

Author responses to: “Brief Communication: Early season snowpack loss and implications for over-snow vehicle recreation travel planning”

Responses to reviewers are in **bold**, new text is in italics (*bold italics for emphasis*)

Responses to Editor Brown

Nice paper and a very useful contribution! A few comments for your consideration during the review process:

Dear Dr. Brown,

We appreciate your positive feedback and suggested revisions. Please find below responses and our revisions to address all of your comments.

1. Please make sure to use units of cm for depth throughout the paper to avoid confusion with SWE in mm e.g. p. 3 line 14 depth is given as 300 mm instead of 30 cm.

Thank you for the suggestion. We have edited the text to “30 cm”

2. I suggest you provide a brief description (method, resolution, caveats etc) for the Margulis et al. (2016) SWE reanalysis given this is one of your major data sources.

Good point, we have added the following discussion regarding the SWE reanalysis:

“The SWE reanalysis utilizes a Bayesian data assimilation framework to condition a priori snow model estimates on Landsat fractional snow-covered area images (Margulis et al., 2015). It verifies the posterior estimates against in situ daily snow pillow and monthly snow course data and is shown to compare favourably to previous studies (Margulis et al., 2016). The limitations of the remote sensing approach include lower temporal frequency of Landsat passes (approximately every 16 days) and potential obscuration of the land surface by clouds and vegetation. Challenges with the in situ verification data include representativeness, or the discrepancies resulting from point-based snow pillow versus transect-based snow course SWE measurements, undersampling of forested and sloped terrain, and the bias of sites in the intermediate elevations of the Sierra Nevada (50% of the stations are between 1500 and 2500 m; Margulis et al., 2016).”

The initial submission did include a sentence on the resolution in time and space of the reanalysis (see below in bold); this sentence precedes the newly added discussion on the method above. We did add the additional citation of the previous Margulis work for readers who might be interested in this approach.

“Daily, gridded estimates of SWE at **100 m horizontal resolution** were provided by a satellite-era SWE reanalysis product (Margulis et al., **2015**, 2016).”

Added reference:

Margulis, S., Girotto, M., Cortés, G., and Durand, M.: A particle batch smoother approach to snow water equivalent estimation, *J. Hydrometeor.*, 16, 1752–1772, doi:<https://doi.org/10.1175/JHM-D-14-0177.1>, 2015.

3. Your paper focusses only on SWE_{min} timing but the duration of SWE ≥ SWE_{min} would also be very relevant, and may be more critical in terms of economic impacts. I’m curious as to why you didn’t include this as part of the study.

Thank you for bringing this up. We did consider this, but wanted to focus on the early season onset as this is when (anecdotally) the desire to recreate on snow is the highest and when the snow depths are most likely to be at the threshold of insufficient coverage for safe OSV usage to avoid damage to the landscape. In other words, the greatest demand for OSV recreation coincides with the early season (holiday periods, excitement to recreate on snow) and in all but the worst snow years, the ability to recreate is not limited by lack of snow in the spring season. In most years (and especially poor snow years), interest wanes during the late season before lack of snow limits OSV recreation. The best economic impacts will likely be during the early-middle season as people are excited to purchase new equipment and utilize holiday periods for extended vacations. As the snow-covered area retreats uphill during the spring season, most users opt to enjoy higher elevation regions anyways given the favorable weather conditions and greater snow stability. The end of season SWE timing can be related to numerous and often interacting issues (radiative forcing due to dust on snow events, warm spells, lack of winter snowfall, cloudiness); addressing those would substantially extend beyond the scope of this paper. To clarify our focus on the early season, we added the following text to the introduction:

“We focus on the initial timing of sufficient snow depth since the greatest demands for OSV recreation and potential ecological impacts occur between early and middle winter.”

4. In your abstract I suggest you talk about delayed onset date of SWE_{min} rather than the date increasing... the later is not intuitive to many people.

Thank you for the suggestion, we have revised the text accordingly to highlight the delayed onset date. Because this is a key message of the paper, we are happy to continue to revise the text to ensure the correct message is clearly conveyed to readers if need be.

*“Since 1985, median SWE_{min} **onset has shifted later** by approximately two weeks. Potential proximal causes of **delayed onset** are investigated;...”*

Best regards, Ross Brown (ed)