The Cryosphere Discuss.,
doi:10.5194/tc-2016-121-RC1, 2016

The Cryosphere Discussions

Interactive comment on "Brief Communication: Thinning of debris-covered and debris-free glaciers in a warming climate" *by* A. Banerjee

Anonymous Referee #1

Received and published: 17 August 2016

This paper presents numerical experiments on response of debris-covered and debris-free glaciers to changing ELA. Different mass balance profiles were assumed for debris-covered and debris-free glaciers to investigate the thinning rate and its temporal evolution. The motivation of the study is observations in Himalaya, in which thinning rates of debris-covered glaciers are not always smaller than those of debris-free glaciers. This is counterintuitive because a debris layer reduces ice melt, which should results in less negative surface mass balance. Based on a series of simple experiments, the authors showed that debris-covered glaciers may thin more rapidly than debris-free glaciers under a warming climate. This happens because vertical straining due to ice flow plays a role in glacier thickness change, and such dynamic response of debris-covered glaciers is slower than that of debris free glaciers.

It is difficult to find the significance of the study. Glacier thinning occurs by a com-

bination of the surface mass balance and the emergence velocity. Initial change in ice thickness is controlled by surface mass balance, and then affected by changes in glacier dynamics later. Response time of a debris-covered glacier is generally longer than that of debris-free glaciers. All these were frequently argued and well demonstrated in previous studies. Therefore, it is not surprising to see the results shown in Figure 2. Moreover, the model and experimental conditions are very simple (1D flow line model, simple ice dynamics and mass balance). Among others, this study neglects important aspects of a debris-covered glacier, which are listed in the introduction of the paper (line 19-20); time-evolution of the debris extent, variability of debris thickness, and highly dynamic supraglacial ponds and ice cliffs. In any case, the paper is too short to report complex behavior of debris-covered glaciers.

Because of the reasons above, I do not think the paper is worth published in The Cryosphere as "Brief communication", which should be a timely report on new developments, significant advances and novel aspects of experimental and technical methods and techniques. I list below specific comments on the manuscript.

page 1, line19-20: These are very important aspects, but completely neglected in the study.

page 2, line 28: "vertical ablation" is odd. Do you mean "surface ablation"?

page 3, line 3-4: "mass balance shape remains the same" » This is a very crude assumption because the debris layer thickens and lakes are formed.

page 3, line 13-14: The result is not "interesting" if "this is an artifact".

page 3, line 25: What is the unit of the mass balance gradient?

page 3, line 3: Why 30 m (not 50 m)?

page 4, line 4-10: These results are easily expected before the experiments. The results are like that, simply because of the assumptions given to the mass balance.

page 4, line 18: "overtakes that of glacier B" » "glacier A"?

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