We would like to thank the reviewer for the insightful comments and suggestions that are helpful for improving the quality of the manuscript. We have carefully revised the manuscript accordingly. The point-by-point responses are below.

This study evaluates the performance of Community Land Model version 5 (CLM5) in simulating snow cover during winter over the Tibetan Plateau (TP) and presents a revised snow cover fraction (SCF) parameterization scheme implemented in the model. This is a very interesting and innovative investigation. The results show that the revised scheme appears to reduce SCF biases and alleviates the cold bias over the TP. Generally, the topic is interesting, as it addresses uncertainties in land surface model simulations of snow processes in alpine cold regions. The findings may therefore provide useful insights for further development and improvement of land surface models. I recommend a minor revision. My comments and concerning that need be clarified are as follows.

1. This study focuses on TP snow cover during winter rather than other seasons, the reason behind it should be explained.

Reply: Thank you for your comment. The reason is that the biases in snow cover fraction (SCF) simulated by CLM5 are largest during winter (December–January–February) compared with the other seasons (as shown in Figure R1). We have added an explanation for the focus on this season in the revised manuscript.

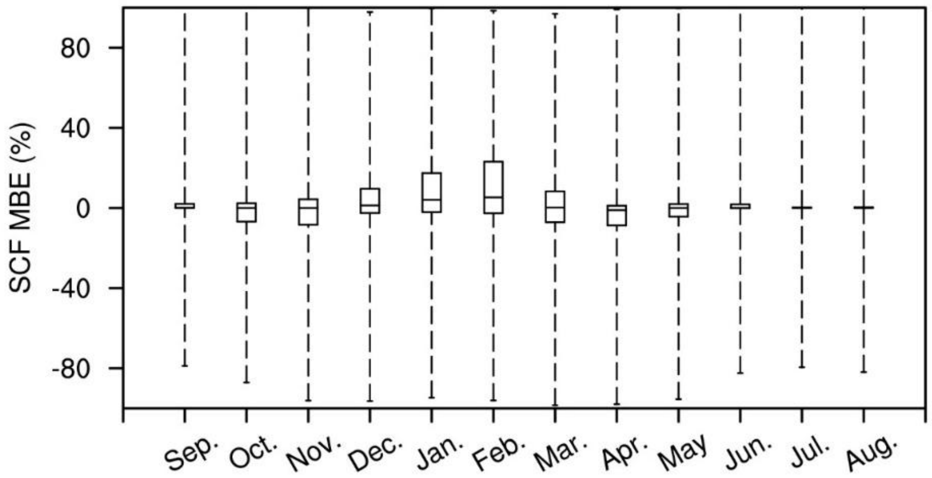

Figure R1. Evolution of the monthly mean bias error (MBE) in CLM5-simulated snow cover fraction over the Tibetan Plateau (TP).

2. The revised scheme parameterizing k_{accum} and revising N_{melt} are based on the consideration of withered grass stems (WGS) and terrain characteristics. While, the proposed formulation appears largely empirical, the physical mechanisms linking these factors (WGS and terrain) to the spatial distribution of snow cover seem not be sufficiently revealed. The authors should provide a clearer theoretical justification, explain the choice of functional form.

Reply: Thanks for your professional comment. Although the parametrizations of k_{accum} and N_{melt} are empirically developed based on statistical method, their theoretical basis and the choice of functional forms can be physically explained.

Over the Tibetan Plateau (TP), snow cover distribution and snowmelt processes are strongly influenced by complex terrain and short vegetation (i.e., withered grass stems). The effects of terrain are twofold: shallow snow over relatively flat terrain tends to melt faster because fresh shallow snow generally has a relatively low albedo, whereas terrain shading in areas with large topographic relief promotes snow persistence and slows snowmelt. Therefore, both topographic relief (σ_{topo}) and withered grass stems

(WGS; represented by the stem area index, SAI) are key factors controlling snow probability distribution (k_{accum}) and snowmelt processes.

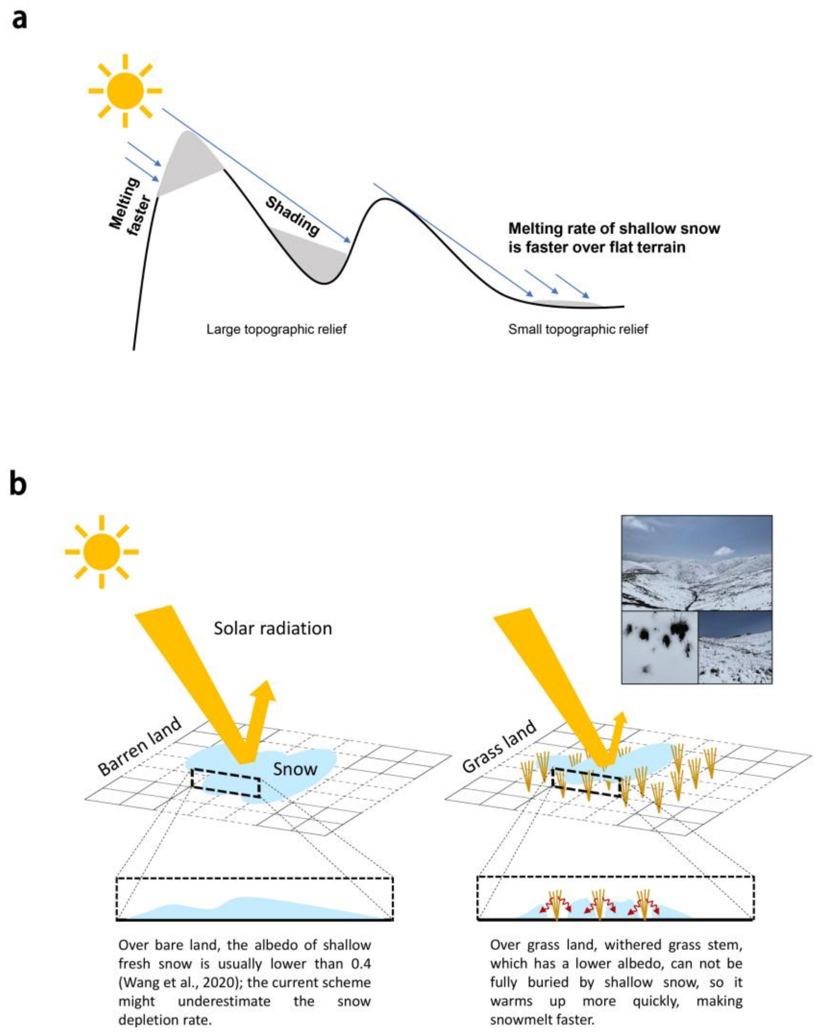

Figure R2. Schematic diagram of (**a**) effects of topographic relief and (**b**) short vegetation (i.e., withered grass stems) on snow cover.

Over barren land, σ_{topo} is the dominant factor controlling both snow accumulation and snowmelt (Figure R2a). The k_{accum} is represented by a power function of σ_{topo}. When σ_{topo} is small, snowfall is distributed more uniformly, leading to higher SCF. As σ_{topo} increases, snow preferentially accumulates in topographic depressions, thereby reducing SCF. However, this suppressing effect weakens under highly complex terrain because snow over the TP is generally shallow, limiting variations in snow distribution. Over grassland, both σ_{topo} and SAI jointly suppress snow distribution; therefore, k_{accum} is parameterized using a linear relationship that incorporates their combined effects.

The current scheme assumes that larger σ_{topo} values correspond to faster snowmelt, while overlooking the shading effect of complex terrain and the influence of WGS. To address these limitations, a revised factor (F) is introduced in the optimized scheme to comprehensively account for these effects, thereby improving the representation of snow depletion. Under relatively flat terrain, smaller F values provide stronger corrections to the overestimation of SCF. In contrast, under complex terrain, terrain shading partially offsets the enhanced melting on sunlit slopes, causing F to approach 1 and thereby weakening the correction effect. Consequently, over barren land, F increases with σ_{topo} and is represented by a linear function of σ_{topo}. Over grassland, withered grass stems enhance snowmelt and dominate the snow depletion process (Figure R2b). As SAI increases, F decreases, indicating a stronger correction effect. To further account for the combined nonlinear influences of σ_{topo} and SAI, F is parameterized using an exponential function based on a combined factor (SAI^2/σ_{topo}).

3. Results show a large reduction in SCF bias (up to ~88%) after optimizing the parameterization. But, it is unclear whether these improvements are spatially uniform across the TP. To identify the advantages and limitations of the revised scheme, it’s suggested to add analysis showing regions where the revised scheme performs particularly well and other regions where biases remain significant.

Reply: Thanks for your comment and suggestion. Indeed, the improvements introduced by the optimized scheme are spatially heterogeneous. As shown in Figure 7a-b, the optimized scheme significantly reduces the positive biases of SCF over the northwestern TP, the Kunlun Mountains, the Bayan Har Mountains, and the Siguniang Mountains, while slightly reducing the negative SCF biases over the southeastern TP. However, it has little effect over the southwestern TP (i.e., the Himalaya Mountains). We have added further analysis and discussion in the revised manuscript.

4. The authors are encouraged to provide a detailed analysis of the energy budget, analyze shortwave and longwave radiation fluxes, sensible and latent heat fluxes, potential changes in snow–albedo feedback, which would help clarify the physical consequences of the revised parameterization scheme.

Reply: Thanks. We have added evaluations of surface shortwave and longwave radiation, as well as surface sensible and latent heat fluxes, in the revised manuscript.

5. This study does not indicate whether the revised scheme was tested in multi-year or long-term simulations. It is necessary to evaluate that the revised scheme remains stable over longer periods. Specifically, whether interannual variability of snow cover over TP is captured.

Reply: Thanks for your comment. We conducted multi-year and long-term simulations and analyzed the averaged biases of CLM5. In the revised manuscript, we have added evaluations of the optimized scheme in reproducing the interannual variability and long-term trends of SCF.