

Climate–human interactions drive widespread peatland subsidence and carbon vulnerability in China

Corresponding Author: Professor Zhenshan Xue

This file contains all editorial decision letters in order by version, followed by all author rebuttals in order by version.

Version 0:

Decision Letter:

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Dear Professor Xue,

Your manuscript titled "Climate–human interactions drive widespread peatland subsidence and carbon vulnerability in China" has now been seen by 2 reviewers, and we include their comments at the end of this message. They find your work of interest, but some important points are raised. We are interested in the possibility of publishing your study in Communications Earth & Environment, but would like to consider your responses to these concerns and assess a revised manuscript before we make a final decision on publication.

We therefore invite you to revise and resubmit your manuscript, along with a point-by-point that takes into account the points raised. Please highlight all changes in the manuscript text file.

Please submit your point-by-point responses as a separate file, distinct from your cover letter where you can add responses to the Editors' comments that you do not want to be made available to the reviewers. Word files are preferred. We recommend that any figures, tables or graphs that are included in the to reviewers are also included in the main article or Supplementary Information.

We are committed to providing a fair and constructive peer-review process. Please don't hesitate to contact us if you wish to discuss the revision in more detail.

Please use the following link to submit your revised manuscript, point-by-point to the referees' comments (which should be in a separate document to any cover letter), a tracked-changes version of the manuscript (as a PDF file) and the completed checklist:

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We hope to receive your revised paper within six weeks; please let us know if you aren't able to submit it within this time so that we can discuss how best to proceed. If we don't hear from you, and the revision process takes significantly longer, we may close your file. In this event, we will still be happy to reconsider your paper at a later date, as long as nothing similar has been accepted for publication at Communications Earth & Environment or published elsewhere in the meantime.

Please do not hesitate to contact us if you have any questions or would like to discuss these revisions further. We look forward to seeing the revised manuscript and thank you for the opportunity to review your work.

Best regards,

Qiming Zheng, PhD
Editorial Board Member
Communications Earth & Environment
orcid.org/0000-0002-7393-6585

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REVIEWER COMMENTS:

Reviewer #1 (Remarks to the Author):

The study by Xue et al. presents a national-scale dataset for mapping peatland distribution and subsidence patterns, as well as for identifying the drivers of subsidence and predicting future changes under different scenarios. This work represents an important and valuable contribution, providing a critical dataset for the peatland research community. Overall, the manuscript is clearly written, and the methodologies are sound and well-structured. I recommend publication after minor revisions. My specific comments are as follows:

1. Line 32: The term "significant" should only be used in a statistical context, accompanied by appropriate statistical metrics (e.g., p-values). The authors are advised to review the manuscript and replace instances of "significant" with more appropriate terms such as "substantial" or "notable" where statistical testing is not involved.
2. Abbreviation: Many abbreviations used in the manuscript are unnecessary, particularly for place names. Furthermore, several abbreviations are introduced without first defining them—for example, "XXAM" in line 101. Please ensure all abbreviations are either removed or clearly defined upon first use.
3. Figure 1: The figure does not effectively convey peatland distribution. 1) The background DEM is not directly relevant to the data presented and could be removed to avoid distraction. 2) The peatland areas are too small to be clearly visualized; I suggest adding local inset panels to display spatial details of major peatlands. 3) The figure caption lacks information about the time period of the data.
4. Figure 2: 1) The figure is cluttered with unnecessary visual elements, such as the background terrain map and gradient-colored bars. 2) Some fitted trend lines do not match the distribution of the scatter points. For instance, in the Caohai region, most subsidence values are below -40, while the fitted line is above -40.
5. Line 140: The section lacks a comprehensive comparison among groups. While the authors mention the primary driver for each factor category, the relative importance of the second and third drivers is not discussed. A Principal Component Analysis (PCA) or similar regression approach could serve as a complementary method to validate the robustness of variable importance rankings.
6. In addition to identifying variable importance, the manuscript should explore how these variables drive peatland subsidence. Specifically, the direction (positive or negative), form (linear or nonlinear), and presence of thresholds or turning points in the relationships between drivers and subsidence should be discussed.
7. Line 161: The word "Current" should be in lowercase: "current."
8. Line 181: The Zoigê Peatland is reported to have the most pronounced subsidence. Can the authors explain this in the context of the driver analysis? For example, if precipitation is the dominant driver of subsidence, does Zoigê receive notably less precipitation compared to other peatlands?
9. Figure 5: This figure could either be integrated into Figure 1 or moved to the supplementary materials for clarity and conciseness.
10. Line 280: The selection criteria for the referenced literature are unclear. How many published studies were used, and what were the inclusion criteria? Please clarify.
11. Line 303: The origin of the hyperparameters used in the Random Forest model is not discussed. Were these parameters tuned through cross-validation or adopted from previous studies? Using 2000 trees may risk overfitting unless justified by performance evaluation.

Reviewer #2 (Remarks to the Author):

In this manuscript Xue et al., compile data on carbon stocks in China, utilizing an impressive number of measurements from existing sources and possibly some new measurements. They then go on to study how surface elevation changed in these peatlands from 2017-2023. Rather alarmingly a large proportion, 61% are subsiding. What follows is a detailed and comprehensive analysis of the factors driving subsidence, which are primarily climatic and associated with lower precipitation, high temperatures and drought. The impact of grazing is also among the most significant drivers.

I sincerely believe this work to be among the most important being done on peatlands now. The conclusions, I believe, are both well supported and important.

While the manuscript is generally of superb quality, there are points that are unclear and some information that is missing. I will describe these specific issues I would like the authors to address below.

General:

There appears to be some temporal mismatch in the drivers, most are derived from global datasets covering different time periods, nowhere is it mentioned which time-period the environmental drivers cover. This needs to be clarified. If there are only minor differences in the timeperiod covered then that is probably fine. But for SPEI for example, the dataset (predicted) seems to run for 120 years (Table S1 row 11: SPEI runs until 2100) obviously it is not good to combine this with NDVI from the last 10 years without making the temporal mismatch clear in the discussion.

Further to this point, the manuscript would strongly benefit from a short discussion of the climatic changes in these regions over the past several centuries and if and how this may have contributed to the subsidence we are now seeing. What does the palaeoecological literature, testate ameabea etc. say about the present wetness compared to the historical average? This would fit well after line 183 when the drainage activity is described.

The authors also need to discuss more the fact that that moderate climate change scenarios result in a decrease in subsidence, is this due to conditions getting wetter or due to a natural falloff in the subsidence rate? This is a major finding of the paper but not currently so obvious unless you read carefully.

A few lines about peat surface oscillation or "bog breathing" would be valuable, suggest line 50, this is a major mechanism for stabilising the relative water table. Bradley et al., contains a good overview of this. Fritz et al., is also a good resource for this.

- Fritz, C., Campbell, D.I. and Schipper, L.A., 2008. Oscillating peat surface levels in a restiad peatland, New Zealand—magnitude and spatiotemporal variability. *Hydrological Processes: An International Journal*, 22(17), pp.3264-3274.

- Bradley et al., 2022 <https://doi.org/10.5194/esurf-10-261-2022>

Minor:

Line: 23 suggest "hotspots of subsidence"

Line 24-25: suggest you put the predictive strength after these

Table S1 row 11: SPEI runs until 2100 according to this, is it correct? If so under what warming scenario? Or was only a subset of measured data used?

Line 35. Nicholes & Peteet has been criticized in the literature, see responses. Would advice removing this.

Line 55: Changes in the plant community also may drive this

Line 102: would be good to refer to the map here

Figure 5: would be good to have the abbreviations listed after the full name in the caption

Figure 3: the caption needs to refer to the SI for the complete information of the abbreviations and data source

Line 182: earlier drainage is implicated only in lateral erosion, but correctly here the authors also point out the effect on vertical subsidence.

Line 207: Waddington et al., 2015 <https://doi.org/10.1002/eco.1493> would be an excellent reference for this.

Line 213: this requires units to understand, suggest an equation. Presumably the maximum subsidence is for each km², rather than applying the maximum rate per km² to an entire region?

Line 237: here it would be good to mention the specific resolution (1km²?) at which extreme subsidence, such as sinkholes, would likely be masked

Line 283: a reference is required for this compilation, or details need to be provided in the SI if unpublished

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Version 1:

Decision Letter:

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Dear Professor Xue,

Your manuscript titled "Climate–human interactions drive widespread peatland subsidence and carbon vulnerability in China" has now been seen by our reviewers, whose comments appear below. In light of their advice we are delighted to say that we are happy, in principle, to publish a suitably revised version in Communications Earth & Environment.

We therefore invite you to revise your paper one last time to address the remaining concerns of our reviewers. At the same

time we ask that you edit your manuscript to comply with our format requirements and to maximise the accessibility and therefore the impact of your work.

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We hope to hear from you within two weeks; please let us know if you need more time.

Best regards,

Qiming Zheng, PhD
Editorial Board Member
Communications Earth & Environment

Martina Grecequet, PhD
Senior Editor,
Communications Earth & Environment
Consulting Editor
Communications Sustainability

REVIEWERS' COMMENTS:

Reviewer #1 (Remarks to the Author):

The authors have addressed my previous comments well, but I still have a few minor suggestions. After these points are addressed, I will be happy to recommend this manuscript for publication.

1. Abbreviations: My previous comment about abbreviations seems to have been misunderstood. While some abbreviations were unnecessary, removing all of them is not what I intended. Appropriate abbreviations are acceptable and improve readability, especially for terms that appear repeatedly throughout the manuscript. Please reintroduce necessary abbreviations where appropriate.

2. Figures: The figures could still be improved for conciseness. A strong scientific figure should only include elements relevant to its central point. For example, the topography shown in Figure 1 is not directly related to the peatland data and should be removed. Similarly, the color gradient in the bars of Figure 2 appears meaningless and should be simplified for clarity.

3. Figure 2: The authors stated that they used LOESS to fit the trend lines in Figure 2. Based on my experience, LOESS is

typically more useful for fitting a curve rather than a straight line. The lines shown in the figure look more like the result of a linear regression. Please double-check the method used to generate these lines and adjust the description accordingly.

Reviewer #2 (Remarks to the Author):

The changes made to the manuscript in to the comments from myself and Reviewer 1 are satisfactory. The manuscript is improved relative to the earlier version and suitable now for publication.

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Manuscript title: *Climate–human interactions drive widespread peatland subsidence and carbon vulnerability in China*

Manuscript ID: *[COMMSENV-25-2579-T]*

Response to the Editor and Reviewers

We sincerely thank the Editors and the two anonymous reviewers for their thorough and constructive evaluation of our manuscript titled “*Climate–human interactions drive widespread peatland subsidence and carbon vulnerability in China.*” We are grateful for the encouraging remarks on the importance and quality of our study, as well as for the insightful comments and suggestions that helped us significantly improve the clarity, methodological rigor, and interpretative depth of the paper.

We have carefully revised the manuscript in accordance with all comments and provide detailed, point-by-point responses below. All changes in the main text have been highlighted, and the revised manuscript now includes new analyses (e.g., SHAP dependence plots, PCA-based validation), revised figures, expanded methodological details, and improved discussion sections to address the reviewers’ concerns. We hope that the revised version meets the standards of *Communications Earth & Environment*.

Reviewer #1 – General Comments:

The study by Xue et al. presents a national-scale dataset for mapping peatland distribution and subsidence patterns, as well as for identifying the drivers of subsidence and predicting future changes under different scenarios. This work represents an important and valuable contribution, providing a critical dataset for the peatland research community. Overall, the manuscript is clearly written, and the methodologies are sound and well-structured. I recommend publication after minor revisions.

Response to General Comments:

We sincerely thank Reviewer #1 for the encouraging and positive assessment of our manuscript. We are grateful for your recognition of the importance of our work and its contribution to the peatland research community. Your comments regarding the clarity of the writing and the soundness of our methodology are greatly appreciated. We have carefully addressed all the points you raised in your detailed comments, which have led to substantial improvements in the manuscript’s clarity, analytical depth, and robustness. A point-by-point response is provided below.

Reviewer #1 – Comment 1:

Line 32: The term "significant" should only be used in a statistical context, accompanied by appropriate statistical metrics (e.g., p-values). The authors are advised to review the

manuscript and replace instances of "significant" with more appropriate terms such as "substantial" or "notable" where statistical testing is not involved.

Response to Comment 1:

We thank the reviewer for pointing this out. We have carefully reviewed the entire manuscript and replaced all uses of the term “significant” that were not supported by statistical metrics with more appropriate alternatives such as “critical,” “substantially,” or “pronounced,” depending on the context. For example, in Line 59 of the original manuscript, “vary significantly” has been revised to “vary substantially.” All such changes have been highlighted in the revised manuscript.

Reviewer #1 – Comment 2:

Abbreviation: Many abbreviations used in the manuscript are unnecessary, particularly for place names. Furthermore, several abbreviations are introduced without first defining them—for example, “XXAM” in line 101. Please ensure all abbreviations are either removed or clearly defined upon first use.

Response to Comment 2:

We thank the reviewer for this comment. In response, we have removed **all abbreviations** from the manuscript to avoid confusion and improve readability. All place names and terms are now written in full throughout the main text.

All revisions have been made and are highlighted in the revised version.

Reviewer #1 – Comment 3:

Figure 1: The figure does not effectively convey peatland distribution. 1) The background DEM is not directly relevant to the data presented and could be removed to avoid distraction. 2) The peatland areas are too small to be clearly visualized; I suggest adding local inset panels to display spatial details of major peatlands. 3) The figure caption lacks information about the time period of the data.

Response to Comment 3:

We appreciate the reviewer’s suggestions to improve the clarity and interpretability of Figure 1. In response, we have made the following revisions:

(1) Removed the background DEM layer to reduce visual distraction and allow peatland distribution to stand out more clearly.

(2) Added inset panels for key regions (e.g., Zoigê, Daxing’an Mountains, and Yunnan–Guizhou Plateau) to better visualize the spatial distribution of major peatlands at a finer scale.

(3) Revised the figure caption text to include the time period (2010–2020) associated with the peatland distribution and carbon-stock metrics.

These changes have been incorporated in the revised Figure 1, and the updated caption now provides clear and complete information. The updated Figure 1 incorporating these revisions is provided below for your reference.

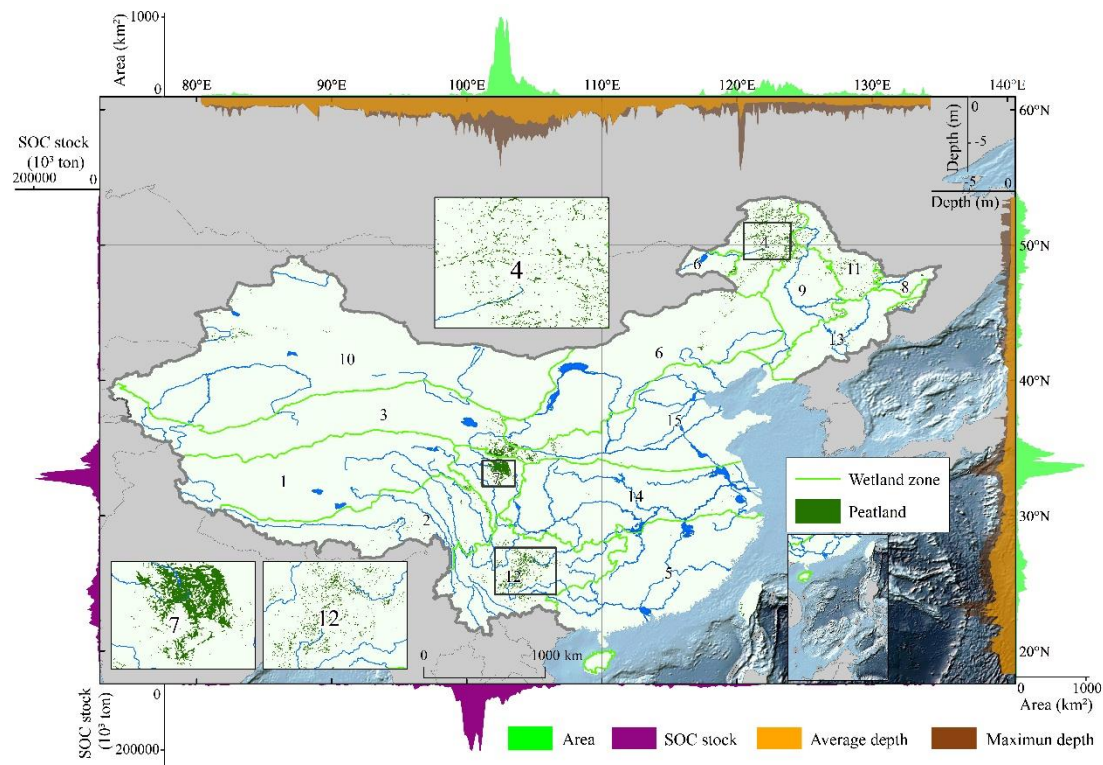


Figure 1. National distribution of peatlands in China with associated depth, area, and carbon stock metrics. The figure represents integrated data reflecting conditions during the 2010–2020 baseline period.

Reviewer #1 – Comment 4:

Figure 2: 1) The figure is cluttered with unnecessary visual elements, such as the background terrain map and gradient-colored bars. 2) Some fitted trend lines do not match the distribution of the scatter points. For instance, in the Caohai region, most subsidence values are below -40, while the fitted line is above -40.

Response to Comment 4:

We thank the reviewer for this valuable feedback regarding Figure 2. In response, we have made the following revisions to improve clarity and accuracy:

(1) Removed unnecessary background elements, including the terrain base map and gradient-colored bars, to reduce visual clutter and better highlight the data patterns.

(2) Replotted all fitted trend lines using local regression (LOESS) with optimized smoothing parameters, ensuring that the curves reflect the actual distribution of observed values more accurately.

These modifications are incorporated in the revised Figure 2, which is included below for your reference.

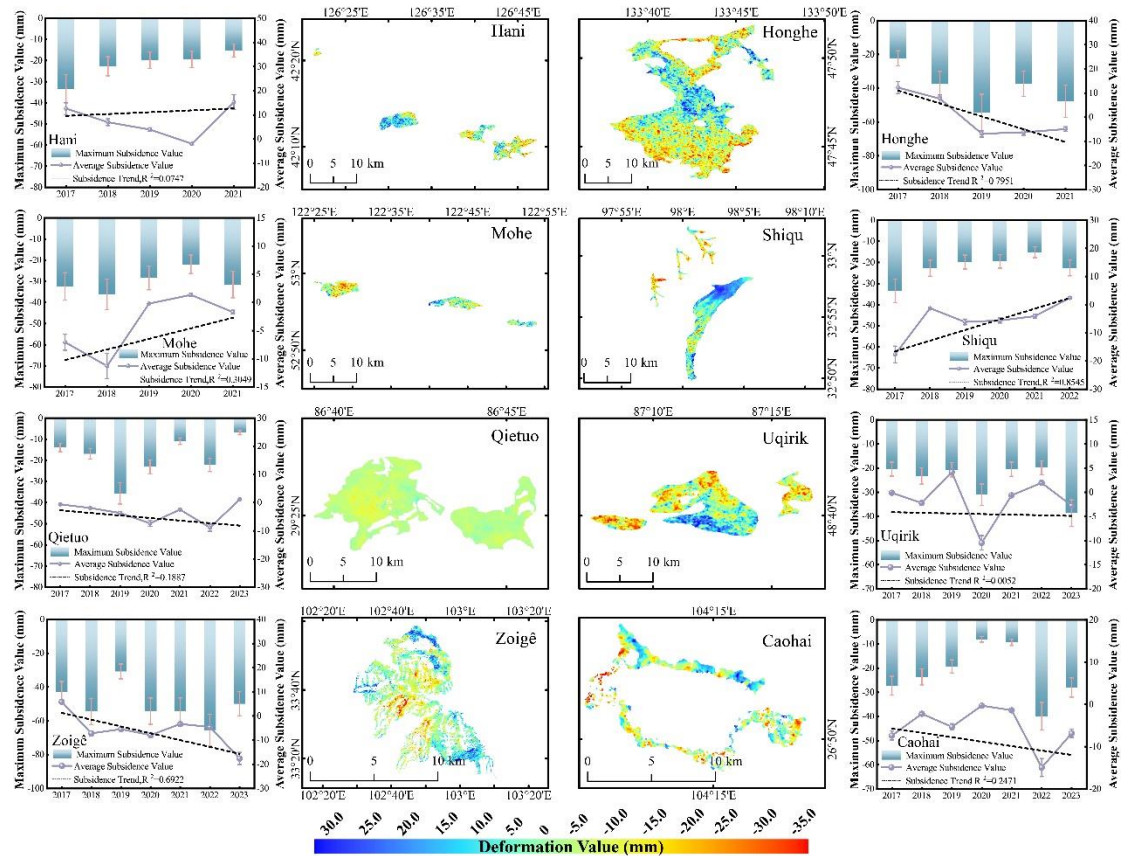


Figure 2. Interannual surface deformation of eight representative peatlands across China based on SBAS-InSAR analysis.

Reviewer #1 – Comment 5 and 6:

5. Line 140: The section lacks a comprehensive comparison among groups... A Principal Component Analysis (PCA) or similar regression approach could serve as a complementary method to validate the robustness of variable importance rankings.

6. In addition to identifying variable importance, the manuscript should explore how these variables drive peatland subsidence. Specifically, the direction (positive or negative), form (linear or nonlinear), and presence of thresholds or turning points...

Response to Comment 5 and 6:

We thank the reviewer for these insightful suggestions. Rather than applying PCA or conventional linear regression, we employed SHAP (SHapley Additive exPlanations) values to

interpret the magnitude, direction, and distribution of variable effects. This approach offers a model-specific, transparent framework that surpasses dimensionality-reduction methods like PCA in both interpretability and ecological relevance.

To address the reviewer's concerns in detail:

(1) Directionality (positive/negative effects):

We used violin plots of SHAP values grouped by variable type (Figure 3) to reveal whether a given environmental variable contributes positively or negatively to predicted subsidence. Many variables exhibited a clear polarity of influence, while others displayed both directions depending on value ranges, suggesting context-dependent responses.

(2) Functional form (linear/nonlinear):

The distribution shape of SHAP values across observations indicates the functional form of each variable's influence. Symmetric or bell-shaped distributions suggest near-linear relationships, while skewed or bimodal patterns (e.g., for NPP, GLW4) reflect pronounced nonlinearities.

(3) Threshold or turning points:

The violin plots further show abrupt changes or shifts in SHAP distributions at certain value ranges, implying ecological thresholds or tipping points—for instance, a marked increase in subsidence sensitivity beyond certain livestock densities or under extreme precipitation conditions.

These SHAP-based interpretations, together with the robustness of variable rankings across scenarios, provide strong justification for our methodological approach. We have expanded the Results section (lines 156–166) accordingly to clarify these aspects, as follows:

“To further characterize how individual variables influenced subsidence, we employed SHAP-based violin plots grouped by thematic category (Figure 1). These plots reveal the directionality, distributional shape, and potential thresholds of variable effects. For instance, precipitation (Pre) and net primary productivity (NPP) exhibited right-skewed SHAP distributions, indicating strong and consistently positive contributions to subsidence. In contrast, variables such as soil sand content and livestock density (GLW4) displayed bimodal or dispersed patterns, suggesting nonlinear relationships and possible thresholds beyond which subsidence risk increases sharply. Notably, some variables (e.g., slope and TWI) showed both positive and negative SHAP values across different regions, reflecting context-dependent interactions. These patterns highlight the complex interplay of hydroclimatic, ecological, and anthropogenic forces in shaping peatland stability, with many variables exhibiting nonlinear, threshold-based, or regionally varying effects.”

Reviewer #1 – Comment 7:

7. Line 161: The word “Current” should be in lowercase: “current.”

Response to Comment 7:

Thank you for pointing this out. We have corrected the capitalization and changed “Current” to “current” in line 161 of the revised manuscript.

Reviewer #1 – Comment 8:

8. Line 181: The Zoigê Peatland is reported to have the most pronounced subsidence. Can the authors explain this in the context of the driver analysis? For example, if precipitation is the dominant driver of subsidence, does Zoigê receive notably less precipitation compared to other peatlands

Response to Comment 8:

We thank the reviewer for this thoughtful suggestion. In the revised manuscript, we have added further explanation of the Zoigê Peatland's pronounced subsidence in relation to its climatic and anthropogenic context.

Specifically, Zoigê exhibits both relatively low precipitation and high interannual drought variability (as indicated by low annual precipitation and severe SPEI), which aligns with our finding that precipitation-related variables are dominant drivers of subsidence. Additionally, the region has a history of drainage, grazing, and road/ditch development, all of which contribute to accelerated peat degradation and vertical instability.

The following text has been added to the revised Results section (lines 201–205):

“In addition to historical anthropogenic impacts, Zoigê is also subject to relatively low annual precipitation and high interannual drought variability (as indicated by SPEI), consistent with the dominant climatic drivers of subsidence identified in our SHAP-based analysis. The combined influence of sustained hydroclimatic stress and legacy human disturbance likely explains the severity of subsidence observed in this region.”

Reviewer #1 – Comment 9:

9. Figure 5: This figure could either be integrated into Figure 1 or moved to the supplementary materials for clarity and conciseness.

Response to Comment 9:

Thank you for the constructive suggestion. To improve the clarity and conciseness of the main text, we have moved Figure 5 to the Supplementary Information (now Supplementary Figure S1). The figure caption and cross-references in the main text have been updated accordingly.

Reviewer #1 – Comment 10:

10. Line 280: The selection criteria for the referenced literature are unclear. How many published studies were used, and what were the inclusion criteria? Please clarify.

Response to Comment 10:

We thank the reviewer for this constructive suggestion. The peatland profile dataset used in this study was primarily derived from a national field survey conducted by our team during 2013–2018, as part of the National Survey on Marsh Wetland Resources and Major Ecological Benefits. This large-scale campaign systematically investigated peat resources and carbon stocks in representative peatlands across China. The resulting dataset has been archived and publicly released through the National Earth System Science Data Center (DOI: 10.12041/geodata.261073484251284.ver1.db).

In addition, a small number of supplementary georeferenced samples were compiled from published literature to enhance spatial coverage. The referenced studies include:

Wang et al. (2021) — Changbai Mountain peatland carbon stocks and microtopography effects

Zhang et al. (2020) — Peat accumulation in the Altai Mountains

Zhang et al. (2015) — Peatland history in the Sanjiang Plain

We have clarified this information in the revised Methods section (Lines 293–295) and added the references accordingly.

Reviewer #1 – Comment 11:

11. Line 303: The origin of the hyperparameters used in the Random Forest model is not discussed. Were these parameters tuned through cross-validation or adopted from previous studies? Using 2000 trees may risk overfitting unless justified by performance evaluation.

Response to Comment 11:

We thank the reviewer for the comment regarding our parameter choices in simulating peat soil properties. We apologize for the inconsistency. We have corrected the number of trees used in the Random Forest (RF) model to 1000 ($n_{tree} = 1000$), which was mistakenly reported as 2000 in the original manuscript. This choice was based on preliminary sensitivity tests in which model performance metrics (RMSE and R^2) stabilized beyond approximately 800 trees. We also set $m_{try} = 4$ and $min.node.size = 10$ to reduce overfitting. Model evaluation on an independent 20% validation subset yielded robust accuracies: for bulk density, $RMSE = 0.12 \text{ g cm}^{-3}$ and $R^2 = 0.47$; for organic matter content, $RMSE = 11.23\%$ and $R^2 = 0.19$. These results reflect moderate but acceptable accuracy for large-scale spatial modeling of subsurface peat properties. These details have been added to the Methods section (Lines 318–320).

Reviewer #2:

In this manuscript Xue et al., compile data on carbon stocks in China, utilizing an impressive number of measurements from existing sources and possibly some new measurements. They then go on to study how surface elevation changed in these peatlands from 2017-2023. Rather alarmingly a large proportion, 61% are subsiding. What follows is a detailed and comprehensive analysis of the factors driving subsidence, which are primarily climatic and associated with lower precipitation, high temperatures and drought. The impact of grazing is also among the most significant drivers. I sincerely believe this work to be among the most important being done on peatlands now. The conclusions, I believe, are both well supported and important. While the manuscript is generally of superb quality, there are points that are unclear and some information that is missing. I will describe these specific issues I would like the authors to address below.

Response to Reviewer #2:

We sincerely thank Reviewer #2 for the highly encouraging and thoughtful feedback. We are especially grateful for the recognition of our study's importance and analytical depth. The reviewer's comments were both constructive and insightful, helping us identify areas for clarification and improvement. We have carefully addressed all points raised and have revised the manuscript accordingly to improve clarity, completeness, and interpretability.

Reviewer #2 – General Comments 1:

General Comments 1: There appears to be some temporal mismatch in the drivers, most are derived from global datasets covering different time periods, nowhere is it mentioned which time-period the environmental drivers cover. This needs to be clarified. If there are only minor differences in the timeperiod covered then that is probably fine. But for SPEI for example, the dataset (predicted) seems to run for 120 years (Table S1 row 11: SPEI runs until 2100) obviously it is not good to combine this with NDVI from the last 10 years without making the temporal mismatch clear in the discussion.

Response to General Comments 1:

We thank the reviewer for raising this important point. In our study, care was taken to ensure temporal consistency among environmental drivers within each modeling context.

For current subsidence modeling, all environmental variables—including SPEI, NDVI, NDWI, and NPP—were derived from datasets covering the same time window of 2010–2020. Specifically, SPEI was calculated based on historical climate data during this period, matching the temporal coverage of other climate and vegetation predictors.

For future scenario simulations, we used SPEI projections for the late 21st century (averaged

over 2081–2100), aligned with the corresponding SSP-specific precipitation (Pre), temperature (Tem), and precipitation seasonality (Bio15) values. All scenario-based simulations used consistent inputs derived under the same Shared Socioeconomic Pathways (SSP1-2.6, SSP3-7.0, and SSP5-8.5).

We have clarified these details in the revised Methods section (Lines 308–312) and Supplementary Table S1. We also added a sentence in the Discussion to highlight this temporal harmonization and acknowledge potential limitations related to using decadal averages to represent dynamic processes (Lines 269–270).

The added text in the Methods section is:

“For modeling under current conditions, climate-related predictors were drawn from datasets representing the 2010 – 2020 period to ensure temporal consistency with other time-sensitive variables. For future scenario simulations (SSP1-2.6, SSP3-7.0, SSP5-8.5), these variables were sourced from the corresponding SSP-specific projections, while other non-climatic predictors were kept constant.”

The added text in the Discussion section is:

“Moreover, residual inconsistencies in the temporal resolution of input predictors may also contribute to uncertainties in subsidence simulations, especially across heterogeneous peatland landscapes.”

Reviewer #2 – General Comments 2:

Further to this point, the manuscript would strongly benefit from a short discussion of the climatic changes in these regions over the past several centuries and if and how this may have contributed to the subsidence we are now seeing. What does the palaeoecological literature, testate amoebae etc. say about the present wetness compared to the historical average? This would fit well after line 183 when the drainage activity is described.

Response to General Comments 2:

We thank the reviewer for this helpful suggestion. To place contemporary peatland subsidence in a deeper climatic context, we have added a new paragraph (Lines 201–203) summarizing palaeoecological evidence from the Zoigê peatland. Studies based on peat cores indicate a consistent warming and drying trend in the region over recent decades, with decreasing water table levels and increased peat decomposition linked to climate change and human disturbances (Cui et al., 2017; Sun et al., 2023). These long-term drying patterns likely predisposed the Zoigê peatland to enhanced subsidence when drainage was initiated.

The added text in the Discussion section is:

“Palaeoecological studies further indicate a progressive drying trend in Zoigê over the past century, marked by declining water tables and enhanced peat decomposition under warming and drying climatic conditions.”

The following references have been added to support this addition:

Ma L, et al. A globally robust relationship between water table decline, subsidence rate, and carbon release from peatlands. Communications Earth & Environment 3, 254 (2022).

Yang T, et al. Impact of climate-induced water-table drawdown on carbon and nitrogen sequestration in a Kobresia-dominated peatland on the central Qinghai-Tibetan Plateau. Communications Earth & Environment 6, 188 (2025). <https://doi.org/10.1038/s43247-025-02168-6>

Reviewer #2 – General Comments 3:

The authors also need to discuss more the fact that that moderate climate change scenarios result in a decrease in subsidence, is this due to conditions getting wetter or due to a natural falloff in the subsidence rate? This is a major finding of the paper but not currently so obvious unless you read carefully.

Response to General Comments 3:

We sincerely thank the reviewer for highlighting this key observation. As you rightly pointed out, the finding that moderate climate change scenarios (e.g., SSP1-2.6) are associated with reduced subsidence risk is one of the major outcomes of our study, and it deserves clearer emphasis and explanation in the manuscript.

We have clarified that this pattern likely arises from two concurrent mechanisms:

Improved hydroclimatic conditions: Under SSP1-2.6, projected increases in precipitation and higher SPEI values may help maintain higher water tables, thereby reducing aerobic decomposition and slowing subsidence. Natural tapering of subsidence rates: Over time, long-term drainage and compaction can lead to the depletion of readily decomposable organic matter in the peat profile, causing subsidence to decline even under continued pressure—a phenomenon supported by previous studies in tropical peatlands.

To ensure this finding is more immediately visible to readers, we have added a concise explanatory sentence to the revised Discussion section (Lines 244–247):

“The projected reduction in subsidence under the moderate SSP1-2.6 scenario may be attributed to two factors: improved hydroclimatic conditions (e.g., increased precipitation and higher SPEI values), and the natural tapering of subsidence over time as the peat body becomes progressively compacted and depleted of labile carbon.”

Reviewer #2 – General Comments 4:

A few lines about peat surface oscillation or “bog breathing” would be valuable, suggest line 50, this is a major mechanism for stabilising the relative water table. Bradley et al., contains a good overview of this. Fritz et al., is also a good resource for this. - Fritz, C., Campbell, D.I. and Schipper, L.A., 2008. Oscillating peat surface levels in a restiad peatland, New Zealand—magnitude and spatiotemporal variability. Hydrological Processes: An International Journal, 22(17), pp.3264-3274. - Bradley et al., 2022 <https://doi.org/10.5194/esurf-10-261-2022>

Response to General Comments 4:

We thank the reviewer for highlighting the importance of peat surface oscillation (also known as “bog breathing”) as a stabilizing mechanism for relative water table levels in peatlands. This is indeed a key process in maintaining peatland hydrological function, particularly in systems with fluctuating water inputs. Following the reviewer’s suggestion, we have added a brief explanation of this mechanism near Line 50 in the Introduction and cited the recommended literature (Bradley et al., 2021; Fritz et al., 2008).

The added text in the Discussion section is:

“Peatlands also exhibit dynamic surface movements, known as peat surface oscillation or “bog breathing,” which play an important role in buffering short-term water table fluctuations. This process involves the swelling and shrinking of the peat matrix in response to hydrological changes and helps stabilize relative water levels during precipitation variability or drought”

The following references have been added to support this addition:

Fritz C, Campbell DI, Schipper LA. Oscillating peat surface levels in a restiad peatland, New Zealand—magnitude and spatiotemporal variability. Hydrological Processes: An International Journal 22, 3264-3274 (2008). <https://doi.org/10.1002/hyp.6912>

Bradley AV, Andersen R, Marshall C, Sowter A, Large DJ. Identification of typical eco-hydrological behaviours using InSAR allows landscape-scale mapping of peatland condition. Earth Surface Dynamics Discussions 2021, 1-28 (2021). <https://doi.org/10.5194/esurf-10-261-2022>

Reviewer #2 – Minor Comment – Line 23:

Line: 23 suggest “hotspots of subsidence”

Response to Minor Comment – Line 23

Thank you for the suggestion. We have revised the sentence accordingly. And now it reads:

“...emerging as persistent hotspots of subsidence”

Reviewer #2 – Minor Comment – Line 24-25

Line 24-25: suggest you put the predictive strength after these Table S1 row 11: SPEI runs until 2100 according to this, is it correct? If so under what warming scenario? Or was only a subset of measured data used?

Response to Minor Comment – Line 24-25

We appreciate the reviewer's attention to the clarity of our SPEI data usage and sentence structure. This comment has been addressed in our response to General Comment 1, where we clarified that:

For current modeling, SPEI data covering 2010–2020 were used, consistent with other environmental variables.

For future projections, SPEI values were drawn from SSP-specific projections for 2081–2100 under SSP1-2.6, SSP3-7.0, and SSP5-8.5 scenarios.

This information has been added to the revised Methods section and Supplementary Table S1.

Reviewer #2 – Minor Comment – Line 35

Line 35. Nicholes & Peteet has been criticized in the literature, see responses. Would advice removing this.

Response to Minor Comment – Line 35

We thank the reviewer for this suggestion. To avoid referencing a potentially contested source, we have removed this citation from the Introduction.

Reviewer #2 – Minor Comment – Line 55

Line 55: Changes in the plant community also may drive this.

Response to Minor Comment – Line 55

We thank the reviewer for this helpful suggestion. We agree that changes in the plant community can also influence subsidence by altering surface vegetation structure, evapotranspiration rates, and root reinforcement. We have revised the sentence accordingly to reflect this additional mechanism. And now it reads:

“Vertical degradation, or subsidence, results from peat oxidation and compaction following drainage, climatic shifts, or vegetation changes, lowering the land surface.”

Reviewer #2 – Minor Comment – Line 102

Line 102: would be good to refer to the map here Figure 5: would be good to have the abbreviations listed after the full name in the caption Figure 3: the caption needs to refer to

the SI for the complete information of the abbreviations and data source.

Response to Minor Comment – Line 102

Thank you for the helpful suggestions regarding figure references and abbreviations. In response:

- As Reviewer #1's recommendation, Figure 5 has been moved to the Supplementary Information. Accordingly, we have revised the main text (original Line 102, now Line 107) to include the reference "(see Supplementary Figure S1)" to guide readers to the appropriate map.
- In response to Reviewer #1's additional suggestion, all abbreviations of geographic regions (e.g., Zoigê Plateau, Daxing'an Mountains) have been replaced with full names throughout the main text to enhance clarity.
- For Figure 3, we have updated the caption to include:

" Abbreviations and data sources are provided in Supplementary Table S1."

Reviewer #2 – Minor Comment – Line 182

Line 182: earlier drainage is implicated only in lateral erosion, but correctly here the authors also point out the effect on vertical subsidence.

Response to Minor Comment – Line 182

Thank you for this helpful comment. To ensure conceptual clarity, we have revised the earlier section of the Introduction (Lines 48–49) to explicitly note that drainage contributes to both lateral and vertical degradation processes.

The added text in the Discussion section is:

“However, drainage not only drives lateral degradation but also contributes to vertical degradation through long-term peat compaction and oxidation.”

Reviewer #2 – Minor Comment – Line 207

Line 207: Waddington et al., 2015 <https://doi.org/10.1002/eco.1493> would be an excellent reference for this.

Response to Minor Comment – Line 207

We appreciate the reviewer's suggestion and have added the recommended citation (Waddington et al., 2015) at original Line 207, now Line 234.

Reviewer #2 – Minor Comment – Line 213

Line 213: this requires units to understand, suggest an equation. Presumably the maximum subsidence is for each km², rather than applying the maximum rate per km² to an entire region?

Response to Minor Comment – Line 213

We appreciate the reviewer's request for clarification. Indeed, the maximum subsidence value used in our hydrological function loss estimate is calculated at the pixel level, not uniformly applied to entire regions. To make this explicit, we have added a brief explanatory sentence and an equation in the text (Lines 239 – 243) to clarify the units and computation method. And now it reads:

“To evaluate the hydrological consequences, we estimated hydrological function loss as:

$$\text{Hydrological loss} = \text{MaxSubsidence} \times \text{SubsidenceArea} \times \text{Porosity} \quad (1)$$

where MaxSubsidence represents the maximum observed subsidence rate (in mm·yr⁻¹) at the pixel level by the area of subsiding peatlands, SubsidenceArea is the total subsiding area (m²), and Porosity is assumed to be 90 (%) based on typical peat properties.”

Reviewer #2 – Minor Comment – Line 237

Line 237: here it would be good to mention the specific resolution (1km²?) at which extreme subsidence, such as sinkholes, would likely be masked.

Response to Minor Comment – Line 237

Thank you for this helpful suggestion. We agree that localized subsidence phenomena such as sinkholes may be masked due to the spatial resolution of our modeling framework. We have added a sentence in the revised manuscript (Line 271-273) to clarify that our 1 km² resolution may not capture such fine-scale events.

The added text in the Discussion section is:

“However, due to the 1 km² spatial resolution of our predictive modeling, highly localized and abrupt deformation events such as peat collapse or sinkholes may not be fully captured.”

Reviewer #2 – Minor Comment – Line 283

Line 283: a reference is required for this compilation, or details need to be provided in the SI if unpublished

Response to Minor Comment – Line 283

Thank you for your comment. This issue has already been addressed in response to Reviewer

#1. We have revised the sentence to clarify that the peatland profile data were primarily derived from the national survey of marsh wetland resources and ecological benefits (DOI: 10.12041/geodata.261073484251284.ver1.db), and supplemented by published georeferenced studies (Lines 309–311).

Response to the Editors and Reviewers

We sincerely thank the Editors and Reviewers for their positive evaluation of our manuscript entitled “Climate – human interactions drive widespread peatland subsidence and carbon vulnerability in China.” We are truly grateful for the opportunity to revise our work for publication in Communications Earth & Environment.

We greatly appreciate the time and effort the reviewers have devoted to our study. Their constructive and insightful suggestions have been invaluable in further improving the clarity, accuracy, and presentation of the manuscript. We have also carefully revised the paper in accordance with the editorial requests outlined in the Editorial Requests Table, ensuring full compliance with the journal’s formatting and policy requirements.

We have addressed all comments in detail and revised the manuscript accordingly. Below, we provide a point-by-point response. Reviewer comments are quoted in bold, followed by our responses in regular text.

Reviewer #1, Comment 1:

Abbreviations: My previous comment about abbreviations seems to have been misunderstood. While some abbreviations were unnecessary, removing all of them is not what I intended. Appropriate abbreviations are acceptable and improve readability, especially for terms that appear repeatedly throughout the manuscript. Please reintroduce necessary abbreviations where appropriate.

Response:

We thank the reviewer for this helpful clarification. We regret our earlier misunderstanding and fully agree that appropriate abbreviations improve readability, especially for frequently used terms. In the revised manuscript, all abbreviations have been carefully checked and standardized. We now ensure that each abbreviation is introduced with its full term at first appearance (in both the Abstract and the main text), and thereafter the abbreviation is used consistently. For example, place names and technical terms are first given in full and then abbreviated on subsequent mention. This revision aligns with the reviewer’s advice and enhances clarity without unnecessary repetition.

Reviewer #1, Comment 2:

Figures: The figures could still be improved for conciseness. A strong scientific figure should only include elements relevant to its central point. For example, the topography shown in Figure 1 is not directly related to the peatland data and should be removed. Similarly, the color gradient in the bars of Figure 2 appears meaningless and should be simplified for clarity.

Response:

We appreciate the reviewer’s thoughtful suggestions on figure design. In the revised manuscript, we have carefully streamlined the figures to improve conciseness. For Figure 1, we confirm that all topographic information has now been completely removed. While we had already eliminated land-surface DEM layers in the previous revision, we realized that seafloor topography was still present. In the current version, both terrestrial and marine topographic information have been entirely removed, leaving only a plain background color to distinguish the study area from surrounding

countries and ocean. This ensures that the figure now focuses exclusively on the peatland distribution. For Figure 2, we have revised the bar colors to remove the unnecessary gradient and now use a uniform color scheme for clarity. The revised Figures are shown below.

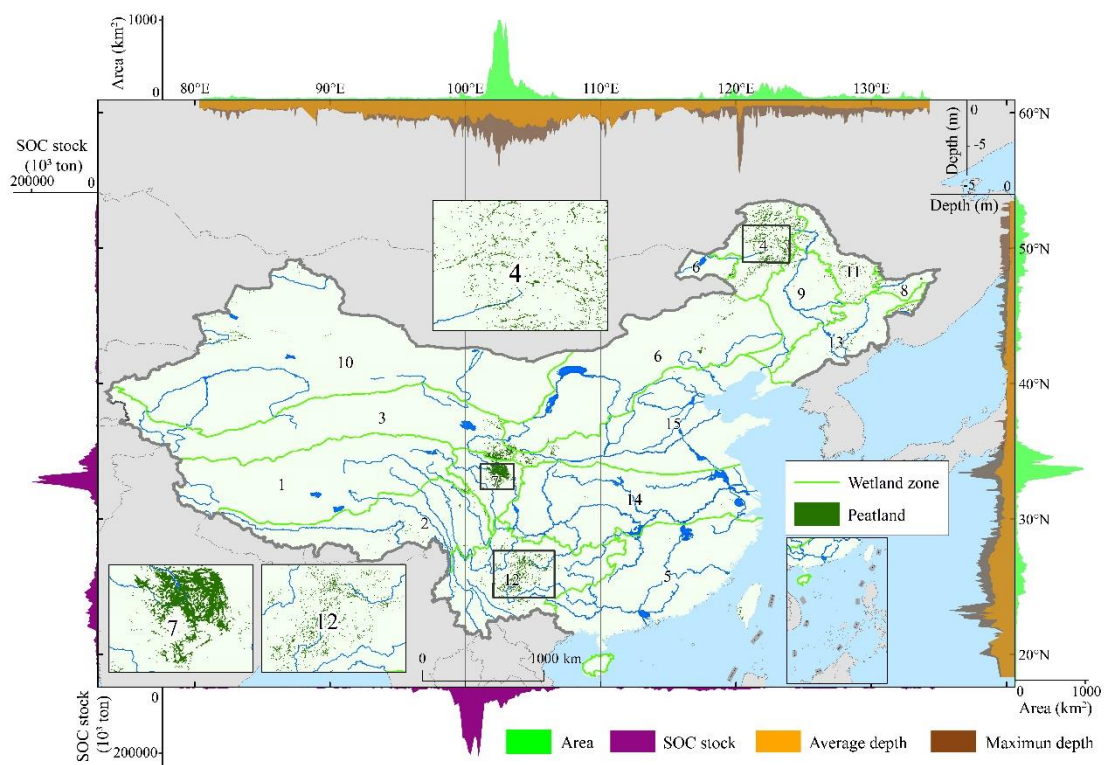


Figure 1. National distribution of peatlands in China with associated depth, area, and carbon stock metrics. The figure represents integrated data reflecting conditions during the 2010 – 2020 baseline period.

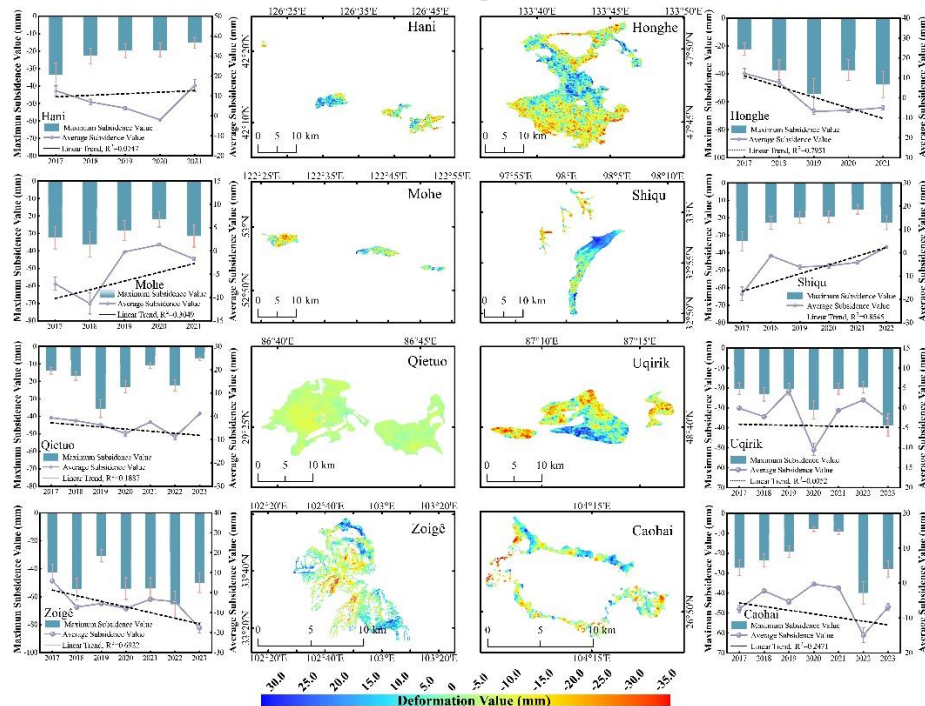


Figure 2. Interannual surface deformation of eight representative peatlands across China based on SBAS-InSAR analysis.

Reviewer #1, Comment 3:

Figure 2: The authors stated that they used LOESS to fit the trend lines in Figure 2. Based on my experience, LOESS is typically more useful for fitting a curve rather than a straight line. The lines shown in the figure look more like the result of a linear regression. Please double-check the method used to generate these lines and adjust the description accordingly.

Response:

We thank the reviewer for this careful observation. The misunderstanding arose from our previous response letter, where we mistakenly described the fitting method as LOESS. In fact, the trend lines in Figure 2 were generated using linear regression. To avoid any confusion, we have revised the legend in Figure 2 to clearly state “Linear trend”. The revised version of Figure 2 is shown above.

Reviewer #2:

The changes made to the manuscript in response to the comments from myself and Reviewer 1 are satisfactory. The manuscript is improved relative to the earlier version and suitable now for publication.

Response:

We sincerely thank the reviewer for their positive evaluation and encouraging remarks. We are pleased that the revisions have improved the manuscript. We are very grateful for the reviewer's support throughout the review process.