LETTER

Response to Mölg et al.: Glacier loss on Kilimanjaro is consistent with widespread ice loss in low latitudes

Our paper (1) does not seek to review all potential controls on glacier mass balance (MB) but to (*i*) present ice volume-change calculations, revealing that glacier thinning now accounts for ~50% of the ice-volume loss for the summit ice fields, (*ii*) update changes in the areal extent of the ice fields based on newer (2007) aerial photographs, and (*iii*) highlight that ice loss on Kilimanjaro is not exceptional. We disagree with Mölg et al. (2) that we inappropriately propose that Kilimanjaro's "shrinking ice fields are not unique" (1). The reduction in areal extent and ice volume (shrinking) of Kilimanjaro's ice fields is not unique; it is consistent with the well-documented widespread glacier retreat in lower latitudes. Mölg et al. (2) obfuscate the issue of Kilimanjaro's glacier recession by not differentiating between processes responsible for decreasing ice area (i.e., vertical wall retreat) and more typical MB processes acting on horizontal surfaces, where the balance is currently negative. In fact, since 2000, we have documented area-weighted plateau thinning of ~4 m, a tremendous increase over the rate of 1 m per decade inferred from historic photographs (3) for the last century.

The use of relative versus absolute numbers does not affect our conclusions. By any measure, the glaciers on Kilimanjaro will be largely gone within decades (Fig. 1), and an earlier disappearance is likely given our result that thinning now plays an important role in total ice loss. Mölg et al.'s (2) statement regarding the differential long-term trend of glacier loss on the summit versus the slopes requires clarification. Fig. 1 (*Inset*) illustrates that, after ~1960, their rates of area loss have been nearly identical. We acknowledge the potential of geothermal heat to influence MB, but the only evidence is extremely localized (meter-scale) impacts at or near the Northern Ice Field (NIF). We are unaware of any evidence suggesting that geothermal heat has contributed to ablation of the water-saturated Furtwängler Glacier (FG).

Aridity, through its impact on the albedo/radiation regime, is important but so is temperature and its threshold capacity to force melting. An incremental rise of surface temperature above melting (observations support multiple hours per day and year-round rises) has tremendous capacity to induce accelerated melt, which is commonly evident at the surface of all Kilimanjaro glaciers. We do not dispute the observations of "strong and widespread melting" in the 1880s (2); however, these do not invalidate the ice-core evidence that the summit of the NIF has not experienced significant melting in prior centuries (4). The evidence simply does not permit unsupportable declarations that Kilimanjaro MB processes "bear only indirect connections, if any, to recent trends in global climate" (3). One model cannot account for all of the observed behavior that reflects a complex interplay of many temporally and spatially variable environmental and glaciological controls. Finally, the only reference in the literature to Kilimanjaro as a flagship is by Mote and Kaser (3).

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The authors declare no conflict of interest.

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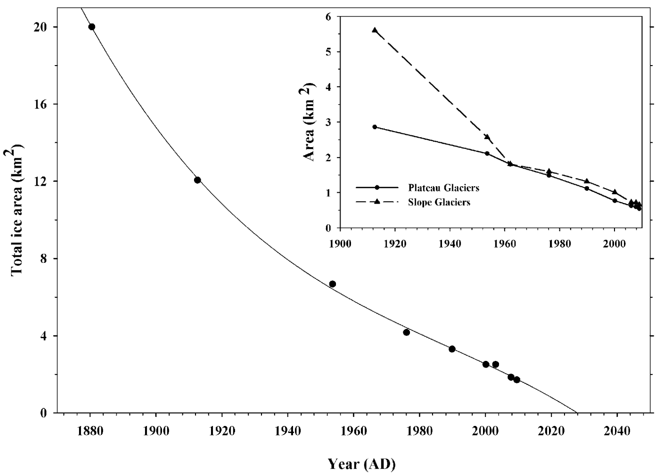

Fig. 1. All available ice area determinations for Kilimanjaro (1880 from ref. 5, 1912, 1953, 1976, and 1989 from ref. 6, 2000 from ref. 4, 2003 from ref. 7, 2007 from ref. 1, and 2009 from previously unpublished data). Smooth line is a third-order regression ($r^2 = 0.999$). *Inset* shows area determinations for glaciers on the summit and the slopes (1912, 1953, 1976, and 1989 from ref. 6).