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# *Interactive comment on* "Remote sensing of upwelling off Australia's north-east coast" *by* Mochamad Furqon Azis Ismail et al.

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Reviewer #1 (R1) General review The manuscript evaluates satellite products (Chl-a, SST, and wind) and model (BRAN3p5) output along the north-east coast of Australia, in an attempt to explain the upwelling mechanisms resulting in enhanced nutrient supply to the euphotic zone, with consequent lower SSTs and higher Chl-a values during austral autumn to winter. While the manuscript is well-written, and easy to read, there is a great deal of missing information about the data and methods, which presents some difficulty for the reader to easily interpret the results, and makes it impossible for these results to be re-produced. Therefore, substantial revision of this manuscript is required to enhance it to the journal standard.



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Discussion paper

Author comment on behalf of all Co-Authors (AC) We do thank Reviewer #1 for carefully examining our work, and we appreciate your interest and support for our work. We would also like to thank Reviewer #1 for the many constructive comments, which have all been addressed and we feel that it has greatly improved our revised and restructured manuscript.

(R1): Specific comments (Introduction) Data Pg 5-6: A more detailed description of the model output is required. What is the spatial and vertical resolution?, etc. This must be discussed in relation to the spatial resolution of the satellite products used. Pg 6, line 5: clicking on the link to the BRAN3p5 data results in an HTTP error indicating that it is not available.

(AC): We have addressed this by adding more information regarding BRAN3p model configuration in the data section. In addition, we have also checked the link to the BRAN3p5 data and is available online (visited on February 5, 2019).

(R1): Study Site Pg 4, line 13: How have the seasons been defined? ie. Were they limited to a calendar year, or did they cross calendar years?).

(AC): The seasons are defined based on the meteorological seasons within a calendar year, not cross calendar year. The austral spring includes September, October, and November; and the austral summer includes December, January, and February.

(R1): Specific comments (Methodologies) Pg 6-7: This section is supposed to describe the Chla and SST upwelling indices. However, there is no description of the formulation of these indices (what exactly are they? Difference values? Anomalies?), as was done for the wind derived upwelling index. Instead, it only provides some substantiation for why Chla values at depths shallower than 40m and those less than 0.2 mg m-3 were excluded. For the SST index it only describes that values at depths shallower than 40m were excluded, and that anomalies were calculated using a centred 90-day mean to remove seasonality, and that SST anomalies below two threshold values indicated upwelling. More detail is required on how those threshold values were determined.

The same applies to the EAC derived upwelling index. The formulation of stress in the bottom boundary layer is given, but I am guessing from the statement that "the upwelling index derived from the EAC BBL stress" means that the reader should not assume that $\tau$b and UIc are the same thing. How is the BBL defined? Do the velocity components used represent the top or bottom or average through the BBL?

(AC): Our text has been amended accordingly. Some more detail is now provided in the description of the Chl-a, SST, and EAC upwelling index.

(R1): Pg 6, line 24: Figure 1 is referred to when explaining that two zonal cross-sections were selected for further investigation. It is recommended that these sections be drawn on Figure 1.

(AC): Yes, thank you. We have added these two zonal cross-sections in Figure 1.

(R1): Pg 8, line 22: "extend" should be "extent" Pg 8-9: Panels (a) and (b) are not labelled on Figure 4, so it is impossible to know which latitudinal section is which. Thus, it is difficult to associate the descriptions referring to seasonal differences between these individual panels.

(AC): Yes, thank you. We have added the labelled.

(R1): Pg 9: In the methodologies section, the authors describe two SSTa threshold values used to indicate upwelling. Were these threshold values applied to each latitude presented in Figure 5?

(AC): Yes. The threshold value of -0.57 oC only applied to the zonal cross-section at 25.5 oS, while the threshold value of -0.48 oC only applied to the zonal cross-section at 26.5.

(R1): Pg 9-10: The authors describe the number of Chl-a, SSTa, and upwelling-favourable wind events obtained from the indices. How were the Chl-a, SSTa, and wind events defined?

(AC): We have added some information regarding how were the Chl-a, SSTa, and wind events are defined in the text. i.e. the number of Chl-a upwelling-favourable events defines as a condition when the Chl-a concentration larger than the background value of 0.2 mg m-3 that last at least 8 days.

(R1): Pg 11: Are the values presented in Figure 10 averaged over the length of each transect? Or are they taken from a single point along each transect?

(AC): The values presented in Figure 10 are averaged over the length of the zonal cross-shelf section at 25.5 oS and 26.5 oS.

(R1): Specific comments (Discussion) Pg 13, line 21: "corresponds" should be "corresponds".

(AC): Yes, thank you.

(R1): Pg 13-14: The authors present a case study in Figure 12 which suggests the higher Chl-a values over the shelf-break and slope are associated with the combined effects of downwelling-favourable wind and current-driven upwelling. Cyclonic vortices are a common occurrence of the landward side of WBCs, yet the authors seem not to have considered that as a possible reason for Chl-a feature presented in Figure 12. How have the authors eliminated the possibility of eddy-driven resulting in the Chl-a feature presented in Figure 12, to be able to attribute this feature solely to convergence of flow in the BBL resulting in subsequent uplift? In the last paragraph of this section, the authors do state that although previous studies have shown elevated Chl-a and lower SST associated with eddy-driven upwelling, they have not considered it. However, for the feature presented in Figure 12 to be solely attributed to their proposed mechanism, the authors need to show that no cyclonic eddy was present at that time.

(AC): We have addressed this issue by applying automated eddy identification algorithm (Penven et al., 2005) to detect and track frontal eddies during the period of 10-12 June 2007 off SEQMCZ. The results from the eddy detection are presented in Figure

Figure 1 below. It appears that during the period of 10-12 June 2007, no cyclonic frontal eddies detected along the shelf-break off SEQMCZ. This gives us confidence that we are capturing shelf-break upwelling, rather than eddy-driven resulting in the Chl-a feature presented in Figure 12.

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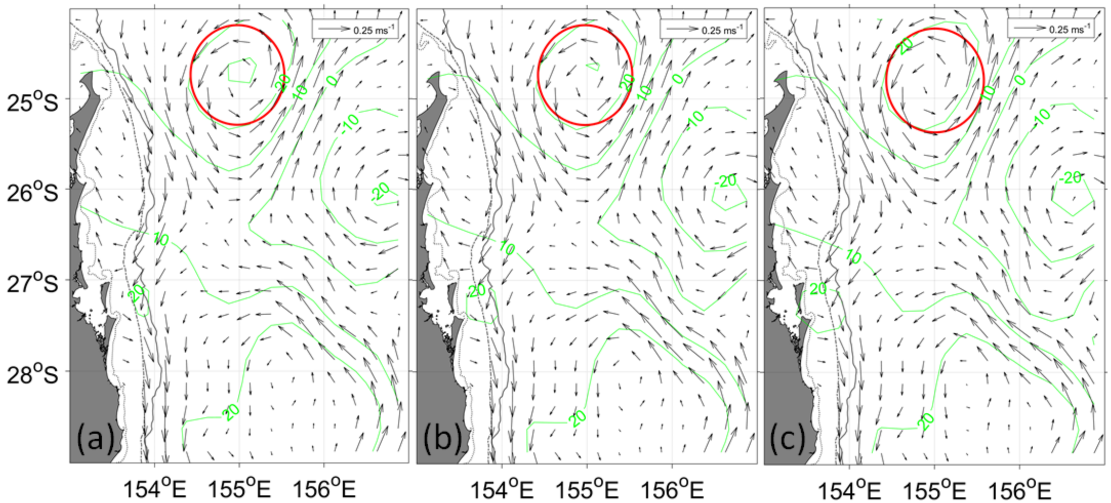


**Fig. 1.** SSHA (green contoured in 10-2 m intervals) and geostrophic current from June 10 (a), June 11 (b), and June 12, 2019. Circles indicate estimated radii of anticyclonic (red) and their centres.