

***Interactive comment on* “Summarizing the state of the terrestrial biosphere in few dimensions” by Guido Kraemer et al.**

Anonymous Referee #4

Received and published: 20 September 2019

The authors present a well-written manuscript on the analysis of two principal components derived from a set of biosphere variables, one related to vegetation productivity and the other one related to water stress. The trajectories of those components over time reveal interesting seasonal patterns, inter-annual changes and anomalies, and can be used to track extreme events and state shifts of ecosystems/biomes. Therefore, I believe that this is a novel and relevant contribution to Biogeosciences.

My major concern lies in the fact that the authors select mainly variables related to productivity and water availability, and thus not surprisingly the PCA shows those two major axes. I wonder whether just selecting for example GPP and evaporative stress for the analysis of time trajectories would give the same results, but it might be easier to interpret than principal components representing a mix of variables. Can the

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authors elaborate in more depth what is the advantage of using PCs in this context? For describing the state of the terrestrial biosphere, I think the authors are missing a very important component related to biodiversity, habitat quality, intactness, forest degradation and fragmentation. These aspects are crucial to describe the state of the terrestrial biosphere. There is still research needed to develop these as operational data streams, but a few examples are available at least at one point in time, e.g. Global Habitat Heterogeneity from EarthEnv, datasets from Global Forest Watch, Dynamic Habitat Indices DHI from Silvislab. This might not be sufficient (in terms of temporal resolution) to include it for this analysis, but the results from this study could be compared to those datasets (especially the DHI) and the need and relevance of global biodiversity and habitat intactness/quality information should be discussed.

Minor comments: L18: new satellite missions, add: Schimel, D., Schneider, F., Bloom, A., Bowman, K., Cawse-Nicholson, K., Elder, C., ... Zheng, T. (2019). Flux towers in the sky: global ecology from space. *New Phytologist*, nph.15934. <https://doi.org/10.1111/nph.15934>

L25: green revolution, add: Chen, C., Park, T., Wang, X., Piao, S., Xu, B., Chaturvedi, R. K., ... Myneni, R. B. (2019). China and India lead in greening of the world through land-use management. *Nature Sustainability*, 2(2), 122–129. <https://doi.org/10.1038/s41893-019-0220-7>

L27: changes are not only occurring in the onset of spring, but also browning trends, see:

- Garonna, I., de Jong, R., de Wit, A. J. W., Mùcher, C. A., Schmid, B., & Schaepman, M. E. (2014). Strong contribution of autumn phenology to changes in satellite-derived growing season length estimates across Europe (1982 - 2011). *Global Change Biology*, 20(11), 3457–3470. <https://doi.org/10.1111/gcb.12625>

- Garonna, I., de Jong, R., & Schaepman, M. E. (2016). Variability and evolution of global land surface phenology over the past three decades (1982-2012). *Global*

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Change Biology, 22(4), 1456–1468. <https://doi.org/10.1111/gcb.13168>

L35: if a principal component is a mix of productivity measures, I don't necessarily think it's more intuitive to interpret than a simple GPP map.

L63: What do you mean by “of parts”? Parts of what?

L75: Isn't this dependent on the coordinate system and/or projection? What is the coordinate system used? And why not try to use an equal-area projection (e.g. equal earth projection)?

L152: So what is contributing to the third component. It's still 9% of explained variance!

L162: Figure 1b is not very intuitive to me. What exactly does it show and how do you read from this that the first component represents productivity and the second hydrology? The figure doesn't seem to show any clear patterns to me. Could you also show the biplots of PC1 and 2, and PC2 and 3?

L177/178: check spelling

Figure 2: Very interesting figure! A degraded or stressed system might show different trajectories, could you somehow visualize the difference between intact and degraded ecosystems?

L258: check spelling

Figure 5: third line, the effects of the drought

Figure 6: This figure is a bit confusing to me. Could you improve the legends? I don't see an increase in seasonal amplitude in 6a, but maybe I just don't read this figure correctly. (b-c-d) seem to show the mean seasonal cycle and an event, but what do we see in 6a?

L305: changes that occurring?

L340

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Additional research is needed to better represent biodiversity, habitat quality and intactness, forest degradation and fragmentation, etc... See:

- Jetz, W., Cavender-Bares, J., Pavlick, R., Schimel, D., Davis, F. W., Asner, G. P., ... Ustin, S. L. (2016). Monitoring plant functional diversity from space. *Nature Plants*, 2(3), 16024. <https://doi.org/10.1038/nplants.2016.24>

- Chiarucci, A., & Piovesan, G. (2019). Need for a global map of forest naturalness for a sustainable future. *Conservation Biology*, 00(0), cobi.13408. <https://doi.org/10.1111/cobi.13408>

- Nicholas C. Coops, Michael A. Wulder, (2019). Breaking the Habit(at), *Trends in Ecology & Evolution*, Volume 34, Issue 7, <https://doi.org/10.1016/j.tree.2019.04.013>.

L352: detected in a similar fashion

Interactive comment on *Biogeosciences Discuss.*, <https://doi.org/10.5194/bg-2019-307>, 2019.

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