Hydrology and
Earth System
Sciences
Discussions

Interactive comment on "The recent developments in spatio-temporally continuous snow cover product generation" *by* Xinghua Li et al.

Anonymous Referee #1

Received and published: 3 April 2019

Li et al review the state of the art of cloud-removal procedures for satellite optical snow products. They focus on MODIS products as these are among the most popular datasets used in the community. They classify existing approaches as spatial, temporal, spatio-temporal, and multi-source methods (that is, methods relying on more than one sensor/platform). They include a brief future-direction section that is mostly geared toward MODIS version 6 and the potential role of machine learning and UAVs for cloud removal.

Several cloud-removal procedures have been recently proposed, which significantly enhanced the applicability of satellite optical products for snow science. From this standpoint, I believe that a review of existing methods is timely and could be an important contribution for the readers of HESS. I also appreciated the effort of authors

to summarize many diverse algorithms in a relatively brief and well-structured paper. That said, there are several points that the authors may want to address. Some of them regard the overall content of the manuscript, while some others regard specific passages. I summarize both below.

The most pressing remark (to me) concerns the future-direction section. According to HESS guidelines, "review articles summarize the status of knowledge and outline future directions of research within the journal scope". I think that the manuscript is extensive in terms of synthesis of the state of the art, and some details may be even summarized. On the other hand, the manuscript is very brief in terms of future directions and in general in terms of research needs and knowledge gaps, which should to me be as central for a review as the state of the art. In other words, what are the main scientific knowledge gaps that authors see in this field and that should be addressed in the future? Is there any unexplored hypothesis related to cloud-removal procedures that authors would like to point out for future research? For example, how could new satellites with a higher resolution than MODIS change this field? Also, what is the specific role that authors envision for UAVs, as these sensors have been generally applied to small patches and are not (to my knowledge) deployed operationally? The latter would guarantee the short revisiting time needed by a cloud-removal procedure. I believe that the manuscript may benefit from more details about these points (some details are already scattered throughout the text) and extensive summarization of the technical details of each cloud-removal procedure.

Some wording choices may also be reconsidered. For example, the manuscript uses a quite extensive number of acronyms and abbreviations that made my reading of specific passages quite difficult. I suggest authors limit acronyms to those that are well known in the community and avoid acronyms that are used only a few times in the text. I point to other examples of wording choices below.

I finally found figures to play a quite marginal role in the manuscript as it is now. For example, I think that Figures 2, 4, 7, and 8 do not add much information to what is

currently written in the corresponding Sections (especially the example in Figure 4 is easy to understand even without the figure: the so-called TAC method simply blends maps from Aqua and Terra satellites). Figure 3 is also quite confusing to me. Maybe more examples of real-world results from previous papers may make a more effective point and could also serve as a basis for commenting limitations and future directions of research?

SPECIFIC – MINOR COMMENTS

- Title: maybe mention MODIS?

- Abstract: please avoid "and so on" here and throughout the text: it would be more informative for readers to include all items in a list that are deemed essential to understand the concept.

- Line 11 page 1: please be more specific on what is the temporal scale of "discontinuity for long-term monitoring".

- Line 15 -16 page 1: please revise the sentence starting with "Experiments were conducted..." as it sounded to me as if these experiments were conducted within this paper. Also, consider including some takeaways about the most important knowledge gaps that authors see in the field.

- Line 21 page 1: more and more -> increasingly (here and throughout the text).

- Line 24 page 1: the short revisit period is relative: for example, for flood control or other emergency situations one would ideally need sub-daily, or even sub-hourly snapshots of snow distribution.

- Line 27 page 1: it is a bit confusing that you first discuss combined products and then optical products (here and in the following paragraphs) as the latter are one of the data sources for the first.

- Line 12ff page 2: please revise qualitative terms like "quickly cover", "high temporal

resolution", "so low", "high spatial resolution" with more quantitative terms.

- Line 19 page 2: please include some more details about the "limitations of the imaging orbit" for readers that are less familiar with this field.

- Line 19 page 3: please include some examples of these problems here.

- Line 21 page 3: again, please replace "poor" with more quantitative terms.

- Line 25 page 3: please replace "higher spatial resolution" with more quantitative terms.

- Line 32 page 3: please replace "long observation time series" and "high spatial resolution" with more quantitative terms.

- Line 8ff page 4: please include some examples of other products (and use quantitative terms) to make these advantages clearer. Also, consider introducing in this paragraph v6 as well.

- Line 5 page 5: maybe change "spatial distribution property" with "spatial patterns"?

- Line 3 page 6: is there any way to quantify "not very sensitive" here?

- Line 20 page 6: carry out -> implement.

- Line 24 page 6: what do you mean with "In a few special cases, the snowline for the whole area is not met"?

- Line 26 page 6: maybe define "commission error" for readers that are less familiar with this field.

- Line 3 page 7: what do you mean with "LWLR enforces on two explanatory variables"?

- Line 7 page 7: please quantify the "high cost".

- Line 21 page 7: changeful -> very variable.

- Line 23 page 7: what do you mean with "obvious accuracy"?

- Line 4 page 8: maybe complete snowmelt? Partial snowmelt would not, in my opinion, be an issue here.

- Line 7 page 8: please replace " in the early days" with a more specific time period.

- Line 9 page 8: what are these slight differences and under which specific circumstances do they emerge?

- Line 19 page 8: please cite some of this literature here.

- Line 16 page 9: it is not clear to me why the fact that accuracy will be lower during transitional periods make this method unsuitable for operations.

- Line 20 page 9: please be more specific with regard to the "constant or flexible way", for example by mentioning some examples.

- Line 9 page 12: what do you mean with "a simple and basic way to exploit the snow cover information"? also, please consider revising wording like "get rid of" or "and so on".

- Line 1 page 13: "As a result .... Methods" -> "As a result, SNOWL is often applied immediately after these methods".

- Line 16 page 13: please provide some more information in support of this final sentence.

- Line 23 page 14: please include units (mm?) for SWE

- Line 19 page 18: powerless -> less effective (or simply ineffective)