

## **Comment on “Reviews and syntheses: Physical and biogeochemical processes associated with upwelling in the Indian Ocean”**

**by Puthenveetil Narayana Menon Vinayachandran, Yukio Masumoto, Mike Roberts, Jenny Hugget, Issufo Halo, Abhisek Chatterjee, Prakash Amol, Garuda V. M. Gupta, Arvind Singh, Arnab Mukherjee, Satya Prakash, Lynnath E. Beckley, Eric Jordan Raes, Raleigh Hood**

We thank the reviewer for his comments and suggestions. In the following, the comments by the reviewer are reproduced in black font and replies are given in blue.

### **General comments:**

This review provides a comprehensive overview on the physical dynamics in upwelling regions and the resulting interplay with biogeochemical processes in the entire Indian Ocean based on observations and model results. Variability of upwelling has a strong impact on climate-relevant trace gases as well as biogeochemical processes both having an effect in many ways on one of the most densely populated regions. Upwelling processes in the Indian Ocean are still less well understood than in the other major oceans, therefore the topic is highly relevant.

The manuscript is well organized, structured and (mainly) easy to read. The authors address main upwelling regions in the Indian Ocean giving a historical background, an overview about recent observations (characteristic of upwelling and impact on physical parameter), present status of modelling these upwelling systems and their upwelling mechanisms, and their impact on marine ecosystems and biogeochemistry. My main concerns are related to the figures, which lack in care and precision and make the text sometimes hard to follow. I would also highly recommend a schematic figure for the different monsoon phases, that summarizes the main upwelling regions together with the monsoonal winds.

We are thankful to the reviewer for reading the manuscript carefully and offering several comments. We have revised the manuscript to enhance its readability and the major change is the organization of each of the upwelling systems into same organizational structure, based on the comments by the other reviewer. We have also included an additional figure (Figure 1B) showing upwelling regions and a schematic of circulation. The figures have been revised as per the suggestions provided by the reviewer. Reply to each of the specific comments are given below.

I recommend publication of this manuscript after minor revision. I will leave my comments below in the specific comments.

### **Specific comments:**

-line992: Upwelling cannot be driven by primary production, it is the other way round.

This has been corrected as : “Summer upwelling, which drives by high primary production, ...”

Figure 2: Port Elizabeth (PE), Port Alfred (PA) and Agulhas Bank are mentioned in the figure caption but not in the figure. It would be easier to follow the descriptions in the text, if some geographical points would be marked in the figure or the latitude-longitude needs to be mentioned in the text.

PE and PA are marked in the figure. Labels for the places are placed at their respective geographic location.

Figure 3: "C.T" and "P.E." are marked in the figure but not explained in the text/figure caption.

Corrected: "C.T and P.E indicates Port Elizabeth and Cape Town respectively." This has been added to the figure caption.

Figure 4: X-axes (longitude) and y-axes (latitude) should be labelled. The font/scales of the colorbars are hard to read/recognize. Acronyms "LHS" and "RHS" should be explained.

The X and Y axes have been labelled. The labels of the color bar has been revised for better readability. The acronyms LHS and RHS have been removed.

Figure 5: Please mark the Transkei shelf in the figure.

Transkei shelf is marked on the top left panel of the figure.

Figure 6: I would recommend to label the x-axes of the lower panels as well.

This figure is now replaced with a different figure.

Figure 8: The titles of the figures are hard to read and a scale vector for the wind stress is missing. I also would recommend to mark the respective months ("JAN", "JUL", "APR", "OCT") in the figures. The colorbar is very tiny as well as the font/scales. The unit for the wind stress curl is missing as well.

The corrections suggested by the Reviewer has been made to all panels in the Figure and a scale vector has been place below bottom left panel.

Figure 9: This figure would improve a lot and the paragraph relating to this figure would be much easier to follow if some geographical points would be marked in the figure such as: Angoche (or Nampula), Sofala Bank (or Ponta Zavora), Inhambane, Delagoa Bright, Maputo.

Geographical points have been printed on the Figure at appropriate locations.

Figure 10: Please mark in the figure the geographical points you are referring to in the text.

All geographical points that are referred in the text have been marked on the figure.

Figure 11: Please mark in the figure the geographical points (Tanzania, Kenya) you are referring to in the text. Please label the currents also in the lower panel.

Labels of Tanzania and Kenya have been added to the figure.

Figure caption: correct “southeast” to “southwest”. Please refer to the contour lines.

The correction ‘southwest’ has been made. Contours are described in the figure caption.

Figure 12: 12a, b: What does the color shade show? A scale vector for the surface currents is missing. 12b: correct “SEM” to “SWM”.

The color panels are appropriately labelled in the revision. A separate vector for the currents are not provided because the color panel clearly shows a scale for the speed.

12c, d: Please also mark the respective monsoon phase (NEM) in the figures as in 12a,b. The text would be easier to follow if country borders are drawn in the figures. I would also recommend to label the colorbars with the respective unit.

The respective seasons have been marked on the figure as well as clearly stated in the Figure caption. The country borders have been marked on the maps. Color bars have been labelled along with respective units.

Figure 13: Please mark a-d in the figure as you are referring to in the figure caption and in the text.

The markings a-d has been made on the figure.

Figure 15: The x-axes of 15c should have the same scale as 15a-b, d-e.

The x-axis of 15c is the same as in other panels of the figure in the revised version.

Figure 17: The font of the colorbar is hard to read and the unit is missing.

The font of the color bar has been revised to make it readable and the unit has been placed.

Figure 18: Could you give the approximate latitude of the hydrographic sections? “approximately midway of the east coast” is not very precise.

The approximate latitude has been mentioned in the figure caption.

### **Technical corrections:**

Thanks to the reviewer for pointing out several minor errors. All of them have been corrected.

-line 121: typo: correct “Northeasterly” to “northeasterly”: [Corrected](#)

- 1156: typo: correct “IIOE-2 (2015-2010)”: [Corrected](#)
- 1236: typo: “day1” should say “day<sup>-1</sup>” : [Corrected](#)
- 1289: typo: correct “Current” to “current” : [Corrected](#)
- 1429: Do you mean “vertical suction”? : [Corrected](#)
- 460: The acronym MC has not been explained yet.: [The acronym has been defined](#)
- 1482: typo: correct “water” to “Water” : [Corrected](#)
- 1495: The terms “northeast orientation” and “southeast orientation” are misleading. Better: “northeasterly winds” and “southeasterly winds” or “southwest directions” and “northwest direction”: [Corrected as “the winds are northeasterly along the southeastern coast, and southeasterly along the southwestern coast”.](#)
- 1515: The acronym EMC has not been explained yet. : [EMC has been replaced with “East Madagascar Current”](#)
- 1565: typo: correct “southeast” to “southwest” : [Corrected](#)
- 1566 and more: correct “SEM” to “SWM”: [Corrected](#)
- 1594: typo: correct “North-East Monsoonal” to “northeast monsoonal” or use the acronym “NEM”: [Corrected](#)
- 1635: correct “move” to “moves”: [Corrected](#)
- 1636: correct “recirculate” to “recirculates”: [Corrected](#)
- 1643: correct “forms” to “form”: [Corrected](#)
- 1654: correct “migrate” to “migrates”: [Corrected](#)
- 1664: correct “result” to “results”: [Corrected](#)
- 1680: typo: delete “the” in “the another”: [Deleted](#)
- 1702: typo: correct “study” to “studies” : [Corrected](#)
- 1710: correct “of” to “off”: [Corrected](#)
- 1747: correct “crossshore” to “cross-shore”: [Corrected](#)
- 1788: typo: correct “21oC”: [Corrected](#)
- 1790: correct “in the shelf” “on the shelf” : [Corrected](#)

-1930: The term “peak” is associated with a maximum, maybe “minima” is a better term.  
: [Corrected](#)

-1998: The paragraphs have the wrong order: paragraph 2.7.5 precedes 2.7.4.:  
[Corrected](#)

-11044: “Figure 16” should be in bold. : [Corrected](#)

-11225: typo: correct “Joshnson” to “Johnson” : [Corrected](#)

-11229: correct “Oxygen minimum zone” to “oxygen minimum zone” or “OMZ” :  
[Corrected](#)

-11249: “belief” – I would prefer “assumption”: “belief” is more appropriate here

-11294: correct “Srilanka” : [Corrected](#)

-11356: correct “appear” to “appears” : [Corrected](#)

-11425: “Other early studies...” This sentence is very long and hard to follow, please rephrase.: [The sentence has been split into two for easy reading.](#)

-11635: Figure 26 does not show wind.: [Changed to Figure 1](#)

-11740: correct “tolarger”: [Corrected](#)

-1747: correct the semicolon: [Corrected](#)

-11752: correct “are caused” to “is caused”: [Corrected](#)

-11771: What do you mean with “high temporal and temporal resolution”, please rephrase. : [Corrected as “high spatial and temporal resolutions”](#)