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Interactive comment on "Temporal evolution of Red Sea temperatures based on insitu observations (1958–2017)" *by* Miguel Agulles et al.

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Interactive comment on "Temporal evolution of Red Sea temperatures based on in-situ observations (1958–2017)" by Miguel Agulles etal. Cheriyeri Poyil Abdulla abducps@gmail.com Received and published: 5 September 2019

Interactive comment on the work entitled "Temporal evolution of Red Sea temperatures based on in situ observations (1958–2017)" is listed below and attached as a file along with this. (by C P Abdulla). Appreciating the authors for the work entitled "Temporal evolution of Red Sea tempera- tures based on in situ observations (1958–2017)" by

Miguel Agulles et al., 2019 which has analyzed the in situ profiles in the region and developed a gridded product based optimal interpolation technique. The article further discussed the seasonal, interannual and decadal signal in the temperature of the Red Sea and outer region (mainly Gulf of Aden).

- We deeply thank the referee's comments and the effort hemade in reviewing carefully our work. In the new version of the manuscript we have implemented all the points raised in the review.

My major concern is on the analysis and some of them are listed below.

C1

Comment 1: Please add in the text about the criteria used for removing the spikes, out layer and density inversion.

- The paragraph that explain this part has been modified to better explain the quality control process. As a brief explanation, the quality control has been done in three steps: Firstly, spikes and profiles with density inversions have been removed in all the area studied (Red Sea and outer region). Secondly, those profiles in the Red Sea showing temperatures colder than 20°C below 500 m have been removed. This has been done because no temperature below 20°C has been found in the reference KAUST dataset at any depth. Finally, as a third step, for the rest of the profiles (in the Red Sea and outer Region), those lying outside a range defined by three times the standard deviation are also rejected. .

Comment 2: In Figure 2, why is the left panel the out data are plotted, it would be better to keep only the Red Sea data to cope with the caption of the Figure.

- Thank you for your comment. We have discussed about this but we think useful for the reader to see the large amount of misplaced profiles existing in the CORA dataset to better understand the quality control applied.

Comment 3: Figure 5 shows the distribution of all the available observations for January in the region and the profiles distribution after applying the K-means algorithm.

- That is correct.

Are these profiles shown in (Figure 5b) the only profiles used in Optimal Interpolation?

- Yes, they are. Prior to run the algorithm to obtain the background fields, we have carried out some tests to know the minimum number of observations required to get the analysis field. As you point out, in Figure 5b there are 135 profiles to obtain the background of January. If we had used more profiles, the computational cost (the inversion of the covariance matrix between observations) would have been higher to obtain basically the same result.

Comment 4: When I check the data availability in the Red Sea region from World Ocean Database, the data points are mostly aligned along the center with significantly lower number profiles towards both eastern and western coast. To what extent the second source of data cover this in space and time?

- Thank you for your appreciation. In fact, we spent some time comparing WOD data and CORA data while preparing the manuscript. In order to clarify this aspect, we attached two figures below(Figure 1-SC1 and Figure 2-SC1). The first one compares the number of observations between both datasets for three different years. The second figure shows the number of observations per year in both datasets. It can be seen that CORA includes more profiles and a better coverage than WOD.

Comment5: The 3D gridded temperature product spanning for the period 1958-2017 is will be very helpful in understanding the Red Sea. From my understanding of the manuscript, I found that the amount of profiles in the Red Sea used for the analysis is very low, except for 2 or 3 years (1959, 2000 and 2016). If this is true, is the derived product will be reliable to discuss interannual and decadal signal?

- We believe the product is reliable to assess the interannual and decadal signal. First, we have to say that the number of observations is not the only thing that matters, as

the spatial distribution of those observations is also very important (i.e. with less than 10 profiles one can obtain a good representation of the large scale patterns if they are well placed). Second, the Optimal Interpolation algorithm also produced an estimate of the error associated to each analysis field depending on the number of observations and their spatial distribution (.ie. the formal error). We deliver that formal error along with the TEMPERSEA product. This can help to identify the periods when the product is less reliable and to quantify those errors.

In the discussion section we show that 10 observations per month in the Red Sea would be enough to do a reliable mapping (see Fig 21 in the paper). Moreover, to reinforce the confidence in the product we compare the results with two source of satellite data and the results are within the error bar (see Fig 10 in the paper).

Comment 6: A table explaining the number of profiles used in the OI per each decade separately in the Red Sea will be helpful to show the data distribution in the Red Sea (which is the prime focus of the study) used in the analysis in addition to a map showing the data spread can be added as supplementary file.

- We think that separating the number of observations per decade would not provide any new information as in Figure 2-SC1 we represent the number of observations per year. In order to clarify your question, see below the Figure 3-SC1 and Table 1 (see in Supplement pdf file) which show the number of observations per decade in the Red Sea and the outer region separately. Nevertheless, we emphasize that what it is important to evaluate the reliability of the product are the number and distribution of the observations per month. So, using the number of profiles per decade would not produce a reliable estimate of the product accuracy. Instead, the most accurate approach to assess the reliability of the product is to use the formal error. It is also included in TEMPERSEA product and will be made freely available at PANGEA repository once the paper for publication.

Comment 7: Most of the data represent the outer region and few only represent the

Red Sea, so the title of the manuscript and the name of the product should consider that. . -We thank the reviewer for the comment. Our main interest is the Red Sea and we use the outer data to put Red Sea variability in context. Nevertheless, we accept the reviewer's suggestion and have modified the title of the paper which now reads:

"Temporal evolution of temperatures in the Red Sea and the Gulf of Aden based on in-situ observations (1958-2017)"

Please also note the supplement to this comment: https://www.ocean-sci-discuss.net/os-2019-66/os-2019-66-SC1-supplement.pdf

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Please also note the supplement to this comment:
https://www.ocean-sci-discuss.net/os-2019-66/os-2019-66-AC2-supplement.pdf

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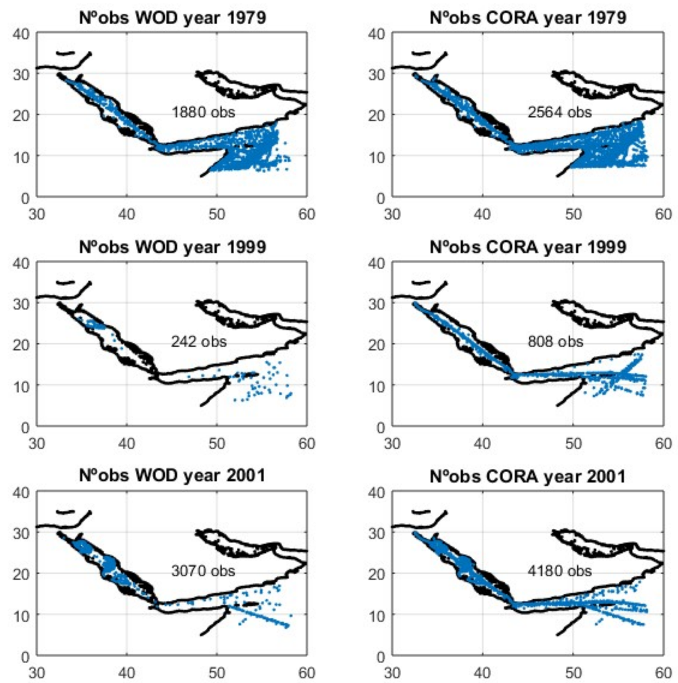

Fig. 1.

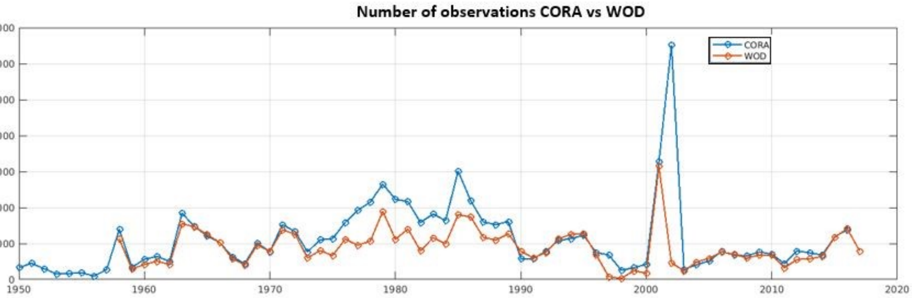
Number of observations CORA vs WOD
CORA
WOD
7000
6000
5000
4000
3000
2000
1000
0
1950
1960
1970
1980
1990
2000
2010
2020

Fig. 2.

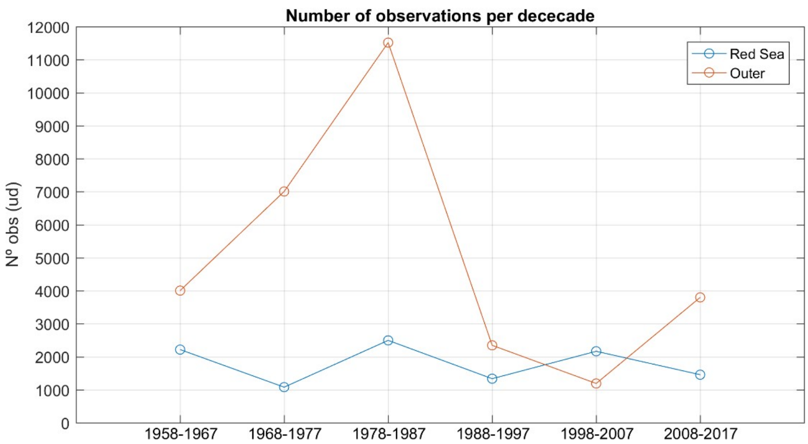
Number of observations per dececade
Red Sea
Outer
Nº obs (ud)
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1958-1967
1968-1977
1978-1987
1988-1997
1998-2007
2008-2017

Fig. 3.