RC1: 'Comment on hess-2022-136', Anonymous Referee #1, 17 Jun 2022

General comments:

The manuscript by Eunsang Cho and others is well organized and clearly presented. The research fits well into the larger picture of mountain snow research and highlights the need for improving LSM estimates of SWE. The authors imply a focus on precipitation/snowfall accumulation is an important first step. Without proper precipitation accumulations, the model is unable to properly evolve the snowpack. It is important to identify the issues with LSM SWE estimates and this manuscript does just that. It does not rank the LSM outputs, but rather uses them to provide strong conclusions about the next steps in improving the models. The authors provide a lengthy discussion that addresses the main shortcomings of the models and observations used in their research. This provides good context to how their work fits into the larger picture of snow research and I found the discussion to be just as important as the rest of the paper.

I am happy to have reviewed this paper and know of the conclusions. The paper receives excellent marks in terms of the HESS review criteria of scientific significance, scientific quality, and presentation quality. Thus, I recommend this paper be accepted to HESS. I have given a few minor suggestions below that may contribute to the improvement of the manuscript:

[Answer] Thank you to the Reviewer for the positive feedback and constructive comments which helped us to improve the manuscript. Please see our response to each comment given below.

1) When discussing the potential of using wet-bulb temperature as a rain/snow partitioning method, the inclusion of Sims and Liu, 2015 (https://journals.ametsoc.org/view/journals/hydr/16/4/jhm-d-14-0211_1.xml) would be beneficial to the reader. This partitioning method is used for satellite remote sensing of precipitation.

[Answer] Thank you for the important literature. We have added the recommended literature in the section “4. Discussion and future perspectives” where we discussed the potential of using wet-bulb temperature as a rain/snow partitioning method as below.

“The two precipitation partitioning approaches used in this study may have limitations. A new precipitation partitioning method incorporating humidity performed better than air temperature-only methods (Jennings et al., 2019). Also, solid precipitation simulations were improved when the wet-bulb temperature, defined as the temperature to which air can be cooled to saturation by the evaporation of water into the air, was used, particularly in the drier, high elevation continental regions of the western U.S. This was because, as compared to air temperature, the wet-bulb temperature was closer to the actual temperature of a falling hydrometeor (Sims and Liu, 2015; Wang et al., 2019). Considering that the wet-bulb temperature is affected by surface skin temperature and vertical lapse rate (Sims and Liu, 2015), future comparison studies with multiple precipitation partitioning methods should consider humidity, wet-bulb temperature, and/or other meteorological variables in various environments in developing the best partitioning approach for the land surface and hydrological modeling communities.”

Sims, E. M., & Liu, G. (2015). A parameterization of the probability of snow–rain transition. Journal of hydrometeorology, 16(4), 1466-1477.

2) A few minor corrections:

Line 74: Rephrase "Furthermore, most of the prior studies used a single or multiple LSMs with a single meteorological forcing and/or simulated/reanalysis SWE with relatively coarse spatial resolutions (e.g., 12.5 km to 50 km), which impedes the quantification of the contributions by producing additional uncertainties." ---> "Furthermore, most of the prior studies used a single or multiple LSMs with one meteorological forcing and either simulated or reanalysis SWE with relatively coarse spatial resolutions...."

[Answer] Thank you for rephrasing the sentence which makes more sense. We applied this as below.

“Furthermore, most of the prior studies used a single or multiple LSMs with one meteorological forcing and either simulated or reanalysis SWE with relatively coarse spatial resolutions (e.g., 12.5 km to 50 km), which impedes the quantification of the contributions by producing additional uncertainties.”

Line 163: Simplify "The data matrix was pre-processed: the values in each column were normalized with the following two steps: 1) the mean of each column is zero, and 2) each column was standardized to the unit norm as the variables have different units." ---> "Data in the matrix was pre-processed such that the mean and standard deviation of each variable is zero and one, respectively."

[Answer] We appreciate your suggestion. We applied the simplified statement in the manuscript.

“The potential sources of the error are obtained from the comparison between SEUP and SNOTEL observations. Data in the matrix was pre-processed such that the mean and standard deviation of each variable is zero and one, respectively.”

Line 199: Change "... fractioning method partitions partial precipitation..." ---> "... fractioning method partitions precipitation..."

[Answer] Thank you for the correction. We agreed and applied this.

“This is not surprising because the fractioning method partitions precipitation amounts with air temperatures ranging from 0 to 2.5 °C as snowfall, which would be classified as liquid rainfall with a single threshold method that uses 0 °C as the rain-snow threshold.”