Dear the Editor and Reviewer

Thank you very much for giving us the opportunity to revise and improve our manuscript. Many thanks also to your valuable comments. We have revised our manuscript accordingly. The revised text is in red in the manuscript. A point-to-point response to all the comments is provided below. The comments are copied in black text. Our responses are in red text.

Responses to Reviewer #1 Evaluations:

1. The English is not good enough and requires revision by a native speaker. Due to this, it was very stressful for me to read the text, and sometimes, I have to guess what the authors could have meant.

Response: We are terribly sorry that we didn't find a suitable native speaker for helping check English writing this time. But we are still trying to find such help in near future.

2. As far as I can see, the study introduces a new method of glacier volume calculation (Section 4.1). I think this requires proper introduction (showing results and uncertainties for individual glaciers) in a more topical journal (e.g. The Cryosphere) before it can be applied widely and used for datasets in ESSD. I do also not fully understand how this method is working, as the text describing the method is very short and equations are poorly illustrated (e.g. where in Fig.2 can I find the variables used in Eqs. (3) and (4) and why is a grid of 1 km used where the SRTM DEM has 30 m resolution?).

Response: Thanks for your valuable suggestion. First, we're sorry for the poor correspondence between Fig.2 and Eqs. (3) and (4). In fact, the number in the subscript of variables corresponds to the grid number in Fig.2. Specifically, Z_0, $slope_0$, x_0, y_0 are the elevation, slope, longitude and latitude, respectively, in the grid with number 0. $Z_{1,i}$, $slope_{1,i}$, $x_{1,i}$, $y_{1,i}$ are the elevation, slope, longitude and latitude, respectively, in the grid with number 1. $Z_{2,j}$, $slope_{2,j}$, $x_{2,j}$, $y_{2,j}$ are the elevation, slope, longitude and latitude, respectively, in the grid with number 2. *i* represents how many the neighboring grids of the grid with number 0 are. *j* is how many the neighboring grids of the grid with number 1 are. To make it clear, relevant description has been added in Lines 322-326 in the revised manuscript.

In this study, the elevation data in the grid of 625 m×625 m was used and resampled from the SRTM DEM with 30 m resolution by using "nearest" technique. The relevant description was shown in Lines 227-230 in the original manuscript.

3. Glacier areas in RGI 4.0 are highly flawed in this region and are generally too large (e.g. due to missing rock outcrops). They should thus better not to be used with methods that are based on an up-scaling of area alone or any change assessment (neither area nor volume). The glacier volume changes calculated here (Table 4) are thus also much too high and basically reflect differences in interpretation rather than real glacier changes.

Response: Thanks for your valuable comment. The flawed glacier areas (including missing rock outcrops) in RGI 4.0 don't affect the results of glacier volume with the proposed algorithm in this study, which means the calculated volume is equal to the actual volume in the glacier with missing rock outcrops. The specific explanation can be shown by the equations as follows.

$$\overline{H} \times A = \overline{H_0} \times A_0$$

$$\overline{H} = \frac{H}{N}$$

$$\overline{H_0} = \frac{H}{N - N_0}$$

$$A = N \times a$$

$$A_0 = (N - N_0) \times a$$

where $\overline{H}$, $\overline{H_0}$ and A, A_0 mean the thickness and area, respectively, of the studied glacier with and without grids at missing rock outcrops. N, N_0 are the number of all grids and the number of grids at missing rock outcrops, respectively, within the studied glacier. a is the area of one grid, which is approximately equal to 0.39 km^2 (625 m×625 m) in this study.

4. Also, the results for disappeared, fragmented and surged glaciers (Figs. 5 to 7) are strongly impacted by the flaws in the digitization of RGI 4.0 and present largely arbitrary results. In my opinion the RGI 4.0 dataset is of insufficient quality for such calculations.

Response: Yes, the flaw in the digitization of RGI 4.0 is a main source of uncertainty in disappeared, fragmented and surged glaciers. However, the RGI 4.0 provides valuable baseline information of glaciers for evolution exploration, so the dataset is prior to be considered in such researches. Another investigation manifests that in the compilation of RGI 4.0, the GIC-I has been used to manually match the glaciers in Chinese territory to validate the locations, approximately 80% of them being in the QTP. In the process, a separation not exceeding 2 km was found sufficiently to match the glacier in GIC-I with its closest RGI 4.0 counterpart. The results show that 38% of them are exactly matched, 43% have separations within 300 m between the RGI 4.0 and GIC-I. Only 1.4% of glaciers fail the 2-km test of proximity. The relevant description has been added in '6.1 Uncertainty of input data' in the revised manuscript (Lines 586-595).

5. It is unclear to me why so many different methods of volume calculation have been applied and which of these are used for which dataset. For example, the authors name it 'Calculated', 'Equation-based' or 'DGA-derived' in Table 2 and Calculated, Equation 1 and Equation 2 in Table 4. Where are they described, which method is used for what purpose?

Response: The empirical Equation 1 and Equation 2 recommended by the compilers in GIC-I and GIC-II, respectively, were obtained by area-volume scaling based on observations in 1970s and 2000s. Both results are "Equation-based". "Calculated" values are computed by the proposed method in this study. The DGA (the derivations of gravity anomaly) data (Liu et al., 2016) are a sum of changes in soil moisture and glacier volume over the QTP from 2003 to 2010 on the grids with spatial resolution of 1°, which were sourced from Gravity Recovery and Climate Experiment outputs (GRACE) (Liu et al., 2015, 2016). Soil moisture data with spatial resolution of 0.25° were extracted from the Global Land Data Assimilation System (GLDAS) products (Hiroko and Rodell, 2016) during the same period to obtain the changes in glacier volumes included in the DGA dataset (DGA-derived results). In detail, the DGA-derived results are the changes in glacier volume in 1°×1° pixels calculated by subtracting the DGA value from the corresponding GLDAS soil moisture value (resampled from the 0.25°×0.25° to the 1°×1° pixel), and used to compare with the recalculated and traditional equation-based glacier volumes by integrating the individual glacier volume into corresponding 1°×1° pixel.

6. The authors describe a long list of uncertainties in Section 6, but miss to mention that RGI 4.0 has such a bad quality in the study region. I see nowhere in the study a figure showing a glacier outline overlays from both inventories to illustrate the problem.

Response: We have added two aspects of the uncertainty in the RGI 4.0. On the one hand, the uncertainty from the digitization of RGI 4.0 has been mentioned in the response to Comment 4. On the other hand, a big part of glacier information was sourced from the Central Asia (Region 13) containing 25 nominal glaciers (24 km^2). It is another uncertainty source. Relevant description has been added in Lines 593-595 in the revised manuscript.

A schematic map for uncertainty estimation has been drawn as Fig. 3 in the revised manuscript., The description as "Provided the grids of center within a glacier are calculated, the minimum and maximum of real glacier area are designed as deducting and including the half area of boundary grids from the grid-based sum of area." has been correspondingly added in Lines 352-354.

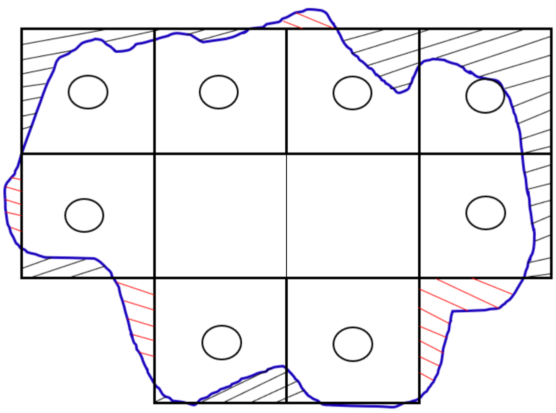

Fig. 3 Schematic map for uncertainty estimation

Note: The area surrounded by the blue curve is a sketched glacier. The grids with "○" and thicker black border line are boundary pixels. The area shaded by left-inclined black lines and right-inclined red lines present unreal-calculated and real-uncalculated part of area, respectively.

7. In effect, it seems the authors present differences between the two inventories as real changes in

glacier number, area and volume and are unaware that these are largely governed by the poor RGI 4.0 quality. Its poor geo-location or missing rock outcrops are not even mentioned.

Response: Thanks for this valuable comment. As for the uncertainty from poor geo-location in the RGI 4.0, the results of manual checking between the RGI 4.0 and GIC-Ⅰ have been given in the response to Comment 4. Regarding missing rock outcrops, we haven't found such information in the technical report of the RGI 4.0. However, even a number of missing rock outcrops included in the RGI 4.0, the result of glacier volume calculated by the proposed method in this study is not affected as the response to Comment 5.

8. As a remark to L11, I think the QTP is only a part of the 'Third Pole'. The Third Pole also includes regions outside of QTP (e.g. western Pamir/Karakoram and Hindu-Kush). As a short note, I think the scale of the map in Fig. 4 is inappropriate to visualize the differences. Where is the class 'mountains' and where are unfilled boundaries (as in the legend)? Please also note that the two datasets in the Supplement have a different projection and file/attribute names contain characters that cannot be displayed.

Response: The difference in projected coordinate system between the two datasets was considered in the manuscript. In this process, the geographic coordinate system GCS_WGS_1984 was employed to display the two datasets in the same map. The class 'mountains' in Fig.4 has been explained in Note and added as "Note: 1-Altin Mountains; 2-Pamir Plateau; 3-Hengduan Mountains; 4-Qilian Mountains; 5-Tangula Mountains; 6-Gandise Mountains; 7-Qiangtang Plateau; 8-Himalayan Mountains; 9-Karakoram Mountains; 10-Nyainqentanglha Mountains; and 11-Kunlun Mountains." in Lines 469-471 in the revised manuscript.

In addition, we didn't find unfilled boundaries as you mentioned. Either, we didn't find the file/attribute names containing characters that cannot be displayed from our side. Could you please specify where the problems are, so then we can try to update them at another time?