

Review for “Spatio-temporal snow data assimilation with the ICESat-2 laser altimeter” by Mazzolini et al. under consideration in The Cryosphere

Summary: The authors clearly put a good amount of effort into addressing comments from the previous round of reviews and the manuscript is greatly improved. I do not have any major concerns about the manuscript but I have a number of minor comments that should be addressed by the authors prior to consideration for publication.

Minor Comments:

- Line 3: Remove “, despite being of great societal interest” because it makes the sentence somewhat awkward with where it is located in the sentence.
- Line 15: You currently end the abstract with stating that the skill score is improved by 19%. I generally recommend that abstracts include quantitative results if possible but this is hard to interpret without the reader knowing what the skill score means. You can keep this if you’d like but I recommend adding another sentence afterwards that summarizes the performance of the joint simulation so that the reader can easily understand the broader importance of the work. Are spatial variations in snow depth reproduced more accurately? Are temporal patterns in catchment-wide averages reproduced more accurately during the accumulation and/or ablation season? Providing this sort of information in the abstract will let the reader interpret the promise of the method even if they aren’t sure how to interpret the skill score.
- lines 21-23: Instead of ending this sentence with a focus on measuring variability in snow “from space”, I would say something like “at a watershed-scale using remote sensing methods” because you mention satellites, aircraft, and drones earlier in the sentence and the issue is really that we have problems getting accurate estimates across full watersheds.
- line 42-43: I found this sentence difficult to read. Consider revising this sentence and the one afterwards to be more straightforward with the fact that the data-assimilating intermediate snow model helps overcome issues with the use of coarse-resolution and potentially inaccurate large-scale atmospheric reanalyses for hydrologic forecasting.
- lines 47-61: Consider revising some of the sentences in this paragraph so that they do not focus as much on the authors of the referenced papers. When you start a sentence with the authors of a paper, you automatically focus on who did the work and not what the work tells you. For example, “Giroto et al. (2020) noted that most snow DA research – with a few exceptions – has focused on purely temporal DA...” could be revised to “Most snow DA research – with a few exceptions – has focused on...” without changing the message but taking the focus off of the citation.
- line 61: Remove the end of this sentence “,as recommended by comment 6 in Anonymous (2023) and by Gascoin et al. (2024)” because it really isn’t needed.
- lines 82-87: The first sentence in this paragraph indicates that the paragraph is going to describe a hypothesis but that is not true. Please revise at least the first sentence.
- line 154: Typo “method”
- line 156: Typo “(Fiddes et al. 2019)”

- line 168: Change “a 3 m height” to “a height of 3 m”
- lines 173-178: For coregistration, you are working with an ICESat-2 track with snow across at least a portion of the domain. Did you only use photon from snow-free areas in your coregistration process? If so, how did you identify them as snow-free? If you used all the photons, that needs to be stated. Either way, it needs to be clear what photons were used because ultimately that impacts the accuracy of your snow depth estimates and therefore the model performance.
- Table 1: Typo “hyperparameters” in the caption. Also, I do not understand how the mean of the precipitation hyperparameter can be a negative number and outside the bounds that are provided. If that is not a typo, then these values should be explained more in the text because their interpretation is not straight-forward.
- line 435: It took me a few reads to understand this sentence. My interpretation is that fSCA in the accumulation season doesn’t tell you much about snow depth because nearly the entire domain can be covered in snow and the depth can vary quite a bit but once you have melting snow and ground is exposed, the depths of the remaining snowpack are more consistent. If my interpretation is correct, try rephrasing so that this point is made more clearly.
- lines 464-466: After this sentence you should point out that ideally you would have incorporated another ICESat-2 profile based on the known improvement in simulations with ablation season observations, but you didn’t have a good track from that time period.