The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2019-119-AC2, 2019

The Cryosphere Discussions

Interactive comment on "Where are the avalanches? Rapid mapping of a large snow avalanche period with optical satellites" *by* Yves Bühler et al.

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Received and published: 13 August 2019

Dear anonymous reviewer

Thank you very much for your review of our paper. Please find in the following our answers to your general and specific comments:

1- Regarding the overall organization of the paper:

As you correctly state we give a lot of information on different satellite sensors we did test but then not use for the final mapping. In our opinion this part is necessary for the paper as it defines the narrative how we get to the decision to select SPOT6/7

data. Furthermore, we are convinced that the findings we describe in chapter 2.3 are very helpful for everyone considering to map an avalanche cycle with satellite data in the future. Therefore, we want to keep these sections. But to reduce the imbalance you state we will expand the information on the mapping procedure in the revised manuscript as stated in the answers to reviewer #1.

2- Figures:

We will improve the figures in the revised manuscript adding additional information such as contour lines.

3- Replication of the mapping elsewhere:

We were very lucky both in 2018 and in 2019 to have good acquisition weather just after the avalanche period and the financial and organizational means to order imagery available thanks to the Federal Office for the Environment and the National Point of Contact NPOC of swisstopo. Generally speaking the limits certainly are cloud cover, satellite tasking availability and costs. However, the availability of satellites for specific tasking is better in winter and if necessary other satellites with similar image characteristics might also be used (as described in chapter 2.2). Besides those two factors, the method we described is replicable anywhere. Depending on the resources for preprocessing and the experience of the person manually mapping the avalanches, it may consume more or less time. Like mentioned in chapter 4.3 it took us approximately 600 hours to map an area of 12'500 km2.

4- data availability:

As mentioned in the section "Data availability" toward the end of our paper the data is already available on request on ENVIDAT (https://www.envidat.ch/ui/#/metadata/spot6-avalanche-outlines-24-january-2018)

5- Mapping methodology:

As stated in the paper the mapping was done entirely manually. The NIR band was

applied to visualize the satellite data as base for the mapping (chapter 3). We do not understand how the NIR band could further help to classify avalanche zones automatically.

6- Mapped avalanches:

We are now conducting additional statistics mentioned but, in our opinion, presenting those additional statistics would go beyond the scope of this paper, which focus on the applied datasets and the mapping methodology. We plan to present the complete statistics of the mapped avalanches and an in-depth discussion in a follow up publication.

7- Large scale hazard mapping:

At the moment we are not able to calculate the avalanche terrain for entire Switzerland. We are now computing different smaller regions in Switzerland, Italy and further abroad after the method of Bühler et al. (2018). So as for now, we cannot apply our avalanche terrain mask but plan to do so in the future.

8- terrain types:

We do not completely understand this point. What types of forests are meant here? What water areas? Lakes maybe but most alpine lakes are frozen and their surface can be treated as flat terrain.

9- Age of avalanches:

Since the occurrence of large avalanche periods cannot be predicted well in advance, we believe it is not possible to plan on distinguishing the age of single avalanches based on two subsequent datasets. Even if theoretically possible, the costs for the tasking and acquisition of a pre-event scene would be too high. Depending on the area and available data, supplementary information like observations and photographs from local people might be used to identify pre-existing avalanches for the statistics. If this is not possible the results of our examination could be an indicator when doing statistics

even though the exact percentage will remain unknown. The outlines itself are relevant despite the age since the release time is not important in hazard zone mapping, for the evaluation of protection measures or for the validation and further development of numerical avalanche simulation software.

References:

Bühler, Y., von Rickenbach, D., Stoffel, A., Margreth, S., Stoffel, L., and Christen, M.: Automated snow avalanche release area delineation – validation of existing algorithms and proposition of a new object-based approach for large-scale hazard indication mapping, Nat. Hazards Earth Syst. Sci., 18, 3235-3251, 10.5194/nhess-18-3235-2018, 2018.

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