Response to CC1

This manuscript addresses a timely and important topic at the intersection of aeolian processes and ice-covered lake dynamics. The study's focus on the Tibetan Plateau is particularly relevant given the region's sensitivity to climate change and the significant sediment sources. I would like to offer a few comments on the current version.

Comment 1: The introduction provides a broad review of light-absorbing particles and snow/ice processes, but it remains largely descriptive. The manuscript would benefit from a sharper articulation of the specific knowledge gap this study addresses. What is currently known versus unknown about the thermal effects of aeolian sediments on lake ice, and how the present work fills that gap. Strengthening this framing would better justify the novelty and significance of the research.

Reply: We sincerely thank Dr. Lei Zheng for this valuable and constructive suggestion. We agree that the specific knowledge gap concerning the thermal effects of aeolian sediments on lake ice could be articulated more clearly in the Introduction.

We will revise and reorganize the Introduction accordingly, with greater emphasis on distinguishing what is currently known from the remaining uncertainties regarding the thermal effects of aeolian sediment deposition on lake ice. In particular, we will clarify that although the radiative and thermal effects of light-absorbing particles on snow and ice have been widely investigated, the spatially explicit thermal response of lake ice to aeolian sediment deposition remains insufficiently constrained, particularly in high-altitude lakes where sediment sources, ice conditions, and atmospheric forcing interact.

We will further clarify how the present study addresses this gap by quantitatively examining the spatial relationship between aeolian sediment distribution and lake ice surface temperature and by investigating how this relationship varies spatially. This revised framing will better highlight the scientific motivation, knowledge gap, and significance of this study.

Comment 2: Several methodological choices require clearer justification. It would be helpful to explain why MOD11A1 was selected over other available surface temperature products, and why Landsat 8 OLI was chosen for sediment mapping given that higher-resolution alternatives (e.g., Sentinel-2) exist. The thresholds for NDSLI are introduced without quantitative validation, providing accuracy metrics based on at least manual interpretation would strengthen the sediment extraction results.

Reply: We agree that the rationale for selecting the LST and optical remote-sensing datasets, as well as the basis of the NDSLI threshold, should be clarified.

Regarding the selection of MOD11A1, this study requires LST observations that temporally match, as closely as possible, the satellite observations used for sediment mapping. MOD11A1 provides daily LST observations, thereby offering more opportunities to obtain LST observations corresponding to the selected sediment-mapping dates. This temporal flexibility is particularly important because the spatial distribution of aeolian sediment on lake ice may change over relatively short timescales. We will clarify that the selection of MOD11A1 was therefore based primarily on its temporal characteristics and suitability for temporal matching, rather than simply on the spatial resolution of the LST product.

Regarding the use of Landsat 8 OLI instead of Sentinel-2, we acknowledge that Sentinel-2 provides higher-spatial-resolution optical observations than Landsat 8 OLI. We also considered the availability of Sentinel-2 imagery during the study period. However, the main limitation was the difficulty in obtaining high-quality MOD11A1 LST observations that corresponded to the available Sentinel-2 acquisition dates, largely due to cloud cover and the overpass time mismatch. Because the objective of this study is to examine the spatial relationship between aeolian sediment distribution and lake ice surface temperature, close temporal correspondence between the sediment observations and LST observations is an important consideration. We therefore selected Landsat 8 OLI based on the availability of suitable observations that could be temporally matched with MOD11A1. We will clarify this data-selection criterion in the revised manuscript and acknowledge the trade-off between spatial resolution and temporal correspondence.

Regarding the NDSLI threshold, we appreciate the suggestion concerning quantitative validation. The threshold used in this study was adopted from our previous published study, in which the threshold was evaluated through comparison with manually interpreted sediment distributions. We will provide a clearer explanation of the origin and basis of this threshold and cite our previous work in the revised manuscript. We will also emphasize that the threshold was not arbitrarily defined for the present study, but was derived and evaluated in our previous work.

We appreciate this comment, which will help us clarify the methodological rationale, the data-selection criteria, and the basis of the sediment extraction approach.

Comment 3: The advantages over conventional GWR are not clearly demonstrated. Is the multiscale GWR framework truly necessary? Moreover, the broadband albedo is used as a key argument for the proposed radiative mechanism. If this analysis is essential, the corresponding data, methods, and results should be moved to the main body.

Reply: We agree that the rationale for applying MGWR rather than conventional GWR, as well as the role of broadband albedo in supporting the proposed radiative mechanism, should be explained more explicitly.

Regarding MGWR, although the manuscript compares OLS, GWR, and MGWR in terms of model performance, we recognize that the conceptual rationale for adopting

MGWR was not sufficiently articulated. The sediment–LST relationship may exhibit spatial heterogeneity at multiple scales. For example, the distribution of aeolian sediments is influenced by localized transport and deposition processes, whereas the thermal response of lake ice may be governed by broader-scale radiative and environmental conditions. Conventional GWR uses a common spatial bandwidth for all explanatory variables, which may not adequately represent processes operating at different spatial scales. MGWR, in contrast, allows individual predictors to have variable-specific spatial bandwidths and therefore provides a more flexible framework for identifying varying spatial scales of influence among predictors.

We will further clarify this rationale in the revised manuscript and explain how model performance and the estimated spatial bandwidths provide complementary information for evaluating the potential advantages of the multiscale framework over conventional GWR. We will also avoid presenting improved model performance alone as sufficient evidence for the necessity of MGWR.

Regarding the broadband albedo analysis, we appreciate the suggestion to integrate this analysis more directly into the main manuscript. We agree that albedo provides important physical evidence for interpreting how aeolian sediment deposition may modify the radiative properties of lake ice and thereby influence its thermal conditions. We will therefore incorporate the relevant albedo data, methodological description, and key results into the main text and explicitly connect these results with the proposed radiative mechanism underlying the observed sediment–LST relationship.

We appreciate the valuable comments, which will help us strengthen both the methodological justification for MGWR and the physical interpretation of the observed thermal effects.