Review of Lake-Mountain synergy in convective clouds and precipitation over the Tibetan Plateau: a large-eddy simulation study

egusphere-2026-869

General Comments

Motivated by a better understanding of convection and precipitation associated with lake- mountain environments in the Tibetan Plateau, this manuscript presents results from CM1 idealized large-eddy simulations of convection. The simulations vary the height of terrain and the presence of a lake located upstream of the terrain. There are a few key findings from this work, including that a lake provides the moisture source required to initiate convection and that the height of terrain downstream of the lake impacts the intensity and distribution of precipitation. This manuscript fits within the scope of Atmospheric Chemistry and Physics and would be suitable for publication after some modifications are made.

Reply: We sincerely thank the reviewer for the encouraging and constructive assessment of our manuscript. We are pleased that the reviewer recognizes the relevance of this idealized LES study to lake-mountain convection and precipitation over the TP. We have carefully addressed all comments by clarifying the model setup and experimental design, improving figure descriptions, strengthening the physical interpretation of the results, and discussing the limitations of the idealized simulations more explicitly. Our detailed point-by-point responses are provided below.

Major Comments

1. Characterization of the Tibetan Plateau geomorphology

Much of the introduction focuses on important processes such as convection, cloud microphysics, lake breezes, and surface heterogeneity, which provides helpful background for the manuscript. However, the introduction lacks a discussion of the characteristics of the Tibetan Plateau itself. The authors should share some information about typical terrain elevations, typical lake sizes, the number of lakes, the fraction of the year during which the lake is frozen, general meteorological characteristics, etc. The map in Fig. 1a can aid with this discussion.

Reply: We have expanded the Introduction to describe the main characteristics of the TP and its lakes, including terrain elevation, lake size and distribution, seasonal frozen conditions, and general meteorological features. (Line 86-91)

"More than 1200 lakes larger than 1 km² are distributed across the TP, providing important local moisture sources (Zhang et al., 2020). These lakes experience seasonal ice cover due to the cold high-altitude climate, while strong land-lake thermal contrasts during the warm season can modify circulations and moisture transport (Kropáček et al., 2013). Given the relatively dry and low-density atmosphere over the TP, lake-induced moisture supply, together with the surrounding topography, may play an important role in regulating cloud development and precipitation (Ma et al., 2010; Wang et al., 2020a, b)".

2. Hydrometeor mass growth and loss (Figure 9)

The authors should reexamine their calculation of Q_{growth} and Q_{loss} in Fig. 9. In the figure, it appears that these variables have the same magnitude, and $Q_{loss}$is simply $Q_{growth} \times -1$, which would make one of the subfigures redundant. Thinking about this physically, it is implausible for Q_{growth} and Q_{loss} to peak at the exact same time (as referenced in L440-442) when calculated over the same domain. It is most likely that the authors have either calculated Q_{growth} or Q_{loss} incorrectly. Following Eq. (6), Eq. (7), and Gowan et al. (2021), Q_{growth} and Q_{loss} should be calculated by integrating all instances in which q_{ten} is positive and negative, respectively. In the current manuscript, it appears that the authors may have calculated $q_{ten_{pos}}$ and simply multiplied that by -1 to find $q_{ten_{neg}}$.

Reply: The Q_{loss} is not obtained by multiplying Q_{growth} by -1. We have carefully reexamined the calculation of Q_{growth} and Q_{loss}. At each model output interval and grid, the total hydrometeor tendency is first calculated as $\overline{q_{ten}} = \frac{\overline{\Delta q}}{\Delta t}$. All positive values of q_{ten} are then independently extracted as $q_{ten,\ pos}$, while all negative values are extracted as $q_{ten,\ neg}$. These two components are subsequently averaged over 7-20 h and over the central 15 km in the y-direction, and then vertically integrated. We have revised *Eqs. 5-7* and the corresponding text to clarify that the positive and negative values of Q_{ten} are identified and processed independently before averaging and vertical integration.

The similar spatial locations of enhanced Q_{growth} and Q_{loss} arise because hydrometeor production and depletion can both be concentrated within the same region. However, their magnitudes and spatial distributions are not identical. To demonstrate this more clearly, we have added the net hydrometeor tendency (Q_{growth}+Q_{loss}) to Fig. R3.

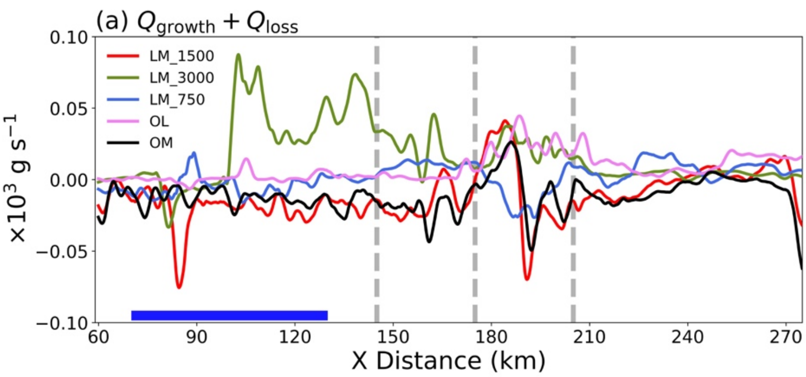

Figure R3. Zonal distributions of the 7-20 h time-mean, 15-km y-averaged (over the central domain) of (a) net hydrometeor mass tendency (10^2 kg s^{-1}) for the five experiments. The thick blue line indicates the lake area (x=70-130 km), and the gray dashed lines mark the windward foothill (x=145 km), mountain summit (x=175 km), and leeward foothill (x=205 km).

3. Flow in Figure 10b.

In Fig. 10b, it appears that the zonal wind goes from the right side of the domain to the left. Is that correct? It is possible that the authors' use of the perturbation wind contributes to this. If so, what is the justification for the use of the perturbation wind? It seems to mislead a reader who would examine the figure without much other context.

Reply: The vectors shown in this figure represent the perturbation wind rather than the total wind field. Therefore, the apparent reversal in flow direction does not indicate a reversal of the background environmental wind, but instead reflects the circulation anomaly induced by the lake-mountain interaction. Specifically, enhanced moisture supplied by the lake promotes cloud and precipitation development over the mountain region. Precipitation-related diabatic cooling, including cooling associated with the evaporation of liquid hydrometeors and the sublimation or melting of ice-phase particles, contributes to negative near-surface temperature perturbations and the formation of a cold pool. Once established, the cold pool interacts with the terrain. The mountain barrier restricts the horizontal ventilation of the cooled air, favoring its accumulation near the windward slope. Stronger terrain blocking in the higher-mountain experiments further enhances this accumulation and is therefore associated with a stronger perturbation circulation near the mountain.

We acknowledge that displaying the perturbation wind alone may lead to confusion if it is interpreted as the total flow. We have therefore revised the description of Fig. 10b to explicitly state that the vectors represent the perturbation circulation associated with the lake-mountain interaction.

4. Moist Froude number (section 2.4.3 and Figure 11)

The authors should think more carefully about their use of the moist Froude number. First, in section 2.4.3, the authors provide a thorough derivation of the Nm *and justify some modification of the standard Durran and Klemp (1983) equation due to the presence of mixed-phase clouds over the Tibetan Plateau. Could the authors consider placing this derivation in an appendix to not disrupt the flow of the manuscript? Figure 11 shows cross sections of time- and* y*-averaged* FRm*. Typically, though, the Froude number is calculated at a site upstream of the mountain range and uses a layer depth for the calculation of* Nm *and* U*. It is unclear how showing* FRm *at 1 km and 4 km, for instance, gives insights into blocked or flow over regimes. Additionally, there is no utility to showing* FRm *at a site on or downstream of the mountain range, which the current figure does. The authors should consider calculating* Nm *and* U *over a layer depth at a site upstream of the mountain and presenting values in a table for each sensitivity study, rather than using cross sections to display* FRm*.*

Reply: The detailed derivation of the modified moist Brunt-Väisälä frequency (N_m) has been moved to the Supplement to improve the readability and flow of the manuscript. We have also revised Fig. 11 to better clarify the purpose and interpretation of the moist Froude number diagnostic.

We agree that the conventional moist Froude number is generally calculated using representative upstream values of wind speed and moist stability over a characteristic layer depth, and is commonly used to characterize the overall blocked or flow-over region. In this study, however, the purpose of the Fr_m analysis is different. We do not use the cross-sectional Fr_m values at individual levels to classify the overall flow regime. Instead, we use a local modified moist Froude number, $Fr_{m,loc}(x,z)$, as a diagnostic quantity to examine how the spatially varying flow structure and moist stability interact within the lake-mountain system.

The quantity shown in Fig. 11 is calculated locally as

$$\mathrm{Fr_{m,loc}}(x, z) = \frac{u(x, z)}{N_m(x, z)H_0}$$

where $u(x, z)$ and $N_m(x, z)$ retain their spatial and vertical variations, while H_0 is the prescribed mountain height. Therefore, the variations of $Fr_{m,loc}(x, z)$ along the cross-section reflect changes in background flow strength and moist stability associated with lake-induced moisture modification, terrain lifting, and mixed-phase cloud processes.

We retain the *x-z* distribution of $Fr_{m,loc}(x, z)$ because it provides additional information that cannot be obtained from a single upstream bulk value. In particular, the cross-sectional distribution allows us to identify where the moist dynamical environment is modified as airflow approaches and interacts with the mountain, and it can be directly compared with the circulation, thermodynamic, and hydrometeor structures shown in the preceding figures. This is especially important in our study because the lake modifies the thermodynamic environment before the flow reaches the mountain, and the resulting changes in moist stability are spatially heterogeneous. Spatially varying Froude number fields and vertical distributions have also been used to diagnose terrain-related flow and convection in previous studies (Burk and Thompson, 2004; Langhans et al., 2011; Li et al., 2025).

5. Interpretation of trajectories

There are dramatic differences in the trajectories in the different sensitivity studies, but the current discussion lacks a thorough comparison between them. The authors should discuss the lack of air parcel movement in the LM_750, OL, and OM trajectories and explain the lack of water vapor depletion in those, despite moderate precipitation amounts (especially in OM; Fig. S2).

Reply: We agree that the differences in trajectory behaviors among the sensitivity experiments require further clarification.

The trajectories released at x = 80 km represent air parcels originating from the lake region. They are used to diagnose the lake-induced circulation and the transport pathways of lake-modified air toward the mountain. As shown in Fig. 12a-j, LM_3000 exhibits pronounced horizontal transport and vertical ascent, indicating strong lake-mountain circulation and efficient transport of lake-modified moist air toward the mountain. In contrast, the weak displacement in LM_750, OL, and OM reflects the weaker circulation response. For LM_750, the reduced mountain height weakens the terrain-induced pressure perturbation and associated lake-mountain circulation. For OL and OM, the absence of lake forcing eliminates the additional thermal contrast between the lake and surrounding land, resulting in weaker low-level circulation and limited horizontal moisture transport.

The trajectories released at x = 120 km are designed to examine the evolution of air parcels approaching the mountain region (Fig. S4), where terrain-induced lifting becomes dominant. In LM_3000, these trajectories experience strong ascent as they approach the mountain, consistent with enhanced orographic lifting and precipitation development. In contrast, although moderate precipitation occurs in OM, the trajectories exhibit limited displacement and weak depletion of water vapor mixing ratio. This is because precipitation in OM is mainly produced by local terrain-induced lifting of the available background moisture rather than sustained moisture transport from the lake.

We further clarify that the trajectory colors in Fig. 12 and Fig. S4 represent the local water vapor mixing ratio interpolated from the Eulerian model output along the calculated trajectories. The trajectory calculation provides airflow pathways based on the simulated wind field, but it does not track the evolution of moisture within an individual air parcel. Therefore, the water vapor mixing ratio along the trajectories is not expected to be conserved. Its variation reflects the spatiotemporal changes of the Eulerian water vapor field encountered by the moving trajectories, which are affected by moisture transport, surface evaporation, condensation, and turbulent mixing processes. The purpose is to diagnose the transport pathways and vertical lifting of near-surface moist air from the lake region toward the mountain and downstream regions, rather than to establish a closed moisture budget for individual air parcels.

6. Supplemental material

1) While Fig. S1 could reasonably be placed in a supplement, the other supplemental figures should be included in the main text, as they are referred to in the text and help tell the manuscript's story. Fig. S2, which shows the precipitation distribution, is quite important and would be better placed in the main text. Additionally, that figure's caption has text "(c) Difference in time-mean precipitation rate (mm h^{-1}) between LM_3000 and LM_1500. (e), (g), (i) As in (c), but showing the differences for LML, OL, and OM relative to ML", which does not describe anything in the figure and should be removed. Additionally, for Fig. S2, the authors should discuss the precipitation *patterns and why they appear. For instance, why are there local maxima in precipitation in the lee of the mountain peak in LM_1500 and OM? And on Fig. S2, the authors should label the y-axis and include an outline of the bell-shaped mountain, rather than the dashed line showing where its summit is.*

Reply: (1) We have retained Fig. S2 in the Supplement because it shows the precipitation distribution accumulated over the entire 0-20 h simulation period, whereas the main text already presents the precipitation distribution during the primary analysis period of 7-20 h (Fig. 5). The 7-20 h period was selected because it represents the established stage of lake-mountain interaction, when lake-induced circulation and moisture transport have developed sufficiently to interact with terrain-induced lifting. Therefore, the precipitation distribution and the associated physical mechanisms are primarily discussed based on Fig. 5 in the main text. Including Fig. S2 in the main text in addition to Fig. 5 would provide largely redundant information.

(2) We have revised Fig. S2 and its caption accordingly. The incorrect references to nonexistent difference panels have been removed, and the y-axis label has been added.

(3) The bell-shaped mountain geometry is explicitly illustrated in the *x-z* cross sections throughout the manuscript. Therefore, in the *x-y* precipitation distribution, we indicate the location of the mountain rather than redundantly displaying the terrain profile.

(4) During the initial 0-7 h period, precipitation development is primarily influenced by terrain forcing, while the lake-induced circulation and associated moisture transport develop more gradually. Consequently, the precipitation accumulated over the full 0-20 h period in Fig. S2 retains a pronounced contribution from the early terrain-driven precipitation. The local precipitation maxima on the leeward side of the mountain crest in LM_1500 and OM are mainly associated with terrain-induced lifting and the subsequent downstream transport of hydrometeors during this early stage. Moisture is lifted as it approaches and passes over the mountain, promoting cloud formation and hydrometeor growth. The resulting hydrometeors are subsequently advected downstream by the background flow, contributing to enhanced precipitation on the leeward side of the mountain.

2) In Fig. S3, does the NLM simulation really produce no precipitation at all? If so, this could be an interesting finding suggesting that this environment requires a lake and/or mountain to generate precipitation. It appears that the caption for Fig. S3 does not line up with the subfigures at all. The *authors should reread the caption and make adjustments to align with the subfigure letters.*

Reply: Yes, the NLM simulation does not produce precipitation. This result reflects the limited moisture availability in the prescribed TP-like background environment. In the absence of lake-induced moisture and thermal forcing, as well as terrain-induced lifting, the background atmosphere alone is insufficient to initiate and sustain precipitating convection. The NLM experiment therefore provides a useful baseline for isolating the individual and combined effects of the lake and mountain on cloud and precipitation development under TP-like conditions. We have added this interpretation to the revised manuscript. We have also carefully revised the caption of Fig. S3 to ensure that the descriptions correspond correctly to the subfigure labels.

3) In Fig. S4, the caption refers to a left column, but the figure only includes a right column.

Reply: We have revised the caption to remove the reference to the left column and to describe only the panels shown in the figure.

7. Conclusions

From the literature review, it appears that there has not been much research on the lake- mountain meteorology of the Tibetan Plateau, so the authors are making a useful, novel contribution to atmospheric science by studying it. The conclusion summarizes the findings well, but the authors should highlight how this work is new and how it could contribute to our understanding in other regions.

Reply: We have revised the conclusion section to better highlight the novelty and broader implications of this study. Specifically, we now emphasize that this study systematically separates the individual and combined effects of lake moisture supply and terrain forcing through controlled idealized simulations, providing a process-based understanding of how lake-mountain interactions regulate convective initiation, cloud development, and precipitation over the TP.

The TP provides a distinctive environment for investigating these processes because convection develops in a low-density atmospheric environment with limited moisture availability and is strongly modulated by the interplay among thermodynamic instability, moisture supply, and complex terrain. The mechanisms identified in this study may also provide useful insights into other high-altitude lake-mountain systems, where local water bodies can modify the thermodynamic and moisture environment and thereby influence convective precipitation.

8. Grammar

There are several grammatical errors throughout the manuscript which impact its readability. The authors should carefully examine the manuscript for grammatical errors. Some examples:

1) L63: *"... can profound influences..." should say "can have profound influences"*

2) L275: *"b" should say "by"*

3) L320: *"precipitation appears as a narrow in the leeward". A noun is required after "narrow".*

4) L390: *"shallower and hydrometeor ... is reduced" should say "hydrometeor mixing ratio is reduced".*

5) L479-480: *"... hydrometeor of condensate growth and transport ..." should say "condensate growth and hydrometeor transport"*

6) L502-503: *"the moisture supply leads to lower N_m. And further strengthen the FR_m." These two sentences should be combined.*

7) L558-559: *This sentence is repeated.*

8) Figure 11 caption: *"most" should say "moist".*

Reply: Thank you for pointing these out. All grammatical errors have been corrected as suggested.

Minor Comments

1) *L155 and Table 1: In Table 1 the authors present 6 experiments that they conducted. However, the results from one such experiment (NLM) are never presented in the manuscript (aside from in the supplement). The authors should either modify the manuscript to present results from NLM or remove the mention of that experiment from Table 1. Additionally, in L173, the authors first mention that the control experiment is LM-1500. It would be helpful if this were highlighted in Table 1 as well.*

Reply: We agree that listing NLM in Table 1 could be confusing because the corresponding results are not discussed in the main text and are only provided in the Supplement. To avoid this inconsistency, we have revised Table 1 to include only the experiments analyzed in the manuscript. In addition, we have highlighted LM_1500 as the control experiment in the revised Table 1. (Line 164)

2) *L189: How does this RKW-type wind profile compare with the Naqu Station radiosonde observations? Some justification of the RKW-type wind profile should be provided. Additionally, the authors should include the wind barbs for the profile in Fig. 3.*

Reply: We have added a comparison between the prescribed wind profile and the radiosonde-observed wind profile at Naqu Station (Fig. R4), and have also added wind barbs to Fig. 3 to illustrate the vertical wind structure more clearly.

The prescribed wind profile is not intended to reproduce a specific observed event, but rather to represent the characteristic background atmospheric structure over the TP. Radiosonde observations at Naqu Station, which is broadly representative of the central TP environment, generally show relatively weak winds in the lower troposphere and increasing wind speeds with height. The idealized profile was therefore designed to retain this characteristic vertical structure, with weak low-level flow and stronger winds aloft, while preserving a simplified background environment suitable for isolating lake-mountain interactions.

The weak low-level flow is important because excessively strong background winds could suppress thermally driven lake-land circulations and weaken the near-surface thermodynamic and moisture modifications induced by the lake. Meanwhile, the stronger winds aloft are consistent with the typical vertical variation of the TP background flow and provide a pathway for downstream moisture transport toward the mountain region, where terrain-induced lifting can further promote cloud development and precipitation formation.

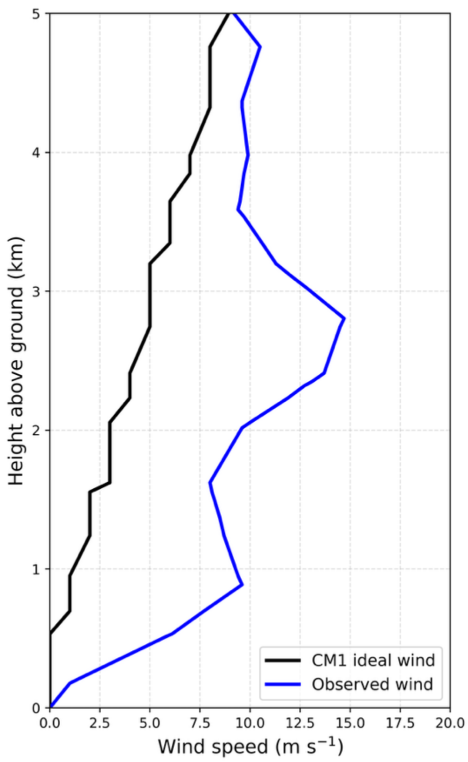

Figure R4. Vertical profiles of the idealized CM1 initial wind shear and observed wind speed. The black line represents the idealized zonal wind profile used in the CM1 simulation, which increases linearly from 0 to 15 m s^{-1} within the lowest 8 km. The blue line denotes the observed wind speed profile from the 55299 sounding, with height referenced to the surface.

3) *L270-275: This section is used to derive the moist Froude number and Nm. The equations, however, do not clearly flow in the text. To improve readability, the authors should modify this section so that Eq. 16 and 17 are part of sentences and clearly flow in the text.*

Reply: We have revised explanations of *Eqs. 16-17* so that the mixed-phase pseudo-adiabatic lapse rate and the corresponding moist Brun-Väisälä frequency are introduced as part of complete sentences. This revision improves readability and clarifies the logical sequence from the effective saturation mixing ratio and mixed-phase latent heat to the modified moist stability and moist Froude number. (Supplement *Eqs. 1-11*)

4) *L293-294: "However, introducing the lake … onset of convection." This sentence feels out of place. The authors had just discussed LM_2000 in L292 and then transition to LM_1500, so there is no introduction of the lake.*

Reply: The original sentence "introducing the lake" was inappropriate because the discussion was comparing different mountain-height configurations rather than lake/no-lake experiments. We have revised the text to clarify that the delayed convection in LM_1500 relative to LM_3000 is associated with weaker terrain-induced triggering and the increasing importance of lake-driven moisture transport. (Line 271-274)

5) *L356-358: Is this sentence correct? Looking at Figs. 6 (b), (d), and (f), it appears that as the mountain height increases, CAPE over the lake decreases. CIN does decrease, though, but rather than "weakens", "decreases" would be better language to describe this.*

Reply: After reexamining Figs. 6b, 6d, and 6f, we agree that the original statement that "CAPE over the lake region increases with increasing mountain height" was incorrect. This was a misinterpretation of the CAPE distribution, and we have revised the corresponding description in the manuscript accordingly. (Line 336-338)

6) *L384 and L395: Fig. 7f is mentioned here but there is no Fig. 7f.*

Reply: Corrected as suggested.

7) *L421: Should the figure reference say "Fig. 8e" since the text is referring to the mountain?*

Reply: We have corrected the figure reference in the revised manuscript.

8) *L564: The "reduced condensate production" is being compared to what? Other mountainous regions?*

Reply: We have revised the sentence to remove the unclear comparison and to state explicitly that the reduced condensate production is caused by limited moisture availability in the idealized lake-mountain environment over the TP. (Line 550-553)

9) *Figure 4: What does the grey vertical dashed line represent in Fig. 4? The caption should clarify this.*

Reply: The gray vertical dashed line in Fig. 4 marks 7 h, which denotes the beginning of the lake-mountain synergy regime defined in this study. This timing corresponds to the stage when the lake-breeze and mountain-induced circulations begin to interact more strongly, while cloud and precipitation processes become well developed and start to influence downstream regions. We have clarified this interpretation in the revised caption of Fig. 4.

***10)** Figure 5 caption: The caption in Fig. 5 references subfigures (f), (h), (g), and (i), but those subfigures are not included in the figure.*

Reply: We have revised the caption so that it describes only the panels shown in the Fig. 5.

***11)** Figure 8: The font size of the y-axis labels on Fig. 8a should be increased. The first sentence in the caption is incomplete.*

Reply: We have increased the font size of the y-axis labels and revised the caption in Fig. 8 to improve readability.

***12)** Figure 12: At some point in the manuscript, the authors should state how many trajectories are plotted, at what time in the simulation they are released, and for how long they are run.*

Reply: We have added the trajectory configuration to the revised manuscript. A total of 6,000 forward trajectories were calculated by releasing air parcels from 40 vertical model levels and 150 locations in the y-direction, with all parcels initialized at x = 80 km. The parcels were released at 7 h of the simulation and integrated forward for 13 h, ending at 20 h. All trajectories were calculated using model output that had been uniformly filtered over 20 × 20 × 2 grid points in the x, y, and vertical directions, respectively. This information has been added to the description of Fig. 12.

Reference:

Burk, S. D. and Thompson, W. T.: Mesoscale Eddy Formation and Shock Features Associated with a Coastally Trapped Disturbance, Mon. Weather Rev., 132, 2204–2223, https://doi.org/10.1175/1520-0493(2004)132%3C2204:MEFASF%3E2.0.CO;2, 2004.

Kropáček, J., Maussion, F., Chen, F., Hoerz, S., and Hochschild, V.: Analysis of ice phenology of lakes on the Tibetan Plateau from MODIS data, The Cryosphere, 7, 287–301, https://doi.org/10.5194/tc-7-287-2013, 2013.

Langhans, W., Gohm, A., and Zängl, G.: The orographic impact on patterns of embedded convection during the August 2005 Alpine flood, Q. J. R. Meteorol. Soc., 137, 2092–2105, https://doi.org/10.1002/qj.879, 2011.

Li, S., Huang, A., Wang, X., Liu, L., and Wang, J.: Roles of terrain in the convection initiation of an extreme rainfall event along the eastern slope of Wushan Mountain, China under weak synoptic forcing, Q. J. R. Meteorol. Soc., 151, e70002, https://doi.org/10.1002/qj.70002, 2025.

Ma, R., Duan, H., Hu, C., Feng, X., Li, A., Ju, W., Jiang, J., and Yang, G.: A half-century of changes in China's lakes: Global warming or human influence?, Geophys. Res. Lett., 37, 2010GL045514, https://doi.org/10.1029/2010GL045514, 2010.

Wang, J., Huang, L., Ju, J., Daut, G., Ma, Q., Zhu, L., Haberzettl, T., Baade, J., Mäusbacher, R., Hamilton, A., Graves, K., Olsthoorn, J., and Laval, B. E.: Seasonal stratification of a deep, high-altitude, dimictic lake: Nam Co, Tibetan Plateau, J. Hydrol., 584, 124668, https://doi.org/10.1016/j.jhydrol.2020.124668, 2020a.

Wang, Y., Zeng, X., Xu, X., Welty, J., Lenschow, D. H., Zhou, M., and Zhao, Y.: Why Are There More Summer Afternoon Low Clouds Over the Tibetan Plateau Compared to Eastern China?, Geophys. Res. Lett., 47, e2020GL089665, https://doi.org/10.1029/2020GL089665, 2020b.

Zhang, G., Yao, T., Xie, H., Yang, K., Zhu, L., Shum, C. K., Bolch, T., Yi, S., Allen, S., Jiang, L., Chen, W., and Ke, C.: Response of Tibetan Plateau lakes to climate change: Trends, patterns, and mechanisms, Earth-Sci. Rev., 208, 103269, https://doi.org/10.1016/j.earscirev.2020.103269, 2020.