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Discussions

Interactive comment on "From Monsoon to marine productivity in the Arabian Sea: insights from glacial and interglacial climates" by Priscilla Le Mézo et al.

Anonymous Referee #2

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The manuscript 'From Monsoon to marine productivity in the Arabian Sea: insights from glacial and interglacial climates' by P. Le Mézo et al. is an interesting model study on the driving forces of ocean productivity in the Arabian Sea. A large number of paleo climate simulations of different warm and cold climates, forced by changes in orbital parameters, greenhouse gases and northern hemisphere ice sheets is used to systematically investigate changes in productivity patterns. Against the common paradigm that there is a straightforward relationship between pure Monsoon strength (wind mixing) and marine productivity, which was often used to infer past Monsoon changes from productivity proxies, the study highlights important aspects of changes in the Monsoon pattern and potentially opposing regional trends, for example in coastal

and open ocean areas. According to the model results, wind stress curl, the changes of which are mostly driven by changes in the Monsoon pattern, turns out to be an equally important factor influencing productivity. The study is well designed, straightforwardly carried out and the demonstrated results are robust and clearly illustrated in many figures. The text could benefit from a number of clarifications, however, this does not compromise the overall excellent quality of the study. I suggest publishing after some minor revisions.

Major comments/questions: Since many readers are maybe not too familiar with the theory of wind stress curl, a short introduction into the most important mechanisms of upward nutrient transport and their interplay would probably be helpful.

Apart from MIS3, the control simulation stands out as the most productive period for the Arabian Sea. Can the results be extrapolated to other ocean areas, for example the prominent eastern boundary upwelling regions (EBUs)? What would be the consequences for the underlying oxygen minimum zone?

What are the model limitations? Does spatial resolution play a role? Since a rather coarse resolution was used here, what are the uncertainties and/or probable effects of parameterizations of sub gridscale processes or why would all these not matter? A first tentative explanation is given on page 15, l. 6-8, but this could be further elaborated.

When describing changes in wind stress curl often the words higher or lower are used, which may cause misunderstandings. Although the relative effect of the curl tendency on upward nutrient transport is the same, it needs to be kept in mind that the change maybe associated with a change of sign of the curl or not. I'd therefore suggest that the use of more or less negative/positive curl is a more correct wording. Please check throughout the text.

Minor points: p. 1, l. 6-8: This sentence is confusing. It seems that the combination of increased wind stress and more positive curl could result in a reduction of productivity. However, this is not the case (Fig. 9). I think it is more correct to state that both changes

in wind stress and curl need to be taken into account and that under opposing changes one or the other may be the ultimately dominating effect. p. 1, l. 12: typo, remove 's' in 'affects' p. 1, l. 21: replace 'in India' by 'over India' p. 3, l. 15: add 'semi-labile' before 'dissolved organic carbon' p. 3, l. 29: add 'greenhouse' before 'gas' p. 3, l. 30: add 'Northern Hemisphere' before ice sheets (at least from Fig. 1 this seems to be the case) p. 4, l. 8: This sentence is confusing. Do you count MIS3 as glacial or interglacial? If glacial then you should mention that five glacial simulations were carried out. Otherwise, it is strange to see it listed among the glacial climates. Please check. p. 4, l. 9: remove 'for' p. 4, l. 26: a few more information on length of simulation and starting conditions would be nice p. 4, l. 31: I guess that 68°N should be 28°N p. 4, l. 33: replace 'sediments bulk' by 'bulk sediment' p. 4, l. 34: replace 'changes' by 'peaks' and 'ones' by 'maxima' p. 4, l. 34: Does the sentence starting here refer to the winter period? If yes, then p. 5, l. 1: add 'dashed line in' before 'Fig. 2b) p. 5, l. 11: typo: NASA's p. 5, l. 16: 'Arabian' instead of 'Arabic' p. 5, l. 29: what do you mean by reconstructions? Observations? Please explain. p. 6, l. 1: move 'coarse' before 'model' p. 6, l. 6 'model's' p. 6, l. 20: in several places of the manuscript I'm wondering about the use of the word 'global'. Do you really mean global here, i.e. average over ALL longitudes and latitudes? It would be perfectly fine to use the regional annual average here. p. 7, l. 1: does total productivity refer to net or gross productivity? I guess net, please clarify. p. 8, l. 2: 'concentrations' p. 8, l. 2: The sentence starting here is difficult to understand. Maybe splitting into several sentences will help. p. 9, l. 12: remove 'than CTRL' p. 9, l. 20: 'macro-nutrient' p. 9, l. 21: the part '...and, productivity...' does not make sense to me. Maybe there's something missing? p. 10, l. 4: reorder sentence to '... as function of changes in summer wind stress ad curl in the central Arabian Sea.' p. 10, l. 21: use of word 'global'. I guess 'overall' or 'general' would be more appropriate here. Furthermore, the decrease is southeastward, which could be mentioned. p. 10, l. 33: replace 'suggests an' by 'demonstrates the' p. 11, l. 1: what do you mean by 'climatic precession'? I'm not familiar with the expression, so please define or use 'precession' or 'precessional index', instead. (see also next

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sentence) p. 11, l. 3: the barycenter position changes with both longitude and latitude, please mention p. 11, l. 17: add 'marine sediment' before 'cores' p. 11, l. 23: 'climates" p. 11, l. 30: which latitude range are you talking about? Shouldn't a high obliquity (= high summer insolation) reduce the latitudinal temperature gradient? p. 12, l. 8: replace 'solar' by 'northern hemisphere summer' p. 12, l. 21: 'simulations" p. 12, l. 24: here is a contradiction to what you say later (l. 34). First you say that there is a mismatch to Bassinot et al., later you explain why your model matches with Bassinot et al., please clarify. p. 13, l. 13: please check use of 'globally' p. 13, l. 17-24: this part belongs to the method section p. 13, l. 27: replace 'are' by 'is' p. 13, l. 31: region up to 68°N? Please check p. 14, l. 2: I don't think that the difference between productivity and export production in particular is a major problem for model and data comparison. It is rather that there are too many unknowns on what is finally best describing the signals contained in sediment records. As it stands, the statement seems to open a completely new aspect, which demands to be further elaborated. However, since it is not the main focus of the study I'd suggest leaving it out. p. 14, l. 11-17: it seems to me that in this paragraph you write about productivity, but it is actually the export, which is explained. Please check. p. 15, l. 3: add 'or less' before 'nutrients' p. 15, l. 20: replace 'on' by 'to'. Again, this sentence seems to give a hint to problems of model-data comparison. I'd suggest adding a full paragraph on what this study contributes to a improved model-data comparison or leave it out. p. 15, l. 24: replace 'should' by 'is expected to' Figure 2, caption: 68°N? Probably this should be 28°N? Figure 8: caption: replace 'Dash' by 'Dashed' Figure 14: 'circles" or 'color of the circles'

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