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.

Anonymous 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 Anonymous Referee comments. The responses to the comments are described below.

Comments to the *Anonymous Referee*

General comment

The paper "Estimation of geostrophic current in the Red Sea based on Sea level anomalies derived from extended satellite altimetry data" by Taqi et al. focuses on describing the geostrophic currents and eddy field in the Red Sea based on altimetry data, extended to the coast using a method proposed by same authors (Taqi et al., 2017). The first part consists of a continuation of the validation of the method (adding hydrographic data for estimating the geostrophic velocity) and the second part provides an analysis of the monthly climatology of the sea level anomaly (SLA) and the corresponding surface currents (averaging 6 years satellite data).

Comment [1]:The validation part provides very little additional analysis compared to the Taqi et al., 2017, while there is no information and/or reference related to the cruises that were used for estimating the geostrophic currents (lines 107-110). Actually, after checking the reference provided later in the text (e.g. Bower and Farrar, 2015) the cruise(s) covered a much larger area than the one used and shown in this paper. It is not understood why the authors selected the specific regions to perform the validation.

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]: The cruises also used an LADCP and thus the adoption of 700 m reference level seems arbitrary (actually most of the stations are shallower than that).

Reply: The manuscript is modified, and the following paragraph is included .

Previous study by Quadfasel and Baudner (1993) used 400 m as level of no motion to calculate geostrophic current in the Red Sea. Based on ADCP measurements, Bower and Farrar (2015) shown that, on average, 75–95 % of the vertical shear is occurred over the top 200 m of the water column. Moreover, the ADCP measurements of current speed below 500 m is very small; about ~0.06m/s at 600 m depth (Bower and Farrar, 2015). Therefore, expecting negligible variability below 500 m, a depth of 500 m was selected as a level of no motion. We have compared the geostrophic current corresponding to level of no motion at 500m and 700m. The observed difference between both are negligibly small.

Line number: [142-150].

Comment [3]: The comparison and error estimation is very qualitative (comparing figures) and in figure 4a&b (the largest area covered) it is impossible to visualize the results.

Reply: As suggested a quantitative analysis is done for the data and added the same in the revised manuscript.

Line number: [201-206, and Table 3].

Comment [4]: The second part is very weak, merely describing the twelve monthly SLA/geostrophic velocity figures. The methodology of averaging 6 years of SLA data to describe the climatology of the complex Red Sea eddy field is not appropriate. While the basin-scale seasonal variability of the SLA can benefit very little from the new method of extending the data to the coast (this comparison is not shown), the averaging could mask the eddy field and produce artificial features. More advanced methods, including the interannual variability of the SLA/geostrophic currents, could provide more reliable information (see Zhan et al., 2014 and many more).

Reply: A) We agree with the reviewer that the averaging of 6 years data will not give the variable eddies in the Red Sea, even it shows the permanent eddies clearly. Please see the attached figure, which compares the climatology with SLA of 2010. The patterns were similar, with small differences. The main differences are the short timing eddies are not visible in the climatology, but the general features of variability of circulation is present.

b) As suggested by the reviewer, more analysis on the SLA/geostrophic currents and the statistical analysis of eddies in the Red Sea are added in the manuscript in fig.7 .
Line number: [278-297].

We have also studied the interannual variability in the SLA and geostrophic current in Fig. 8 and Table 4
Line number: [308-316].

Comment [5]: Finally, the schematic circulation, presented in figure 7, based on the annual geostrophic currents is not convincing (at least compared to the black arrows shown in the figure). A seasonal schematic could be more appropriate.

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

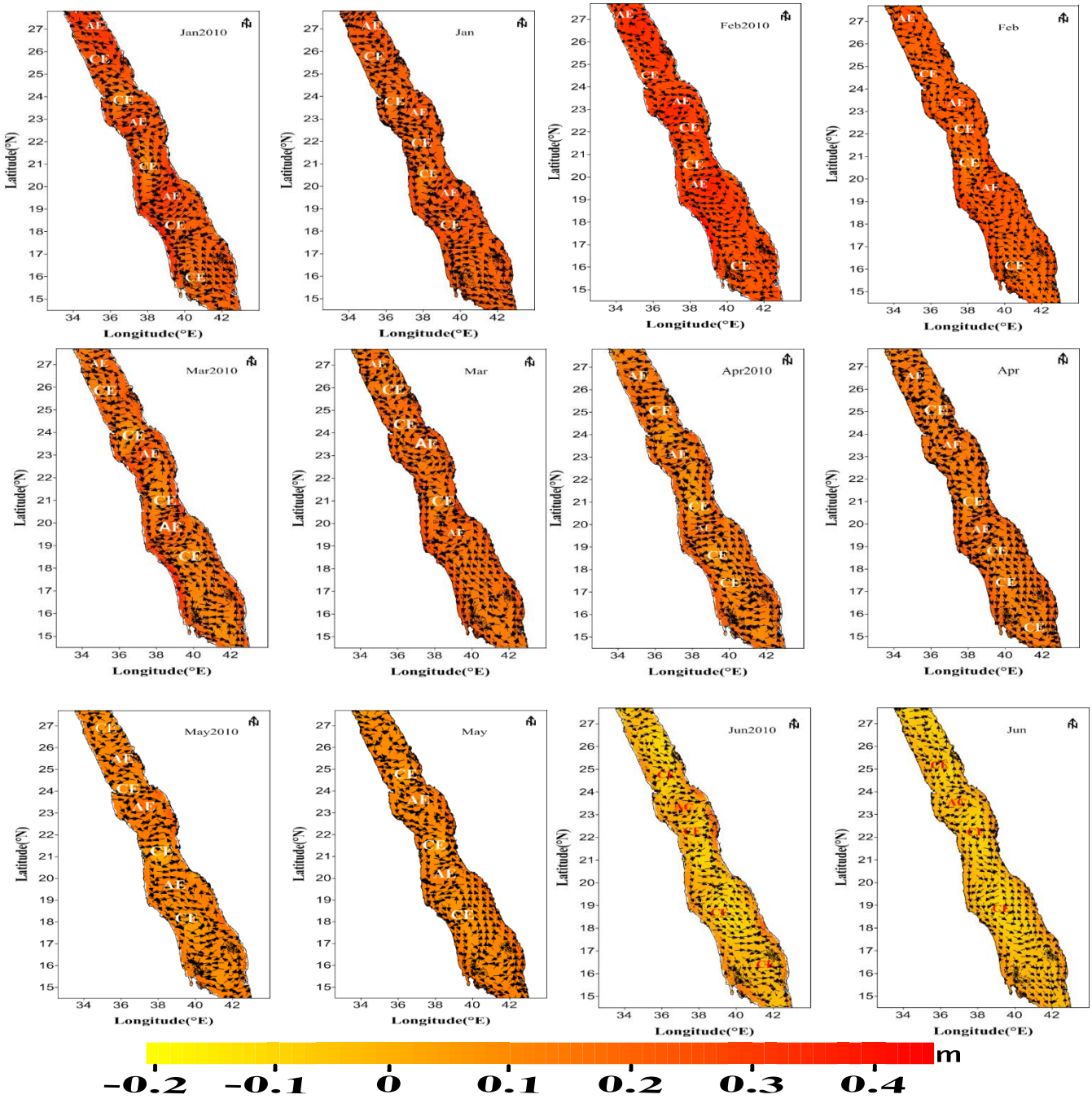

Figure compared between year 2010 and monthly climatology for geostrophic current and Sea level anomaly (Reference current length =0.5 m/sec)

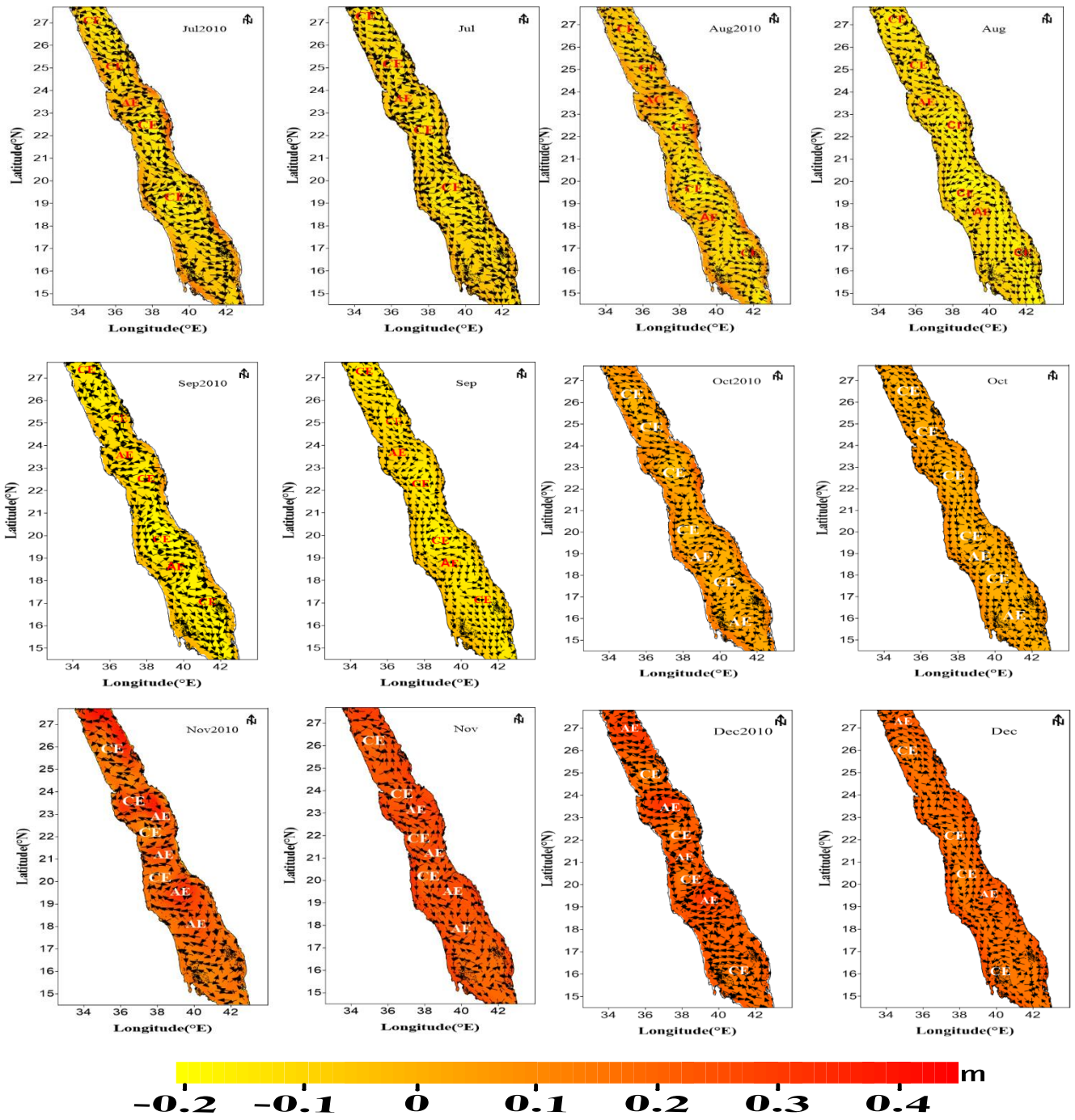

Figure 6 As figure 5 for July to December