

Review: Changing Snow Water Storage in Natural Snow Reservoirs

Summary: I thank the authors for addressing my comments made during the first round of reviews. My overall summary of the work remains consistent, with additional suggestions made below as line-by-line comments. In general, the additions made to the text and figures greatly enhance the work and the introduction of the Snow Water Storage metric (SwS). My remaining comments are with respect to needed clarification in the text and further representation of SwS in the figures (beyond represented *changes* in SwS). My hope is that addressing this round of feedback will further highlight the importance and applicability of the SwS metric. I look forward to seeing an updated version of the manuscript ready for publication soon.

Line-by-line

Line 6: Suggest more specific synonym for “special” (particular?).

Lines 9: Suggest stating the *direction* of change when possible. Annual SwS is stated to have decreased across almost all mountainous ecoregions in line 12-14. Also suggest reporting annual trends separately from monthly trends, as opposed to switching back and forth between sentences. For example, the sentence at lines 12-14 could replace the sentence at line 9. Monthly SwS averages and trends could be reported after annual results. Stating results as non-mountainous ecoregions and mountainous ecoregions (since there is a special focus on these regions) might also increase readability, as that distinction is not clear.

Line 10-11: It is unclear if “in mountainous regions” is (or is not) referring to the 16 mountainous ecoregions here.

Line 15 and Line 19: Is there a mechanism that has been explored to explain why monthly SwS has increased and decreased across the area/across elevation bands? If so, it is suggested these results (or potential mechanisms) be added to the abstract to exemplify how the SwS may become more “valuable.” With respect to the use of “valuable,” what type of applications are the authors referring to when “valuable” is mentioned? Valuable for predicting snow water resources (referring to “provide information on the natural reservoir function of snowpacks” at lines 16 and 17)? Similarly, is “more valuable” in reference to a comparison to other snowpack metrics or a comparison to its value in the past?

Lines 21-24: Suggest citations.

Lines 29-33: Suggest moving these sentences to the end of the introduction or methods.

Line 34: Suggest a citation.

Line 42: It is unclear what “composite” in quotation marks means (could the quotes be removed?).

Line 48-54: While the figure is extremely helpful in demonstrating the SwS concept, it is unclear what the purpose of this figure is in the context of the introduction. Suggest starting this paragraph with the potential research gap that has been identified by the authors after reviewing the metrics in the previous two paragraphs.

Line 75-76: The reference to Greenland and Antarctica seems irrelevant to this study

Line 77: Similar comment to “more valuable” in Line 19, it is unclear what “less useful” is referring to here – less useful for what exactly?

Suggest including a half or full paragraph in introduction on “future of increased climate variability” (taken from abstract).

Line 78-79: Great set up for this final introductory paragraph. The following sentences before the research questions, however, read as though they belong in the methods section. Instead, the authors could emphasize why and where there is a need for quantifying changes in snow water storage in a new, integrated way.

Line 111: Suggest remaining consistent between “we used” vs. “This study also uses” (e.g., “In this study, we also used...?”).

Line 179: “Typical mountain snowpack” is what was used earlier with respect to “mountain snowpack” here (add “average” or “historical” or “typical”?). A definition of “typical mountain snowpack” vs. “permanent or persistent snowpack” vs. “intermittent or ephemeral snowpack” would be helpful to set the readership up for items in the discussion section.

Section 3.1: My outstanding comment here and from my previous review is with respect to reporting how the SwS has changed in these areas (i.e., the physical changes in SWE curve and SwS representation). Figure 11 is an excellent addition to this manuscript – however readership is still left wondering what SwS actually looks like, numerically, across the region and each individual ecoregion. For now, suggest mentioning that the specific ways in which annual SwS has changed will be shown in section 3.3. This is in addition to the way in which Figure 11 exemplifies the SwS’ uniqueness to other snow metrics. See further comments below.

Figure 6: The use of actual/raw SwS values in the text helps contextualize the metric – however this figure only shows percent change. Suggest making this a two-panel plot with average annual SwS across the region and then change through time (current figure).

Section 3.2: Perhaps the ecoregions which are considered mountainous vs. non-mountainous could be listed in the text (as shown in Figure 2) and used as a distinction between Section 3.1 and 3.2 (listed first in Section 2.3). In averaging annual SwS across stations – how many of those stations are in and outside of mountainous ecoregions? It would be very beneficial to include those points in Figure 2 (I see they are shown in Figure 4 but without the ecoregion boundaries). Many of the non-mountainous eco-regions would not be represented by those station results (albeit they are represented via the modeling results). As such, the spatial average results from the station data and the results from the model are very different, and I’m not sure those differences are obviously noted in the text. In general, it is challenging to follow which areas in Figure 2 are represented across sections 3.1 and 3.2. And differences in station results between sections 3.1 and 3.2 are challenging to distinguish, given the areas of interest (i.e., entire CONUS above SCD threshold vs. mountainous ecoregions).

Figure 10: Suggest labeling these panels with the name of each ecoregion.

Figure 11: This is a very helpful addition to the manuscript and is the figure that truly highlights the utility of this metric. Again, suggest labeling these panels with the name of each ecoregion, especially since they are most easily referenced by name in the text. Also suggest letting the y-axis change such that readers can see the changes in SWE curves for all ecoregions (especially 23, 62, 67, 69). Suggest labeling each colored line on one panel – it is challenging to decipher what each line indicates from the figure caption. Does the red labeling indicate a significant decrease or increase in annual SwS (currently says “change”)? Those differences in direction should be noted. Finally, it is unclear what “conceptual SWE curve” represents from the actual SWE curve or SwS as represented by the datasets. Is the SwS represented here at all? That is unclear but would be the final, most important piece – to see what SwS actually looks like through time (start of study period vs. end of study period). Perhaps even noting the final numerical SwS calculation for the red dotted line triangle and the red solid line triangle would provide context for this metric.

Line 284: Suggest elaborating on or rephrasing “paint the full picture.”

Line 287-288: Citation or figure?

Figure 13: In the text, it is suggested that this figure is a side-by-side comparison of annual SwS, April 1 SWE, max SWE, and snow-covered days – however that is not teased apart in the actual figure. This case study would be extremely valuable if the readership could observe how – perhaps – April 1 SWE have not changed (e.g., it is mentioned that April 1 SWE is often 0 here), SCD has increased, but SwS has decreased. In addition to SWE curves, suggest plotting a subpanel of SCD through time, maximum SWE through time, and then SwS through time with

example curves (e.g., first year on record SWE curve + annual SwS value, final year on record SWE curve + annual SwS value).

Line 308-310: As mentioned above and from the first review, *showing* the SWE curve flattening through time, on average, would be very informative to see and complement the results written in Section 3.1 and shown by ecoregion in Figure 11.

Line 311: “More informative” for what? I ask these repetitive questions because it seems a half sentence is often missing in emphasizing the utility of this metrics over others with respect for water resources. These results seem to hint at incorporating the SwS in a water management scenario.

Line 368: This is a comment likely intended for the methods or results, but the elevation bands (low vs. higher) could generally be defined for each region, since Figure 10 (referencing hypsometry) shows results relative to elevation in each ecoregion.

Discussion: Suggest somewhere in this section to interpret and discuss the implications of the changes seen in Figure 11 and the average “flattening of the SWE curve.” Does this indicate that melt is occurring earlier in the year and/or more intermittently throughout the winter? Or is less snow falling throughout the year? Or both? How do these results compare to the metrics mentioned in the introduction? (A good example of this is at line 380 – but this is specific to SWE variability at higher elevations).