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Reply on RC1

Lianyu Yu et al.

Author comment on "STEMMUS-UEB v1.0.0: integrated modeling of snowpack and soil water and energy transfer with three complexity levels of soil physical processes" by Lianyu Yu et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2020-416-AC1, 2021

Anonymous Referee #1

Referee comment on "STEMMUS-UEB v1.0.0: Integrated Modelling of Snowpack and Soil Mass and Energy Transfer with Three Levels of Soil Physical Process Complexities" by Lianyu Yu et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2020-416-RC1, 2021

This manuscript aims to incorporate the snowpack effect into a STEMMUS-FT modeling framework, with various complexities of mass and energy transfer physics, then investigate the effect of snowpack on soil moisture and heat transfer. In general, the manuscript is well written and interesting to me. I recommend a major revision for this manuscript before its acceptance for publication.

We thank the reviewer very much for the time and effort and also for the insightful comments. Please see our specific response below.

General comments:

[1] There are too many long sentences which make them hard to follow.

Response: We have made changes, separate the long sentences into short ones, trying to make it easy to read and follow.

[2] Can the simulated time series of daily average albedo and LE (latent heat flux) be longer?

Response: We thank the reviewer for the insightful comments. Yes, the temporal spectrum of daily average albedo and LE (latent heat flux) can be longer. For instance, we have run about 3-year simulation (Mar. 2016 – Aug. 2018) of surface energy fluxes, including radiative components, sensible heat fluxes and LE, against the in-situ observations for this site. It well demonstrated the performance of STEMMUS-FT (Yu et al., 2020). The UEB model also shows its widely and successful application spanning a variety of hydrological conditions (Table S3). All these give us confidence that the integrated STEMMUS-UEB model can be applicable to this experimental site. On the other hand, we have to admit that as the harsh environment, the dataset is difficult to achieve and to have it fully corroborated. The accuracy of precipitation measurement (both the amount and its liquid/solid fractions), which is important to have the snowpack dynamics right, is uncertain and needs efforts to have more dataset to constrain it. We add some text in Section 4.1 Limitations.

For this work, we focused on developing the integrated STEMMUS-UEB model (in Sect. 2 and Supplement). Furthermore, upon the confirmation of STEMMUS-UEB model performance, we are trying to emphasize/demonstrate its capability for understanding the effect of snowpack on the subsurface soil water and heat transfer processes. With the aid of both in-situ measurements and numerical experiments, we can see that: i) the presence of snowpack can be identified by the abrupt dynamics of daily average albedo. STEMMUS-UEB model well captured the large abrupt of daily average albedo with the precipitation. ii) models considering the snowpack process generally presented better simulation performance than models without snowpack. Then we further illustrated the capability of STEMMUS-UEB, in terms of understanding how snow water infiltrates downwards and interacts with subsurface soil water and heat regimes.

[3] The freezing and melting processes are a cyclic process, it will be more reasonable to describe the two processes together (section3.4.1 & 3.4.2).

Response: We agree that freezing and melting processes are inherently bounded together. We made changes about section 3.4.1 & 3.4.2 according to the reviewer's comments. First, we presented diurnal dynamics of the observed and model-simulated latent heat flux (LE) during the rapid freezing and thawing periods with precipitation events in Figures 6 and 7, respectively.

Then the relative contribution of individual flux components to the total mass transfer was presented in Figures 8 and 9, respectively, for the freezing and thawing periods.

The freezing and thawing processes were described together in Section 3.4.

[4] The language could be polished in various places in order to facilitate understanding.

Response: Thanks a lot for the helpful comments. We had the manuscript English edited.

Specific comments:

[5] The overview of the coupled STEMMUS-FT and UEB model framework and model structure in figure 1, the text is too small to read.

Response: We made modifications to the text in figure 1 and also made it as Landscape orientation instead of Portrait orientation.

[6] Figure 6 is too long, which can be divided into three figures or rearranged. Time series of different variables overlapped and changes in different variables are not visible. Such as qLh and qLT. Same as other figures.

Response: Figures were rearranged to make it easy to read. Figure 6 and Figure 7 were further presented as Figure 6, Figure 7, Figure 8, and Figure 9. The state variables were presented together as a cyclic freezing-thawing process. The comparison of observed and model simulated latent heat fluxes (LE) for the freezing and thawing periods were given sequentially in Figure 6 and Figure 7. Figure 8 and Figure 9 present the model simulated latent heat flux and surface soil thermal and isothermal liquid water and vapor fluxes for the freezing and thawing periods.

We use different types of lines (dotted line for q_{LT}, dashed lines for q_{Vh}, and q_{Va}, and solid lines for q_{VT}, q_{Lh}, q_{La}, with different colors) to make the different flux component visible in figures.

[7] In Figure 7 (e, f, h, i), the sharp changes should be explained on Day 103. The figure and legend are overlapped.

Response: We moved the legend a little bit to avoid its overlapping with the figure content. For the sharp changes of isothermal liquid and vapor fluxes (q_{Lh}, q_{Vh}), it is due to the large increase of surface soil moisture after the precipitation events (see Supplement Figure S2 d & f). This resulted in the large gradient of matric potential thus the sharp changes of isothermal liquid and vapor fluxes. We add the explanation in Section 3.4.