Response to editor:

We sincerely thank the associate editor for the careful evaluation of our manuscript and for the constructive suggestion. We appreciate the helpful guidance provided during the final revision process.

In addition, we have updated the affiliation of the first author to reflect a recent change in institutional affiliation. The previous affiliation:
1 College of Mechanical and Electrical Engineering, Northeast Forestry University
has been replaced by:
1 School of Ecology, Northeast Forestry University.

Below, we respond to the comment in detail. Our response is shown in blue font, while the revised manuscript text is presented in bold italic blue font.

Comment 1
Given the revised discussion regarding the interpretation of the limited temperature response to the freeze-thaw-related hydraulic constraint, it would be useful to provide readers with a brief description of the soil thermal scheme, including the heat diffusion scheme, lower boundary condition, and ice-dependent thermal properties.

Please add this information to the manuscript before final acceptance.

Response:
We thank the associate editor for this helpful suggestion. We agree that a brief description of the existing soil thermal scheme is necessary to clarify how soil water and ice states influence soil temperature dynamics and to better contextualize the newly implemented freeze-thaw-related hydraulic constraint.

We have added a brief description of the existing soil thermal scheme in Sect. 2.2 (P5, L105-115). The added text describes the heat diffusion scheme, lower boundary condition, and the role of soil water and ice states in determining thermal properties and phase-change energy exchange.

The revised text is provided below: **"In the default LPJ-GUESS configuration, soil temperature is simulated using a one-dimensional heat diffusion scheme, which describes vertical heat conduction through the soil profile:**

$$C_v \frac{\partial T}{\partial t} = \frac{\partial}{\partial z}(k \frac{\partial T}{\partial z})$$

where T represents soil temperature, t represents time, and z represents soil depth. C_v represents volumetric heat capacity, and k represents thermal conductivity.

The thermal properties are dynamically determined from the volumetric fractions of mineral soil, organic matter, liquid water, ice, and air. Therefore, changes in soil water and ice states influence soil temperature through their effects on thermal properties and energy storage associated with phase transitions. The lower boundary condition is implemented as a zero heat flux condition by setting the thermal diffusion coefficient at the bottom layer to zero. The existing LPJ-GUESS thermal formulation was retained in this study, while the present developments focus on improving soil vertical representation and frozen-soil water redistribution."