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Interactive comment on "Climatic controls and climate proxy potential of Lewis Glacier, Mt Kenya" *by* R. Prinz et al.

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Prinz et al. attempt to determine whether the 19th century maximum (L19) extent of Lewis Glacier (LG) in Mt Kenya can be reconstructed from modern mass and energy balance regime. The climate setting of the glacier is dominated by tropical, high-altitude conditions. As of today the glacier has lost more than 80% of its L19 extent, which can be associated, as the authors explain, either to an increase in air temperature or a reduction in air moisture during at least the last decades. Based on local weather station data acquired in recent years, the authors discuss why they lean in favour of the second hypothesis and, through a thorough climatological and meteorological sensitivity analysis, come to the conclusion that the L19 cannot be reached from its current state without invoking a notable rise in precipitation. The authors also evaluate the

potential for using the last decade/century glacier recession dynamics as a proxy for climate evolution. Their answer to this question is in the negative, since it appears that climate and ice cover settings during the last glacial maximum were distinctly too different from modern-day conditions to validate such an approach. Given the complexity of the issue, I believe that the authors do a great job of focusing and building on the important factors that can reasonably be explored from field-acquired weather data to provide a robust view of current glacier sensibility to climate change in tropical latitudes. I recommend publishing this paper with minor revisions as described below.

I have two general comments.

- First, the authors underpin at several instances that precipitation, albedo and cloud cover are key factors controlling mass and energy balance. They propose a suite of synthetic climate scenarios to illustrate the coupling of specific climatic variables and their dominance on mass balance variability. However this coupling pattern is not straightforward, especially in the case of a glacier having so much mass/surface in a short time period. I would find interesting for the community to be able to see, in addition to (or based on) these scenarios, e.g. graphs or schematics of the direct influence of factors like temperature, albedo or cloud cover on the corresponding mass balance budgets.

- Second, it is made clear from the authors' work, that (1) the glacier is not in equilibrium with modern-day climatic conditions, and (2) that modern-day conditions cannot be used to infer glacier retreat dynamics and climate evolution in the last centuries. However, given the apparent intercorrelation between temperature, moisture, cloud cover etc, I would find it interesting exploring which past time period covered by instrumental records or robust proxies, would provide the best constraining data set for retrieving L19 climate conditions. In other words, since, owing to glacier geometry and climate dissymmetry, the present cannot be used to reconstruct past climate at LG, is there a favourable past time window allowing so at all? Further calculations are not necessarily needed here; I think the reader might expect the authors to elaborate some

more on this.

I also have some specific, technical comments.

P. 3889, Line 7: “filtered by glacier dynamics” -> did you mean “counterbalanced by glacier dynamics” or so?

P. 3889, Line 26: . . . revealed that glaciers on Kilimanjaro. . .

P. 3890, Line 9: . . . both. . . are. . .

P. 3890, Line 28: ... additional (?) data is now available. . .

P. 3899, Line 24: . . . were sampled with replacement -> could you clarify this?

P. 3900, Line 21: . . . maximum. . . -> typo: remove the parenthesis.

P. 3900, Line 23: “fresh snow density of 315 kg.m-3” -> can this really be called “fresh snow”? How is this value obtained?

P. 3903, Line 1-2: “For the latter it is crucial that albedo is high. . . to compensate for increased SWI from clear sky conditions”. Could you elaborate a bit more on this?

P. 3905, Line 18-20: “This supports the idea that a larger glacier can develop a deeper katabatic boundary layer. . . more difficult to entrain through advection. . . of warm air”. Do the authors imply here that a reduction in temperature would lead to a less negative mass balance? My question deals with my first general comment above – no temperature range is provided here that would allow appreciating to which extent ‘colder’ temperatures can lead to reduced precipitation on LG.

Fig. 1: The caption and the map are lacking basic features, such as country of location or a sketch map. Perhaps also include basic weather indications (e.g. wind patterns).

Table 4: The interpretation of the different scenarios results is not really handy from this table. An additional sketch figure with prominent scenario characteristics and results would certainly help.

Interactive comment on The Cryosphere Discuss., 9, 3887, 2015.