Reviewer Comments for:

Snowmelt response to simulated warming across a large elevation gradient, southern Sierra Nevada, California

By Musselman et al.

Submitted to The Cryosphere

The authors provide a new approach to addressing projected climate impacts on mountain snowpack by focusing on snowmelt. Most previous studies have focused on snowpack. Their perspective is relevant, especially for water management.

Overall the structure of the paper was well organized and presented, and the conceptual design and research is worthy of publication. Before this research is publishable I have one major concern regarding the lack of detail and specifics of the modeling for meteorological conditions and validation of snowpack.

From the paper I inferred that the authors modeled snowpack using all of the available meteorological stations, but did not validate the meteorological outputs. For example, the authors state "*Interpolations were conducted with the data access and pre-processing library MeteoIO [Bavay and Egger, 2014] and computed with an Inverse Distance Weighting (IDW) algorithm with elevation lapse rate adjustments for air temperature, wind speed, and precipitation.*"

The authors had 19 stations of meteorological forcing data. But were any used to assess the meteorological outputs before calibrating snowpack?

If not the authors calibrated a model to three snow years and then applied projected increased temperatures. If this is the case, their approach is problematic. It is critical to ensure that you are getting modelled results correct for the right reasons (Kirchner, 2006). Modeling snowpack without ensuring that you have the underlying meteorological conditions correct is problematic, because any modeled error propagates through the climate projections. It is pertinent to get the right answers for the right reasons and demonstrate this to the reader.

In my opinion this paper should not be published until the authors clarify their approach or remove some of the forcing stations and use them to validate the meteorological outputs.

Other specific comments:
Line 1: The abstract is very well written, with the exception of the first sentence. I did not understand your point until I read the sentence three times. Please consider restructuring it so that there is little to no ambiguity.

Lines 90 – 93: I like your description of why you chose only to change changes in temperature.

Line 143: You describe that the model has an arbitrary number of layers. I found myself wanting more information about how the number of layers is/was decided. By the modeler or the model?

Lines 242-243: How were the automated SWE measurements evaluated? This should be provided in the methods.

Lines 281 – 282: This is a very informative way to organize the elevation bands!

Lines 327 – 329: Please provide some of the result values for Snow Disappearance Date.

Lines 341 – 346: There are a lot of generalities (i.e. in general is used two times in three sentences). It would be informative to have to have detailed values and let the reader decide in general or not. In its present form, the reader simply has to assume what the authors are telling them with minimal supporting data/evidence.

Lines 359 – 361: I did not see the step-wise jump that you all are referring to here. I fully assume it is my error, but it might be helpful to annotate the jumps for your readers.

Lines 368 – 375: This is great data, and well organized.

Lines 445 – 455: This is an important policy/infrastructure component of this work. Consider adding an even more bold statement here. Something along the lines of: “The shift of SWE towards higher unmonitored elevations highlights the need for expanding the existing monitoring network to better manage water resources. For example, in the extremely low snow year of 2015, 1 March 47% of snow monitoring sites in the Willamette River basin, Oregon registered zero SWE, while snow was still present at higher elevations. (Sproles et al., 2017)“.

Use the citation or not, but I recommend a stronger policy statement regarding the absence of SWE monitoring at higher elevations, and how the addition of these sites would be critical to monitor snowmelt response to warmer temperatures and for water resource management. Your efforts demonstrate why additional monitoring is important.

Lines 481 – 483: This statement is an important discussion point that could be made stronger by adding a more recent citation and examples from the winters of 2014 and 2015.

Lines 519 – 520: Throughout the paper I was expecting snowmelt lysimeters to be included, as either data or as discussion topic. I found the absence of any discussion of

lysimeters in a paper focused on snowmelt to be incomplete. Are there no lysimeters in the study area? If not would this also be an infrastructure recommendation?

At the minimum, I would suggest a brief explanation of how lysimeters could or could not improve the scientific understanding of snowmelt processes.

Lines 529 – 531: This is a pretty critical point, especially since one of your primary findings is that the higher elevation snowpack will be more important under warmer conditions. The fact that the model performs better near forcing stations further supports my concerns modeled temperature and precipitation data not being calibrated/validated. This is an important component of modeling distributed snowpack. Doing so could perhaps improve model performance at higher elevations.

Figure 2: Your color ramp for snow is counterintuitive. Red usually represents warning/drier conditions, but here it represents more snow. Additionally, if you are displaying sequential data it should be on a single color ramp.

Light, Adam, and Patrick J. Bartlein. "The end of the rainbow? Color schemes for improved data graphics." *Eos* 85.40 (2004): 385-391.

Also, http://colorbrewer2.org/, has color schemes that work really well. I believe there is a Matlab function for Colorbrewer as well.

https://www.mathworks.com/matlabcentral/fileexchange/34087-cbrewer---colorbrewer-schemes-for-matlab

Figure 5: Again, colors are counterintuitive and should be redesigned.

Figures 6, 7, and 10 are really informative. They provide a lot of information!