Review of

„Satellite monitoring of glaciers in the Karakoram from 1977 to 2013: an overall almost stable population of dynamic glaciers“

by

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General

Glaciers in the Karakoram show a considerable stable behavior in contrast to most other glaciated regions in the world. Especially the glacier area shows almost no changes for the large majority of glaciers, while at the same time the concentration of surging glaciers is unusually high in this region. During the last years an increasing number of studies, mostly based on remote sensing applications, investigated area and elevation change for the Karakoram glaciers. Glacier inventories have been created for different points in time and area changes have been derived. Especially the western part of the Karakoram was in the focus of several glacier change studies (e.g. Gardelle et al., 2013; Minora et al., 2013). This manuscript extends the observation of glacier area changes towards the eastern Karakoram, including the Shyok and Nubra basins. This extension completes the high-resolution investigations of area changes for the entire Karakoram and therefore is a valuable contribution to overall effort of describing the recent glacier conditions in the Karakoram.

Unfortunately, the presentation of the material, the methods and the results show a number of weaknesses and flaws, which considerably decrease the value of this contribution. Especially the systematic presentation of the results and significant conclusions require a much more detailed investigation of the observations. Many results are discussed in the “Findings” chapter without condensing the numbers into easily comparable tables, making the reading of this chapter rather cumbersome. A main drawback is the missing critical evaluation of the glacier changes with respect to different glacier types and classes. In fact, the majority of debris covered glaciers show almost no area change, even under persistent negative mass balances. Therefore, these glaciers cannot be used for any conclusions regarding climate related glacier response, as long as only the area change is considered. On the other hand, surging glaciers are connected to the climate conditions in a rather difficult and mostly unknown relation, which also prevents climate related conclusions. Because of these conditions, the overall results structure should much more differentiate between these different glacier types. Especially in the “Discussion” section these issues should be elaborated: What are the area changes with respect to debris covered glaciers, surging glaciers, clean glaciers. Is there a dependency of glacier reaction with glacier length, area, location along the Karakoram, elevation and elevation range? Only if the subsets of glaciers are grouped in such sensible ways, conclusions about general causes are possible and meaningful. If this is done, also a comparison with existing studies is required and possible (e.g. with Minora et al., 2013, which covers also considerable parts of this study, but only for one period of time).

The structure of the manuscript needs improvement. Especially no chapter about the investigated area exists, there is no reason given why this glacier sample has been chosen and the methodology is very crudely described.

Below I specify some more concrete issues, which might help to improve the manuscript:

Abstract

The abstract speculates about some findings hardly investigated in the Discussion. It should much more focus on the real findings and retain a structure where also the area of investigation, the applied methods and the results are contained.

P. 1556, L. 7/8: inconsistencies in behavior: the behavior is surely consistent, but the samples used do not fit to the governing processes. It is no inconsistency if there exists a surging glacier in the neighborhood of a stagnant glacier, but the basic process very likely is different.

P. 1556, L. 17-20: The response time issue raised in the Abstract is not discussed further in the text.

Introduction:

P. 1557, L. 21/22: Gardelle et al. (2913) did not use gravimetric methods.

P. 1558: this part requires a better structure, which authors dealt with which kind of glaciers/processes in which area.

P. 1558, L. 11-16: This part mixes two different papers.

P. 1558, L. 18-21: Only a part of the Karakoram glaciers has been investigated (even though a large part). Not all of the intervals are used in the study. The list of data displayed in Table 1 shows many more scenes than actually used. There should be a clear indication which data have been used for what. Other data have to be discarded from the table.

P. 1558, L. 22-24: I agree that this analysis is a very valuable contribution, but it covers a different area and thus cannot be directly compared to other studies. The new temporal resolution is investigated, but not exploited with respect to external drivers in this study.

P. 1558, L. 26: such a formulation is not suitable for a scientific publication.

Data and methodology

P. 1559, L. 1-13: The details about the used images and channels are much better concentrated in a table. The description in the text then only states the principle strategy (shorter and not so cumbersome to read).

P. 1559, L. 13: Which months are chosen for which years (table)?

P. 1559, L. 17-19: Please specify the processing steps.

P. 1559, L. 20-26: this paragraph is rather unclear and should be rewritten. How did you exploite slopes in 2D images?

P. 1559, L. 27/28: I strongly oppose this statement. Glacier area change gives indications about glacier change, but only observations of distributed volume change will provide the necessary details for investigating glacier change in detail.

P. 1560, L. 5: You used only one DEM

P. 1560, L. 9/10: What is the reason for this statement? A glacier could easily cross a former lateral moraine during an advance. Is this connected to delineation problems?

Estimation of uncertainties

L. 19: I agree that is important to provide clear information about the methodology, but it is not given at the moment (see Data and methodology).

P. 1560/61, L. 26-17: These two paragraphs are a very general statement, without a direct connection to the uncertainty problem as it is discussed further down. This part can be condensed to two sentences without losing any necessary information.

P. 1562, L. 8/9: Which reason is behind the 0.5 pixel threshold?

P. 1562, L. 9-12: This part is not clear to me. Of course, glacier change is usually not as expressed in higher altitudes. But this should not affect the methodology and accuracy.

Findings

In general, most of the findings are insignificant based on the error level. Therefore, the findings section should be structured to clearly present the general changes, but also give more room to the real significant findings. Here, results and discussion are often mixed, speculating about reasons for the observed changes. There should be a clear distinction between the results of the few longer time periods and the investigations relating to the "high resolution" observations in the 2000s.

P. 1562, L. 14-17: As mentioned above, a study area section is missing and a reason why this area is selected. Otherwise a statistics table does not make sense and is out of context.

P. 1562, L. 17: The supplement is not necessary. The tables in the supplement can easily be made much smaller and then be introduced in the main manuscript.

P. 1562/63, L. 19-9: This paragraph is rather unclear. It should be clearly stated which uncertainties relate to which measurement. Also, I suggest to include the absolute error not only the relative error in percent. The readability of the manuscript would improve, if there would be a table with these results.

P. 1563, L. 9: The authors should be more specific about the glaciers. If there are glaciers with significant changes, they should be presented including a figure.

P. 1563, L. 13: What are trends in this context? It is rather difficult to derive a trend from such a data basis.

P. 1563, L. 14/15: It is the normal case that the change of individual glaciers is larger the mean.

P. 1564, L. 4: What is the reason for the temporal basis 1977-1990 which has the highest error?

P. 1564, L. 16: Is that a gradual increase in area?

P. 1564/65, L. 25-6: This should go into the discussions chapter. It would be much better to discriminate between surging glaciers and non-surging glaciers and then concentrate the discussion on the non-surging glaciers. That´s the glaciers which show a real advance signal.

P. 1565, L. 7-15: There is a lot of repetition. This paragraph could be shortened.

P. 1565, L. 16-29: This paragraph also needs restructuring in order to clearly describe the general trend and the individual evolution of "non-standard" glaciers.

P. 1565, L. 25-27: How did you account for the glacier change of glaciers which merged with a main glacier? Sometimes a clear area gain is visible on top of the main glacier, which would account for a real area gain if no main glacier would be present. This needs clarification.

P. 1565, L. 29: A bit more information should be given for these 13 surge-type glaciers.

Discussion

The discussion is mostly speculation with no reference to other work done in the Karakoram. Also a reference to the climatic evolution, or papers dealing with such a relation are missing. In this chapter the results should be set into context with the general situation and the findings of the other research groups. Reasons and mechanisms which support the observations should be discussed. Instead, many statements are provided without a clear reference to their origin. The investigation of the annual observations are only very shortly presented in the findings section and not discussed in the discussion.

Conclusion

The conclusion is very short and provides only a short summary of the findings, but no vision of their significance. This needs a fundamental revision.

Figs. 7-13: It is very hard to read the symbols. Maybe there is another way to represent the changes in a more clear way?