub-sampled every 6 days; and if the period is 5 or 10 days, no subsampling is applied. Afterward, each profile was linearly interpolated from the surface (0 m) to the bottom every 10 m to obtain comparable profiles; and finally, a running filter with a 20 m window, was applied to the data along the depth axis, to smooth any residual spike.

Finally, the minimum/maximum global salinity value in each profile is associated to the AW/LIW core in the respective depth layer. Then, the correspondent depth and temperature values are considered.

Once the AW and LIW core are identified in each profile, the AW and LIW inter-basin variabilities were analyzed taking advantage of the boxplot approach applied to each parameter and region (Fig. 2). In Fig.2, the whiskers (black dashed line out of the box) extend to the most extreme data points not considering the outliers at the 5% significance level (pvalue≤0.05). In order to test the significance, the Student's t distribution was applied to each hydrological parameter in every sub-basin (Kreyszig and Erwin 1970). The null hypothesis (that states that the population is normally distributed) is rejected with a 5% level of statistical significance. This method is also applied to the timeseries trends. In section 3.1 we often refer to the range and skewness of the distributions, that are the difference between the upper and lower limits and the measure of the symmetry of the distributions, respectively (including only the 5% significance values).

Considering only salinity, temperature, and depth AW and LIW values at 95% level of significance (Fig.2), as done for the spatial analysis, the timeseries from 2001 to 2019 have been computed in each subbasin to analyze the low frequency variability (LFV) and trends at interannual to decadal timescale over the available observed periods. In this respect, the high frequency variability was filtered out, first by subtracting the mean seasonal cycle to the raw timeseries, and then applying a median yearly average filter. This last step is needed since the data are not homogeneous in time in every subbasin from 2001 to 2019, and therefore without it, the seasonal variability can contaminate the estimation of the trends. The latter have been computed using the linear least-squares method to fit a linear regression model to the data.”

Therefore, with this new approach no prominence threshold has been included and only the values of salinity, temperature, and depth at 95% level of significance are considered. Deleting the outliers, any noise which can still perturb the results is ignored.

No huge changes are found in the results except for trends over the Adriatic and Levantine subbasins, demonstrating that over them too many profiles have been ignored in the previous analyses.

- **Did you exclude lower salinity in the Cretan sub-basin (i.e. where the highest salinity of LIW was found)?**

The analyses have been updated and only values considered outliers are ignored.

- **Authors are encouraged to double-check their conclusions, which seems to be in contradiction with the main results found: e.g. as it states in the results and Fig 2, LIW becomes saltier (particularly in the Adriatic) and warmer (except in the Cretan and Levantine sub-basins), but the conclusion (L-487) states that LIW is less salty (i.e. fresher), and colder.**

We thank the reviewer for this comment, but those conclusions refer to the mean zonal gradients over (inter-basin variability) the Mediterranean Sea at Lines 420-423, which is also captured by Fig.2.

- **It may also be worth further investigation about the drivers of the AW and LIW interbasin and interannual variability in the context of this study.**

We agree with the reviewer that more analyses would be necessary to explain the processes that are behind the variability observed in the timeseries, and that the part regarding the wavelet is not complete. Therefore, a more in-depth analysis on these processes is left to future studies and the part regarding the wavelets has been removed from this manuscript.

- **As a general comment regarding the in-text citation and reference list order:**

- **please consider to review the in-text citation order, listing the sources alphabetically by author surname (APA reference) or using author-date referencing, ordering the citation based on data of publication.**

We thank the reviewer for this suggestion, we have sorted the publications in the right alphabetical order.

please, consider to review the reference list, to arrange entries in the alphabetical order by the surname of the fist author (e.g. incorrect order found in L555 before L558; L571 after L565; L625 before L629, etc.).

Thanks for this comment, we have sorted the publications in the right alphabetical order.

Technical corrections

L-56: specify the different approaches for identifying AW and LIW and the advantage of the methodology used in this study by means of the identification of min and max values, particularly for the characterization of the AW (i.e. much more influenced by other forcings)

We thank the reviewer for the comment. This part has been removed in this version of the manuscript.

L-56: add references of different approaches (e.g. Juza et al., 2019; Várgas-Yañez et al., 2020)

Thanks, these references have been included.

L-65: add references about the hydrological properties of AW (as the authors properly do for the LIW in L-77)

Thanks, these references have been included.

L-84: add additional recent studies including, for example, Juza et al., 2019; Várgas-Yañez et al., 2020

Thanks, these references have been included.

L-143: add one paragraph about the new initiatives of deploying floats in shallow coastal areas (e.g. off the North Adriatic coast and off the Bulgarian Black Sea). Authors can access to the tracks in this link: https://www.euro-argo.eu/EU-Projects/Euro-Argo-RISE-2019-2022/Access-to-Euro-Argo-RISE-Data

We thank the reviewer for this suggestion, but we believe it is out of topic and therefore we don't include this in the manuscript.

L-151: please, add the URL to access the float monitoring and data (https://fleetmonitoring.euro-argo.eu/dashboard?Status=Active)

Thanks per the suggestion, this link has been included. Please see L.150.

L-235: please, add eight Mediterranean "climatic" regions

This correction has been included in the manuscript.

L-345: authors are encouraged to justify the main reasons of the contradiction found with the results provided by Millot (2007), is it just a matter of the period selected?

This correction has been included in the manuscript. Please see L.314.

L-345: do you mean Mediterranean "outflow"?

Yes, we did. This correction has been included in the manuscript. Please see L.313.

L-365: authors are encouraged to further explain the agreement found with Schuckmann et al., (2019) about the SST warming (0.018 versus 0.04 ºC/yr., it is more than twice)

Thanks for the comment, we give explanation at L. 337-341.

L-469: please, consider to replace non-stationary with "variable".

This correction has been included in the manuscript.

Fig.1: please, increase resolution of the image. The use of different colors for

different sub-basins might help.

Thanks for the suggestion, we increased the resolution and changed the colors.

Fig.3-8: authors are invited to include the trends/yr. included in Table 1 in each one of the subplots, to better identify higher/lower trends in the figures.

We thank the reviewer for the suggestion but we believe that the figure is cleaner as it is, and Table 1 is complementary with the "trend plots".

Fig.5 and 8: In order to help in the interpretation of the results at a first glance, please include the following in the caption of the figures. "Positive/negative trends (red/blue squares) in this case corresponds to an increase/decrease of the depth (i.e. deeper/shallower)"

Thanks for the suggestions. These comments have been included in their captions.