Review of “A century of ice retreat on Kilimanjaro: the mapping reloaded” N.J. Cullen et al. doi.10.5194/lcd-6-4233-2012

General comments

I believe that this work is a significant and meaningful contribution to the continuing investigations of the historically well-documented recession of the glaciers on Kilimanjaro over the last 100 years. The methods and the conclusions drawn from the results of the measurements appear to be sound and the main argument presented for doing the work, i.e. consistency of mappings at each epoch, seems to me to justify the evident effort expended.

RESPONSE: We greatly appreciate the thoughtful and careful comments by the referee (Henry Brecher) who has made an important contribution to the mapping of Kilimanjaro’s glaciers. We have made the following changes to the manuscript based on the specific comments and suggested technical corrections.

Specific comments

I believe that the statement in the abstract (p. 4234, line 4) is too assertive and should be qualified by inserting the phrase “most of the” between “remove” and “uncertainty”. Clearly some (unknown and unknowable) uncertainty remains both from the “corrections” of positioning and from interpretation of ice boundaries.

Action: We have changed the text so that it now reads “which helps remove uncertainty”.

The statement on p. 4236, lines 14-16 re. “the expectation…of fitting within previously published maps” does not apply to the T09FS2 mappings (see sec.2.32) which are based on independently determined control point positions determined from GPS surveys.

Action: This statement does not explicitly imply that T09FS2 mappings suffer from this expectation. It is intended to frame the problem that we faced, which was to place existing ice bodies within past boundaries. Our new sequence as presented in this manuscript has allowed us, we believe, to overcome some of the past uncertainty. No change to the text has been made.

The wording on p.4237, line 11 is not strictly correct because, in fact, only something less than half the area depicted on the Klute map was compiled by terrestrial photogrammetric means; the remainder was produced by sketch mapping and from older maps at 1:100,000 scale by Meyer and Jaeger. It is true, however, that with the exception of the summit plateau all the ice bodies fall within the stereophotogrammetric coverage. See UEBERSICHT attached.

Action: This sentence has been modified and now explicitly names the two people responsible for the photogrammetry (Eduard Oehler and Fritz Klute) and makes it clear that the work was also dependent on sketches and mapping from previous efforts. We provide two key sources for this, Klute (1920) that contains the original map and Klute (1921) that describes the photogrammetry in more detail:

A detailed ground-based photogrammetric survey of Kilimanjaro was conducted in 1912 by Fritz Klute and Eduard Oehler, which in conjunction with information from previous sketches and mapping efforts

(e.g. Meyer, 1900; Jaeger, 1909) led to a 1:50,000 scale map being produced, based on a modified Clark 1880 ellipsoid datum (Klute, 1920, 1921).

The UTM zone (p.4237, lines 15 and 16) should be 37S; Kilimanjaro is east of 36 degrees East.

Action: This has been corrected. All the mapping was done on UTM 37S as can be seen on the coordinates shown in the figures. The reference to zone 36 was a typographical error and we are grateful to the referee for pointing this out.

Reasonably reliable latitude/longitude line intersections could easily be added to the Hastenrath and Greischar (1997) sketch map (p.4241, lines 25 and 26) if their orientation to North is accepted. These authors are at some pains to point out their correction of the Klute and Oehler map in that respect.

Action: We have not changed our comment that the single geographical coordinate made it difficult to perform a rigorous registration. It is not entirely clear what the referee means by “reasonably reliable” in this context.

In the sentence in lines 4 and 5 on p.4242 it should be noted that the caption for Fig.1 in Thompson et al. (2002) points this out.

Action: We have modified the text to ensure that readers appreciate that the acknowledgement of prior use of maps by Thompson et al. (2002, 2009) was made. However, it should be noted that the caption for Fig. 1 in Thompson et al. (2002) does not point this out.

P.4248, line 27 “density of ice cover” should be defined; is it ice surface area/total surface area?

Action: When relying on a histogram to depict a distribution such as in Fig. 3, we believe it is good practice to normalize the area under the histogram curve so that its integral is unity. In doing so, the magnitude of the distribution is often referred to as a "probability density function". It describes the relative likelihood for the random variable to take on a given value. We have changed the text and provided additional information to readers in the Fig. 3 caption, which should allow them to appreciate what is meant by “density” on the y-axis.

P.4249, line 23 is a reference for Gaussian Mixture needed?

Action: We have included a reference for this approach, which was carried out using the gmdistribution function in Matlab. A gmdistribution class defines a Gaussian mixture distribution, which is a multivariate distribution that consists of a mixture of one or more multivariate Gaussian distribution components. The source for this function is:

McLachlan, G. and Peel D.: Finite Mixture Models, John Wiley and Sons, New York, 2000.

On p.4261 the second line in the boxed legend in Fig.1, change “Revisited” to “Revised”.

Action: This has been changed.

P.4262, Fig.2 I suggest enlarging the images at least as much as one page will allow in order to make it easier to identify smaller ice bodies. In this connection it would also help if a few of the more prominent ice bodies were labeled.

Action: We have made this improvement to Fig. 2.1.

P.4265 Fig.5 add “thin” before “solid lines” in parentheses.

Action: This has been changed.

There are more appropriate references to the Klute and Oehler 1912 map and mapping than Klute’s book, “Ergebnisse…” (1920) which does not mention the mapping at all and does not include the map. In fact, he specifically points this out in the Foreword: “Eine Beschreibung ueber die Herstellung der Karte und die Mitteilungen der Messungsergebnisse muss ich mir aus Sparsamkeitsgruenden fuer spaeter vorbehalten”. The description of the stereophotogrammetric mapping is in Klute, F. 1921. Die stereophotogrammetrische Aufnahme der Hochregionen des Kilimandscharo. Zeitschrift der Gesellschaft fuer Erdkunde zu Berlin, 56, 144-151 and includes the map. The same map is also published as Plate XXX of a review of Klute’s 1920 book by Hans Reck in Zeitschrift fuer Vulkanologie, 6, 198. Hastenrath and Greischar (1997) cite it as: Klute,F. and E.Oehler. 1922. Karte der Hochregionen des Kilimandscharo-Gebirges nach stereophotogrammetrischen Aufname[sic] 1912. Scale 1:50 000. Zeitschrift fuer Vulkanologie, 6, 198.

Action: This was an interesting comment and we agree that the book we cited (Klute, 1920) does not contain a comprehensive description of the photogrammetry survey. However, we would like to point out that the book does have a copy of the map, which is referred to on the front cover as "EINER STEREOPHOTOGRAMMETRISCHEN KARTE". The book and the map can be observed in digital format at the following location:

http://archive.org/details/ergebnissederfor00klut

We agree that Klute (1921) provides a more comprehensive description of the methodology used, which we now cite as well. However, given that Klute (1920) is the earliest publication to contain the map used we still prefer to cite this as the original source despite the informed comments above.

On the assumption that I should use your Manuscript Evaluation Criteria I “rate” the manuscript in every category that you list below:
Originality(Novelty) 2
Scientific Quality(Rigour)
A. 1
B. 1
C. 1
Significance(Impact) 2
Presentation Quality 1
The other criteria are listed by number and rated below:
1. 1
2. 2
3. 1
4. 2

5. 1
6. 2
7. 1
8. 1
9. 1
10. 1
11. 1
12. n/a
13. Enlarge images in Fig.2
14. 1
15. n/a

Technical corrections

p.4234,line 14 IMPLIES not imply – **correction made**

4235 10 CONVINCING not commanding - **correction made**

p.4235:
line 13 critical THAT we - **correction made**
16 ELEVATION instead of height? - **correction made**
24 RESPONSES not response - **correction made**

4236 11 of THE SOLUTION OF this – **a text change has been made**

4237 12 produced, BASED ON a modified Clark 1880 ellipsoid DATUM. - **correction made**

4238 13 MANJARO - **correction made**

4239 6 UTM37S - **correction made**

16 CHECK points rather than Control points? - **correction made**

19 COEFFICIENTS - **correction made**

4240 4 EASTING, NORTHING, ELEVATION instead of X,Y,Z? - **correction made**

4241 12 delete “to be completed” - **correction made**

18 REVISED not revisited - **correction made**

4245 14 ARE not is - **correction made**

4246 18 INDISPUTABLY not undisputably - **correction made**

4247 12 1970s delete apostrophe - **correction made**
23 DEBRIS-COVERED add hyphen - **correction made**

4248 11 the DECAY OF THE ice - **correction made**

4249 1 FIGURES 3b AND c - **correction made**
5 EAST-FACING - **correction made**
28 RADIATION-INDUCED add hyphen - **correction made**

4250 8 (Table 2 AND Fig.5) - **correction made**
13 delete “enough” after “sufficient” - **correction made**

4251 2 “ “ “ “- **correction made**
14 delete “still” after “would” - **correction made**
21 add comma after “said” - **correction made**
22 SHOWS not show - **correction made**
24 ARE FOR not is on - **correction made**

4252 14 2 AND 3 - **correction made**

4254 4 APPLIED not explored - **correction made**
6 INDICATES THAT - **correction made**

4259 2,3 in Table 1. Klute (1921) **– we have included Klute (1921)**
Klute and Oehler (1922)

4260 last line of caption for Table 2. PARENTHESES not parenthesis- - **correction made**

4263 Fig.3b label on ordinate. Is 10-2 correct or should it be 10-3 as in 3a? **– this is correct**

4264 as a matter of “style” and consistency, same number of significant figures should appear in all numbers on axes, i.e. 9.660 on ordinate and 3.20 on abscissa **– this has been modified as suggested**