

Review

Journal: Earth System Science Data (ESSD)
Title: Global ocean biomes: mean and temporal variability
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MS No.: essd-2014-7
MS Type: Review Article

General comments:

Fay and McKinley present maps showing delineation of “biomes” obtained by applying limits to time-variable interpolated gridded datasets. Using these definitions, they provide 13 annual mean maps of 17 biomes between 1998 and 2010 and show that the area of some biomes changes in time. They also isolate clusters of grid points whose biome assignment does not change in time to highlight regions where biome definitions are temporally stable.

Overall, I think this paper suffers many flaws in logic and organization. There is also no estimate of error and no sensitivity analysis is presented to assess how the results from their classification scheme depend on their choices of parameter threshold. Lastly, since the authors re-use existing and already published data sets and only provide limited analysis and interpretation, **I don't think that the material presented in this manuscript is sufficient to warrant publication.**

In summary, I think the main problems are:

- 1) No error/sensitivity analysis
- 2) No justification for the parameter thresholds used
- 3) Limited interpretation and no mention of the possible role of the seasonal cycle. The interplay between the seasonal cycle of MLD and Chl a seems particularly relevant, and so is the seasonal cycle of sea ice.
- 4) Not clear what is gained (aside from the temporal aspect) from using the limited number of biomes described here as opposed to other published biomes and studying the temporal variability of these existing definitions. It feels like a step back.
- 5) Organization of the text: Section 2.1 for example, describes some biomes, but there is no justification why these are the focus of the manuscript or how these are defined.
- 6) No explanation is provided why the parameters used here (SST, Chl a, Ice, MLD) are accurate descriptor of biogeography. There is also no definition of biogeography.
- 7) They claim the community will want to use these biomes to study carbon fluxes, yet, they do not allow the equatorial regions used to define equatorial biomes, home of El Nino (one of the main driver of inter-annual variability), to vary.

Specific comments:

The list below provides specific comments related to the text.

p108/L20: perhaps “latitudinally-defined “

p108/L25: It seems to me that heterogeneities on land are much greater than in the ocean. Be more specific about what you mean by biogeography and can that definition apply similarly on land and in the ocean?

P109/L9-10: Why do you focus on open ocean only? Provide a rationale for that choice. Define what you mean by open-ocean. Why not study the variability of the Reygondeau et al (2013) or Longhurst (1995) biomes instead?

P109/L21-23: Explain explicitly why you think these biomes would be better to use than other existing definitions. Also, if the biogeochemistry of a model were to differ from the observations, why would one want to analyze fluxes or other parameters using these biomes instead of biomes defined specifically for the particular model? In addition, why use biomes at all and why not try to compare the models with the actual measurements where measurements exist? Why interpolate sparse measurements into biomes at all?

P110/L5: Biomes are described before being defined (section 2.1). Why are these biomes the ones that matter?

P110/L10-11: Why use 50%? Why not 20% or any other value? That seems very arbitrary.

P110/L12-23: If wind stress curl is such an important factor, as described here, why is it not used in the definition of the biomes?

P110/L17: Surface temperature is largely a function of latitude. I am not sure I understand your statement that the Pacific is warmer? Be more specific.

P110/L24-p111/L6: Why fix the equatorial domain with latitude/longitude lines. I thought the point of that paper (as stated in the abstract/introduction) is to allow for flexible boundaries? Given the role of El Nino on inter-annual variability, I would imagine that equatorial variability should be an important component of this analysis.

P111/L7-9: Why exclude these regions? Variability in these regions that are ignored is large, so if the purpose is to define how variable the biomes are, ignoring these seems very limiting. Why is the ICE biome not defined to be coastal and thus ignored?

P111/L13-15: Please provide a discussion of the errors associated with this data product.

P111/L16/17: Why use that 0.5 threshold? What is the effect of that choice on your final product? Why not follow Sarmiento et al. (2004)?

P112/L3: What is SMIGEN?

P112/L7: I understand there are data limitations in winter, but variability in the seasonal cycle is a very important factor governing mean inter-annual variability. This choice of using mean spring/summer values must be justified and the effect of this assumption on the final product must be evaluated.

P112/L12: Artificially filling in 2008 values with the climatological mean and then interpreting inter-annual variability for that year is not a very robust approach. If you do that, provide an estimate of how this choice affects the final product.

P112/L13-14: Does this have an influence on the final boundaries set for STPS?

P112/L19: MLD does not vary annually.

P113/L5-8: If filling missing MLD grid cell has no influence on the biome assignment, why discuss it? It would be more helpful to provide a rationale why you are using threshold values of 125 and 150 m.

P113/L10-11: I don't understand the motivation for this smoothing step. Why not defining the core-biomes without this? This smoothing appears to artificially limit variability, yet the purpose of this paper seems to provide an estimate of variability. This seems counterproductive.

P113/L14: What is the rationale for this choice of 300-400 cell?

P113/L17: More than the relative number of cell that changes in each biome, it is important to comment on the location of these cells that change assignment. Do these cells form coherent clusters?

P113/L18-19: the previous sentence says 15%, not 14%? If more than 300-400 cells were allowed to change, would more cells change?

P114/L10: I don't understand that sentence "From the 5°S northward in both...". Do you mean "North of 5°N...".

P114/L23: Show the maps for each year in the paper directly ... this is after all the point of the paper.

P115/L5-P116/L7: Provide a deeper analysis of why grid cells change assignment? What variable controls this change? Is variability in the defining parameter correlated in these cells? Is variability in the defining parameters (e.g. SST and Chl a) correlated anywhere? If there is correlation, why use fixed biome definitions? The definitions should take into account covariance between defining parameters. To what extent are these annual mean changes governed by changes in seasonality?

P116/L22: "there are NO significant trend"

P116/L24: is that trend significant?

P117/... : What is significance of these trends? What does the “error” reported in each case represent?

P117/L11: These represent just 2 years shift, hardly a stringent test. Also, none of the mean area presented come with an estimate of error such that the errors presented here are greatly underestimating the true errors.

P117/L17-19: Is the variability reported in this analysis important to a degree that would lead us to doubt previous conclusions provided by previous papers by Fay and McKinley? If so, discuss this in detail.

P117/L23: Fay and McKinley.... provide explicit references.

P117/L24: are the same MLD criterion used in all the studies?

P117/L24: What aspect of MLD is improved? Also, variability in MLD is not considered. Is it possible that variability in MLD would counteract variability in the other variables such that this would bias the biome assignment of some grid cells? Would that have an effect on the trends discussed in Figures 3 and 4 and in section 4?

P118/L9: I don't think that statement is true: “...full coverage of the open ocean...”. Looking at the maps you provide, there are clearly grid cells that many would consider “open ocean” that are not covered. “open ocean” is not defined.

P118/L19-21: “If as widely...”. Rewrite sentence.

Table/Figures:

Table 1: No rationale is provided for the choice of variable and thresholds listed in Table 1.

Figures 3 and 4: Color-coordinate the lines in figures 3 and 4 with the colors of the regions on the maps.