Response to Anonymous Referee comments on "Estimation of geostrophic current in the Red Sea based on Sea level anomalies derived from extended satellite altimetry data" by Ahmed Mohammed Taqi et al.

Referee

Thank you very much for your interest in the manuscript, and for spending your effort and time in the review, comments, and suggestions, which helped in improving the manuscript. The manuscript was modified based on the Referee comments. The responses to the comments are described below.

General Comment:

In this article the authors use data from Jason-2 to extend SLA observations from AVISO towards the coasts of the Red Sea. Altimetric products from AVISO are commonly used to describe the open ocean dynamics but their resolutions are coarse near the coasts. The combined satellite dataset is validated with three tide gauges situated along the western coast of the Red Sea and with geostrophic surface velocities estimated from CTD. This new merged satellite product shows good agreement with the other available dataset and allows the authors to have better observations of the SLA C1 along the coasts. Once validation of the products, the authors describe the monthly climatological evolution of the the SLA and surface currents, exhibiting the evolution of mesoscale eddies, in size, position and rotation. A month to month analysis of the surface fields describe the observed eddies and link them to the structure previously studied in the scientific literature. I think this article is well written, the merged dataset allows us to understand the climatological circulation in the Red Sea, where previous satellite dataset allowed only a partial coverage linked to the geography of the basin.

Comment [1]: Still it lacks some informations of the dataset used to validate the data and the justifications of some diagnosed.

Reply: To validate the geostrophic current, we used the available in situ profiles during the available periods and regions. The in situ data include the following cruises; 1) March 16 to 29, 2010 onboard R/V Aegaeo between 22°N to 28°N along the eastern Red Sea, 2) April 3 to 7, 2011

onboard Poseidon between 17°N to 22°N in the central eastern Red Sea, and 3) October 16 to 19, 2011 onboard the same vessel between 19°N to 23°N in the central eastern Red Sea,. We understand that we are limited in space and time because of the spatial and temporal distribution of the available cruises. Regarding the cruise 1 by Bower and Farrar (2015), unfortunately, we do not have complete data set used by the Bower and Farrar (2015), and therefore we used only the available profiles for validation.

The text in the manuscript is modified accordingly.

Line number: [114-122].

Comment [2]: Nevertheless I felt that the last part of the article did not emphasize the main contribution of this study : the calculation of surface currents and SLA along the coast. As I wrote above, the authors did a good job comparing their results with previous studies, and where they agree, but it would be important in my opinion to add informations on where it provides new informations, particularly along the coasts.

Reply: The manuscript is modified, and the following text is included in the "conclusion" section.

The finding of this paper considered the first of its type in the Red Sea for extending SLA and geostrophic currents to the coast beside giving more details of eddies spatial and temporal variabilities in the coastal region. In addition, in winter, the cyclonic eddies are along the west coast and anticyclonic eddies on the east side of the Red Sea, while in summer it is the opposite. Also, in some locations there is a noticeable change from anticyclonic during winter to cyclonic during summer and vice versa between 26.3°N –27.5°N.

The major new findings from the present study include the monthly geostrophic pattern in the Red Sea which has not been published before. Seasonally, the geostrophic currents in summer are flowing northward except the eastern coast which flows in the opposite. In winter, currents flow to the north for the entire sea except small part of the eastern coast (22°N-24°N) and the western coast (23°N-20°N).

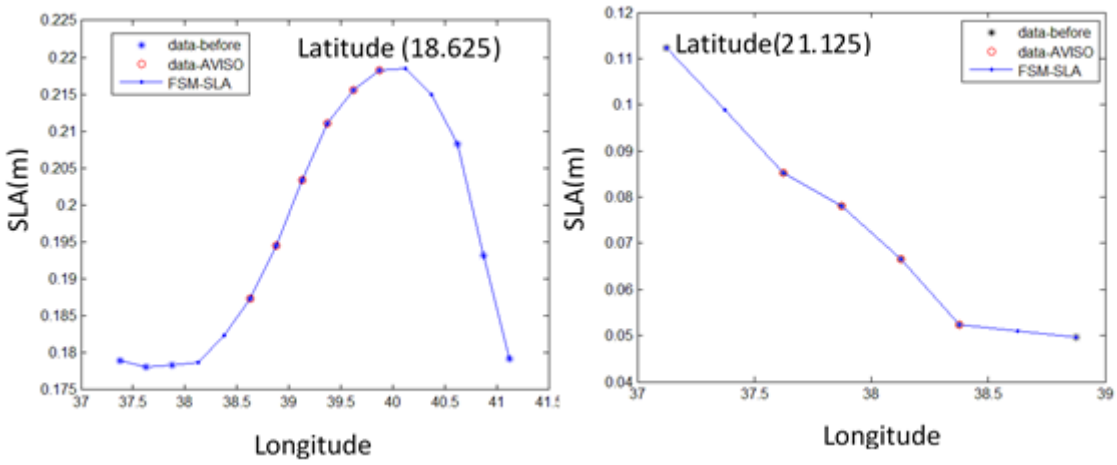
Line number: [334-338, 342-344, 351-353].

Comment[3]: The conclusion is a little short, and adding these informations will help wrapping the article nicely.

Reply: The conclusion in the manuscript is improved.

Comment [4]: The SLA from AVISO gives measurements offshore, while the FSMSLA method extends these measurements toward the coasts. I wonder how are the discontinuities between dataset removed or smoothed ?

Reply: The AVISO data was removed near the coast using the polygon. The blank area was replaced by the FSMSLA data with space leaving between the two data set according to the width of the sea either one or two grid cells. This gap was filled using kriging interpolation method to smooth the dataset. See figure below which include two examples.



Comment [5]: On figure 2 the authors show the correlation between the AVSIO and FSM data, how are they calculated where the AVSIO dataset does not provide measurements (again along the coast)

Reply: Please note that the Gridded AVISO data is available in the coastal region as well as in the offshore area, but the accuracy of the AVISO data near the coast is questionable, especially in narrow basin like the Red Sea. FSM data was gridded to the same resolution as AVISO (0.25°x0.25°). We compared the data along the coast from both data products (AVISO and FSM) against the in-situ (tide gauge) measurements. The statistics of the comparison is shown

in Table 2. The FSM data showed better correlation against the in-situ data in all the cases. For this reason, we have used FSM instead of AVISO data near the coast.

Comment from Results:

Comment [6]: I suggest separating this section in two part, a first with the validation of the method (down to line 17), and a second with the analysis of the SLA.

Reply: The revised manuscript is modified accordingly

Comment [7] About the CTD: on figure 4 the authors display different part of the Red Sea a different period comparing AVSIO and the FSM-SLA. What are the justifications for these specific area and periods. I think providing a quantitative analysis would help validating the approach.

Reply:

To validate the geostrophic current, we used the available in situ profiles during the available periods and regions. The in situ data include the following cruises; 1) March 16 to 29, 2010 onboard R/V Aegaeo between 22°N to 28°N along the eastern Red Sea, 2) April 3 to 7, 2011 onboard Poseidon between 17°N to 22°N in the central eastern Red Sea, and 3) October 16 to 19, 2011 onboard the same vessel between 19°N to 23°N in the central eastern Red Sea,. We understand that we are limited in space and time because of the spatial and temporal distribution of the available cruises. Regarding the cruise 1 by Bower and Farrar (2015), unfortunately, we do not have complete data set used by the Bower and Farrar (2015), and therefore we used only the available profiles for validation.

The text in the manuscript is modified accordingly.

Line number: [114-122].

Comment [8] The visibility of the geostrophic currents and eddies name of figures 5 and 6 have a low visibility. As they exhibit the main results of the study I suggest remapping them by adding a light opaque filter on the SLA and then adding the arrows and names. The same goes for figure 4 where the arrows are difficult to see.

Reply: The visibility of the geostrophic currents and eddies names of figures 5 and 6 arrows and names has been changed.

Comment [9] Figure 7 wrap up the paper with a schematic representation of the currents, but, as the authors state, the monsoons have a strong impact on the Red Sea, particularly on its southern edge. I suggest adding a schematic representation for the winter and summer seasons in order to point out the differences in circulations.

Reply: The annual schematic has been changed to the winter and summer seasons see figure 10, in the revised manuscript.