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The Cryosphere Discussions

Interactive comment on "Relative effect of slope and equilibrium line altitude on the retreat of Himalayan glaciers" *by* T. N. Venkatesh et al.

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This manuscript describes an interesting approach in identifying glacial retreat behavior in the Himalaya. It uses a combination of previously published methods in conjunction with an approach considering gravity-driven ice flow to estimate frontal retreat behavior. The authors apply their new methodology to a dataset throughout the Himalaya with moderate to reasonable good results. One of the key arguments of the paper is that glacial-front behavior is driven by either climatic (mass balance) or gravity-driven (in the wider sense slopes) variations. That is that glaciers experiencing similar climatic forcing can behave very different depending on the steepness. This finding is not new and has been previously stated; however, for the Himalaya it has not been shown in a quantitative context.

The manuscript provides a good scientific contributions, quality and presentation. There are changes necessary, but these are of minor to moderate nature.

The paper presents a simple approach and will certainly attract attention. Because of this, the authors should consider the below comments and especially carefully state the model's limitations.

Overall, the paper is well written and well presented with a detailed description of the methodological approach. The figures are all useful and of good quality, but see my comments below. Importantly, the manuscript lacks several key citations that have looked at glaciers and glacial retreat behavior in the Himalaya through integrated studies of remote sensing, mass-balance measurements, and field work.

There are some issues with the paper that should be remedied prior to final acceptance:

(1) One element that is missing is a somewhat more critical treatment of the underlying assumption. For example, it is not reasonable to assume that the western and eastern Himalaya have similar climatic conditions: not only does the summer monsoon season vary between these area, but also the western and northwestern Himalaya is heavily influenced by snowfall during the winter westerlies. Second, the authors should clearly mention that there are several other factors playing an important role of glacial-frontal behavior, for example: debris coverage, glacial exposure or aspect, internal dynamics, topographic relief that influences debris coverage, solar shielding, and snow avalanching. In general, the manuscript lacks citation from the cryospheric community, which have looked at some of the other factors influencing glacial frontal behavior. (2) In addition to the above element, there are previous publications which point out several links between individual parameters. For example, Scherler et al. (2011-JGR) and Scherler et al. (2011-nature geoscience) argue that steeper glaciers are often characterized by higher relief and result in higher debris coverage. Debris Coverage, especially in the ablation zone, strongly influences frontal retreat behavior. In addition,

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steeper catchments also have higher numbers of snow avalanches that change the mass behavior of the glacier. This has been documented to be an important factor in some Himalayan catchments (see publications by Kevin Hewitt). (3) Specifically, when comparing the Zemu and Gangotri glaciers that sit in very different climatic regions in the Himalaya. The Gangotri glacier receives some winter precipitation, while the Zemu glacier is heavily influenced by the summer monsoon. Certainly, the steepness of the glacier results in different behavior (I agree with the authors), but there are several other factors that may be related to steepness (see above) and thus steepness is not the process controlling glacial behavior. (4) Comparing probability distribution. I suggest the other use a simple parametric (e.g., Kolmogorov Smirnov (KS) test) to test if both distributions are drawn from different sources. In other words, are the distributions shown in Figure 3 are really different given the sample sizes? Note: I am not arguing against the author's statement, but a KS test would strengthen their point. Instead of a KS test, a more sophisticated parametric test can be used as well.

Figures: Change the order of the figures. Before referring to individual locations in the Himalaya, you should present the location map – this is currently Figure 10! The location map should include international borders (and say so in the captions). The state border between individual Indian states can be omitted.

Second, consider plotting Figure 3 + 9 (both probability distributions of slope) right next to each other – I found myself flipping back and forth several times. The captions of Figure 3+9 should also include the bin sizes used for plotting the PD.

Interactive comment on The Cryosphere Discuss., 5, 2571, 2011.