Review on manuscript "Impact of frozen soil processes on soil thermal characteristics at seasonal to decadal scales over the Tibetan Plateau and North China"

This work firstly introduced a multi-layer FSM into the SSiB3 to represent the freezing-thawing process and the heat and water transfer in a multi-layer frozen soil (SSiB3-FSM). To overcome the difficulties in achieving stable numerical solutions for frozen soil, a new semi-implicit scheme and a physics-based freezing-thawing scheme were applied to solve the governing equations. With that, the performance of the SSiB3-FSM model, as well as the effects of frozen soil process on the soil temperature profile and soil memory and maximum frozen soil depth, were investigated by using observation and models simulations over the Tibetan Plateau and North China region. The study allows for a better understanding that frozen soil processes are of great importance in controlling surface water and energy balances during the cold season and in cold regions. Furthermore, it also allows for accurate freeze-thaw cycle simulation and frozen soil predictions.

How to solve the highly nonlinear equations in multi-layer frozen soil are the difficulties in land surface model and the climate models. The study has a great potential to provide guidance for future development of frozen soil model in land surface model and climate models. Few published papers focus on the effects of frozen soil processes on soil temperature, soil memory and maximum frozen depth in the TP and NC. This study provides useful information.

The analyses in the paper are well organized and the results are reasonable. The presentation of this article is generally clear. Based on my evaluation for the merit of this paper, I suggest publication of this paper with some minor revisions.

1. In abstract, line 20. Consider clarifying how they are investigated. Observations are mentioned below, please state which observations were used for the comparison.
2. At the end of the abstract, please consider adding an additional sentence to describe the impact of your findings for future research or practical applications.
3. At line 185, "It can effectively produce stable solutions for long-term integrations

with the heat and mass balances." It's too general. Please provide relevant data or citations to support these statements. Otherwise,

4. At line 272, it is not clear why this is not just Section 4.1.2. Consider revising to use the section headings instead of a numbered list. Otherwise, write a sentence to introduce the list first. The same problems are at line 306 and 308.

5. At line 347-349, "To more clearly display these relationships, the soil temperature phase lag time, defined as the point at which the cross-correlation with the first soil layer equals 1, with depth is shown in Fig. 7b and Fig. 8b." Please check that this is what was meant here. Please revise to clarify.

6. Why do you plot Figure 11 with the simulated soil temperature instead of observed data?

7. There might be errors in Figure 2. Please check at the last step of Fig.2 $\theta_{l,j}^{k}$ should be $\theta_{l,j}^{k+1}$ or not.

8. Please check it is "1.5cm" or "15cm" at line 412.