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Biogeosciences Discussions

# *Interactive comment on* "Spatially asynchronous changes in strength and stability of terrestrial net ecosystem productivity" *by* Erqian Cui et al.

**Erqian Cui et al.**

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Response to comments from reviewer #1 Dear editor: Thank you very much for handling our manuscript. We really appreciate the reviewer's insightful comments and suggestions. Below, we address the comments from reviewer #1 point-by-point. The comments are italicized and our response follow in blue, and we hope we could address the concerns from reviewer. Reply to Reviewer #1 General comments: Comment 1A: In the manuscript "Spatially asynchronous changes in strength and stability of terrestrial net ecosystem productivity", Chen et al. studied the spatial variations of annual mean NEP and IAV_NEP using in-situ eddy covariance observations and gridded NEP datasets from FLUXCOM and CLM4.5. They proposed a new approach that decomposes NEP into beta, log(U/R) and log (CUP/CRP) and used some of them as "local



indicators" to indicate the spatial variation of NEP and IAV_NEP. I am intrigued by this study and find it has the potential to provide some emergent constraints on NEP that we much need at local scales, though I feel some minor revisions are needed to clarify the motivation and the interpretations of the Results. Response: Thanks for the recognitions and valuable suggestions. Specific comments: Comment 2A: "Spatially asynchronous" is a bit misleading phrase as it makes me wondering what is meant to be spatially asynchronous/synchronous for NEP, or is it simply used as a substitute for "spatial variation". I think the running title of the manuscript is more accurate which suggests that the authors studied "spatial variability" of NEP and NEP_IAV and found local indicators for them. Response: Thanks, we have revised the title as "Spatial variations in terrestrial net ecosystem productivity and its local indicators". Comment 3A: The first part of the results (section 3.1) serves to prove that there are large spatial variations in NEP and IAV_NEP, and to further motivate a need to study "local indicators" for NEP and IAV_NEP. However, many literatures have reported large spatial variations of NEP and IAV_NEP already, and I feel this kind of reasoning is more suitable to be included in Introduction rather than Results. In addition, FLUXCOM NEP is used here but we know is might not be the best source to study IAV_NEP (Jung et al., 2020). Response: Thanks for this suggestion. We have deleted this part of results, and moved the related content to the Introduction Section: "Large spatial difference in terrestrial NEP has been reported from eddy-flux measurements, model outputs and atmospheric inversion products. In addition, the global average IAV of NEP was large relative to global annual mean NEP (Baldocchi et al., 2018). More importantly, the spatial variations of NEP and IAVNEP were typically underestimated by the compiled global dataset and the process-based global models (Jung et al., 2020; Fu et al., 2019)." Comment 4A: The IAV_NEP and beta for shrublands and savannas are among the smallest compared to other PFTs (Figure 3). Is it at odds with previous global studies that suggest semi-arid ecosystems contributed the most to global IAV_NEP? (Ahlström et al., 2015). Response: Thanks for this suggestion. As the reviewer has mentioned, there are very few semi-arid ecosystems (e.g. 2 shrublands and 5 savannas in the presented study)

in the FLUXNET sites, while they represent a large portion of land at the global scale and have been shown to substantially control the interannual variability of NEP. Therefore, we have added several sentences in Discussion Section to illustrate this point: "However, the relatively lower $\beta$ in shrublands and savannas should be interpreted cautiously. There are very few semi-arid ecosystems in the FLUXNET sites, while they represent a large portion of land at the global scale and have been shown to substantially control the interannual variability of NEP (Ahlström et al., 2015)." Technical comments: Comment 5A: In the legend of Figure 1 please indicate the source of NEP data. Response: This section has been removed. Comment 6A: L74. Do you mean the "relative differences" between photosynthesis and respiration or between their covariances? Response: Thanks, we have rephrased this sentence as "Because photosynthesis and respiration are strongly correlated over space (Baldocchi et al., 2015; Biederman et al., 2016), their relative difference could determine the spatial variation of NEP." Comment 7A: L100. Rephrase. "to address the local indicators"? Response: Thanks, we have rephrased this sentence as "In this study, we decomposed annual NEP into U and R, and explored the local indicators for spatially varying NEP." Comment 8A: L102. Reference for FLUXNET2015 is Pastorello et al., 2017. Response: Thanks, revised. Comment 9A: L84 -86. Generally, I feel there is a need to clarify why there is a need to find a local indicator (which is also a new phrase)? Does it help in the attribution of spatial variation of NEP and IAV_NEP to different processes, or does it provide an independent constrain on NEP and IAV_NEP? Response: Thanks for this valuable suggestion. The suggestion proposed by the reviewer inspires us to reorganize the importance of our work. We have added several sentences in Introduction Section to state the necessary of exploring the local indicators: "However, despite the previous efforts in a predictive understanding of the land-atmospheric C exchanges, the multi-model spread has not changed over time (Arora et al., 2019). Therefore, it is imperative to explore the potential indicators for the spatially varying NEP, which could help attribute the spatial variation of NEP and IAVNEP into different processes and provide valuable constraints for the global C cycle." Comment 10A: L135. I understand



the scale-mismatch between model and eddy-covariance sites is difficult to address, but is it possible that muted spatial variation of NEP and IAV_NEP from gridded products is partly related to the scale mismatch? Response: Thanks for this suggestion. Considering the scale mismatch between FLUXNET sites and the gridded product, we have run the same analysis at the global scale based on Jena Inversion product, FLUXCOM product and CLM4.5 model (Figure 1A). The results have strengthened our major conclusion that the spatial variation of mean annual NEP can be indicated by ln(U/R), while the spatial distribution of IAVNEP is well indicated by the slope (i.e., $\beta$) of the demonstrated logarithmic correlation. We have added these new analyses in Results Section as Figure 6. The major revisions in Results Section are as below: "However, the spatial variations of NEP and IAVNEP were associated with the spatial resolution of the product (Marcolla et al., 2017). At the global scale, the spatial variation of mean annual NEP can be also well indicated by ln(U/R) (Fig. 6). The widely reported larger C uptake in FLUXCOM (Jung et al., 2020) resulted from its higher simulations for U/R. In addition, the larger spatial variation of IAVNEP in CLM4.5 could be inferred from the indicator $\beta$."

Figure 1A. Representations of the spatially varying NEP and its local indicators in FLUXCOM product and the Community Land Model (CLM4.5) at the global scale. a, The variation of mean annual NEP and IAVNEP derives from Jena Inversion, FLUXCOM and CLM4.5. Variation in mean annual NEP: the spatial variation of mean annual NEPs; Variation in IAVNEP: the spatial variation of standard deviation in IAVNEP. b, Representations of the local indicators for NEP in Jena Inversion, FLUXCOM and CLM4.5. Comment 11A: L229. "difference" -> "variation". Response: Done as suggested.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2020-26/bg-2020-26-AC2-supplement.pdf

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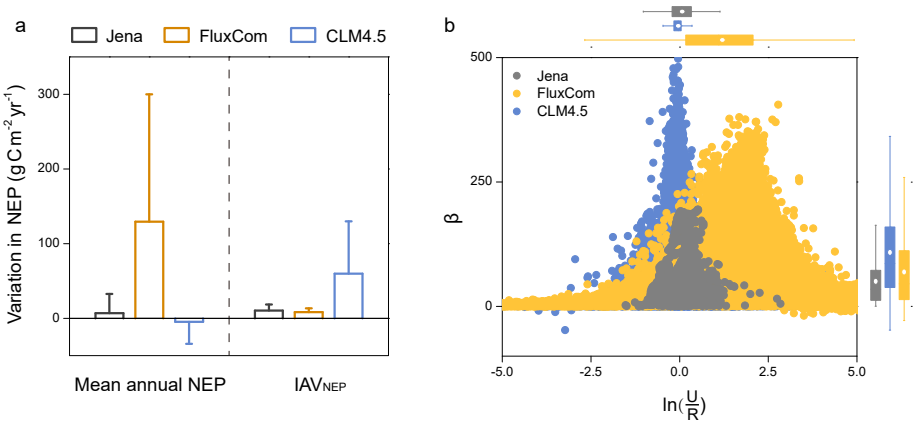


**Fig. 1.** Representations of the spatially varying NEP and its local indicators in FLUXCOM product and the Community Land Model (CLM4.5) at the global scale.