

Interactive
Comment

Interactive comment on “2001–2010 glacier changes in the Central Karakoram National Park: a contribution to evaluate the magnitude and rate of the “Karakoram anomaly”” by U. Minora et al.

Anonymous Referee #1

Received and published: 22 August 2013

The highlight of the manuscript is a set of two new glacier inventories covering the Central Karakoram National Park, based on Landsat scenes from 2001 and 2010. Glacier change from comparison of glacier margins mapped in these two inventories is then discussed in connection with regional climate trends inferred from neighboring weather stations (temperature and precipitation) and MODIS-derived snow cover extent, used as a proxy of accumulation. The region is already covered by the Randolph Glacier Inventory, but the quality of the existing polygons is likely inadequate to detect the very small glacier change being investigated. It was therefore a sensible choice to produce two new glacier masks and inventories, and they are an important contribution adding to the discussion of this anomalous region. However the ms. should briefly mention

C1505

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



the existence and limitations of previous datasets.

I'm not an expert on the existing weather observations and regional climate analyses for this region, so I will not comment on the novelty and exhaustiveness of the climate analysis presented in this work.

The major problem with the ms. in its present form is a lack of details in the Methods and Results sections, and the language is at times unclear or imprecise. This makes it difficult to completely understand it. In particular:

- Were the glacier outlines produced mostly by automatic classification followed by manual corrections, as I would understand from lines 2899/19-24, or were they mostly digitized manually, with automatic classification only for shadowed areas (line 2900/3-4)? If they were mostly done automatically, what method was used for non-shadow areas?

- Were ice polygons split into individual glaciers, and if so, how were the ice divides identified? If they were not, discussing them in terms of 'glaciers' is misleading. If they were, what exactly was entered as perimeter in Eq. 1? The parts of the perimeter belonging to ice divides between adjacent glaciers has no relevance to LRE, and they would even get double-counted if the complete perimeters of each glacier were used. The perimeter of the 'unsplit' ice polygons should be used, and it should be clarified in the description of Eq. 1 parameters.

- Some of the 'semi-automatic' classification seems to use pan-sharpened combinations of various bands. Why is the uncertainty of the resulting ice masks calculated on the basis of the 15 m panchromatic band? The spectral information is still at 30 m.

- What is the actual expression of the error in area change? Eq. 1 does not seem to match the text immediately above it: the two terms squared and summed are not 'the root of the squared sum of all the buffer areas' (line 2901/14-15).

- Were the detected surge events removed from the analysis? They do not contain a

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



usable climatic signal, so they should not contribute to glacier change figures discussed in the context of regional climate.

- The statement about 2001-2010 area change being detected at only 40 out of 700+ glaciers (line 2910/23, reiterated at 2914/11) is unclear. Is this to be understood as 'no change at all', or 'no significant change'? If the former: minor misclassifications of one pixel around the ice margin are to be expected in the assumed error model, so how did you discriminate between mapping uncertainty and genuine margin fluctuations? If the latter: how was significance defined and determined for each individual glacier?

- Area change of $+27 \pm 42 \text{ km}^2$ only indicates stability, it cannot be claimed to indicate any increase, either 'remarkable' or not, so please improve lines 2910/20-22 and 2914/7-10. The abstract got this right.

- Error assessments seem either incompletely developed, or incompletely described: the 'errors from specific scene conditions' are discussed at page 2901, and they are not argued to be negligible, so were they quantified and included? If not, the $\pm 42 \text{ km}^2$ accuracy stated later on would be too optimistic.

- Except for well-developed medial moraines, the transition between clean ice and debris-covered ice is typically gradual. This is especially the case for most parts of glaciers newly becoming debris covered. Here, two classes "clean-ice" and "supraglacial debris" were used for training, so I would expect "supraglacial debris" to mean "complete supraglacial debris cover". Fig. 7 (top) is quite small, but it looks like mixed pixels between the two end-members were also recognized as "supraglacial debris" (see the 'swarm' of yellow pixels where the southernmost medial moraine fades eastwards into clean ice). Was this the case, or is Fig. 7 just too small? Inclusion of mixed pixels would raise the issue of how consistently the supervised classification performed between scenes with different illumination and ground conditions. The ms. only mentions 'visual validation', but gives no information about what fraction of debris cover was taken to separate "clean ice" and "supraglacial debris", and how this could

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

be consistently enforced without concurrent ground observations.

- The half-pixel buffer concept underlying Eq. 1 estimates a very high uncertainty when the size of many objects mapped as distinct entities approaches the pixel size of the satellite image. From Fig. 7, this seems to be the case of the ‘debris’ class, and it is the reason for the very poor accuracies reported (+-14% in 2001 and +-18% in 2010). This is not to suggest that the debris cover estimates are more accurate than reported, but rather that this purely geometrical accuracy estimate entirely neglects what may be the largest error source (see my previous point on the performance of the supervised classification).

- What is the accuracy of snow cover extent figures given in section 4.3 and Tab. 2? Section 3.2.2 discusses this issue but does not attempt any actual estimate. Section 3.2.1 further states that the time series is too short for any statistical analysis of the observed trends, but then there is no basis at all for fitting any trend, and the MODIS work should be left out entirely.

Clarifying and adding the details listed above should be possible without making the ms. longer than it is, because the present version is not concise, with several repetitions both among and within sections, and with long paragraphs only marginally relevant or misplaced. For instance, most or all of page 2897 can be deleted or briefly summarized and moved to the Introduction. Sentences like 2911/1-2 are entirely self-apparent. A page worth of text should be deleted from line 2907/14 to 2908/10 and replaced by an appropriate reference. The style and occasionally grammar need to be improved.

Other remarks: Line 2894/22. . .29 ‘recent’ terminus fluctuations in general do not simply reflect ‘recent’ climate, especially for large glaciers, and the response time of each glacier must be taken into account to properly relate the two.

2895/1 both trends, not just T

2895/11 ‘glacier dynamics’ may be ambiguous, especially since flow instabilities are

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

mentioned in the same ms. Perhaps 'to link surface mass balance and local climate' may be better?

2896/24 'rainfall' or 'precipitations'?

2900/12-15 what do you mean by 'analyze'?

2900/19-20 '...due to co-registration and classification errors.'?

2900/24-25 clarify/rephrase

2900/27 'correction process' -> georeferencing and orthorectification?

2901/4 'contrast' do you mean 'roughness'?

2901/22 image -> pixel

2902/25 'highest line of ablation' do you mean ELA?

2903/20 I never saw a general purpose programming language referenced in this way

2904/16 if there is no significance, there is no trend either

2907/5 LR?

2908/12 N in NAO is 'North' 2910/1 what is rho? The Spearman correlation? Significance of this 'significant correlation'?

2910/20 change within uncertainty, can't say it increased.

2911/1-2 sentence doesn't add anything

/13 'movements' ->fluctuations

/13-28 were these surging glacier excluded from the climate-related analysis and discussion?

/28 what is a 'complex perimeter'?

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

2912/17-21 AND tab 2: why these particular ‘elevation belts’? Give elevation ranges, not A,B,...

2913 DT_G ?

2914 Conclusions: several remarks above apply again here

2915 last paragraph is awkward

2916 add acknowledgment for MODIS data

Fig 8 Julian day – Day of year. Trend lines are not trends unless shown significant

Fig 7 too small

Fig. 5 may be left out

All tables: on my pdf I don't see any bold typeface. Also, verify that all symbols are consistent with, and defined in the text.

Interactive comment on The Cryosphere Discuss., 7, 2891, 2013.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

