

The authors would like to thank the reviewer for the comments and suggestions for the improvement of the manuscript.

All the comments mentioned in the supplement document "essd-2018-51-RC1-supplement.pdf" were taken into account (see "essd-2018-51-response\_to\_RC1-supplement.pdf") and the manuscript was edited accordingly. In particular the units were revised throughout the document and the figures re-created.

Please see below *our response (in italics)* and the *changes (in red)* following the **reviewer's comments (in bold)**.

Athanasia Iona, on behalf of the authors' team.

#### **Comments by A. Karageorgis (Referee #1)**

##### **General Comments.**

The article presents a new set of products, i.e. thermohaline climatic indices, from 1950 to 2015, in the Mediterranean Sea, based on temperature and salinity anomalies and ocean heat and salt content estimates at discrete depth layers. The products are based on a high-resolution temperature and salinity regular grid ( $1/8^\circ \times 1/8^\circ$ ), derived by historical in situ observations that was published recently by Iona et al., 2018 in "Earth System Science Data" (<https://doi.org/10.5194/essd-2018-9>).

The methodology applied is sound and presented comprehensively, whereas some example-products exhibit interesting results. However, a number of issues need to be addressed and discussed in more detail. First of all, since ESSD is a journal for the publication of articles on original research datasets and not for publishing scientific results, I would recommend that the authors reduce to a minimal the purely scientific information that appears in the Results section which is rather long. This is not the scope of the article, as it is also mentioned by the authors (Page 7, Lines 24-25).

##### Reply to the reviewer:

*A minimum of scientific information was given in the Results section to highlight the capabilities of the new products and to compare it with those of Rixen and Levitus. Comparison of research datasets with other existing results in the study area is a practice that is used as a validation or assessment tool in data publications. However, as it is commented, in the revised manuscript the scientific information that appears in Results will be reduced to a minimum.*

**Below, a list of specific comments is given, addressing various points that need to be further elaborated. Although I am not a native English speaker, I tried to correct obvious syntax and spelling errors that appear in an annotated pdf that is uploaded together with the general and specific comments. However, language editing by a native English speaker is recommended.**

Reply to the reviewer:

*All comments, typos and other errors were addressed (see “[essd-2018-51-response\\_to\\_RC1-supplement.pdf](#)”).*

### **Specific comments**

**The Mediterranean Sea’s sensitivity to climate change is adequately presented in the Introduction section, as well as its role in influencing the global thermohaline circulation (and not calculation, as it appears in Page 2, Line 10). However, the latter may be an overestimation, since the volume of the saltier Mediterranean water flowing into the Atlantic Ocean is rather small.**

Reply to the reviewer:

*Even if the Mediterranean outflow is small, several studies have shown that it has an effect on the water formation processes and thermohaline circulation in the North Atlantic.*

*The sentence of Page 2, Line 9-10 will be rephrased as: “[In turn, the Mediterranean Sea plays an essential role in influencing the water formation processes and thermohaline circulation in the North Atlantic. \(Lozier et al., 1995; Béthoux et al., 1998; Rahmstorf, 1998\).](#)”*

**There is a confusion with respect to Ocean Salt Content (OSC) units: in Page 4, Line 6. OSC is given in m<sup>3</sup>, in Page 9, Line 2 in ppt m<sup>3</sup>, and in Page 10, all 4 Figure 2 panels and the caption, in m. The authors should carefully check and correct accordingly throughout the document.**

Reply to the reviewer:

*In this manuscript, the following units are used:*

- *OSC in ppt m<sup>3</sup>*
- *Areal density of OSC in ppt m (areal density is the OSC per m)*

*Page 4, Line 6: This is taken from Rixen et al., 2005 (page 2, paragraph [9]). In this paper salinity is expressed in PSU and OSC in PSU m<sup>3</sup>. Apparently PSU has been omitted in the text as Practical Salinity is unitless. Please note that in Rixen's paper, PSU is used in the figures (Figure 2 and Figure 3, pages 2 and 3 respectively).*

*For clarification, in the revised manuscript, in page 4, line 6, “[1.4–1.6] 10<sup>14</sup> m<sup>3</sup>” will be replaced by “[1.4–1.6] 10<sup>14</sup> PSU m<sup>3</sup>”.*

Page 9, Line 2: there is an error here as the change of OSC per decade is in ( $10^{13}$  ppt  $m^3$ /decade) and not in ( $10^{13}$  ppt  $m^3$ ). In the revised manuscript the " $(10^{13}$  ppt  $m^3$ )" will become " $(10^{13}$  ppt  $m^3$ )/decade".

Page 10, all 4 Figure 2 panels: The unit of the areal OSC density is "ppt m" because it is the OSC (ppt  $m^3$ ) per  $m^2$ .

**The comparison of two distinct periods (1950 to 1979 and 1980 to 2015), reveals a climatic shift in the Mediterranean concerning the heat and salt contents which show increasing trends and spatial differences. The results are of high value for the study of long term climatic change. Some clarification regarding the selection of those time slots would be helpful.**

Reply to the reviewer:

*The observations used for the calculation of the climatic indices are spanning from 1950 to 2015. As it is explained in the paragraph 2.2. (Definitions) and for consistency with the World Meteorological Organization recommendation of using as climate normals 30-year periods which are called "climates", two distinct periods from 1950 to 1979 and 1980 to 2015 were selected.*

**Page 7, Line 1: Since the authors know the T, S and depths of each layer, why don't they calculate and cp separately for each layer? That is partly answered at the Conclusions section but should be also mentioned here**

Reply to the reviewer:

*The calculation of density and Cp is not calculated separately in this version of the product but it would be possible to derive them from T and S gridded fields. Such calculations will be available in the next releases. In the revise manuscript, the following text will be added: "In the current climatologies density is not calculated separately but it would be possible to derive them from T and S gridded fields. Such calculations will be available in future releases of the indices."*

**Page 7, Line 2: dx varies with latitude roughly with the equation  $dx = dy \cdot \cos(\text{lat})$ . The estimation here corresponds to latitude  $\sim 38^\circ\text{N}$ . Does this simplification provide valid results?**

Reply to the reviewer:

*Constant dx (delta lon) is not a constraint imposed by the software tool used for the interpolation and production of climatologies. We could add a range of dx, for example from 0.108 to 0.086 (from 30-46N) but it is a common practice in oceanography for the climatologies. For instance the World Ocean Atlas, the global climatology by Levitus and others also use this kind of grid with uniform dx (delta lon)*

and  $dy$  (delta lat) who have an even greater range. We want to be able to make the comparison with their products so it makes sense to have the same output grid resolution.

Please also note that if we needed to have a uniform grid in kilometers, we could convert the degrees to distance using a suitable projection and apply the transformation to the data and the coastlines.

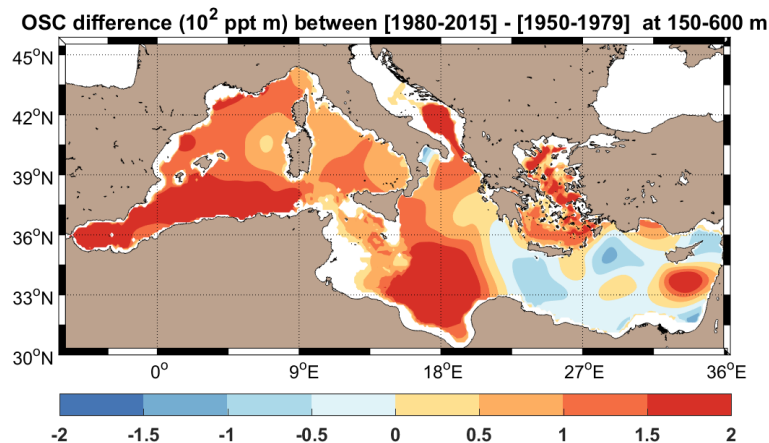
**Page 8, Line 9:** it should be “warming” not “cooling”. At this point the authors could provide estimates of temperature in °C that correspond to the OSC difference shown in the panels of Figure 2 (please correct 19802015-19501979 to e.g. [1980-2015]-[1950-1979] or use "1980/2015 - 1950/1979" and add one space before m to all panels of Figures 1 and 2).

Reply to the reviewer:

Page 8, Line 9: you are right, there is an error in the phrase “cooling spot”. In the revised manuscript it will corrected to: “The surface layer of Eastern Mediterranean (Fig. 1(a)) is cooling with a noticeable **warming spot**”

The comment “At this point the authors could provide estimates of temperature in °C that correspond to the OSC difference shown in the panels of Figure 2” is not clear to the authors.

In the revised manuscript, at Figure 1, 2 the 19802015-19501979 will be changed according to the reviewer’s suggestion and one space before m to all panels of Figures 1 and 2 as in the example below:



**Page 9, Lines 1-5:** Such estimates must be handled with caution because of their paramount oceanographic implications. I’m not sure if they should be mentioned or removed completely and would like to have the Editor’s opinion on that because it relates to the policy of the journal.

Reply to the reviewer:

As it was explained before the comparison was done with the results of Rixen, Levitus who are the pioneers in the field (especially Levitus for the global ocean) as part of the current product validation. The higher temperature increase than the global ocean is a relevant piece of information, which can be justified by:

- More data
- Finer resolution
- Regional domain vs global

Nevertheless, in the revised manuscript the text will be limited only to the obtained numbers without any interpretation or comparison with other works. The relevant paragraph will become: *“For the study period from 1950–2015 there is a (statistically significant) spatial overall increase of heat and salt content of about  $(3.8 \pm 0.5)$  ( $10^{20}$  J/decade) and  $(4.7 \pm 0.4)$  ( $10^{13}$  ppt m<sup>3</sup>/decade) respectively.”*

In addition in Figure 3c the linear trend will not be denoted and the Figure will become as follows (where OSC has been corrected and space added before n):

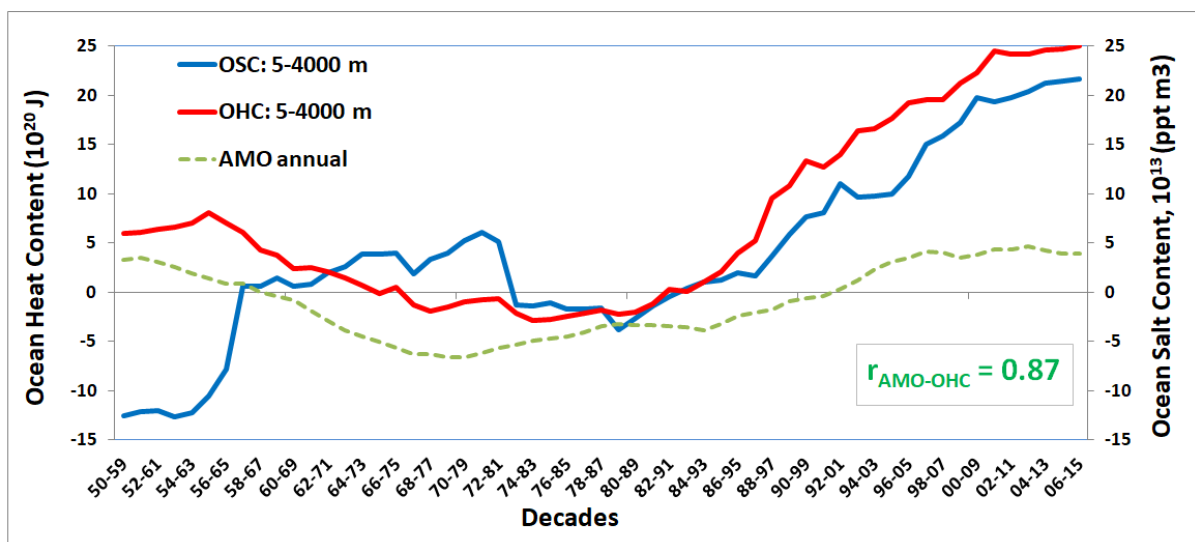


Figure 3c

Page 10, lines 4-5: Rephrase sentence, it is difficult to follow and understand

Reply to the reviewer:

This sentence will be rephrased as: *“Mesoscale features have been filtered out from the climatologies used in the computation of T/S anomalies and their trends as the spatial scales that the numerical grid can capture are of order 300-350 km at the surface (Iona et al., 2018). This means that the patterns shown in the surface layers at Fig 4 (a, b) reveal the long-term term T/S changes of the large scale features of the Mediterranean Sea.”*

Page 11, Figure 3c: Correct OHS to OSC and add space before m

Reply to the reviewer:

*See figure above*

**Page 12, Line 20: The role of S.S. is not mentioned and S.F., S.I. do not exist**

*You are right, there is an error in the initials provided. In the revised manuscript the initials will be corrected as:*

*“Author contributions. A.I. created the climatic indices product, wrote the first version of the manuscript and prepared the figures. J.-M.B., S.W., C.T., A.T. and S.S. reviewed the manuscript. A.I., C.T. and S.W. formatted the document in LATEX.”*