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Interactive comment on “A comparative study of biological production in eastern boundary upwelling systems using an artificial neural network” by Z. Lachkar and N. Gruber

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We would like to thank the Reviewer #1, Dr Yonggang Liu, for his comments, suggestions and remarks that have helped to improve the quality of our manuscript.

Response to Reviewer's Comments:

The complex relationships between various environmental factors and marine biological production in four major eastern boundary upwelling systems of the world's coastal oceans are examined using a powerful tool, Self-Organizing Map (SOM), along with a Hierarchical Agglomerative Clustering method. Indeed, the authors have chosen a right data analysis technique to tackle such a complicated

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system. The SOM, as a nonlinear mapping method, can effectively extract the dominant features from a complex data set. Over all, the paper is informative and within the scope of the journal. Some quite interesting results are reported. Thus, I would like to recommend it be accepted for publication after some minor revisions, mostly in clarifications of SOM applications and discussion of coastal upwelling on a wide continental shelf.

Specific comments:

1) The variable "shelf width" is not a time series. How was this variable manipulated to calculate the correlation coefficients with the other time series? Similarly, how was it arranged in the input data set for the SOM mapping? These should be clarified in the paper.

Although it does not vary in time, the variable "shelf width" turned out to be crucial for our analysis because it explains an important fraction of the spatial variability in NPP. Combining time-series variables with those which do not vary in time (like shelf width) is not an issue in our study as each combination of NPP and its drivers is presented to the SOM as a new occurrence of a certain production regime pattern. For the calculation of correlation coefficients and for the SOM mapping the shelf width data (90 meridional bins) has been repeated over time, that is 41 times (i.e., the number of months covered by the study). This is now explicitly stated in the revised manuscript (see page 7, lines 10-13).

2) P9906, L24, did "the offshore component of Ekman transport" take into account of the change of the offshore direction along the coastlines? Some people simply use the zonal component of the Ekman transport.

In our study we calculated the truly offshore component of the Ekman transport by taking into account the local orientation of the coast. This has been made explicit in the revised manuscript (see Page 6, lines 15-17).

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3) P9907, L14-15, it seems that the authors define the offshore boundary lines of the 500 km coastal strip in Fig. 1 as a zonal extension of the coastlines to the west. It is not a line 500 km from the coast in the strict offshore direction. Even within the 500 km band, a portion of the ocean regions may not be "coastal" in nature. The definition of the coastal strip should be clarified. It would be good to see whether or not a change of this definition affects the main results of the study.

It is right that the 500km offshore extension is considered in zonal direction only. We used this convention following the offshore regions definitions given in an earlier EBUS comparative study by Carr 2001. This has been now made explicit in the revised manuscript (see page 6, line 27 & page7, lines 3-5). Finally, changing slightly this definition by limiting our analysis to the first 400km offshore did not have any significant impact on the results.

4) P9908, L15-22, the description of SOM parameter choices should be in more details so that the work can be reproduced/followed by others. The authors have mentioned map size and lattice structure. What are the choices of neighborhood function, initialization, etc? Liu et al. (2006) tested a number of SOM parameter choices with known patterns, and made some recommendations on the SOM applications. For example, the ep neighborhood function is recommended for more accurate mapping, while the Gaussian neighborhood function is suggested for more smoothed patterns.

We tried different neighborhood functions including the Gaussian and Epanechnikov functions. Overall, the results remained very similar. However, since our focus in this study is more on pattern generalization, we opted for a Gaussian neighborhood function as it produced slightly smoother projections and lower topographical errors. For the initialization of the neurons, we used a linear initialization, where the weight vectors are initialized along the linear subspace spanned by the two principal eigenvectors of the input data set. This ensured a faster convergence of the algorithm and smaller final

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topological error. This has been clarified in the revised manuscript (see page 8, lines 16-18).

5) PP9915, L7-17, there are relevant observational evidences for your statements. On a typical wide continental shelf, the coastal upwelling jet is located offshore (more offshore than the downwelling jet), as clearly seen from the SOM extraction of the current structures that were observed with a moored ADCP array (Liu and Weisberg, 2007). The long-term mean current patterns also showed that there is a transition area offshore where the near surface currents tend to be convergent and the near bottom currents tend to be divergent (Weisberg et al., 2009). These observed current patterns favors the trapping of the nutrient within the inner shelf. It would be more convincing if the observational evidences are added to the discussion.

Following the reviewer's suggestion, we added a few observational evidences to our discussion of the role the wide continental shelves may play in NPP enhancement (see page 14, line 24 to page 15, line 4). We first refer to several previous observational studies that have reported minimum SST tongues located away from the coast signaling an upwelling occurring farther offshore (as far as 100 km) in several regions of the Canary system characterized with a wide continental shelf (Barton et, 1997, Demarq and Faure, 2000). This substantially contrasts with the general observation of minimum temperature occurring at the coast reported in coastal upwelling systems with narrow continental shelves such as central California system. Second, we cite the ADCP based current observations in West Florida shelf reported by Liu and Weisberg (2007) showing the presence of a surface convergent flow in the case of a shallow and wide continental shelf, which might indeed favor nutrient trapping within the inner shelf.

6) P9905, L5-7, "SOMs....have a number of advantages over traditional statistical methods...". Here, a reference to EOF analysis should be added as "...Empirical Orthogonal Function (Liu et al., 2006) and Principal Component Analysis (Astel., 2007)."

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Done. The reference to EOF analysis has been added.

7) One color bar can be used for all the four panels, and the figure would be more compact.

Done.

8) Fig. 10, the names of the coasts should be placed on top of the figure as "figure subtitles" instead of within the top panels. Also, one color bar can be used for all the panels to save space and for better clarity.

Done.

Technical corrections:

9) P9902, L7, "The identification of NPP drivers is done with the aid of..." is better written as "The NPP drivers are identified with the aid of..."

The statement is corrected following Referee's suggestion.

10) P9902, L17, "a weaker factors" should be "weaker factors".

Corrected.

11) P9904, L3-5, the sentence should be rewritten for better clarity.

We now give some examples of local forcing and large scale circulation factors for better clarity.

12) P9907, L7-9, there should be a space between "N" and the next words. Same for "S".

Fixed.

13) P9907, L25, the extra quotation mark after "neurons" should be removed.

Done.

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14) P9923, L4-5, the correct citation should be: Liu, Y. and Weisberg, R.: Patterns of ocean current variability on the West Florida Shelf using self-organizing map, J.Geophys. Res, 110, C06003, doi:10.1029/2004JC002786, 2005.

Reference has been corrected.

15) P9925, L19-21, the correct citation should be: Solidoro, C., Bandelj, V., Barbieri, P., Cossarini, G., and Umani, S. F.: Understanding dynamic of biogeochemical properties in the northern Adriatic Sea by using self-organizing maps and k-means clustering, J. Geophys. Res, 112, C07S90, doi:10.1029/2006JC003553, 2007.

Reference has been corrected.

16) Fig. 3 caption, "the" is needed before "SOM".

Corrected.

17) Fig. 4 caption, "Frequency of SOM patterns" should be revised as "Frequency of occurrence of the SOM patterns."

Corrected.

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