Authors' response to comments

We would like to thank the topical editor Reinhard Drews for accepting the manuscript for publication, his kind words and for the comments for further improvement of the article. We responded to all comments raised point by point in blue italic font below.

Topical Editor Decision: Publish subject to technical corrections (28 Jun 2021) by Reinhard Drews
Comments to the Author:
Dear Authors,

Thank you for your revisions in response to the re-review. Both reviewers have positively evaluated this version of the paper. I agree with their evaluation and accept the paper for ESSD. Congratulations. I complement you for a detailed response-to-review which treated the reviewer's comments with much respect.

In my re-read of the paper I found some smaller issues that require attention, but most those can be hopefully dealt with straightforwardly.

Kind regards & congratulations,
-- Reinhard Drews

l 42. "misinformation" is pretty strong wording referring to IPPC AR4. Maybe "overstating" ? Also, what's the point of citing an old IPCC report, what happened to this statement in the fifth report? I think this sentenced can be removed without much loss of information. If you insist on maintaining it include the latest IPPC report.
There was an issue in the IPCC AR4 regarding a statement about glaciers in the Himalayas and a small team looked into it in 2009 (discussions on cryolist in 2009). As a result, Cogley et al. (2010) tracked down the source of the issue and used the word "misinformation" to address it, hence, it seems a legitimate word to be used.
Following the discussions two aspects became clear: (1) this specific information in the IPCC AR4 didn't satisfy the requirements of science, and (2) there was not sufficient information available regarding the actual state of the glaciers in this region. A substantial amount of funding became available to address this knowledge gap. In this regard, the AR4 took an important role in the Himalayas compared to other IPCC reports. Newly gained and more accurate knowledge is integrated in later IPCC reports but it was AR4 that boosted glacier research and capacity building in the HKH region, which is the reason for referring to it in the following sentence. Both sentences have been kept as they were.

Cogley, J. G., Kargel, J. S., Kaser, G., and van der Veen, C. J.: Tracking the source of glacier misinformation, Science, 327(5965), 522, https://doi.org/10.1126/science.327.5965.522-a, 2010.

Fig 1b include scalebar in legend.
Corrected, scalebar shifted.

l. 235 I don't quite understand how snow compaction can "push" a stake up.
We write "…the underlying snow and firn layers compact over time and [the layers] may push or pull the stake up or down." Hence, it is the snow and firn layers that cause the stake to move. The compaction happens in the snow and firn layers. However, the stake cannot be compacted with the snow and firn, and is usually somehow frozen into firn or ice layers. Consequently, the stakes are pushed or pulled up or down, depending on the forces, where the compaction happens, where the stake is frozen into and where space is available.

l. 262 remove “so-called” (also elsewhere. I am never quite sure what this adds.)
Based on the comment of a reviewer, “so-called” has been added in L262, and removed again now. In L310, “so-called” deleted, and in L688, “so-called preferable ELAs” kept.

l. 383 If GPS data from 2012 are available, why weren’t they used as GCPs in Section 3.3?
We generated the DEM2012 using GCPs with help of T. Bolch and colleagues in February 2014. Up to that time we had only very limited access to dGNSS devices, and limited time to conduct dGNSS surveys besides the mass balance measurements and trainings of about 25 participants. In May 2012, we conducted various dGNSS surveys (Table S2), but no GCP survey that should have been conducted on stable non-glaciated terrain.

l. 423 SRTM 3 has an accuracy of plus minus 16 m (l. 274) and was used as GCP to offset the stereographic DEM. I am not sure how this uncertainty can then melt down to 7.4 m.
We corrected the sentences: “To assess the uncertainty of the thickness change, we estimated the vertical precision of the DEMs by calculating the normalized median absolute deviation (NMAD), which is ±7.41 m (Holzer et al., 2015; Höhle and Höhle, 2009). The uncertainty of the geodetic mass balance is the root of the sum of each squared error term, which consist of the NMAD and the uncertainty for the ice density of ±60 kg m^{-3} (Huss, 2013).”

The accuracy of ±16 m is the vertical accuracy of the elevation of the SRTM3 (absolute system). The uncertainty of ±7.4 m is the uncertainty of the thickness change of the two DEMs SRTM3 and DEM2012 (relative system). To generate the DEM2012 (slave DEM), we used the SRTM3 as master DEM, and for that we used the elevation of the SRTM3 for the GCPs.

Reference added: Höhle, J. and Höhle, M.: Accuracy assessment of digital elevation models by means of robust statistical methods. ISPRS J. Photogramm. Remote Sens., 64, 398–406, https://doi.org/10.1016/j.isprsjprs.2009.02.003, 2009.

Fig 2 Label panels with (a)-(d). Replace this with description “far left”.
Corrected, “far left” replaced with (a), headings of panels deleted, caption edited.

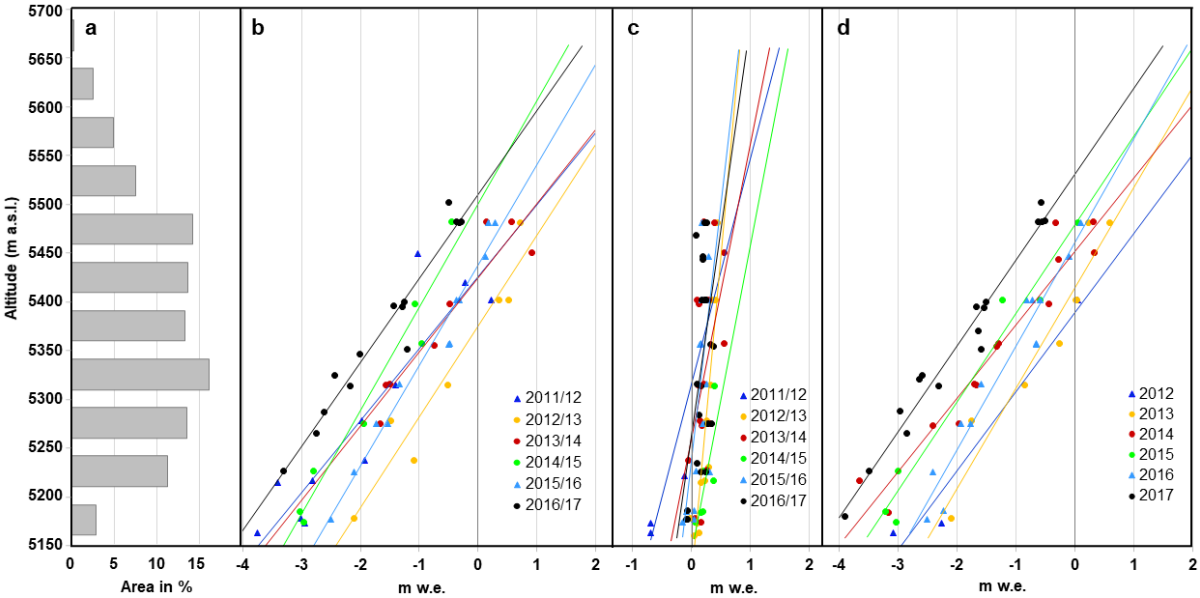

Figure 2: The glacier hypsography (a), and the mass balances and gradients for the annual, winter and summer mass balance for Yala Glacier from 2011–2017 (b-d).

Fig 4/13 add x-axis label “years”
Corrected for both Figures 4 and 13.
Fig 10: “years” added and y-axis labelled with “Cumulative frontal variation (m)”

Fig 7 I could be wrong but I suspect that at least some of this thickness change is due to the pm 16 m of SRTM uncertainty.
Yes, the uncertainties of the DEMs influence the thickness change, which is reflected in the uncertainty of the glacier wide thickness change of ±7.41 m, calculated with the NMAD. Please also note response for L 423.

Fig7 I suggest to divide the thickness difference by the 8 year time period to get "per year" thickness change which is a quantity more familiar for most.
It is common to either display thickness differences as total value or annual rate. We prefer to display the information as total value. Examples of articles that display the total thickness change:

- *Goerlich, F., Bolch, T., and Paul, F.: More dynamic than expected: an updated survey of surging glaciers in the Pamir, Earth Syst. Sci. Data, 12, 3161–3176, https://doi.org/10.5194/essd-12-3161-2020, 2020.*
- *Liu et al.: Recent Accelerating Glacier Mass Loss of the Geladandong Mountain, Inner Tibetan Plateau, Estimated from ZiYuan-3 and TanDEM-X Measurements, Remote Sens. 2020, 12, 472. https://doi.org/10.3390/rs12030472, 2020.*
- *Bolch, T., Pieczonka, T., Mukherjee, K., and Shea, J.: Brief communication: Glaciers in the Hunza catchment (Karakoram) have been nearly in balance since the 1970s, The Cryosphere, 11, 531–539, https://doi.org/10.5194/tc-11-531-2017, 2017.*
- *Holzer, N., Vijay, S., Yao, T., Xu, B., Buchroithner, M., and Bolch, T.: Four decades of glacier variations at Muztagh Ata (eastern Pamir): a multi-sensor study including Hexagon KH-9 and Pléiades data, The Cryosphere, 9, 2071–2088, https://doi.org/10.5194/tc-9-2071-2015, 2015.*
- *Pieczonka et al. (2013) Heterogeneous mass loss of glacier in the Aksu-Tarim Catchment revealed by 1976 KH-9 Hexagon and 2009 SPOR-5 stereo imagery, Remote Sensing of Environment 130, 233–244, http://dx.doi.org/10.1016/j.rse.2012.11.020, 2013.*

L 540 there is a "per year" missing after "-3.8 m"
Corrected in L 540 and L 741

Fig S1 insert "months of the year" as x-label
Corrected

S2 define if you refer to horizontal or vertical dGNSS accuracy.
Corrected: "Horizontal accuracy" instead "Accuracy measurements"

Other changes
L 425: "were" instead of "are"
L 824: value of the geodetic mass balance corrected (value was by accident from thickness change): "…geodetic mass balance of Yala Glacier showed a mass loss of -8.92 ±6.33 m w. e. …"