The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC2
https://doi.org/10.5194/tc-2020-377-RC2, 2021


# Comment on tc-2020-377

Anonymous Referee #2

Referee comment on "A seasonal algorithm of the snow-covered area fraction for mountainous terrain" by Nora Helbig et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2020-377-RC2, 2021

Review of "A seasonal algorithm of the snow-covered area fraction for mountainous terrain" by Helbig et al.

This study describes a fractional snow-cover algorithm for use in snow models over mountainous terrain. The fractional snow cover algorithm combines different parametrizations for flat and alpine terrain based on previous work. The algorithm's performance is evaluated across the season for a range of elevations based on observations over the Swiss Alps.

**General Comments:**

I found the evaluations of the algorithm generally convincing. The authors make use of a variety of evaluation data in order to assess the algorithm over a broad range of spatial and temporal scales and across a range of elevations. However the details of the algorithm implementation are *not* described clearly enough for the reader to follow. Furthermore, it's unclear whether the performance of the topographic algorithm is an improvement on existing algorithms that have been used to model fSCA in mountain regions. Both of these issues should be addressed prior to publication.

"mountainous vs flat terrain":

- Please be clear about whether you expect this algorithm to be applicable to nonmountainous regions (in the introduction and reiterate in discussions/conclusions) or whether it will be possible to merge it with other "flat" algorithms to make a global fSCA algorithm (I'm not sure to what extent equation 3 + equation 1 represents what is typically used in models over flat terrain). Do you anticipate that subgrid topographic parameters could be computed globally for every model grid cell and the parametrization used for flat grid cells as well? If so, does the expression for sigma_topo reduce to the "flat" sigma formula for perfectly flat terrain? If not, please state that you expect this algorithm as presently implemented is intended only to be used in simulations over mountainous terrain and it would require modification to implement it in a global climate model.

- Your results comparing with ALS/ADS/camera/Sentinel data are well presented, but I would like to compare them with the typical performance of previous fSCA algorithms that have been applied in mountainous terrain. This may only require showing an extra row in your tables for how the “flat” parametrization (equation 3 only) performs relative to your combined eq 2+3, or a summary figure contrasting their performance. However, if there are other more standard parametrizations that have been used in mountain regions please consider demonstrating whether your algorithm is an improvement on those as well.

“algorithm description”:

Section 2.4 (lines 110-123). This section only provides the reader with the most basic outline of how the algorithm works. I think this section needs to be broadened in particular with regards to how the seasonal and snow event aspects of the algorithm work together. A cartoon/schematic figure which illustrates several key decisions made within a two week window of time-varying HS and how those decisions affect the “seasonal” and “nsnow" curves would be extremely helpful. Ideally this schematic would highlight the differences between fSCA_season, fSCA_curr, and the full fSCA algorithm. At present I have no idea what the difference is between JIM_season and JIM_curr output because the point of the HS tracking has not been clearly communicated. For example, I don’t understand how switching off new snow updates differs from performing no HS tracking? (line 143)

Appendix: The pseudocode and text currently provided in the appendix aren’t clear enough to communicate the implementation of the algorithm. If you intend to publish the complete algorithm (see the request to clarify this below), I would suggest you focus on providing a full description of the concepts/decision-making that it uses rather than pseudocode. The main text should communicate a basic understanding of how the algorithm operates (this is not the case presently), with further details deferred to the appendix, if you wish. While I think it would be helpful to provide a clearer version of the pseudocode along with the published algorithm (since the algorithm will presumably be provided in a specific computer language), I’m not sure it needs to be included in the paper if the rest of the description is sufficient. Please provide definitions for all terms. E.g. what does “recent” mean? What does “current” mean? Does recent snow = current snow? The treatment of melting (which I presume is tracked to remove the flat snow layer before reverting to the underlying topography-dependent layer) is unclear. The reason for tracking HS differences is never fully articulated. Again, I think that some sort of visual depiction/description of what’s going on would be extremely valuable.

**Specific comments:**

Line 50: You introduce the idea of hysteresis here, but don’t explicitly state that your algorithm includes it until Section 2. I think it’s worth mentioning in the paper description at lines 62-73.

Why was 2 weeks chosen as the period to track new snow and melted snow over? This may only cover 1 synoptic scale event – is that sufficient?

I realize you are using the “flat” parametrization to approximate a uniform blanketing of new snow, however the scatter at low elevations (fig 8) suggests that there may be better alternatives (although I’m not sure what level of agreement can be expected between modelled and observed fSCA at such elevations – a comment on this would be useful).

Please confirm: HS=HS(X,t), where X is the location on the coarse model grid (with grid size, L from eq 2) and t is the time (day of the year, for example). Likewise in equations 2 and 3 the HS variables based on the temporally and spatially varying values of HS from the model (hence one could substitute eqs 2 and 3 into eq 1 and simplify to get two forms of eq 1) – is that correct?

Fig 1: By "reset" fSCA_season do you mean that you assign the FSCA_nsnow value to fSCA_season?

Figure 3+4: the colors of the "red and blue stars" appear close to orange and purple to me – especially if the page is zoomed out. Can you adjust the colors or the text to be slightly more in line with each other? Adjusting the red stars closer to orange may actually be more helpful since it would further distinguish it from the red circles of the model output data.

Line 327: Your argument isn't 100% clear here -- isn't it an easy comparison to provide results using only sigma_topo and to explicitly see if the flat parametrization of new snow events is helpful?

Line 350: Rephrase. It's unclear what you mean by "modelled fSCA does not show similar strong trends when compared to Sentinel-derived fSCA…"

Line 386: do you mean "versus Table 3, I"?

Line 387-407: Your points about deriving fSCA from camera images may be valid, however, the ALS and ADS evaluations also represent a spatially averaged evaluation at a single time generally closer to mid-season, while the camera evaluation represents a near-point location evaluated continuously including the very beginning and end of the season. Hence the difference in NRMSE could also represent a true difference in the ability of the algorithm to capture snow cover on average versus at a single location. Or how performance varies with HS.

Code: availability: Does the "depletion curve implementation" differ from the full algorithm?

**Technical Comments:**

The paper contains a lot of non-standard English grammar to the point that it affects reading comprehension. The paper would benefit from a professional copy-editing service.