

Responses to the comments of Referee#2

Dear Reviewer,

We would like to express our sincere gratitude for dedicating considerable time and effort to providing valuable feedback on our manuscript. Your insightful comments and suggestions have proven instrumental in enhancing the overall quality of our work. We have meticulously considered and incorporated your feedback into our revised manuscript.

1. Some extra data quality control on the eddy covariance (EC) measurements is still needed, and much key information was still missing. Firstly, in lines 180-184, it is not clear for me how the authors discard nighttime NEE data that were observed when friction velocity (u^*) is less than 0.28 and 0.39 m s^{-1} . More importantly, there is no such u^* criteria of 0.28 and 0.39 m s^{-1} in the study of Papale et al., 2006. Besides, based on my understanding in Eddy Covariance data processing, the "0-1-2" labels (which were mistakenly interpreted as a method to evaluate the turbulence steadiness, in line 177) are not enough for the quality control, extra steps such as the median of absolute deviation about the median (MAD) method from Papale et al., 2006 should be applied to detect the outliers as well. In addition, the number of measurements that were discarded in each outlier detection should be revealed in order to evaluate the quality of the EC dataset. Secondly, the footprint analysis results should be stated in the manuscript. At this stage, key information about the underlying terrain, the composition of each tree species in the forest, the age of the forest, and the footprint of the EC tower are still missing. Finally, in Lines 188-189, it could be problematic to set the storage flux as zero. Since continuous concentration profile measurements are lacking in this study, I suggest the authors apply the decoupling filtering method (Thomas, C.K., Martin, J.G., Law, B.E., Davis, K., 2013. Toward biologically meaningful net carbon exchange estimates for tall, dense canopies: multi-level eddy covariance observations and canopy coupling regimes in a mature Douglas-fir forest in Oregon. *Agric. For. Meteorol.* 173, 14–27.) to account for both the storage and advection effects.

Response: Regarding the uncertainty in the removal of nighttime NEE data based on friction velocity (u^*), we appreciate your clarification. In our data processing using the TOVI software, we employed the moving point method (MPT) to calculate u^* thresholds separately for each year, aiming to mitigate potential errors due to prolonged computations. We acknowledge the error in referencing Papale et al., 2006, and have duly corrected it in the revised manuscript. Additionally, we have provided a more accurate description of our data processing methods and the criteria for discarding weak turbulence periods. Concerning the "0-1-2" labels, we agree with your suggestion. Prior to this step, multiple quality controls, utilizing Eddypro and TOVI, were conducted, resulting in 10Hz data with quality indicators. We have clarified the rationale behind removing data labeled as "2" during the final outlier detection process. Recognizing the importance of footprint analysis, we have supplemented Table 1 in the manuscript with information on the distances of different flux contribution areas from our flux tower during different seasons.

Table 1 Distance of flux contribution area

Year	2020.11-2021.10					2021.11-2022.10					
	Season	Winter	Spring	Summer	Autumn	Yearly	Winter	Spring	Summer	Autumn	Yearly
10% flux contribution distance (m)		44.9	49.4	47.9	43.2	46.35	48.4	44	43.4	42	44.5
30% flux contribution distance (m)		107.8	112.3	107.5	99.3	106.7	109.5	101.9	103.8	100.9	104
50% flux contribution distance (m)		162.7	163.1	160.8	151.2	159.5	168.6	148.6	160.6	153.9	157.9
70% flux contribution distance (m)		228.9	219.5	235	220.1	225.9	239	217	235.3	217.6	227.2
90% flux contribution distance (m)		337.4	361.2	342.2	344	346.2	370.4	355.2	357.9	344.8	357.1

We acknowledge the significance of providing key information about the underlying terrain, forest composition, and age of the forest. We have addressed these gaps in the manuscript, explaining the slope of the underlying terrain and providing details about the forest composition and age. The study site is located in the Hongla Mountain Yunnan Snub-nosed Monkey National Nature Reserve, characterized by trees below 30m, minimal human disturbance, and active growth due to ecological restoration efforts by the local government, including the planting of a small number of birch trees (2.1 Overview of the study site).

We appreciate your suggestion regarding the treatment of storage flux. In response, we have modified our description to acknowledge the potential influence of storage flux and incorporated the decoupling filtering method from Thomas et al., 2013, to account for both storage and advection effects.

2. The introduction and discussion part seem to me a bit plain. Both the importance of subalpine forests in the QTP and its correlations with climate change factors in regard to NEE, GPP, and ER are not deeply revealed and discussed. I recommend the authors to elaborate more on the degradation of permafrost in the QTP and the coming upward migration of tree line. In addition, only linear regression was used to explain the links between NEE and environmental factors. It is highly recommended that the authors utilizing other advanced methods such as PCA loading or wavelet analysis to reveal the details in these correlations.

Response: Thank you for your valuable suggestions. Your insights have been crucial in improving the introduction and discussion sections. We have emphasized the importance of subalpine forests in the Qinghai-Tibet Plateau and their correlations with climate change factors, addressing the perceived plainness. Furthermore, we have expanded the discussion on permafrost degradation in the Qinghai-Tibet Plateau and the anticipated upward migration of the tree line to enhance the manuscript's depth and richness. Regarding your second point, we agree with the need for advanced methods in correlation analysis. In response, we have incorporated Principal Component Analysis (PCA) into the manuscript to provide a more nuanced perspective on the relationships between NEE and environmental factors.

3. The division of seasons is ambiguous to me. In Lines 18-19, the authors used the term growing and dormant season. However, the length of the growing season and dormant season is missing, making it hard to follow what the authors are trying to describe. As for the normal four seasons, I

assume the authors used the common calendar which delineates them into three months each season. This might be not useful for evaluating the seasonality of NEE since the vegetation status was not illustrated. I would suggest the authors carefully define the length of growing and dormant seasons based on relevant conditions such as air temperature and soil moisture and then analyze the seasonality of NEE and its climatic controls.

Response: We appreciate your keen observations regarding the ambiguity in the division of seasons in our manuscript. We acknowledge the inadequacy of using the common calendar to describe the growing and dormant seasons without conducting a detailed analysis in the current study. In response to your suggestion, we have removed the inappropriate descriptions related to growing and dormant seasons from the manuscript. Additionally, we understand the importance of accurately defining the length of seasons based on relevant conditions such as air temperature and soil moisture. However, given the limited duration of our monitoring (two years) and the absence of explicit research results in our study area, using the common calendar was chosen to avoid potential errors in season delineation. We recognize the limitations and acknowledge the need for more precise definitions. Furthermore, we are actively addressing the issue of seasonality by deploying multiple phenocams in the forest. These cameras are continuously monitoring phenological dynamics, and we plan to integrate long-term environmental factor data, such as air temperature and soil moisture, in future research to accurately define seasonal boundaries based on empirical data.

4. The comparison of NEE measurements from ecosystems over the QTP seems redundant to me. Even if the compilation is needed for this study, details such as the number of each ecosystem, the year of the observation, and the general environmental factors (air temperature, precipitation) should be illustrated clearly. It is also important to explain how the average NEE of each ecosystem was calculated and how these sites can represent the same kind.

Response : Thank you for your insightful comments regarding the comparison of NEE measurements from ecosystems over the Qinghai-Tibet Plateau in our manuscript. We acknowledge the sudden introduction of this section in the text and recognize the need for more context in the preceding sections, which we will emphasize in the revised manuscript. The comparison of carbon sequestration in alpine forests with other ecosystems on the Qinghai-Tibet Plateau is a crucial objective of our study. Previous research on the carbon sink potential of alpine forests in the Qinghai-Tibet Plateau has been limited, and our study aims to fill this knowledge gap. We appreciate your acknowledgment of the importance of this analysis. Furthermore, we appreciate your suggestion to provide additional details in this section. We have made careful revisions to address this concern. Specifically, we have increased the information on the number of collected ecosystem types and provided a more comprehensive description of the environmental factors, including the temperature and precipitation ranges for each ecosystem. Detailed information such as vegetation types, latitude, and longitude for each site will be compiled in an Excel file, which will be made available as supplementary material to meet the readers' requirements.

5. Line 29, the NEE value should be negative.

Response: We have added a negative sign in front of the NEE value.

6. Line 30, rephrase the word “enormous” if you can’t support the argument with statistics.

Response: Our initial description was inappropriate, and we have replaced the word. The revised

sentence now reads, "Despite challenges caused by climate change, these forests still have the potential to sequester carbon."

7. Lines 39-40, references are needed to show where this number of 419 comes from and which year was the measurement.

Response: We have added references to support the mentioned number, including the relevant year of measurement.

8. Lines 67-68, this statement seems too arbitrary and could be controversial.

Response: We have revised the statement to convey a more accurate representation. The updated sentence now reads, "However, currently, there are various methods available to accurately quantify the carbon sequestration potential of forests, each with its own advantages and disadvantages."

9. Lines 80-89, the description and review here seem too simple and redundant to me.

Response: We have refined the description to make it more concise. The revised content is, "The eddy covariance (EC) method allows continuous, long-term carbon flux calculation, providing fundamental data for model establishment and calibration. It is widely applied across various ecosystems, including urban areas, farmlands, grasslands, forests, and water bodies (Konopka et al., 2021; Vote et al., 2015; Du et al., 2022a; Kondo et al., 2017; Li et al., 2022)."

10. Line 133, delete this sentence.

Response: We have removed this sentence.

11. Lines 134-135, add relevant references to show where these measurements come from.

Response: We have added references at this point to support the mentioned measurements.

12. Line 139, be careful when using the term "vegetation resources", would be better to be more specific.

Response: We have removed the sentence containing "vegetation resources."

13. Lines 141-144, refine these sentences to focus more on the subalpine forest ecosystem.

Response: We have added more specific descriptions focusing on the subalpine forest ecosystem.

14. Line 147, the source of the ecosystem type map needs to be reported as well.

Response: We have indicated the source of the ecosystem type map.

15. Line 152, it is the frequency of measurements rather than the response frequency.

Response: We have used "frequency of measurements" instead of "response frequency."

16. Line 153, the specific heights need to be revealed here.

Response: We have added specific heights in the manuscript.

17. Lines 159-168, these basic eddy covariance descriptions should be more concise.

Response: We have condensed these sentences to make them more concise.

18. Line 169, should be calibration rather than correction.

Response: We have replaced "correction" with "calibration."

19. Line 170, please confirm whether EddyPro has the function of outlier detection.

Response: We have confirmed that the processing software used has the function of outlier detection.

20. Lines 175-176, please elaborate on how this process was applied to the correction.

Response: We have provided additional details on how this process was applied for correction.

21. Lines 190-191, this is the gap-filling strategy, not filling the missing value.

Response: We have corrected this inaccurate description.

22. Line 199, replace "a" with " α ".

Response: We have replaced "a" with " α ".

23. Line 201, ecosystem respiration.

Response: We have used "ecosystem respiration" instead of "respiration".

24. Line 2017-210, are both daytime and nighttime data gaps being filled using the Tovi software?

The number of the gaps should be stated.

Response: We have added information on data completeness during the data processing.

25. Line 211, we normally use the term "flux partitioning", not "flux splitting".

Response: We have used "flux partitioning" instead of "flux splitting".

26. Line 222, what are the environmental conditions?

Response: We have used "factors" instead of "conditions".

27. Lines 236-238, delete this sentence.

Response: We have removed this sentence.

28. Line 241, what is 'short periods'? Please be precise.

Response: We have removed this inaccurate description from the manuscript.

29. In figure 2, the unit of VPD should be hPa rather than Pa.

Response: We have corrected the unit of VPD in Figure 2.

30. Line 250, where is this nearby station, and which data was interpolated?

Response: We have added the name and coordinates of the nearby station in the manuscript.

31. Line 255 and Line 258, the UTC+8 time needed to be revealed in the first place.

Response: We have placed the UTC+8 time at the beginning of the mentioned lines.

32. Line 258, the term “carbon sequestration period” is not defined.

Response: We have removed “period”.

33. Lines 261-265, rephrase this sentence.

Response: We have rephrased this sentence.

34. Line 265, only one unit is required in this sentence.

Response: We have modified this section for clarity.

35. Lines 270-271, the P value is not enough to determine the significance.

Response: We have revised Figure 3, utilizing PCA for further analysis.

36. Line 276-277, delete this sentence.

Response: We have deleted this content.

37. In figure 4, please confirm whether the unit of VPD is correct or not.

Response: We have confirmed the unit in Figure 4.

38. Line 281, Figure 4. Relationship...

Response: We have modified this expression and added a new figure.

39. Line 283, delete “rate”.

Response: We have removed “rate”.

40. Lines 313-318, more discussion and description are needed to support your claim of the “findings”. This writing style fits the conclusion part, not the result part.

Response: We have modified this part for clearer result presentation and added more detailed information.

41. Line 350, what is “ecological respiration sensitivity”?

Response: We have used “ecosystem” instead of “ecological”.

42. Lines 386-388, more evidence is needed to support this conclusion.

Response: We have removed this speculative statement as it lacked detailed ecosystem information.

43. Line 412, please confirm whether this reference style here is correct or not.

Response: Thank you for pointing out the issue. We have made the necessary corrections.

44. It would be better if the authors could show the standard deviation error bars in figure 3.

Response: You have provided an excellent suggestion, and we have added the standard deviation error bars to Figure 3.

Our heartfelt thanks go to the esteemed reviewer for their dedicated efforts and valuable insights that have immensely enriched our manuscript. The meticulous attention to detail and thoughtful

comments have played a pivotal role in elevating the overall quality of our research. We sincerely appreciate the time and expertise invested by the reviewer, which have undoubtedly contributed to the refinement and clarity of our work. Your commitment to excellence in the peer review process has been a guiding light, and we are truly grateful for the collaborative spirit demonstrated throughout this constructive review.