Response to comments of RC1

Thank you very much for your positive comments and suggestions. We have carefully revised the original manuscript according to your suggestions. All changes are marked by red color in the revised manuscript.

Below is our response to the key points raised in the review:

* Technical details for model methods are confusing. For example, section 3.1.1. The temperature equation presents an energy balance equation which includes a temperature term, presumably the temperature of the glacier ice. But is it the temperature of the glacier at the surface? The bed? How does the temperature of the bedrock (Equation 7) enter this modeling of ice temperature?

A: Thank you very much for your constructive comments. In section 3.1.1, the temperature variable T represents the internal temperature field of glacier ice, and the energy transfer process of the temperature field includes heat convection and heat exchange. The glacier surface temperature and basal temperature are not solved variables but are prescribed through boundary conditions. Equation 7 is the boundary condition of the energy balance equation, and the glacier base temperature is given by Equation 7 as the boundary condition. We have clearly explained the physical meaning of the temperature variable in Section 3.1.1 of the revised manuscript.

* Establish context for modeling choices. Subglacial water flow section needs to reference other work that uses this modeling approach, more recent than Richard (1931).

A: Accepted the reviewer's suggestion. Although the Richards equation was originally proposed by Richards (1931), it remains the fundamental governing equation for unsaturated flow in porous media and has been widely applied in modern glacier hydrology and subglacial drainage studies. In particular, it has been used to describe meltwater transport within subglacial sediments beneath temperate glaciers. We have supplemented the references in recent years in the paper.

The Richards equation is the classical governing equation for unsaturated flow in porous media and has been widely used in glacier hydrology and subglacial drainage studies to describe meltwater transport within subglacial sediments and ice–till mixtures beneath temperate glaciers (Hewitt, 2011; Werder et al., 2013; de Fleurian et al., 2014). Therefore, the Richards equation is adopted here to represent subglacial unsaturated water flow.

Hewitt, I. J.: Modelling distributed and channelized subglacial drainage: the spacing of channels. Journal of Glaciology. 57(202), 302-314. https://doi.org/10.3189/002214311796405951, 2011.

Werder, M. A., Hewitt, I. J., Schoof, C. G., and Flowers, G. E.: Modeling channelized and distributed subglacial drainage in two dimensions. Journal of Geophysical Research: Earth Surface. 118, 2140–2158. https://doi.org/10.1002/jgrf.20146, 2013.

de Fleurian, B., Gagliardini, O., Zwinger, T., Durand, G., Le Meur, E., Mair, D., and Råback, P.: A double continuum hydrological model for glacier applications. The Cryosphere. 8, 137–153. https://doi.org/10.5194/tc-8-137-2014, 2014.

* The model spatial and time domains are unclear. Eventually, the reader can understand that the model results are for a cross-section (2D) spatial domain of the study glacier, but this – and the time domain – are not clearly communicated in the model methods section. For example, Figure 12 shows "Year 0-10" on the x-axis but what are the corresponding calendar years?

A: Thank you for this important comment. We agree that the spatial and temporal domains of the model should be more clearly specified.In this study, the thermo-hydromechanical model was implemented in COMSOL as a two-dimensional longitudinal cross-section of the study glacier under plane strain conditions (see Fig. 10d). The spatial domain corresponds to the central flowline section of the glacier.The model was solved as a transient simulation with a total duration of 10 years. The simulation start time corresponds to the beginning of field monitoring, i.e., October 2023. Therefore, the modeled time period spans from 2023 to 2033.In the revised manuscript, we have clarified the spatial domain (2D cross-section) and temporal domain (2023 – 2033) in section 3.2. The x-axis of Figure 12 has also been revised to indicate the corresponding calendar years.

* How does the modeled stress field evolve? Line 262-263 "First, the stress field of the model under gravity is calculated" yet gravity is always the driving force for the glacier. This condition does not change. The geometry (surface slope, ice thickness) can change the driving stress, but does the model evolve these terms?

A: Thank you for this insightful comment. We agree that gravity is the persistent driving force of glacier motion and remains active throughout the entire simulation.

The initial gravity-only calculation is performed to establish geostatic equilibrium and generate a physically consistent initial stress field without artificial initial strain. This step ensures that the model begins from a mechanically balanced state.

During the subsequent transient thermo-hydromechanical simulation, gravity continues to act, and the stress field evolves dynamically. The mechanical behavior of glacier ice is described using the Mohr-Coulomb yield criterion combined with the strength reduction method. Importantly, the cohesion (c) and internal friction angle (φ) are defined as temperature-dependent functions based on experimental fitting. Therefore, as the temperature field evolves over time, the material strength parameters change, leading to redistribution of stresses and progressive weakening.

In the model, the glacier geometry (surface slope and ice thickness) is prescribed and does not evolve. Thus, the magnitude of the gravitational driving stress associated with geometry remains constant, while the internal stress state evolves due to coupling effect and strength degradation.

We have clarified this in the revised manuscript.

* Insufficient technical detail for input data. The DEM used to define the study glacier surface is from earthexplorer.usgs.gov but this citation is too general. What was the method of DEM development? What is DEM uncertainty?

A: Thank you for this important comment. We agree that it is necessary to specify the DEM dataset and its characteristics. We have revised the manuscript to explicitly specify the DEM dataset, its spatial resolution, generation method, and uncertainty.

In this study, the glacier surface topography was derived from the SRTM 1 Arc-Second Digital Elevation Model (30 m resolution), acquired via the USGS EarthExplorer platform. The SRTM DEM was generated using C-band radar interferometry during the Shuttle Radar Topography Mission. The vertical accuracy of the SRTM DEM is reported to be approximately ±16 m at 90% confidence globally. There are voids in SRTM data in areas such as high and steep mountains and extreme terrain, which can be filled by interpolation and other methods.

In order to analyze the velocity, temperature and stress distribution of the Midui glacier, a two-dimensional numerical simulation was established. Firstly, the cross-section line is drawn based on the centerline of the glacier movement (Fig. 6a). As shown in Fig. 6b and c, the topography of the surface and base is obtained from the surface elevation and ice thickness data (The DEM data were acquired from: https://earthexplorer.usgs.gov/, and the glacier thickness were acquired from: https://www.research-collection.ethz.ch/handle/20.500.11850/315707). The glacier surface topography was derived from the SRTM 1 Arc-Second Digital Elevation Model (30 m resolution). The SRTM DEM was generated using C-band radar interferometry during the Shuttle Radar Topography Mission. The vertical accuracy of the SRTM DEM is reported to be approximately ±16 m at 90% confidence globally. There are voids in SRTM data in areas such as high and steep terrain, which can be filled by interpolation and other methods.The base topography is the surface elevation minus the ice thickness. Finally, the two-dimensional cross-section of the Midui glacier is obtained, and the 2D cross-section of the glacier is drawn in actual proportion (Fig. 6d). The length of the glacier computational domain is 874.7 m, and the altitude difference is 730 m. The thickest of glacier reaches 77.9 m, and the thinnest is 9.37 m. The thickness of the subglacial water flow permeability layer was assumed to be 1 m.

The numerical model was implemented in COMSOL using a two-dimensional longitudinal cross-section. The model was solved in a transient framework with a total simulation duration of 10 years. The simulation start time is October 2023, and the modeled period spans from 2023 to 2033.
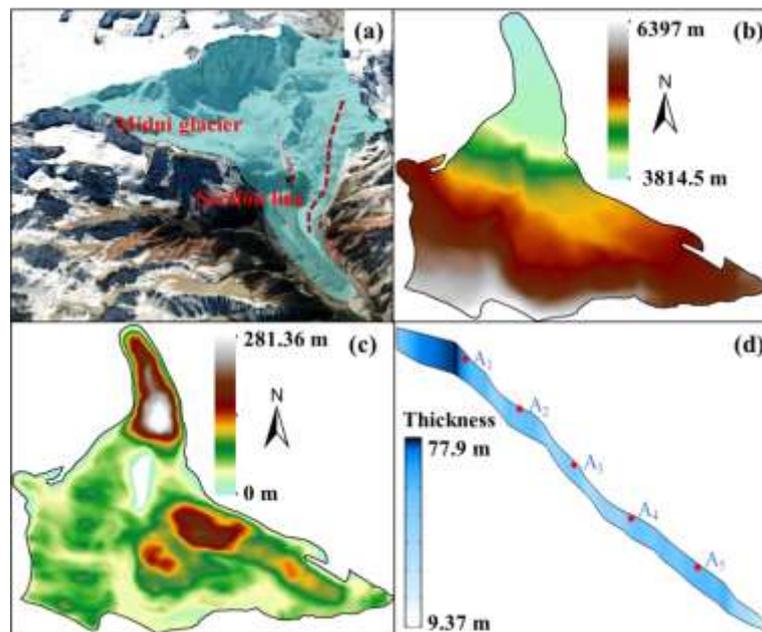

Figure 6. Computational model for glacier. (a) Longitudinal section diagram. (b) Glacier DEM. (c) Glacier thickness. (d) The 2D cross-section of computational model.

* Figure captions are terse. Elaborate. Figure 7 could explain the instruments shown in each monitoring station

A: Thank you for this helpful suggestion. We agree that a clearer description of the monitoring instruments would improve the manuscript. We have added a detailed description of the monitoring system in Section 4.1 to explain the instruments shown in Fig. 7.

In order to verify the reliability of the numerical coupling model and calculation method, we monitored the temperature at 1.2 meters below the glacier surface and glacier displacement in the study area. To ensure the reliability of the field observation data, a comprehensive monitoring station was set up on the glacier (Fig. 7a). The monitoring station includes a meteorological monitoring system (temperature, precipitation, etc.), a temperature sensor at 1.2 m below the glacier surface, and a GNSS measurement station for glacier displacement. The GNSS monitoring station includes a measurement station and a reference station. Therefore, a GNSS reference station was established at the stable bedrock near the glacier (Fig. 7b), and the displacement monitoring accuracy was improved by differential positioning.
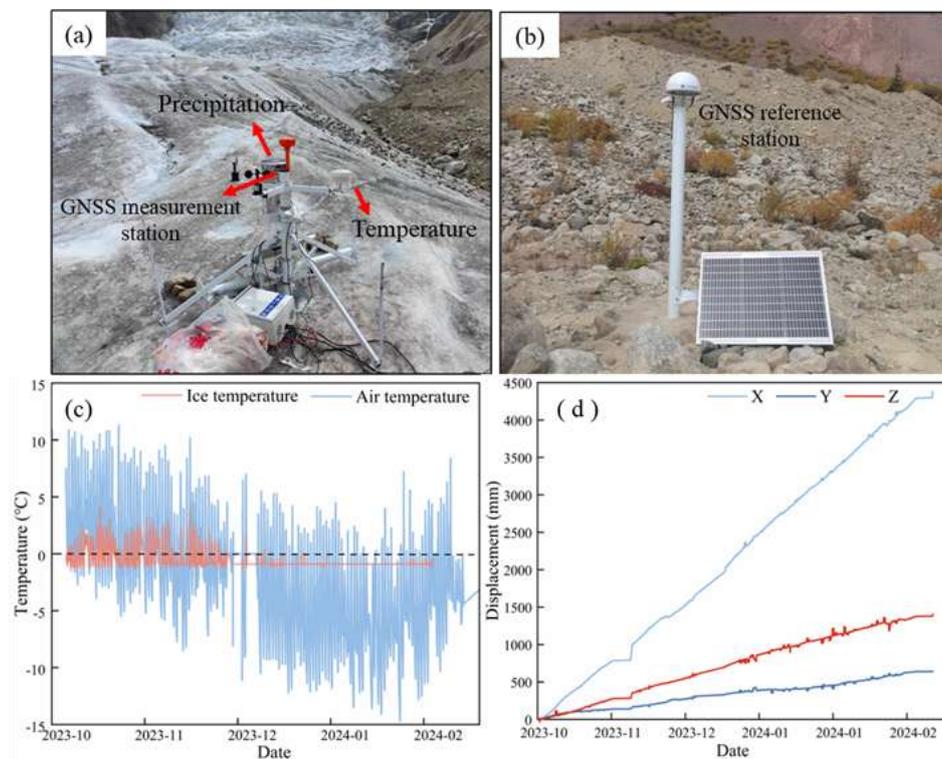

Figure 7. Comparison of observed and simulated values. (a) and (b) The monitoring stations. (c) The glacier temperature. (d) The glacier displacement.

* Figure 9 does not state the different y-axis scales for surface temperature.

A: Thank you for this important comment. We agree that the dual y-axis scales should be more clearly indicated to avoid potential confusion. In Figure 9, the left y-axis represents the glacier surface temperature in January and July, while the right y-axis represents the basal temperature in January and July. The two axes use different scales, because the magnitude of seasonal temperature variation at the surface is much larger than that at the base. We have clarified this in the revised manuscript.

Fig. 9 shows the temperature variation of the glacier surface and base in January and July,

respectively. In Fig. 9, the left y-axis corresponds to the glacier surface temperature in January and July, whereas the right y-axis corresponds to the basal temperature for the same months. Dual y-axes with different scales are adopted to clearly illustrate the contrast in temperature variation magnitudes. It can be seen that the surface temperature is more sensitive to the external environment temperature. The glacier surface temperature varies greatly between January and July. The maximum fluctuation range is 9.1 °C. There is almost no difference in the basal temperature between January and July, which is maintained at melting point temperature, and the fluctuation range is not more than 0.25 °C. Seasonal temperature fluctuations on the glacier surface have little effect on the temperature of the glacier base, and the heat source is derived from the geothermal heat.

* Figure 10 does not explain A_1, A_2, etc.

A: Thank you for this important comment. . We agree that the A_1, A_2, A_3, A_4, and A_5 points shown in Figure 10 should be more clearly explained. These points correspond to five locations that were evenly selected along the glacier surface to represent temperature variations at different elevations. **They are shown in Fig. 6d.** The coordinates of these points are as follows: A1 (179.89, 4825.3), A2 (321.95, 4699.5), A3 (427.55, 4574.5), A4 (568.5, 4449.8), and A5 (726.02, 4325). We have provided a clearer explanation of these points in the revised manuscript.

* Figure 16 does not explain the two inset plots and the main plot has no axis labels.

A: Thank you for your valuable comment. We agree that the two inset plots and the axis labels in the main plot should be more clearly explained. We have modified the figure and figure caption accordingly for better clarity. At the same time, we have added description of the the two inset plots in the revised manuscript.

Through the unsaturated seepage simulation of the permeable layer, the subglacial fluid pressure is obtained when the reduction coefficient is 1.96 (Fig. 16). The fluid pressure at the inlet and outlet of the glacier is low, and reaches the maximum in the upstream region (Fig. 16b). The crevasses in this area are densely distributed, and a large amount of meltwater enters the subglacial hydrological system, resulting in a rapid increase in fluid pressure. The high fluid pressure may cause the basal sliding, resulting in more prone to IA in this area, which is verified by Fig. 15. Fig. 16c shows the variation of fluid pressure along the arc length of glacier base. It can be seen that there are two peaks of fluid pressure in the process of decreasing, which is caused by the change of slope.
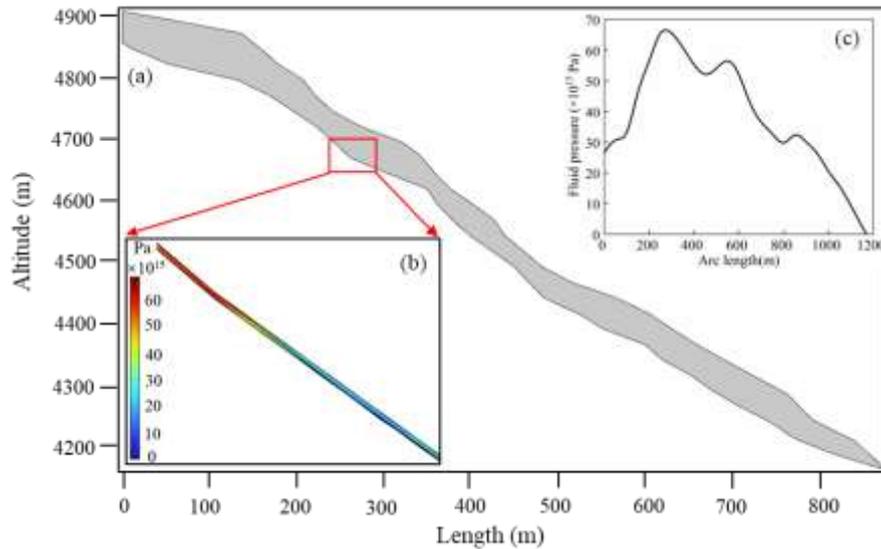
Figure 16. Subglacial fluid pressure. (a) The glacier 2D section. (b) The region where the subglacial fluid pressure reaches the maximum. (c) The variation of fluid pressure along the arc length of glacier base.

* Vertical exaggeration on each cross section needs to be defined.

A: Thank you for your comment. In the current manuscript, each cross section is drawn according to the actual scale (no vertical exaggeration). The vertical and horizontal scales are consistent, and there is no exaggeration in the representation of the vertical dimension. We have added a description in Section 3.2, pointing out that the 2D cross section of the glacier is drawn in actual proportion.

* Limited model validation. Ice velocity is validated using observational field data collected at a debris-covered ice location? It is confusing that the RTK "monitoring station" photograph (Figure 7b) depicts debris and vegetation. Where is the ice margin? Where is this on the study glacier? I am skeptical that validating ice velocity at this location informs the validity of modeled ice velocities at different locations, such as the upper glacier..

A: Thank you for your valuable comments. We agree that a clearer explanation of the monitoring station and the specific locations used for validation is necessary.

The RTK monitoring station shown in Figure 7b is indeed located near the glacier, but not directly on the glacier itself. The GNSS monitoring station includes a reference station and a measurement station. The GNSS reference station is installed on stable bedrock adjacent to the glacier. and receives GNSS satellite signals and provides positioning correction data to improve the accuracy of displacement measurement. The GNSS measurement station is installed on the glacier (Fig.7a) to monitor the displacement of the glacier in real time. The presence of debris and vegetation in Fig. 7b reflects the surrounding terrain where the reference station is installed, which is on stable ground close to the glacier margin. The GNSS measurement station on the glacier measures displacement, and the data from this station is used to validate the modeled ice velocity.

We have updated the manuscript and the Fig.7 to clearly explain this distinction and to specify that the GNSS measurement station is installed on the glacier, while the reference station is located on stable bedrock nearby.

* Unclear connection between physical processes discussed vs. studied: For example, Line 316 mentions albedo effects in the snow-covered accumulation zone on glacier heat flux yet this is the only time "albedo" is mentioned in the paper. Thus, it is unclear if the model takes this (potentially important) feedback effect into account.

A: Thank you for your insightful comment. We agree that a clearer explanation is needed regarding the albedo effect in our model.In our model, we consider heat fluxes between the glacier surface and the atmosphere, specifically through convective and radiative heat exchange. However, we did not explicitly include the albedo feedback in the model, which means that the effect of snow cover on surface albedo is not accounted for in the current simulations. The mention of albedo in the text (Line 316) is based on observed phenomena at high-altitude glacier locations, where snow cover increases surface albedo and consequently affects heat flux variability. This statement was intended to describe the general behavior of glaciers in such regions but was not a direct input into the numerical model.

To avoid ambiguity, we have deleted the description of the albedo effects in the snow-covered accumulation zone on glacier heat flux. We also added the reason why the higher the altitude is, the larger the fluctuation range of glacier surface heat flux is.

* Unclear connection between physical processes discussed vs. studied: Another example is L334, which mentions basal water pressure, but it is unclear whether the model results account for this variable?

A: Thank you very much for your constructive comments. In our model, we consider the influence of gravity on the glacier's deformation and flow. The increase in glacier thickness indeed generates higher basal pressure, which increases the sliding velocity and deformation at the glacier basement. This is implicitly taken into account by the gravity effect in the model, which is used to calculate the stress and pressure of the glacier basement. At the same time, the effect of basal lubrication helps the glacier slide. As the glacier thickens, the increased pressure at the base leads to a higher sliding velocity, which is consistent with the observed behavior in both the cold and warm seasons.

We have clarified this in the revised manuscript that the effect of increased basal pressure caused by glacier's thickness and gravity enhances the sliding and deformation of the glacier basement.

* Define the Factor of Safety (FOS). FOS is first presented in L351, then FOS results are given in L356, without any context on how this metric is generated.

A: Thank you for your valuable comment. We apologize for any confusion caused by the presentation of the factor of safety (FOS) in the manuscript. The FOS is first introduced in L222 (Section 3.1.4), where we explain that it is calculated using the strength reduction method to evaluate the stability of the glacier. This method is to reduce the shear strength parameters in equal proportion until the glacier reaches the limit equilibrium state. The reduction coefficient at this time is the factor of safety (FOS), as described in the equations (24) and (25). The FOS results presented in Line 351 are based on this calculation. In order to explain FOS more clearly, we also added the explanation in L 351.

Glacier stability analysis is to study the instability behavior and potential risk of IAs under different conditions. Herein, according to the thermo-hydromechanical coupling model and

strength reduction method, the FOS of glacier can be obtained. The FOS is calculated using the strength reduction method, where the shear strength parameters are gradually reduced until the glacier reaches the limit equilibrium state. The corresponding reduction coefficient is the FOS, which is used to evaluate the glacier's stability.

* Define the Factor of Safety (FOS). Is this metric novel? Has it been used in other studies? Explain.

A: Thank you for your comment. The Factor of Safety (FOS) calculated by the strength reduction method is widely used to evaluate the stability of structures, including in the fields of geohazards and glacier stability analysis. The principle and calculation method for FOS were introduced in Section 3.1.4. This approach has been extensively applied in other studies to assess the stability of glaciers and other geotechnical structures.
We have revised the manuscript to clarify that the FOS used in this study is based on well-known techniques and has been widely used in prior research. The innovation of this study is to apply this method to the analysis of glacier stability and combine it with the thermo-hydromechanical coupling model to analyze glacier behavior.

The strength reduction method can reflect the instability process of glaciers after strength degradation. This method is to reduce the shear strength parameters in equal proportion until the glacier reaches the limit equilibrium state. The reduction coefficient at this time is the factor of safety (FOS) (Li et al., 2023; Wei et al., 2024):

Li, G., Tang, M.G., Zhang, M.l., Peng, D.L., Zhao, H.L., and Zhou, J.: Slope stability under the influence of irrigation and frozen stagnant water effect in Heifangtai. Bull Eng Geol Environ. 82, 254. https://doi.org/10.1007/s10064-023-03264-7, 2023.

Wei, M., Zhang, L., and Jiang, R.: A conceptual model for evaluating the stability of high-altitude ice-rich slopes through coupled thermo-hydro-mechanical simulation. Eng. Geol. 334, 107514. https://doi.org/10.1016/j.enggeo.2024.107514, 2024.

* Discussion is theoretical and does not invoke results from the study. For example, the opening section of the discussion addresses earthquake effects on glacier stability, whereas the study does not address, model, or mention earthquakes.

A: Accepted the reviewer's suggestion. We recognize that the earthquake effect mentioned in the discussion is not relevant to this study. Therefore, we have deleted the earthquake-related content from the discussion section.

* The Discussion is short (4 paragraphs) and does not explain how the results of the study enhance our understanding of ice collapse.

A: Accepted the reviewer's suggestion. We agree that the discussion should reflect more of the actual contribution of the research results. Therefore, we extend the discussion to explain how the results of this study deepen our understanding of glacier instability, especially the effects of temperature and rainfall.

* Authors might consider discussing study results in the context of research summarized in the Introduction.

A: Thanks for your important comment. In the discussion, we have compared the research results

with the relevant research summarized in the introduction, and clarified how this study provides a new perspective and contribution to the existing glacier stability research.

Response to Line item and minor comments:

1. Capitalize "Midui Glacier" throughout. I flagged the first few, but not all, instances.

A: Thank the reviewer for pointing out the mistake. We have carefully checked the entire manuscript and corrected all occurrences of "Midui glacier" to "Midui Glacier"

2. Change "material balance" to "mass balance" throughout.

A: Accepted the reviewer's suggestion. We have replaced "material balance" with "mass balance" in the revision.

3. Change "outward mass flow" to "mass flux" throughout.

A: Thanks. We have changed "outward mass flow" to "mass flux" throughout.

4. Define "cold season" and "warm season" and explain how these seasons are determined.

A: Accepted the reviewer's suggestion. In the revised manuscript, we have clarified the definition of the "cold season" and "warm season". These seasons are determined based on the temperature characteristics of the study area. Specifically, the cold season refers to December–February, when the air temperature is relatively low. While the warm season refers to June–August, when air temperature is higher and glacier melting and flow are more significant. This clarification has been added to the revised manuscript.

5. Distinguish catastrophic ice avalanche (glacier collapse) from lake calving. For example, Fig. 2 labels the lake-terminating glacier front as "glacier collapse" yet how is this different from lake-calving ice?

A: Thank you for this insightful comment. We agree that a clear distinction between catastrophic ice avalanches (glacier collapse) and lake-calving processes is necessary. A catastrophic ice avalanche refers to the sudden and large-scale detachment and rapid movement of glacier ice from a steep slope. In contrast, lake calving refers to the detachment of relatively small ice blocks from a glacier terminus that is in contact with a proglacial lake.

In Figure 2(c), the label "glacier collapse" was intended to illustrate a typical collapse feature near the glacier tongue. To avoid confusion with lake-calving processes, we have revised the figure label and description accordingly in the manuscript.

6. Define "geohazard chain" and clarify which specific hazards it encompasses.

A: Thank you for your helpful comment. In this study, the term "geohazard chain" refers to a sequence of cascading hazards triggered by an initial event, in which IA induces subsequent hazards through dynamic interactions.

In the study area, the geohazard chain is initiated by an IA in 1988, and the IA caused a glacial lake outburst. The loose material along the downstream channel was wrapped to form a large-scale debris flow. The debris flow flowed into the Parlung Zangbo, forming a barrier dam about 10 meters high. After the barrier dam failed, it caused widespread flood disasters. Therefore, A

geohazard chain of IA-glacial lake outburst- debris flow- barrier dam- flood is formed.

To clarify this concept, we have revised the manuscript and added a definition and description of the geohazard chain in the corresponding section.

7. Line 27. Provide a citation to support the statement, "… the Tibetan Plateu (TP) has the fastest warming rate."

A: Thank you for this helpful suggestion. We agree that this statement requires supporting references. In the revised manuscript, we have added appropriate citations to support the statement.

As Asian water tower, the Tibetan Plateau (TP) has the fastest warming rate (Yan et al., 2020).

Yan, Y.P., You, Q.L, Wu, F.Y., Pepin, N., Kang, S.C.: Surface mean temperature from the observational stations and multiple reanalyses over the Tibetan Plateau. Climate Dynamics. 55, 2405-2419. https://doi.org/10.1007/s00382-020-05386-0, 2020

8. Line 28. Edit "leading" to "which can lead" because the cited study is a case study, not an exhaustive, comprehensive study of glaciers writ large.

A: Accepted the reviewer's suggestion. We have changed "leading" to "which can lead"

9. Line 32. Edit "the glacial and periglacial environment is experiencing" to "both glacial and periglacial environments are experiencing."

A: Accepted the reviewer's suggestion. We have edited "the glacial and periglacial environment is experiencing" to "both glacial and periglacial environments are experiencing".

10. Line 33. Edit "The ice avalanches (IAs)" to "Ice avalanches (IAs)."

A: Accepted the reviewer's suggestion. We have edited "The ice avalanches (IAs)" to "Ice avalanches (IAs)".

11. Line 35. Edit "will pose" to "can pose."

A: Accepted the reviewer's suggestion. We have edited "will pose" to "can pose."

12. Line 36. Delete "the" that precedes "Ngari, Tibet."

A: Accepted the reviewer's suggestion. We have deleted "the" that precedes "Ngari, Tibet."

13. Line 38. The lake reference is unclear. Perhaps "caused a lake dammed by previous IA and debris-flows to collapse" could clarify.

A: Accepted the reviewer's suggestion. We have replaced "caused an IA-debris flow-dammed lake" with "caused a lake dammed by previous IA and debris-flows to collapse" in the revision.

14. Line 47. Revise to "the conservation of mass and momentum are used to."

A: Accepted the reviewer's suggestion. We have revised to "the conservation of mass and momentum are used to."

15. Line 49. Edit "approximate" to "approximation."

A: Accepted the reviewer's suggestion. We have edited "approximate" to "approximation."

16. Line 53. Capitalize "Bowdoin Glacier."

A: Thank the reviewer for pointing out the mistake. We have corrected the capitalization of "Bowdoin Glacier" in the revised manuscript.

17. Line 55. Edit "Due to" to "Despite."

A: Accepted the reviewer's suggestion. We have edited "Due to" to "Despite."

18. Line 56. Revise "the simulation research" to "research simulating temperate glaciers."

A: Accepted the reviewer's suggestion. We have replaced "the simulation research" with "research simulating temperate glaciers" in the revision.

19. Line 59. Change to "This research gap."

A: Accepted the reviewer's suggestion. We have changed to "This research gap."

20. Line 62. Change the "will" to "can" in "rapid sliding of the glacier can lead to IAs."

A: Accepted the reviewer's suggestion. We have changed the "will" to "can."

21. Line 64. Change "different" to "differences."

A: Thank the reviewer for pointing out the mistake. We have changed "different" to "differences."

22. Line 75. Change to "Midui Glacier."

A: Thank the reviewer for pointing out the mistake. We have changed to "Midui Glacier."

23. Line 81. Define firn basin.

A: Thanks for your helpful suggestion. In the revised manuscript, we have added a definition of firn basin. The firn basin refers to the upper accumulation area of glacier where snow is gradually transformed into firn through compaction and recrystallization processes, forming a basin-shaped accumulation zone.

24. Line 94. What penetrates into the glacier? Crevasses?

A: Thank you for pointing this out. The sentence was unclear in the original manuscript. The intention was to describe that the crevasses penetrate several meters into the glacier. In the revised manuscript, the sentence has been clarified accordingly.

The crevasses can penetrate into glacier for several meters.

25. Line 102. Edit to "days prior to the triggering" for each parenthetical statement.

A: Thanks for your helpful suggestion. We have edited to "days prior to the triggering" for each parenthetical statement.

26. Line 109. Check significant figures on precipitation. Is it really known to a fraction of a mm?

A: Thank you for the comment. The precipitation data used in this study were obtained from Free Weather API (https://open-meteo.com/), where precipitation is measured with a resolution of 0.1 mm.

27. Line 156. There is not necessarily a large amount of meltwater at the temperate glacier base. Revise to clarify.

A: Thank the reviewer for pointing out the mistake. We agree that the previous wording is too absolute. The sentence has been revised to clarify that meltwater may exist at the temperate glacier base.

28. Line 240. Correct spelling on "thickness."

A: Thank the reviewer for pointing out the mistake. The spelling of "thickness" has been corrected in the revised manuscript.

29. Line 241. Revise "section" to "cross-section."

A: Thank the reviewer for pointing out the mistake. We have revised "section" to "cross-section."

30. Line 244. Change "and the heat flux can enter and leave the domain," to "and the heat flux is not fixed."

A: Thanks for your helpful suggestion. We have changed "and the heat flux can enter and leave the domain." to "and the heat flux is not fixed."

31. Line 246. Justify setting the wind speed to 1.01 m/s.

A: Thank you for the comment. The wind speed value of 1.01 m/s was determined based on the average wind speed over the past 20 years in the study area. The wind speed data were obtained from the Free Weather API (https://open-meteo.com/). The long-term average value was used to represent the atmospheric conditions for the convective heat exchange boundary condition at the glacier surface.

32. Line 282. Change "station" to "stations."

A: Thank the reviewer for pointing out the mistake. We have changed "station" to "stations."

33. Line 289. Clarify if it is the air temperature, or ice temperature, referenced.

A: Thanks for your helpful suggestion. The temperature referenced in this section refers to the glacier temperature. We has clarified in the revised manuscript to avoid ambiguity.

34. Line 312. Change "material balance" to "mass balance."

A: Thank the reviewer for pointing out the mistake. We have changed "material balance" to "mass balance."

35. Line 316. Change "sun" to "glacier surface."

A: Thank the reviewer for pointing out the mistake. We have deleted this sentence.

36. Line 320. Delete "and the glacier is retreating." Negative mass balance does not instantaneously (or necessarily) result in glacier retreat.

A: Thank the reviewer for pointing out the mistake. We have deleted this sentence.

37. Line 327. Edit section title to "Glacier flow velocity and mass flux"

A: Thanks for your helpful suggestion. We have edited section title to "Glacier flow velocity and mass flux"

38. Line 343. Delete, "indicating that the glacier is melting more and more violently." Ice flow acceleration does not in and of itself indicate enhanced melt.

A: Thank the reviewer for pointing out the mistake. We have deleted this sentence.

39. Line 349. Edit "Glacier stability analysis is to study" to "Here, we conduct glacier stability analysis to study."

A: Thanks for your helpful suggestion. We have edited "Glacier stability analysis is to study" to "Here, we conduct glacier stability analysis to study."

40. Line 351. Define FOS.

A: Thanks for your helpful suggestion. We have defined FOS. The FOS is calculated using the strength reduction method, where the shear strength parameters are gradually reduced until the glacier reaches the limit equilibrium state. The corresponding reduction coefficient is the FOS, which is used to evaluate the glacier's stability.

At the same time, we have already introduced FOS in Section 3.1.4.

41. Line 371. "Glacier is more prone to collapse." This is an incomplete sentence. Perhaps combine it with the previous sentence.

A: Thank you for the helpful comment. We agree that the sentence was incomplete. It has been combined with the previous sentence and revised in the manuscript.

42. Line 396. Clarify whether the referenced statistical analysis is in this study or prior study.

A: Thank you for the helpful comment. The statistical analysis referred to here was conducted in a previous study by the authors (Tang et al., 2024) rather than in the present study. We have clarified in the revised manuscript by citing the reference.

Tang, M., Li, G., Zhao, H., Xu, Q., Wu, G., Yang, W., and Guo, D.: Advances in ice avalanches on the Tibetan Plateau. J. Mountain. Sci. 21(6), 1814-1829. https://doi.org/10.1007/s11629-023-8530-7, 2024.

43. Line 407. Change "crevasses expansion" to "crevasse expansion."

A: Thank the reviewer for pointing out the mistake. We have changed "crevasses expansion" to "crevasse expansion."

44. Line 428. Change "the multi-physical factors and their coupling mechanisms in the glacier flow process" to "multiple, coupled physical factors in glacier ice flow."

A: Accepted the reviewer's suggestion. We have changed "the multi-physical factors and their coupling mechanisms in the glacier flow process" to "multiple, coupled physical factors in glacier ice flow."

45. Line 430. Revise. Misleading. The conceptual model was not developed. Instead, models

developed during prior studies were applied to the study glacier.

A: Thank the reviewer for pointing out the mistake. We agree that this study does not develop a new conceptual model. Instead, the previously developed thermo-hydromechanical coupling model was applied to the Midui Glacier to analyze the dynamic characteristics, hydrothermal distribution, and stability. The sentence has been revised in the manuscript.

46. Line 440. Clarify if the stated significance refers to statistical significance.

A: Thank you for the comment. The term "significantly" in this sentence was not intended to indicate statistical significance, but rather to describe an evident difference of glacier flow velocity in the warm and cold seasons. We have revised it in the manuscript.

47. Line 449. Delete "/."

A: Thank the reviewer for pointing out the mistake. We have deleted "/."