

Interactive comment on “Variations in diurnal and seasonal net ecosystem carbon dioxide exchange in a semiarid sandy grassland ecosystem in China’s Horqin Sandy Land” by Yayi Niu et al.

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Reviewer 1

RE: Submission of the revised manuscript (No. bg-2020-89): Variations in diurnal and seasonal net ecosystem carbon dioxide exchange in a semiarid sandy grassland ecosystem in China’s Horqin Sandy Land.

Dear Reviewer#1: Thank you very much for your assistance in the review of our manuscript. We have revised the manuscript carefully according to your comments. We have also had this revised manuscript edited by Mr. Geoffrey Hart

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(ghart@videotron.ca/geoff@geoff-hart.com), an English science editor with nearly 30 years of experience, to ensure that the quality of the language will be acceptable. Please contact him if necessary to confirm that he has performed this work or if you have any questions about the nature of the work that he has done. Our detailed responses to comments are presented in the remainder of this letter. All of revisions have been highlighted in red in the revision.

General comments:

Niu et al. report on 5-years of CO₂ fluxes from a sandy grassland ecosystem in China's Horqin Sandy Land region. While this paper presents important information on the carbon source/sink activity of a degraded, sandy grassland system, I have concerns about the presentation and interpretation of results. Throughout the manuscript, it is unclear how some interpretations and conclusions are drawn from the presented results, and some results critical to the authors' conclusions are only found in the supplemental information. Below I address several specific concerns:

1. Results. While the results address an important knowledge gap on the carbon dynamics of a degraded sandy grassland, the presentation is unclear. Re-structuring the results may increase the impact and clarify of this manuscript. In its current state, the results begin with information on meteorological conditions (3.1). However, these results do not appear to be a major part of the authors' conclusions, and, from my perspective as a reader, this disrupts the flow of the manuscript. One way to re-structure the results would be to first present information on annual mean fluxes. This would address the authors' first goal: to quantify annual variation in fluxes. After presenting annual fluxes, the authors could examine seasonal then diurnal variation in fluxes. Finally, the authors could present results on meteorological conditions as possible drivers of dynamics in observed carbon fluxes.

Although re-structuring the Results section has some advantages, the meteorological conditions (3.1) provide essential context for understanding our results, as they are

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the primary factors that drive CO₂ fluxes in the sandy grassland. Therefore, we have retained the original section 3.1, but focus our analysis on the environmental factors that are drivers of the observed dynamics of the carbon fluxes (lines 264-294 in the revision). We then present the annual mean fluxes (lines 296-310 in the revision), then examine the seasonal and diurnal variation of the fluxes (lines 311-341 in the revision). Finally, we analyze the responses of the CO₂ fluxes to changes in meteorological conditions as possible drivers of the observed carbon fluxes (lines 343-376 in the revision).

2. Figure 2. In L244, the authors state “Figure 2 suggests the sandy grassland was a net CO₂ source.” I do not see clear evidence for this in Figure 2 and it is not clear how the authors made this interpretation. Because Figure 2 depicts seasonal variation in daily CO₂ fluxes, it is hard to determine the sign and magnitude of annual mean carbon exchange. To make inferences about the annual source/sink activity of this system, I suggest adding a figure showing cumulative fluxes or a table depicting integrated or annual-mean fluxes. Related, the numbers listed in L244-246 show that GPP was greater than Rec, implying carbon sink behavior. However, because the reported NEE is positive, the authors conclude carbon source activity. This is very confusing and must be clarified. Please define the sign convention used for NEE.

We have added Figure 3f to present the annual cumulative NEE, GPP, and Rec and to show the net source results more clearly (lines 296-300, Fig. 3f in the revision). We apologize for typing incorrect values for GPP and Rec, which incorrectly caused GPP to be greater than Rec. We have revised the values of the GPP and Rec and have checked all other numbers throughout the revision to prevent other errors (lines 298-299 in the revision). In response to your comments, we have defined the sign convention we used for NEE (lines 246-248 in the revision).

3. Figure 3. This figure is clear and provides good evidence in support of the study goals and conclusions. One suggestion would be to add another panel or figure representing annual mean fluxes, or annually integrated fluxes. The authors could then cite such a figure as evidence of carbon source/sink behavior at the annual scale.

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We have added another panel to present the annual mean fluxes (Figure 4 in the revision).

4. Figure 4. This is a strong figure, but the interpretation in the main text is unclear. The authors report in L262-266 that NEE showed an absorption peak from 7:30 to 16:30 and that “the rest of the day was characterized by weak carbon absorption.” There is no evidence for this. Before 7:30 and after 16:30, positive NEE indicates carbon emissions to the atmosphere. Please clarify. Also, I suggest adding a horizontal line to all figure at 0.0 on the y-axis. This would help the reader to quickly infer the sign carbon fluxes.

We have revised the description to clarify our meaning (lines 314-315 in the revision). We have also added a horizontal line to all graphs at 0.0 on the y-axis (Fig. 5 in the revision).

5. Tables 1, 2, and 3. Why is precipitation included in Tables 2 and 3 but not Table 1? One of the major study conclusions is that annual precipitation strongly regulated NEE (Section 5). However, precipitation is absent from the PCA for seasonal NEE (Table 1). The authors should explain why precipitation is not included in Table 1.

In response to Reviewer #2, we have removed the PCA results for seasonal NEE, GPP, and Rec, and focused on the impact of precipitation and soil water content on the CO₂ flux at seasonal and annual scales, because precipitation is the factor that most strongly affects the CO₂ flux in arid and semiarid regions (lines 343-376, 395-403, 449-504 in the revision).

6. Discussion. Throughout the discussion, claims are made with no reference to evidence. For example, this happens in L379 and again in L404-405 and L425-428. These claims would be stronger if they were supported with evidence.

We have added references to support our claims in the Discussion. These are highlighted in red in the revision.

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7. What I find absent in the discussion is an explanation for how drought may have influenced the interpretation of results. The authors note that the study was conducted during relatively dry years (L232-235). I appreciate that the authors considered land degradation as a possible cause of carbon source behavior. However, it would be helpful if the authors explained how interactions between land degradation and drought make it hard to attribute the observed low productivity to a single driver.

We have added an analyses of the relationship between annual precipitation and the NEE, GPP, and Rec in the Results (Lines 343-350 and Fig. 6 in the revision), and have explained how the precipitation affected the NEE, GPP, and Rec in the Discussion (Lines 449-461 in the revision). We have also noted (lines 406-409 in the revision) that although we did not quantify the degree of degradation of the study site, our results suggest that the site has not yet recovered sufficiently to become a net sink.

8. Throughout the manuscript, the definition and sign convention of NEE is unclear. This happens in the results (L244-246) and in the discussion (L415) when the authors write that NEE increased with increasing light intensity. Is this a typing error? Should this be GPP instead of NEE?

We have revised the values of GPP and Rec and checked throughout the revision to ensure that they are correct (lines 298-299 in the revision). We have defined the sign convention used for NEE (lines 246-248 in the revision) and have revised the description in the Discussion to agree with this convention (lines 429-431 in the revision).

9. L413: I do not see evidence of daytime CO₂ uptake in autumn (Fig. 4c). Please clarify.

We have revised the description to correct this error (lines 433-434 in the revision).

10. L448-450: The observed dependency of Rec on soil water is consistent with existing theoretical and empirical evidence that episodic rain events drive pulses of soil respiration in semiarid regions (Huxman et al., 2004; Roby et al., 2019; Sponseller,

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2007).

Thank you for bringing these papers to our attention. We have revised the description to include a citation of these papers (lines 498-500 in the revision).

Technical corrections

11. L22: please specify that these are CO₂ flux measurements.

We have added that these are CO₂ flux measurements (line 22 in the revision).

12. L166: Check the alignment of this text.

We have revised the alignment of the text (line 218 in the revision).

Supplemental material

13. L10: What is diurnal-scale mean value? Does this refer to the daily mean value? Fig. S3. Panel e appears to show daily mean values for each year. Despite similar captions, panel e in Figs. S1 and S2 appear to show daily mean values averaged across years. Please clarify.

We have revised Fig. S1 (e) and Fig. S2 (e) to show the daily mean values for each year in order to more intuitively display the variations in these environmental factors during the whole study period (lines 10-11, and 15 in the supplement).

Thanks for your efforts to improve our manuscript. We hope that our replies and the resulting changes will be satisfactory, but we will be happy to work with you to resolve any remaining issues.

Sincerely,

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Please also note the supplement to this comment:

<https://www.biogeosciences-discuss.net/bg-2020-89/bg-2020-89-AC1-supplement.pdf>

Interactive comment on Biogeosciences Discuss., <https://doi.org/10.5194/bg-2020-89>, 2020.

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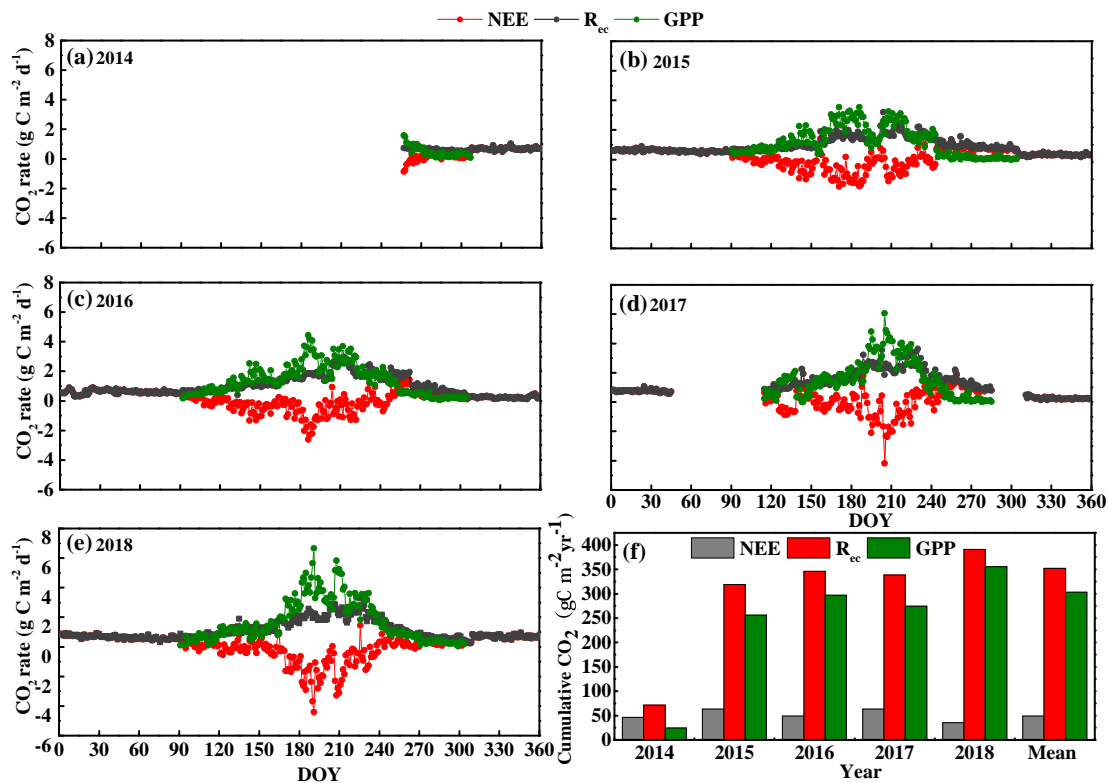


Fig. 1. Seasonal and inter-annual variation in the daily average NEE, GPP and Rec from (a-e) 2014 to 2018. (f) Annual cumulative NEE, GPP and Rec from 2014 to 2018.

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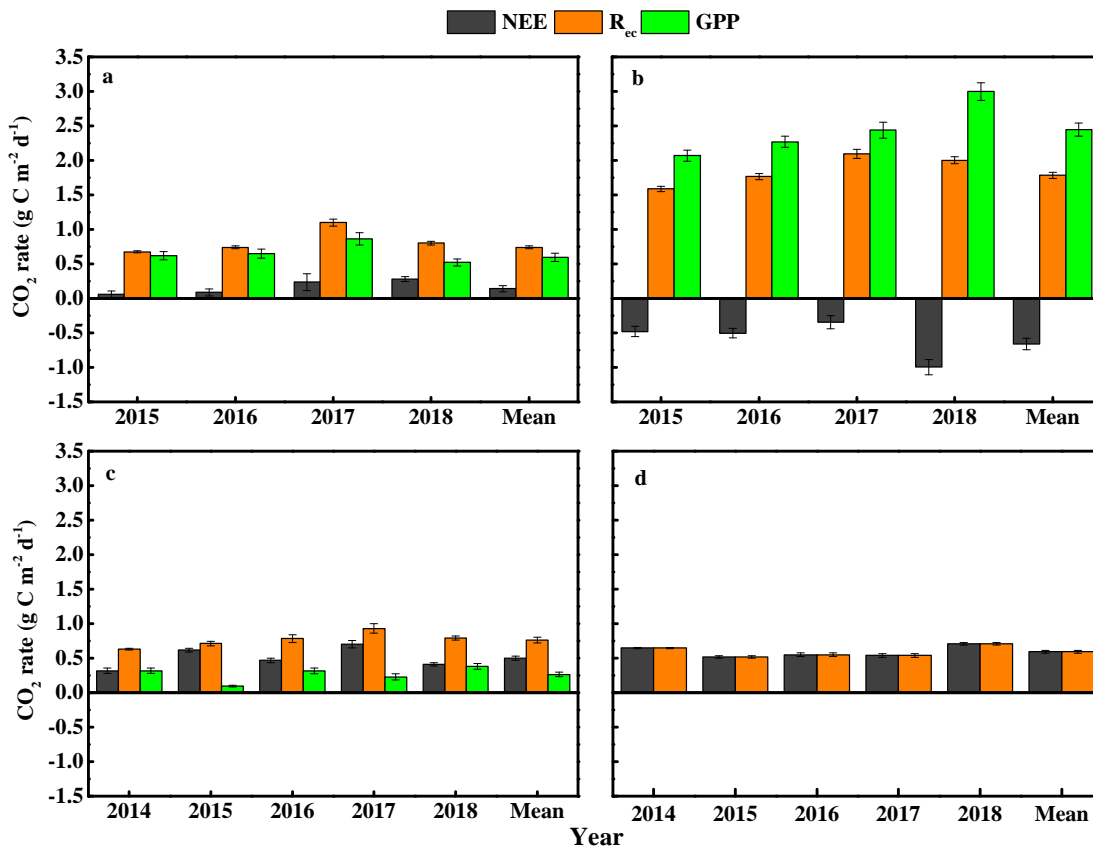


Fig. 2. Seasonal mean NEE, GPP and Rec from 2014 to 2018: (a) spring, (b) summer (c) autumn, and (d) winter.

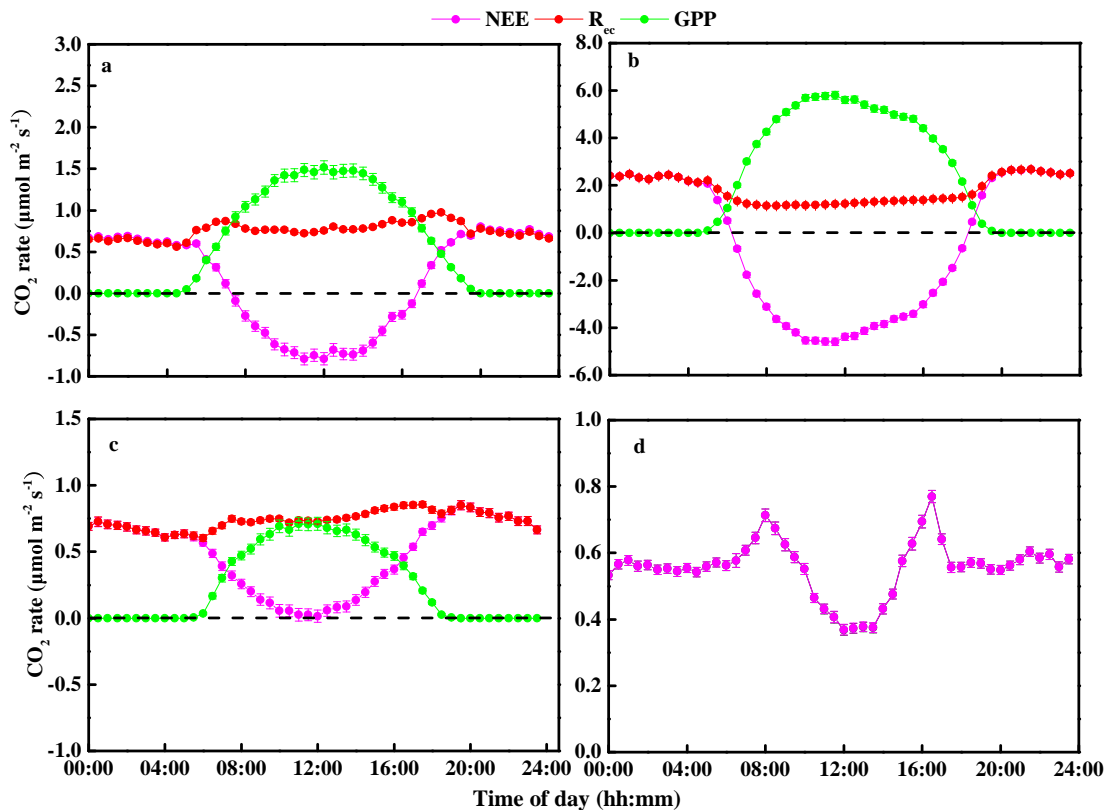


Fig. 3. Diurnal changes in mean NEE, GPP and Rec from 2014 to 2018: (a) spring, (b) summer (c) autumn, and (d) winter.

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