

Biogeosciences Discuss., referee comment RC2  
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## Comment on bg-2022-171

Renee Prokopavicius (Referee)

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Referee comment on "Variations of carbon flux at different time scales in a semi-fixed sandy land ecosystem in Horqin Sandy Land, China" by Yayi Niu et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2022-171-RC2>, 2022

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This study used the eddy covariance method to assess carbon fluxes over five years (2017-2021) at a semi-arid, temperate shrubland in China. The site was severely desertified due to overgrazing but has undergone restoration through grazing exclosures. The aim of the study was to analyse what environmental variables affect carbon fluxes over different time scales, from monthly to interannual, and precipitation and soil water content was hypothesized to have a dominant effect on carbon fluxes. The methods are poorly described, with authors referring to other published studies rather than thoroughly describing the equipment at their study site and their statistical analysis. The figures and tables are nicely done, although a few corrections are needed here too. While not highly novel, as a single site eddy covariance study, it is nevertheless a valuable contribution to our understanding of ecosystem functioning and carbon fluxes in an understudied region. The title is rather generic, however, so I recommend the authors selecting a more informative title.

The site was a carbon sink in wet years ( $-14$ ,  $-126$  g C m<sup>-2</sup> yr<sup>-1</sup>) but a carbon source in dry or average years ( $49$ - $75$  g C m<sup>-2</sup> yr<sup>-1</sup>). The authors confirm their hypothesis that precipitation is an important driver of carbon fluxes and focus on this in the Conclusion and Abstract, although air and soil temperature are also important (in fact, more important for ecosystem respiration and GPP, Fig. 5) but largely neglected. The manuscript falls short of its potential, as the authors do not discuss how (1) desertification and/or restoration or (2) warming has affected (or could have, or potentially will affect) the ecosystem. Perhaps this is because they do not know, given that there is only one site with five years of data, but this should at least be discussed, given that desertification/restoration is mentioned in both the Introduction and Conclusion. The potential effects of climate change, including both precipitation and warming, would make a valuable addition to their Conclusions, which currently only repeat their results. This manuscript should be edited for proper English grammar and language throughout. Please see specific comments below:

## Abstract

Line 16: "Sandy land" is a regionally specific community type and not widely understood, so a better description of the specific study location is needed here in the abstract (e.g., is it arid or semi-arid? Is it a grassland or shrubland?).

Lines 21-23: Confusing statement. Do you mean this was the average value across five study years? Given the high variability, it may not even be worth stating this mean value, but instead describing the range of variability between the driest year and wettest year.

Line 24: Results (line 213, Fig. 4F) state that 2018 was a carbon source, not sink.

## **Introduction**

Line 69: Over what time scale has this happened? The last 10 years, the last 100 years?

Line 72: Can you define the term "semi-fixed"? It is somewhat intuitive but not a common term, bringing to mind less plant cover and more bare soil than I was originally imagining. Perhaps including a range of vegetation basal cover would help.

Line 74: Consider replacing "carbon release" and "carbon emission" throughout the text with "carbon source" as the more commonly used term.

Line 80: Here you allude to natural recovery of sandy land, but this is not referred to again in the last paragraph of the Introduction. It could be an interesting angle for discussion, but it is largely ignored in this manuscript.

## **Methods**

Lines 122-124: These methods sentences should be incorporated into the Introduction (last paragraph) to provide a clear statement of all your project aims. How has this restoration affected the ecosystem? What state is it at now – fully recovered, recovering, or still desertified?

Lines 125-128: What time range is used to calculate mean annual temperature and precipitation? Given that warming is ongoing, it is important to know the years used to

calculate these values.

Line 141-144: It is fine to state that more detailed methods are provided in another study, but these references are presumably for other eddy covariance sites, so you should report the eddy covariance equipment and environmental monitoring equipment (instruments, models, manufacturers) plus a brief description of the flux analysis, as a minimum. Your methods should be relatively stand-alone so readers can interpret your results.

Line 145: This is less than the range of the average energy balance closure for the global FLUXNET tower network:  $0.84 \pm 0.2$  SE (Stoy et al., 2013, <https://www.sciencedirect.com/science/article/pii/S0168192312003413>). Why?

Line 149: What timescale was the Random Forests analysis conducted on? Seasonal mean monthly flux averages? This is important in interpreting results.

Line 154: Your statistical analyses should be fully described here, rather than referring to other papers.

Line 163: What ANOVA and correlation analysis? Please describe. Also, any testing for normality, transformations, and the threshold p-value should be described.

## Results

Table 1: The letter is missing from 2021 PPT and is not consistent across the mean row. Logically, the mean row should not have letters, which highlight differences *between* years here. What is the sampling unit used to describe significant differences among years? Is it monthly means? Daily means? This should be added to the caption and the methods. Also, it would be helpful to add a column for NEE, if not also GPP and Reco, to this table. They are presented in Figure 4F but are useful in Table format. If space is limiting, perhaps the 4 SWC and 4 Ts columns could be limited to 1 column each with the remaining data provided as a Supplementary Table.

Figure 4: Please rescale the x-axis in panels A-E from something like 0.5 to 12.5 so that the bars are more centred.

Figure 6: In other panels, you have plotted GPP in green and Reco in blue so is there an error in the legend here?

Figures 7 and 9: Relationships in Panel A appears non-linear, perhaps in some other panels too... have you tested if linear or nonlinear relationship provides a better fit here?

Line 173: Missing decimal in the 2020 PPF?

Line 182: "and" not "but"

Line 186-187: It's not necessary to repeat all the information already provided in Table 1, delete. It would be more informative to describe significant differences among years, e.g., wet vs. dry years, or the minimum vs. maximum rainfall.

Line 196: "resemble" might be the wrong word here, I'm not sure what this means.

Line 206: Replace "not significantly different from the long-term average close to a normal" with "average".

Line 239-241: This sentence belongs in Methods, while "The results are summarized in Table 2." is unnecessary and could be added as "(Table 2)" at the end of the relevant sentence(s).

## **Discussion**

Line 261: "ecosystem" might be the wrong word here, I'm not sure what this means.

Line 264: "carbon source" and "carbon sink" would be more easily understood terms here.

Lines 289-295: Why was PPF lower in 2020? This is not discussed but should be, as it may (or may not) be helpful in supporting your conclusions here. Is radiation expected to change dramatically in coming years at your site? If not, I question the value of this discussion on the role of solar irradiance in driving daily or seasonal changes in GPP and NEE. Instead, I miss a more detailed discussion on the importance of soil and air temperature, which are important in driving carbon fluxes at your temperate site and are expected to increase with climate change. Based on your dataset, how might this affect your ecosystem?

Lines 343-345: Awkward sentence, rephrase, could also be more specific. Greater rainfall would allow for higher stomatal conductance, and thus higher photosynthesis and leaf area.

## **Conclusion**

Lines 357-371: Much of this Conclusion section simply repeats information presented in Results and Discussion, rather than synthesizing the overall importance of your study. Desertification and restoration are not really discussed anywhere but would make an interesting addition to the Discussion/Conclusions. Has the fencing fully restored the ecosystem's function? How many years did (or will) restoration take? Is fencing enough to restore the ecosystem? How much of the landscape is under restoration?

Lines 373-374: What are the climate predictions regarding precipitation for your region? Is precipitation expected to increase, decrease, or highly uncertain? What about temperature, how will warming affect the ecosystem?