Overall comments

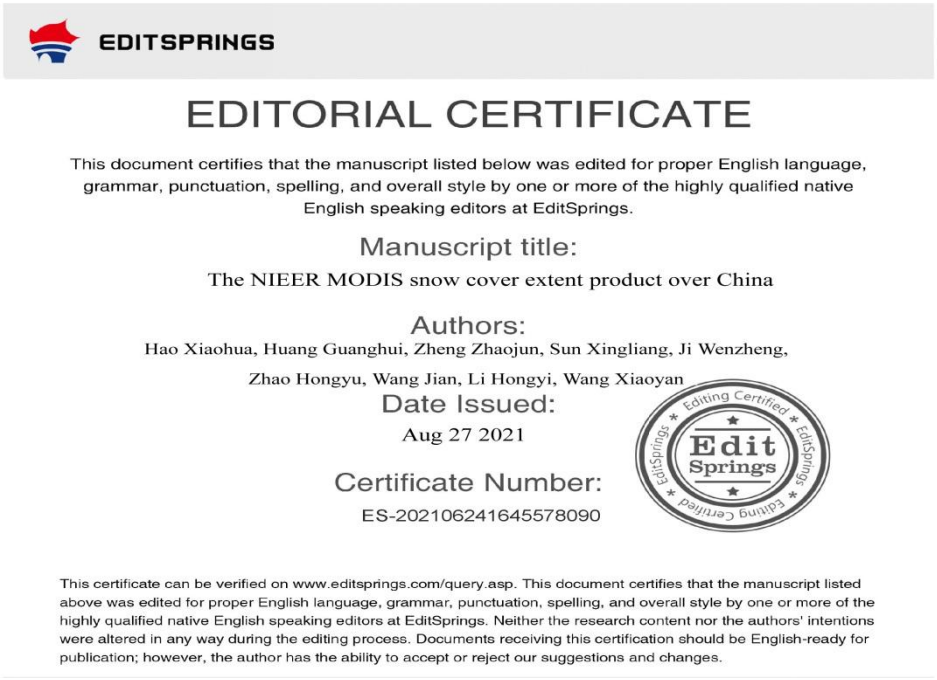
Hao's paper produced a daily cloud-free snow cover extent product with 500 m spatial resolution based on MOD09GA and MYD09GA land surface reflectance dataset in China. The new daily cloud-free snow product was also verified by snow depth observation from climate stations. The results show that the new snow cover product with higher overall accuracy than the standard MODIS daily snow product released by NSIDC, which provides a more reliable snow dataset for other related studies.

So far as we know, the NDSI threshold is the crucial parameter for snow detection by use of optical remote sensing data. However, the NDSI threshold varies with the snow depth, snow fraction, pollution, as well as different land-use types, which cause great difficulty in remote sensing mapping of snow cover at present. From the content of this paper, this paper analyzes the sensitivity of NDSI, that is, the effect of different land cover types on NDSI, then to find the optimal NDSI threshold for different land cover types in the study area. Especially in forest areas, the NDVI and NDFSI were involved in decision tree classification.

The paper is scientifically sounding. I hesitate to say major revisions since it is mostly about reorganizing the paper structure and a few data process issues need to clarify, but quite a few minor revisions should be undertaken, and the editorial changes for language usage throughout the manuscript need to be addressed before publishing this manuscript to journal of Hydrology Earth System Sciences.

Response: Thank you very much for the time and effort put into reviewing our manuscript. We will try our best to make the manuscript better. Your comments really help us a lot.

We know as a non-native speaker there must be language problems throughout the manuscript, more or less. Therefore, before the submission to HESS it in fact had been edited by a professional company, EDITSPRINGS. Please see the below certificate (at that time, our manuscript title is "The NIEER MODIS snow extent product over China"). After this revision, we asked them to polish the English again.



EDITSPRINGS

EDITORIAL CERTIFICATE

This document certifies that the manuscript listed below was edited for proper English language, grammar, punctuation, spelling, and overall style by one or more of the highly qualified native English speaking editors at EditSprings.

Manuscript title:

The NIEER MODIS snow cover extent product over China

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This certificate can be verified on www.editsprings.com/query.asp. This document certifies that the manuscript listed above was edited for proper English language, grammar, punctuation, spelling, and overall style by one or more of the highly qualified native English speaking editors at EditSprings. Neither the research content nor the authors' intentions were altered in any way during the editing process. Documents receiving this certification should be English-ready for publication; however, the author has the ability to accept or reject our suggestions and changes.

General Comments

1. The structure of the paper is not following the convention, the results and methods are mixed. I think the paper requires a better structural organization to improve its readability.

Response: Very good suggestion. We have reorganized the paper according to your comments. In section 3, we only preset the algorithm we have developed in the paper, but introduce the new product in section 4 simply. Because one of our most important objectives is producing a new SCE product, we indeed need a separate section to show these contents.

2. A large number of Landsat snow data are used in this paper, partly for training and partly for verification. But why is the new MODIS snow product verified eventually by the ground observation data from meteorological stations?

Response: Our previous arrangements around these contents may mislead you. We have reorganized them. Please see the new sections 2.2 and 3.1. We use the Landsat OLI snow maps only to obtain training samples and subsequently refine the snow detection rules, rather than partly for training and partly for verification. This is done for the following reasons. First, it seems unreasonable to use the data from the same source for both training and validating, and one may certainly think your validation is better because the same source training data are utilized. Second,

Landsat OLI snow maps are obtained usually in clear skies, which indicates the comparisons or validations are conducted only in clear skies. This will result in a very similar accuracy no matter for clear products and cloudy products and may bring a larger confusion in the section of validation. After all, the CGF SCE is our final object. Isn't it sounder, using Landsat OLI snow maps to obtain training samples but using the stations' observations to validate the final products?

3. According to the characteristic curve of the snow refection spectrum, snow cover usually has a high NDSI value in traditional cognition, but the NDSI value calculated by using surface reflectance in this paper shows that the NDSI of snow cover under most land cover types is relatively low. If this is true because the MODIS standard product uses zenith reflectance rather than an atmospherically corrected product to calculate NDSI, the authors should highlight this conclusion in the Conclusion section.

Response: Yes, for a totally snow covering pixel generally its NDSI is very high, but for a mixed pixel that fractional snow cover is > 0.5, the NDSI may be not that high. In our study, we find fixed pixels are very common. We think this may be caused by the following two reasons. First, relative to small TM or ETM pixels, spatially much larger MODIS pixels undoubtedly are even inclined to be mixed. Second, over a mid-latitude region like China the snow distribution is always patchy, and such a snow cover feature also results in more mixed pixels. Due to the problem of mixed pixels, the optimal NDSI threshold may be pulled down dramatically, much less than 0.4 that previously is thought as best. Lower NDSI thresholds are not unusual in literature. For example, the study of Zhang et al (2019) concluded an optimal NDSI threshold of 0.1, which is very close to our thresholds shown in table 1. We don't think the discrepancy of TOA and surface NDSIs will influence the threshold determination significantly except in some extreme cases (such as heavy aerosols).

Zhang, H. B., Zhang, F., Zhang, G. Q., Che, T., Yan, W., Ye, M., and Ma, N.: Ground-based evaluation of MODIS snow cover product V6 across China: Implications for the selection of NDSI threshold, Sci. Total Environ., 651, 2712-2726, doi:10.1016/j.scitotenv.2018.10.128, 2019.

Minor Comments

1. L15, surface reflectance data, a new daily MODIS snow cover extent (SCE) product from 2000 to 2020 over China has been produced.

Response: Thanks. We have modified the sentence accordingly. But we think the word “daily” may be inappropriate used here because strictly only the final CGF dataset is daily and the first two datasets are not.

2. L21, Against 362 China Meteorological Administration (CMA) stations, the validation results show…

Response: Very good suggestion. We have modified the sentence accordingly.

3. L24, Biases ranging from 0.98 to 1.02, indicating that the SCEs given by the new snow product are neither overestimated nor underestimated significantly.

Response: Thanks. We have modified the sentence accordingly.

4. L26, clearly – obviously

Response: Done. Thanks.

5. L55，NDSI >=0.4

Response: Very good suggestion. We have modified the sentence accordingly.

6. L57, The C6 snow product provides a standardized NDSI but does not redefine a new threshold of snow cover.

Response: Yes, the C6 snow products do not redefine the new threshold explicitly. But there is a sentence on page 13 in the “C6_MODIS_Snow_User_Guide” saying “Pixels detected with snow cover in the 0.0 < NDSI < 0.10 are reversed to a ‘not snow’ result and bit 2 of the NDSI_Snow_Cover_Algorithm_Flags_QA is set. That bit flag can be used to find where a snow

cover detection was reversed to ‘not snow.’” From this sentence and the User Guide, 0.1 in fact is indicated.

Riggs, G.A., Hall, D.K., Roman, M.O.: MODIS snow products user guide for collection 6, http://modis-snow-ice.gsfc.nasa.gov/?c=userguide, 2016.

7. Suggest simplifying L48-57, and focusing on the idea of cloud removal algorithm in MOD10A1F snow product.

Response: We reorganized these paragraphs and sentences. Our arrangements are: first, introducing the standard MOD10A1F and MYD10A1F under clear skies, and then pointing out their shortcomings; second, introducing the standard CGF products, and then analyzing their shortcoming; and finally in the last paragraph of the section “introduction” presenting what we will do to improve or mitigate these shortcomings. Therefore, the idea of cloud removal algorithm adopted by MOD10A1F is shown in the next paragraph.

8. Line58，While the released MODIS snow products have…

Response: Thanks. We have deleted this sentence.

9. L64-66，need a reference here.

Response: Thanks. We have added a such reference.

10. Line68, add a summary of the current cloud removal algorithms for MODIS daily snow product.

Response: Thanks. We have added a summary sentence at the end of this paragraph.

11. L88-89, which version and period of MOD09GA and MYD09GA were used, and which year of MCD12Q1 was used in this study.

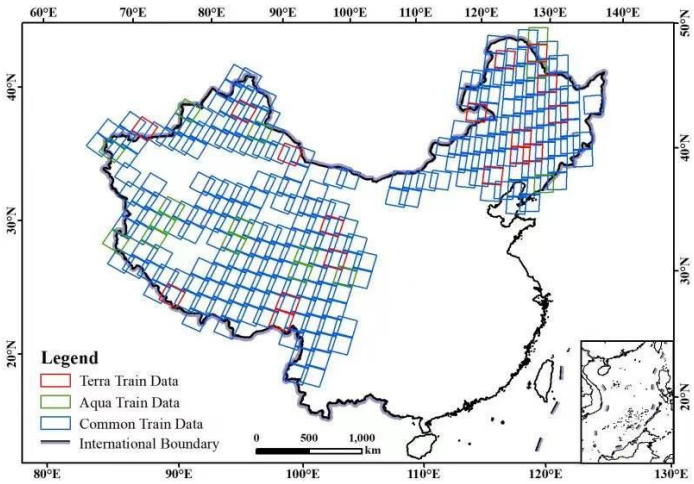
Response: Thanks. We have added these information. Please see the revised section 2.1.

12. L90, land surface reflectance

Response: Done. Thanks.

13. L94, how do the Landsat OLI snow maps come from? Suggest making a spatial distribution map of Landsat images, distinguishing training data sets from validation data sets, and also including meteorological stations.

Response: We have revised section 2.2 and also rescheduled the introduction on MOD09GA and MYD09GA training samples here. The previous separate arrangements may mislead you. We use the Landsat OLI snow maps only to refine the snow detection rules, rather than to validate our products. Please also see our above response to the general comment 2. In the initial draft, we indeed give such a map to show the spatial distribution of all OLI snow maps. But there are too many scenes of OLI snow maps (1509 for Terra and 1648 for Aqua) and placing them together will make the figure so messy that little information can be seen. Please see the following figure. Isn't it ugly?



Besides, from figure 9 and 10 which show the accuracies of the Terra-MODIS SCE and CGF-MODIS SCE datasets at each CMA station, one can easily see the distribution of these stations. Therefore, this information may seem unnecessary here.

14. L107, resampled, and delete 'or aggregated'

Response: We have changed the "re-sampled" into "resampled", but not deleted "or aggregated"

because for the first two products whose resolution is much larger than 500m the word “resample” is reasonable but for the last product whose resolution is much less than 500m the word “aggregate” is more proper.

15. L109, Provide the period of climate stations data used.

Response: Done, please note the words “since 2000”.

16. Change the headline of the 3 sections to 'Method'.

Response: Done. Thanks.

17. L133-135. Please statement as clear as possible.

Response: We have reorganized them. Please see the revised manuscript.

18. L136-138, during the preliminarily screening, what is the internal purpose of each threshold? Please explain.

Response: As we have mentioned in line 130 in the previous manuscript, the purpose of the preliminarily screening is to preclude the pixels that are impossibly covered by snow completely. These thresholds are combined together to achieve this goal. This is a step also adopted by the MODIS standard products. The internal implication is that snow is impossible to own too low visible reflectances and too high band 6 reflectance.

19. In 3.1.2, put Table 1 into the results section, this part only focuses on the method used in this study. And the title of the table is 'Optimal NDSI thresholds over eight non-forest land-cover types', but the content of the table has the forest land cover, such as ‘Evergreen Broadleaf Forest’.

Response: Here it is a very simple decision rule, namely, pixels whose NDSI value is ≥ the NDSI threshold will be identified as snow cover, and otherwise they are snow-free. Therefore, in this section the optimal NSDI threshold is crucial. We’d better directly present the results here, we

think. Yes, in table 1 there is an exception, “Evergreen Broadleaf Forest”. We have explained it in the text. This may be resulted by its sparse number in China.

20. In 3.1.3, the same suggestion is with 3.1.2.

Response: Thanks. But please see the above response.

21. L162, Eq. (1) is about NDSI, not NDFSI.

Response: Yes, but we have pointed that NDSFI is using band 2 to substitute band 4 in Eq. (1).

22. In 3.1.4, can you add a reference for the accurate evaluation of EAR surface temperature products? The LST and elevation thresholds were used for snow misclassification in high elevation areas in MOD/MYD10A1 V006, not for ice clouds.

Response: We have added a such reference. Our previous expressions may mislead you. We have modified them. Initially, LST is introduced to screen out the false snow pixels that may be led by ice clouds no matter what its DEM is (C5 snow products). But later they find there may be warm snows existing over highlands. Therefore, DEM is also introduced in C6. Please see the following sentences in the user guide. If snow is detected in a pixel at height < 1300 m and that pixel has an estimated band 31 brightness temperature (BT) ≥ 281 K, that snow detection decision is reversed to ‘not snow’. In C6 the surface temperature screen is combined with surface elevation and is used in two ways. This combined screen reverses snow cover detection on low elevation < 1300 m surfaces that are too warm for snow and the algorithm QA bit flag is set. Snow cover detection at ≥1300 m on a surface that is too warm for snow is not reversed but that snow cover detection is flagged as too warm by setting the algorithm QA bit flag.

23. L190, change the ‘gap’ to ‘data gap’. And please clarify the source of the data gap, such as the cloud.

Response: Done. Thanks.

24. In 3.3.2, the results of Figure 5 should be in the Results section, here only focus method.

Response: We have reorganized these sections.

25. Combine the 3.2 and 3.4 into one section, and suggest deleting the content of the 3.2, 3.3, and 3.4 section.

Response: Thanks for your suggestion. We have reorganized the manuscript according to your advice.

26. Change the headline of 4 to Results.

Response: Done. Thanks!

27. Section '4.1 Accuracy metrics' should be in the Method section.

Response: We have reorganized these sections.

28. L258-262. Dose the Terre/Aqua MODIS SEC dataset were validate by ground measurements under clear sky?

Response: Yes. Terre/Aqua MODIS SEC can only provide the snow cover conditions under clear-skies. Therefore, their validations are conducted in clear skies.

29. In the 4.3 section, the accuracy varies from year to year, mainly due to ground observation, as the authors mentioned. Any other explanations?

Response: Besides ground observation, the contrast of snow days versus snow-free days may also impact the accuracy. If snow days are more and snow-free days are less in one year, then in this year the commission will prone to be larger. Otherwise, omission error will be larger. The over accuracy will be better only if the contrast of snow days versus snow-free days reaches one balance.