This accompanies the paper by Thompson *et al.* (10.1073/pnas.0909029106) published November 3, 2009 in *PNAS.* The supplemental text on the PNAS web site indicated that additional information would be provided. This addendum includes (1) a detailed discussion of each domain and its ice entities present in the different aerial photographs and (2) additional examples of the interpretative discrepancies between the areal coverage determinations by Cullen *et al.* (1, henceforth CU06) and Thompson *et al.* (2).

Figures from the supplement relevant to this discussion are repeated here and the original figure numbers have been retained for consistency. The different ice entities discussed below are shown in figure S2 (included below).

CU06 determined that in 2003 the sum of the areas for the Southern Ice Field, Rebmann, Decken, Kersten, Heim and Diamond glaciers (entities 4-8 and 10) in domain D was 1.025 km^2, which is 0.222 km^2 greater than the interpolation of the 2003 extent based on the 2000 and 2006 aerial photographs (see Figs. 1A and S1, respectively). Their area for all the existing glaciers in domain D (entities 4-8 and 10), except the "lower ice lobe of the Diamond Glacier" is 0.915 km^2. This is obtained by subtracting their 0.11 km^2 area of the "lobe" from their 1.025 km^2 total for domain D. The interpolated area in 2003 for these glaciers is 0.803 km^2. This includes the Ratzel Glacier (entity 3) which was present in 2000 but absent in 2006 (and apparently absent in 2003) and accounts for the additional 0.11 km^2 difference in domain D.

CU06 identified entities in domain E that were not included in the Thompson *et al.* (2) classification, specifically the Great Barranco (Great Breach) Glacier (0.056 km^2) and "a small body of ice above the Arrow Glacier". Their total area of 0.132 km^2 for domain E is the result of adding 0.056 km^2 from the Great Breach Glacier (entity 12) and 0.055 km^2 from the Little Breach Glacier (entity 13), plus what they call the Arrow Glacier (entity 14) and their "small body" above it, without giving areas for the last two. We recognize only one ice body in domain E, the Little Breach Glacier (entity 13), and its interpolated area for 2003 is 0.064 km^2.

CU06 do not mention that their outlines of the lowest edges of the Decken (entity 6) and Kersten (entity 7) glaciers extend well beyond those in Thompson et al. (2002). The lowest edges of entities 6 and 7 are about 200 to 250 m beyond our determinations for 2000 and 2006 and even for 1962. Obviously, because of its small publication scale, there are limitations on how well one can represent their outlines from their Figure 1. However, the details can be traced quite well by enlarging their PDF image to the scale of our maps (Fig. S4). Although this is the region in which viewing in the stereoscopic model, and thus measurement, is the most difficult, measurement errors of this order of magnitude are extremely unlikely**.** They would imply errors of more than 7 mm at the scale of the photographs, which is about 500 times as large as is to be expected using the conservative estimate of 15 μm pointing precision. We have also considered the possibility that the steep walls of the glaciers have masked part of the slopes below their southern edges from view in the 2000 and 2006 photographs. But a simple model of the geometry of the situation indicates that even a 10-m- high vertical wall would mask a stretch only about 20 to 30 m long. And outlines for 2007 from a second line of photographs designed specifically to provide a better view of the ice on the southern slopes confirm the earlier results.

Area measurements from our sets of photographs were made independently of each other and of other results (1). In an attempt to resolve the discrepancies described above other results of which we are aware were examined. Perhaps most relevant is a 2001 poster, Vanishing Icecap of Kilimanjaro by the United Nations Environmental Programme / Division of Early Warning

and Assessment (UNEP/DEWA) available at http://www.unep.org/dewa/assessments/EcoSystems/land/mountain/VanKilimanjaro/index.asp which presents the extent of the glaciers in February 1962 based on a geologic map and their extent on January 29, 2000 based on a Landsat 7 (ETM+, band 8, panchromatic, 15 m resolution) image, with hand-held photographs from an aerial survey in August 2001 used to differentiate ice from snow.

The glacier outlines from these two determinations were scaled and registered to our maps by an "eyeball" best fit (Fig.S3). The outlines match very well for 2000 and reasonably, but not as well, not surprisingly, for 1962. The more relevant point, however, is that essentially none of the "ice bodies that were not included in the Thompson *et al.* (2) classification" but identified by CU06 for 2003 are shown for either 1962 or for 2000. Entity 14 and the "small body of ice above the Arrow Glacier" are not shown although both are imaged on the satellite scene; i.e. neither was classified as ice. The elongated feature southeast of entity 13 is presumably the Great Breach Glacier (entity 12) but it is of an entirely different shape and in a different location than in CU06. The "lower ice lobe of the Diamond Glacier" is entirely absent for 1962. For 2000 entity 8 is shown as extending into that region to some extent but a much larger white area adjacent to it and more or less coincident with CU06's "lobe" is not classified as ice. The lowest edges of entities 6 and 7 for 2000 agree much better with ours than with CU06 for 2003. Even for 1962 they are well above those of CU06 for 2003.

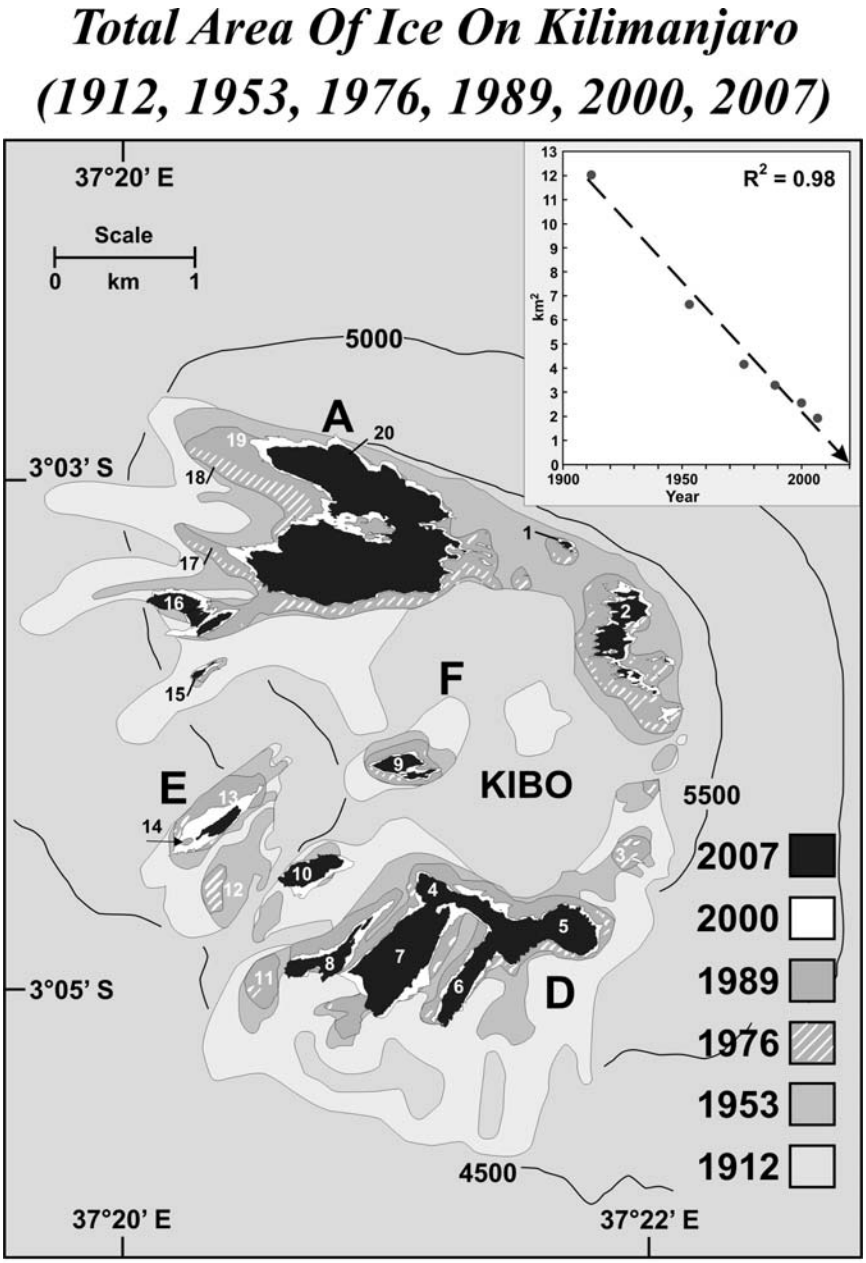
The 2000 delineations are also supported by Hastenrath and Greischar (figure 4 in ref. 3), in which the "small body of ice above the Arrow Glacier" and entity 14 in CU06's location are not present in any epoch; indeed even the 1912 outline does not include them. Examination of the Klute and Oehler (4) map of the 1912 glaciers shows the Little Barranco (Little Breach) and another small region of ice northwest of the outline of domain E, but see the discussion in Hastenrath and Greischar (3) of their adjustments to the Klute and Oehler map.

Messerli's (5) determinations also appear to support ours. His outlines for 1976, based on "...an overflight and a partial field reconnaissance" and a "…schematic drawing 1:30,480 (Sampson, 1971).." (6) show the Big (i.e. Great) Breach Glacier in the UNEP/DEWA location but no "small body of ice above the Arrow Glacier" nor any ice in the location of CU06's "lower ice lobe of the Diamond Glacier.

References

1. Cullen, NJ, *et al.* (2006). Kilimanjaro Glaciers: Recent areal extent from satellite data and new interpretation of observed 20th century retreat rates. *Geophys Res Lett* 33, L16502, doi: 10.1029/2006 GL027084.
2. Thompson, LG, *et al.* (2002) Kilimanjaro ice core records: Evidence of Holocene climate change in tropical Africa. *Science* 298:589-593.
3. Hastenrath S, Greischar L (1997) Glacier recession on Kilimanjaro, East Africa, 1912-89. *J Glaciol* 43:455-459.
4. Klute F, Oehler E (1922) Karte der Hochregionen des Kilimandscharo-Gebirges nach stereophotogrammetrischen Aufnahmen 1912. Scale 1:50 000, *Z Vulkanologie* 6, 198, Pl. XXX.
5. Messerli B (1980) Mountain glaciers in the Mediterranean area and in Africa, in World Glacier Inventory, *IAHS-AISH* Publ. no. 126, 197-211.
6. Sampson DN (1971) in Guide Book to Mt. Kenya and Kilimanjaro, ed Mitchell J (Mountain Club of Kenya, Nairobi) pp. 155-171.

Figures (figure numbers are retained from the publication).



Maps for 1912 - 1989, domains (A, D, E, F) and glaciers 1 - 20 after Hastenrath and Greischar, *J. Glaciol.*, 1997; 2000 after Thompson *et al.*, *Science*, 2002

Figure S2. Map of Kilimanjaro ice fields (Fig. 2) modified with the domains and numbered ice fields according to the classification by Hastenrath and Greischar (3).

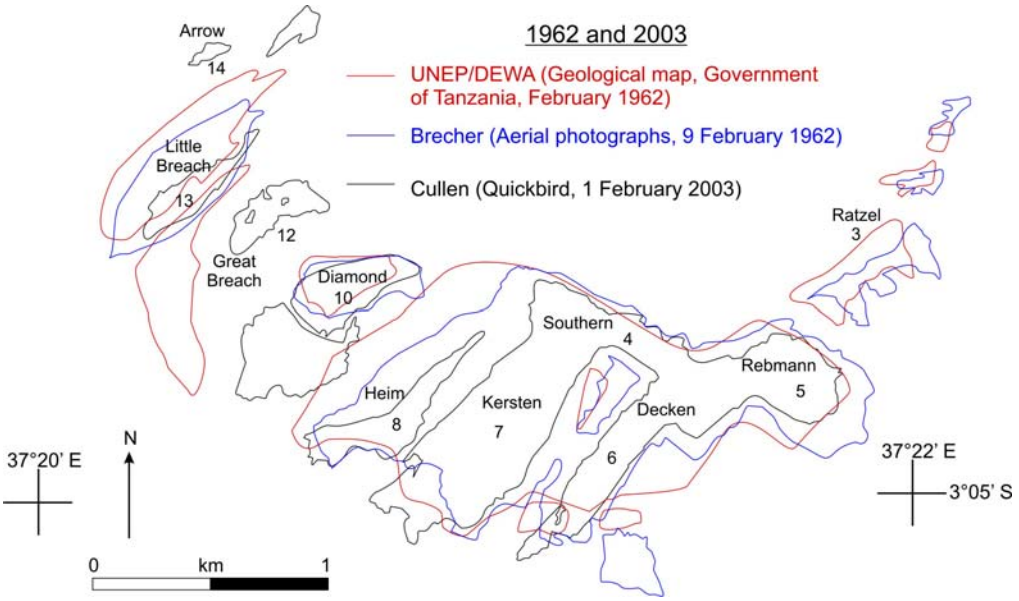


Fig. S3. Comparison of the glacier outlines in domains D and E by Cullen *et al.* (1) for 2003, by the United Nations Environmental Programme / Division of Early Warning and Assessment 2001 (www.unep.org/dewa/assessments/EcoSystems/land/mountain/VanKilimanjaro/index.asp), and by H.H.B. (this paper) for 1962.

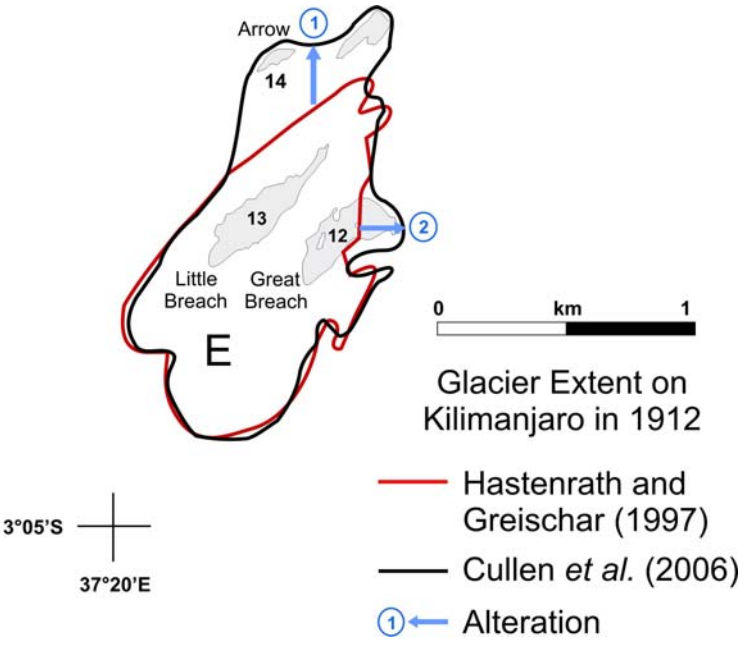


Fig. S4. Differences between outlines of ice in 1912 from Hastenrath and Greischar (3) and Cullen *et al.* (1). The two most prominent alterations in shape and extent are shown.