#Reviewer 2

General comments:

The manuscript presents interesting case studies that contribute to the understanding of outburst processes and introduces valuable data that could enhance knowledge of natural hazards. However, the depth of the presentation and interpretation is somewhat lacking. Conclusions are often drawn too quickly, with the authors frequently suggesting the need for further research without fully engaging with the existing data. This limits the overall impact of the study.

The explanation of methods and the presentation of results are imprecise. Some data and results, particularly in Section 3.3, are introduced abruptly, and the connection to broader findings is not always clear. Moreover, the discussion is superficial, leaving the reader with unanswered questions about the mechanisms being studied.

A significant issue lies with the figures, which, while containing essential information and most of the results presented, are often difficult to interpret. The explanations provided are too brief. Clearer, more detailed descriptions and better-structured visual aids are needed to improve the flow of information and help readers understand the material presented. Additionally, numerous textual errors and a lack of precision in technical details reduce the manuscript's clarity and understanding, weakening its overall impact.

Response: We sincerely thank the reviewer for the constructive comments, which has greatly contributed to the improvement of our manuscript. In response to the comments, we have carefully revised the manuscript to strengthen the depth of our analysis. To address concerns about drawing quick conclusions, we included additional evidence and detailed reasoning to support our conclusions.

To improve clarity in the methods and result sections, we have added more detailed explanations of the methodologies used, ensuring a clearer understanding of our approach. Additionally, in Section 3.3, we have revised the title to "3.3 Climate mechanisms of recent lake outbursts" and strengthened the presentation of climate mechanisms to make clear the purpose and necessity of examining the atmospheric mechanisms of precipitation. This change improves the relevance to earlier sections of the manuscript. The discussion has been expanded to include comparisons between the outburst events discussed in our study and other type events on the Tibetan Plateau. This comparative analysis highlights the distinct causes and responses of different outburst events, enriching the overall context.

Furthermore, we have made substantial revisions to the figures, improving their clarity and interpretability. These changes include reorganizing certain figures, adding clearer labels, and expanding the figure captions to provide more comprehensive explanations. Additionally, we have added new figures to better support the findings and enhance the manuscript's overall readability. We have carefully read the text to eliminate any technical errors and ensure greater precision throughout the manuscript. We appreciate the reviewer's valuable suggestions, which have been helpful in refining and improving our work. Below, please find our detailed responses to the original feedback. For clarity, the original reviewers' comments are presented in black, and our responses are shown in blue.

Specific comments

L46-48: Why are alpine lakes considered sentinels of climate change?

Response: Alpine lakes, located in climate-sensitive regions (such as the Tibetan Plateau), are directly influenced by climate factors such as glacier/snow melt, precipitation, and evaporation, making their response to climate change rapid and significant. Additionally, the relatively closed ecosystems of alpine lakes make it easier to observe the impacts of climate change on lakes. Furthermore, as long-term monitoring targets, alpine lakes provide direct evidence of climate change through recorded changes in sensitive indicators such as lake

area, water level, ice cover duration, and surface water temperature. Therefore, they are regarded as sentinels of climate change. Some related papers below also support this.

Zhang, G., and S. Duan (2021), Lakes as sentinels of climate change on the Tibetan Plateau, All Earth, 33(1), 161-165, doi: 10.1080/27669645.2021.2015870

Adrian, R., C. M. O'Reilly, H. Zagarese, S. B. Baines, D. O. Hessen, W. Keller, D. M. Livingstone, R. Sommaruga, D. Straile, and E. Van Donk (2009), Lakes as sentinels of climate change, *Limnol Oceanogr*, *54*(6), 2283–2297, doi: 10.4319/lo.2009.54.6_part_2.2283

L107-L116: It is not very clear how the PlanetScope imagery was used. Was it employed as orthophoto for visual interpretation and lake delineation, or was it to compute NDWI using the NIR and Green bands?

Response: In our study, the PlanetScope imagery was used to track the outburst process of Selin Co by visual interpretation, and to extract the area of Selin Co during 2022-2023 based on the NDWI index. To be clearer, we have improved the sentence as "*High-resolution PlanetScope satellite images with 3-m pixel and a 1-day cycle, were used to track the lake outburst process of Selin Co by visual interpretation, and to map the area change of Selin Co during 2022-2023 based on the NDWI index.*".

L133: "The area-water level relationship was used to obtain water levels from the 1970s to 2023." It's not clear what relationship the authors are referring to here.

Response: The area-water level relationship means the significant linear relationship between lake area and water level. Based on this relationship, we can estimate the area change by inputting water level, or water level change by inputting area. For example, LELVEL=0.015*AREA+4512.749 is the relationship between water level and area in Selin Co. We have improved this sentence as: "*The area-water level linear relationship was used to obtain water levels from the 1970s to 2023 by inputting lake area (Zhang et al., 2021)*".

L118-134: If I understood correctly, they calculated water levels using Sentinel-3 for the period ranging from 2016-2024 and using CryoSat-2 for 2010-2020? Did the authors intend to have this overlap? Or did I miss something? This section (2.2) could be slightly rearranged to improve readability.

Response: Thank you for your careful comment. CryoSat-2 data was used in previous study but not this. We apologize for the confuse in the text, and we have removed the mention of CryoSat-2 to clarify this.

L148: What is the resolution of NASADEM? Is it relevant to use that data source to define the depth of the breach for modeling?

Response: The spatial resolution of NASADEM is 30 m, but it is not relevant to determining the breach depth. The previous breach depth was estimated based on the assumption of a gentle slope at the breach site. However, the current breach depth is based on field measurements from Lei et al. (2024).

Reference:

Lei, Y., J. Zhou, T. Yao, B. W. Bird, Y. Yu, S. Wang, K. Yang, Y. Zhang, J. Zhai, and Y. Dai (2024), Overflow of Siling Co on the central Tibetan Plateau and its environmental impacts, Sci Bull. doi: 10.1016/j.scib.2024.07.035.

L152-153: How did the authors estimate the depth of the breach? It's only written "due to the flat topography," but I'm wondering how they concluded it was 0.8m?

Response: The previous breach depth was estimated based on the assumption of a gentle slope at the breach

site. However, the current breach depth (2 m) in the revised manuscript is based on field measurements from Lei et al. (2024). After all the parameters were updated, we rerun the model and have improved this sentence as: "*The depth of the breach was set to 2 m, which is based on field measurements (Lei et al., 2024)*".

Reference:

Lei, Y. et al., 2024. Overflow of Siling Co on the central Tibetan Plateau and its environmental impacts. Sci Bull. doi:10.1016/j.scib.2024.07.035.

L153: How did they determine the breach formation time? Were there any eyewitness accounts?

Response: We thank the reviewer for this question. The breach formation time was initially based on assumptions but is now accurately determined using high-resolution PlanetScope imagery in the revised manuscript. Specifically, the breach width was approximately 60 m on 23 September 2024, expanded to ~160 m by 27 September, reached ~180 m by 3 October, and finally developed to ~200 m on 8 October. Based on this progression, we determined that the breach formation time took 18 days, beginning from the initial breach on 21 September. After all the parameters were updated, we rerun the model. We have improved this sentence as: "*The width and breach formation time of the breach was determined by tracking its progression using high-resolution PlanetScope imagery. Specifically, the breach width was approximately 60 m on 23 September 2024, expanded to ~160 m by 27 September, reached ~180 m by 3 October, and finally developed to ~200 m on 8 October. Based on this progression, we estimated that the breach formation time took 18 days beginning from the initial breach on 21 September and width of breach was 200 m*".

L154: Based on which parameters did the authors set the Manning roughness to 0.04?

Response: The Manning roughness coefficient was set to 0.04 based on field surveys, which showed that the river channel area is covered by sparse herbaceous vegetation. We have improved this sentence as: "*The Manning roughness coefficient was set to 0.04 based on field surveys, which showed that the river channel area is covered by sparse herbaceous vegetation.*".

L184: What do the authors mean by "long- and short-changes"?

Response: The "long-changes" refer to precipitation changes over several decades, while "short-changes" indicate precipitation variations occurring shortly before the lake outburst event. We have clarified these terms in the revised manuscript as "*The daily in situ precipitation records from the China Meteorological Administration (https://www.cma.gov.cn) were used to the analyze long changes overs several decades and precipitation variations occurring shortly before the lake outburst event*".

L233: Is there any measurement of Zonag Lake's area between August 22, 2011, and September 15, 2011?

Response: Yes, the area of Zonag Lake in August 22, 2011 and September 15, 2011 is from the Chinese HJ-A/B satellites satellite observation (Liu et al., 2016). These satellite measurements provide accurate data for assessing the lake's changes during this period. We have improved the sentence as "*The lake area of Zonag Lake reduced by ~107.52 km2 observed by Chinese HJ-A/B satellites satellite within 28 days (~3.84 km2/day) (Liu et al., 2016)*".

Reference:

Liu, B., Y. e. Du, L. Li, Q. Feng, H. Xie, T. Liang, F. Hou, and J. Ren (2016), Outburst Flooding of the Moraine-Dammed Zhuonai Lake on Tibetan Plateau: Causes and Impacts, IEEE Geoscience and Remote Sensing

Letters, 13(4), 570-574.doi: 10.1109/lgrs.2016.2525778.

Figures 3i and 3j: What are they used for? What do they illustrate? I'm not sure how they contribute to the interpretation.

Response: Figures 3i and 3j illustrate the impact of the outburst event. To improve clarity, we have added the description and arrows to the panels to better facilitate understanding. The figure was referenced in the subsection "4.2 Consequences of Zonag Lake and Selin Co outburst" to highlight the specific effects of the outburst.

In Figure 4, I'm not sure how the profile P1-P2 is relevant.

Response: The profile P1-P2 illustrates the elevation change along the river channel between Selin Co and Bange Co before the Selin Co outburst. This profile is relevant as it shows that the water level in Selin Co had risen to the maximum level that the basin could contain, providing important context for the outburst event.

Figures 6g and 6h: It might be interesting to add the location of the built dam. I think I misunderstood something because, regarding Figures 6e and 6g, it seems that the water depth increased between September 28 and October 13, but the inset shows no variation.

Response: Thank you for the suggestion. We have added the location of the built dam in original Figures 6g and 6h (now Figures 8g and 8h). The water depth of Bange Co increased between September 28 and October 13 due to the inflow from the Selin Co outburst flood. However, the inset shows the water depth at the damaged road, not in Bange Co.

Figures 7a and 7b: What about the peaks in 2008 and 2002, respectively, for Selin Co and Zonag Lake? Did they induce any hazards in the region?

Response: Original Figures 7a and 7b (now merge them into Figure 3a, b) show the interannual variation in precipitation, with peaks in 2008 for Selin Co and 2002 for Zonag Lake representing sudden increases in annual precipitation observed at nearby stations. These peaks contributed to the expansion of the lakes but did not induce any hazards, as the lakes had not yet reached the maximum extent to trigger an outburst during this period.

L316-317: The authors stipulate, "In addition, seismic events prior to the breach may have weakened the geological stability of the dam (Liu et al., 2016)." I found this statement a bit vague. I would prefer some specifics about these events (location, intensity, impact).

Response: Thank you for the suggestion. We have added specific descriptions for the seismic events as: "*Additionally, two seismic events occurred prior to the breach: one on 27 July 2011 (62 km from Zonag Lake, magnitude 4.0), and another on 22 August 2011 (57 km from Zonag Lake, magnitude 3.1). These events may have weakened the geological stability of the lake dam (Liu et al., 2016)*".

Figures 8e and 8f need to be described in more detail for non-expert readers (the explanation of the x-axis comes in Figure 9, but it should be detailed earlier).

Response: Thank you for your suggestion. We have added more detail in caption as "*(e, f) The contribution of each term (precipitation (P'), Evaporation (E'), the change in vertical ($-\langle\omega\partial_p q\rangle'$) and horizontal moisture advection ($-\langle \boldsymbol{V}_h \cdot \nabla_h q\rangle'$), residual ter effects m (δ), thermodynamic effects $-\langle\bar{\omega}\partial_p q'\rangle$, dynamic ($-\langle\omega'\partial_p \bar{q}\rangle$), the nonlinear effects ($-\langle\omega'\partial_p q'\rangle$)) of moisture budget components (mm/day) to precipitation changes averaged over*

the Zonag Lake and Selin Co basins."

L330: I don't clearly see the "continuous heavy or extreme precipitation prior to the outburst" mentioned by the authors.

Response: Thank you for the question. We have added a subplot in original Figure 7 (now Figure 4) to show the daily precipitation changes prior to the outburst based on data from a nearby weather station, which indicate the continuous heavy precipitation prior to the outburst (Figure 4).

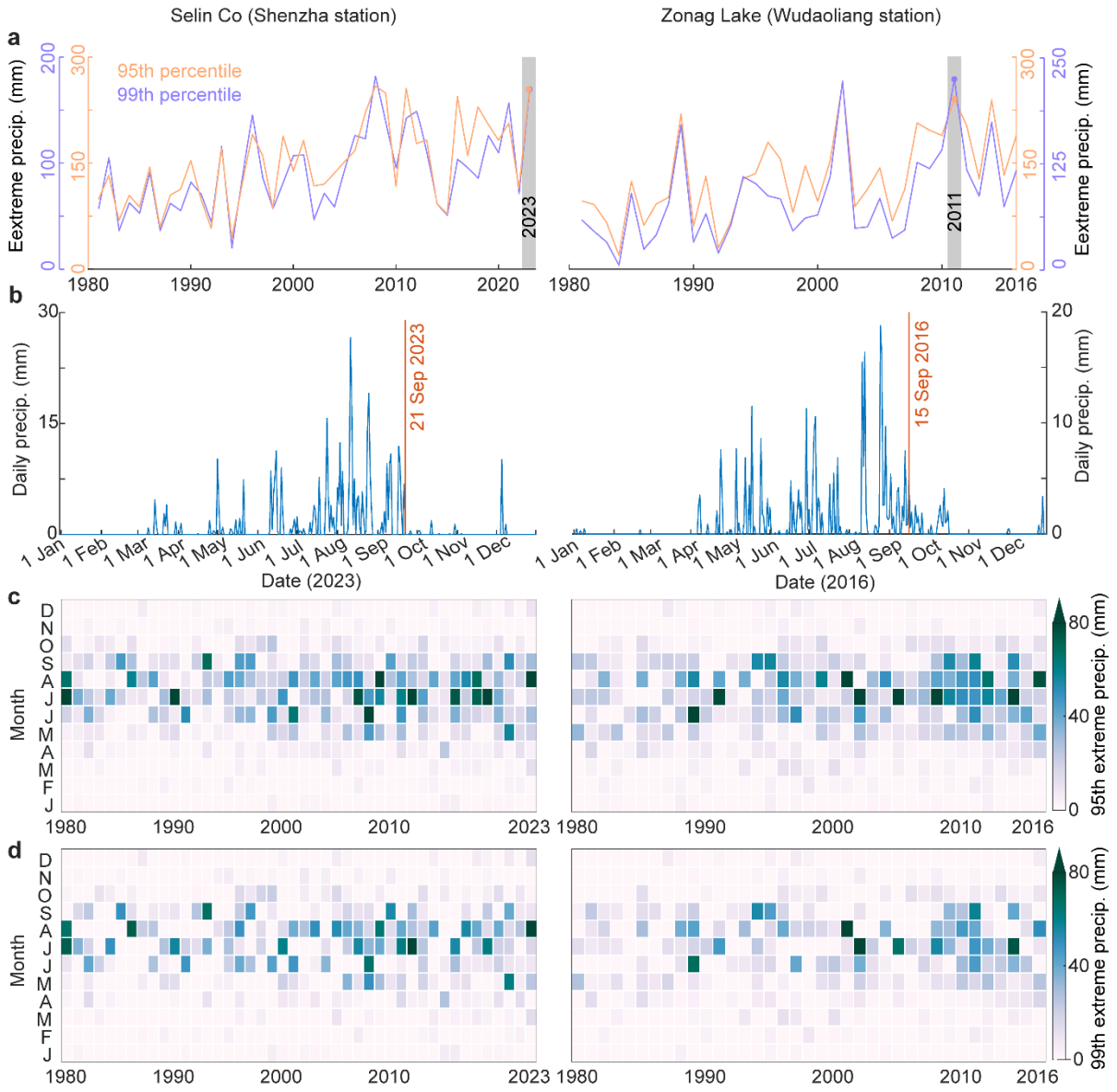

Figure 4 (original Figure 7). The change in extreme precipitation derived from Shenzha (near Selin Co) and Wudaoliang (near Zonag lake) weather stations. (a) Extreme precipitation (total precipitation that exceeds a 95th and 99th percentile during the historical period from 1981 to 2010) change from 1980 to 2023. (b) The daily change of precipitation prior to the outburst. (c) Monthly extreme precipitation change based on the 95th percentile from 1980 to 2023. (d) Monthly extreme precipitation change based on the 99th percentile from 1980 to 2023. The location of the weather station was shown in Figure 1.

L375: "…with the wave train in 2011 being relatively flat and the wave train in 2023 being curved." What does

this observation imply?

Response: Thanks. The propagation of wave activity fluxes can induce changes in downstream circulation through the process of energy dispersion. Hence, the propagation path of wave activity flux plays a crucial role in the evolution of downstream circulation patterns. As shown in Figure 10, the propagation path of wave activity flux in 2011 is relatively flat, whereas in 2023, it follows a more curved trajectory. The discrepancies in propagation path of wave activity flux between 2011 and 2023 led to variations in regional atmospheric circulation around the TP.

L395: "Pacific Decadal Oscillation (PDO), and Atlantic Multidecadal Oscillation (AMO)." A few words about this would be appropriate. Also, the authors cite "2023," but is that correct? What is the year 2023 referencing?

Response: Thanks. We have added relevant content. "*The decadal increase in precipitation on the TP can be attributed to the external forcing, Pacific Decadal Oscillation (PDO), and Atlantic Multidecadal Oscillation (AMO) (Liu et al. 2021, 2023). For example, the combined influence of external forcing and the PDO could result in an anomalous cyclone over the Inner-TP and a weakened East Asian westerly jet, subsequently contributing to the decadal increase in precipitation in the Inner-TP (Liu et al. 2023). A positive phase of the AMO may lead to a northward shift and weakening of the subtropical westerly jet stream, which in turn affects moisture transport and results in changes in precipitation patterns (Liu et al., 2021; Sun et al., 2020)*".

References:

Liu, Y., H. Chen, H. Li, G. Zhang, and H. Wang (2021), What induces the interdecadal shift of the dipole patterns of summer precipitation trends over Tibetan Plateau. International Journal of Climatology. 41(11): 5159-5177.

Liu, Y., H. Wang, H. Chen, Z. Zhang, H. Li, and B. Liu (2023), Anthropogenic forcing and Pacific internal variability-determined decadal increase in summer precipitation over the Asian water tower. npj Climate and Atmospheric Science. 6: 38.

Sun et al., (2020), Why has the Inner Tibetan Plateau become wetter since the mid-1990s? Journal of Climate. 33(19): 8507-8522.

L437-442: "This outburst resulted in a significant increase in discharge pressure in the downstream river channels, which had substantial impacts on human living environments, affecting five townships and resulting in the death of approximately 195 livestock. Additionally, about 24.95 km of roads and pastoral paths and some water management facilities were destroyed by flooding, and some pastures were also inundated. Emergency repairs were promptly undertaken, and the damaged gate was sealed on February 21." Any citation for this information?

Response: This information is from CCTV NEWS. We have added the citation in revised manuscript as: "*Wang, H. Flooding in Qinghai Province? Official response: not consistent with the facts did not cause casualties. https://news.cctv.com/2024/03/02/ARTIwBthTZFUklWgPzClQmOu240302.shtml, CCTV NEWS, last access: 15 October 2024.*"

Technical corrections

L52: "The significant expansion of these lakes could potentially threaten the fragile …"

Response: Thanks. We have improved this sentence as: "The significant expansion of these lakes could threaten the fragile ecological environment of the TP, particularly by inundating grasslands, altering water resources, disrupting habitats, and impacting biodiversity (Xu et al., 2024a)."

Figure 1: a. The areas corresponding to Zonag Lake basin and Selin Co basin could be colored in a darker grey because they are not very visible as they are. Perhaps the authors could use the same blue as in Fig. 1a-1 and 1a-2. Additionally, orange is used in Fig. 1a-1 to show the diversion engineering, but it shows a newly formed channel in Fig. 1a-2. The authors could consider using another color. "Lake" is missing in the legend of Fig. 1a-1, and I believe it should be "Newly formed channel" and not "formd" in the legend of Fig. 1a-2.

Response: Thank you for your helpful suggestions. We have improved by the following: the Zonag Lake and Selin Co basin areas are now colored in the same blue as in Fig.1a-1 and 1a-2 for better visibility. Additionally, the color of the newly formed channel in Fig. 1a-2 has been changed from orange to yellow to avoid confusion with other elements. The missing "Lake" in the legend of Fig.1a-1 has been added, and the term "formd" in Fig.1a-2 legend has been corrected to "formed".

Figure 1a-1 refers to Salt Lake, but it is not mentioned in the text. What about Yanhu Lake mentioned on line 65?

Response: The term "Salt Lake" has been corrected to "Yanhu Lake" for consistency with the text.

Figure 1a-2: Correct "formd" to "formed" in the legend.

Response: Corrected.

L97-99: The authors could quantify what they meant by "low cloud cover" and specify which months?

Response: Thank you for your valuable comment. From the MODIS-observed cloud-cover cycle, it can be found that cloud cover is significantly higher in summer (>50%) compared to autumn and winter. Additionally, lake area extraction in spring and winter are often affected by lake ice cover and snowfall, resulting in inaccurate lake boundaries. For this reason, we prioritize autumn, particularly October, when cloud cover is lower, and the lake area is more stable, reaching its annual maximum. We have added more detail as: "*Based on the MODIS-observed cloud-cover cycle, it can be found that cloud cover is significantly higher in summer (>50%) compared to autumn and winter (Zhang et al., 2017a). Additionally, lake outline extraction in spring and winter are often hampered by frozen ice cover and snow, resulting in inaccurate lake boundaries. Therefore, October images are prioritized due to the low cloud cover and relative stability of the lake area (annual maximum).*"

L100: Use "Green" instead of "GREEN."

Response: Corrected.

L107: Since the authors specify the spatial resolution of PlanetScope satellite images, they might also add the spatial resolutions of Sentinel-2 and Landsat-8, which were also used.

Response: Thank you for the suggestion. We have added the spatial resolutions of Sentinel-2 and Landsat-8 to the revised manuscript.

The authors could add references regarding the technical specifications of the satellites, as an example: "Since June 2016, over 430+ Doves and SuperDoves sensors from the PlanetScope mission have been launched into 475-525 km sun-synchronous orbits, circling the Earth every 90 minutes." [L108-110], or "Sentinel-3A and Sentinel-3B were launched in February 2016 and April 2018, respectively, both equipped with a dual-frequency (Ku and C-band) Synthetic Aperture Radar Altimeter operating in open-loop mode with a cycle period of 27

days, providing high-quality observations of lake water levels." [L120-123].

Response: Thank you for the suggestion. References to the technical specifications of PlanetScope, Sentinel-2, Landsat-8, and Sentinel-3 have been added to enhance the clarity of the methodology.

References:

Mullen, A. L., et al. (2023), Using High-Resolution Satellite Imagery and Deep Learning to Track Dynamic Seasonality in Small Water Bodies, Geophysical Research Letters, 50(7). doi: 1029/2022gl102327, 2023. (**for PlaneScope**).

Xu, F., G. Zhang, S. Yi, and W. Chen (2021), Seasonal trends and cycles of lake-level variations over the Tibetan Plateau using multi-sensor altimetry data, Journal of Hydrology, 604, 127251.doi: 10.1016/j.jhydrol.2021.127251. (**for Sentinel-3**).

Yang, X., Q. Qin, H. Yésou, T. Ledauphin, M. Koehl, P. Grussenmeyer, and Z. Zhu (2020), Monthly estimation of the surface water extent in France at a 10-m resolution using Sentinel-2 data, Remote Sensing of Environment, 244. doi: 10.1016/j.rse.2020.111803. (**for Sentinel-2**).

Zhang, G., et al. (2019), Regional differences of lake evolution across China during 1960s–2015 and its natural and anthropogenic causes, Remote Sensing of Environment, 221, 386-404. doi: 10.1016/j.rse.2018.11.038. (**for Landsat**).

Equation 1: What does "Halt" stand for?

Response: Thank you for pointing this out. H_{alt} represents the satellite altitude. We have clarified this in the revised manuscript by extending the sentence: "H_{alt} *is the satellite altitude*".

L187: Be consistent in writing dates.

Response: We have rechecked the writing dates throughout the text and unified the date format.

L239: Be consistent with the names of the lakes (i.e., Hedin Noel Lake differs in Figure 3a).

Response: Corrected.

Figure 3: Due to the size of the second graph focusing on the years 2022 to 2024, Figure 3c appears unclear. Perhaps the readability of this graph could be improved.

Response: Thank you for your comment. In Figure 3, we firstly aim to show the long-term variation of Selin Co area from 1975 to 2023, as the lake expansion serves as the foundation for the breach. Additionally, we included an inset focusing on the 2022 to 2024 period to highlight recent changes in Selin Co area. The inset was designed to emphasize short-term variations without losing sight of the broader long-term trend. To further emphasize the changes between 2022 and 2024, we have enlarged the size of the illustration to improve readability.

Figures 4, 5d, and 6: The authors should add a scale and a North arrow.

Response: Added.

Typographical Error: "Flood conditions on September 27, 2023" (also correct "September 28" on the left side of the figure).

Response: Thanks. We have improved this sentence to "*Flood simulation on 28 September 2023*".

Figure 8a-d: Please add the locations of Zonag Lake and Selin Co.

Response: Thanks. We have added a yellow box in Figure 8a-d to represent the locations of Zonag Lake and Selin Co (new Figure 9).

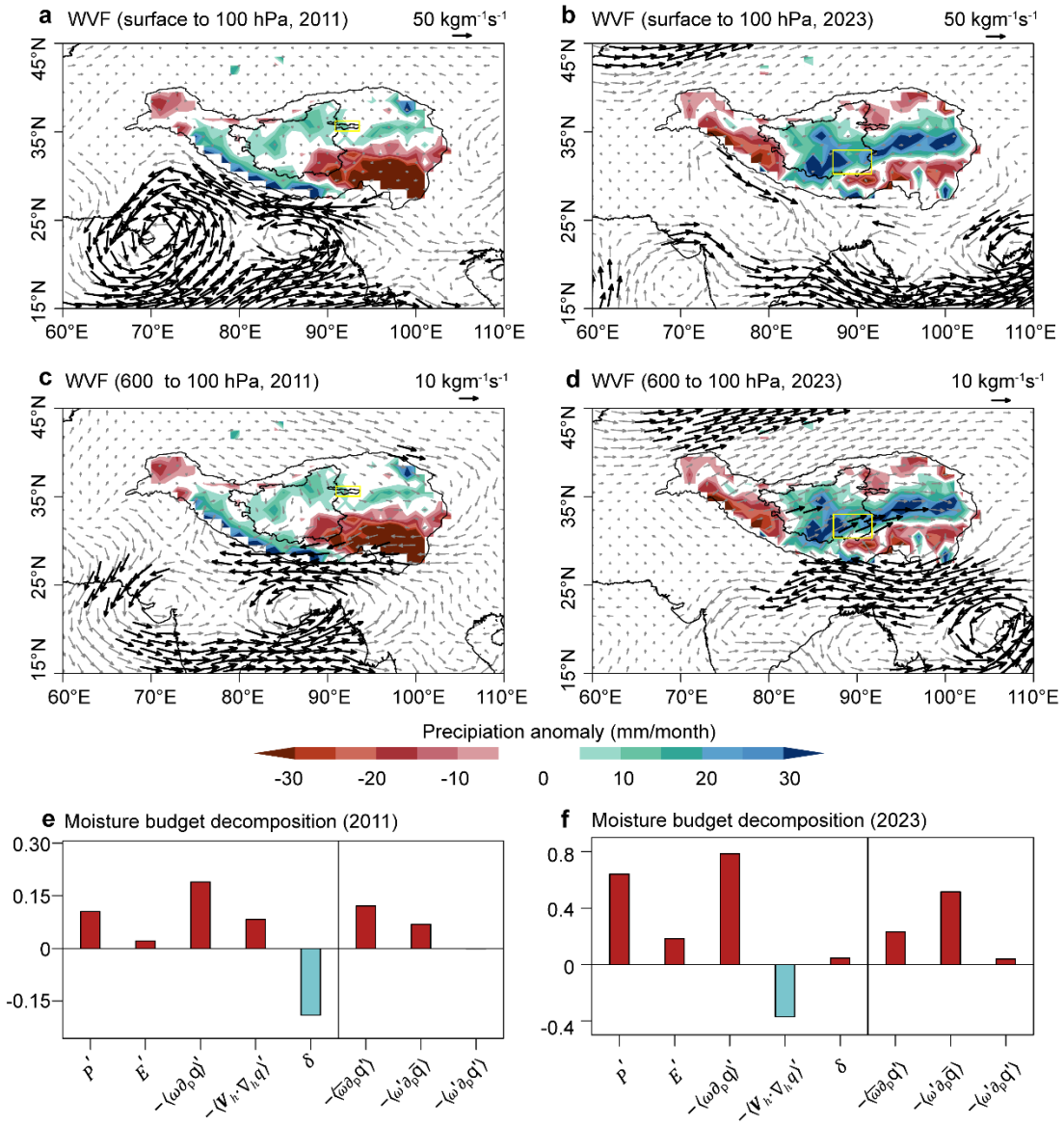

Figure 9 (original Figure 8). The atmospheric mechanism of precipitation-induced events in Zonag Lake and Selin Co. (**a, b, c, d**) Composite maps of anomalous vertically integrated moisture flux based on ERA5 data (WVF; integrated from surface to 100 hPa and from 600 to 100 hPa; vector; $kgm^{-1}s^{-1}$) in Zonag Lake basin during 2011 and Selin Co basin during 2023. The shading indicates precipitation anomalies. The black vectors indicate WVF exceeds the reference value. The reference climate state was selected as the average from 1981 to 2010. The yellow boxes represent the location of the Zonag Lake and Selin Co, respectively. (**e, f**) The contribution of each term (precipitation (P'), Evaporation (E'), the change in vertical ($-\langle\omega\partial_p q\rangle'$) and horizontal moisture advections ($-\langle \boldsymbol{V}_h \cdot \nabla_h q\rangle'$), residual term ($\delta$), thermodynamic $-\langle\bar{\omega}\,\partial_p q'\rangle$, dynamic ($-\langle\omega'\,\partial_p \bar{q}\rangle$), and the nonlinear effects ($-\langle\omega'\,\partial_p q'\rangle$)) of moisture budget components (mm/day) to precipitation changes averaged over the Zonag Lake and Selin Co basins.

Figures 8e and 8f must be described in more detail for non-expert readers (the explanation of the x-axis comes

in Figure 9, but it should be detailed earlier).

Response: Thank you for your suggestion. We have added more detail in caption as "*(e, f) The contribution of each term (precipitation (P'), Evaporation (E'), the change in vertical ($-\langle\omega\partial_p q\rangle'$) and horizontal moisture advection ($-\langle \boldsymbol{V}_h \cdot \nabla_h q\rangle'$), residual ter effects m (δ), thermodynamic effects $-\langle\bar{\omega}\partial_p q'\rangle$, dynamic ($-\langle\omega'\partial_p \bar{q}\rangle$), the nonlinear effects ($-\langle\omega'\partial_p q'\rangle$)) of moisture budget components (mm/day) to precipitation changes averaged over the Zonag Lake and Selin Co basins.*"

The legend of Figure 9 is unclear; the letters are not in order, and there is no consistency in the typographical style used (e.g., (i) is not in bold).

Response: Thank you. We have revised the legend of Figure 9 (now Figure S4) to ensure that the caption letters are now in the correct order. The updated legend now is: "***Figure S4***. *The moisture budget components (mm/day) in 2011. (**a**) precipitation (P'). (**b**) Evaporation (E'). (**c**) residual term. The horizontal moisture advection induced by (**d**) thermodynamic $-\langle\bar{\omega}\partial_p q'\rangle$, (**e**) dynamic $-\langle\omega'\partial_p \bar{q}\rangle$ and (**f**) the nonlinear component $-\langle\omega'\partial_p q'\rangle$. The horizontal moisture advection induced by (**g**) moisture changes $-\langle \boldsymbol{V}_h \cdot \nabla_h q'\rangle$, (**h**) anomalous winds $-\langle \boldsymbol{V}'_h \cdot \nabla_h q\rangle$ and (**i**) the nonlinear component $-\langle \boldsymbol{V}'_h \cdot \nabla_h q'\rangle$*".