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The Cryosphere Discussions

Interactive comment on "High-resolution interactive modelling of the mountain glacier–atmosphere interface: an application over the Karakoram" *by* E. Collier et al.

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Dear colleagues,

It is beyond my scientific expertise to comment on this paper as a whole. It is well-written and I read it with a strong interest given the study region (Karakoram) where the model is applied. I just want to post a short comment regarding the following statement (P123, L24-26): "However, it is noteworthy that geodetic estimates of early 21st century thickness changes in the Karakoram (Gardelle et al., 2012; Kääb et al., 2012) do not show differential ablation between clean and debris-covered ice".

Neither Gardelle et al. nor Kaab et al. measured difference in ablation between clean

and debris-covered ice. They measured similar elevation changes on the two types of glacier surface but, carefully, none of those two papers concluded to similar ablation rates. Elevation changes and ablation are different quantities and are unfortunately often confused (the same confusion is by the way made in the submission by Goulden et al, also currently in discussion for The Cryosphere, http://www.the-cryosphere-discuss.net/7/55/2013/tcd-7-55-2013.html, and in which the term 'melt rate' is used instead of, correctly, 'rate of elevation changes', e.g. in their Table 1). The fundamental mass continuity equation requires that a glacier elevation change is the result of the vertical component of ice flux (i.e., emergence velocity) AND mass balance. As a result, an elevation change can only be equal to mass balance (here: ablation) for a zero emergence velocity which is rarely the case.

* Gardelle et al. explicitly stated that slower glacier flow of debris covered parts (i.e., smaller emergent velocity) could compensate for lower ablation rate due to the insulating effect of debris: "Two hypotheses could explain this counter-intuitive observation. First, the surface ablation may be higher than previously thought on debris-covered glacier tongues due to several factors (thin debris layers, meltwater ponds and exposed ice cliffs) that are known to enhance tongue-wide ablation (ref 19). [. . .] A second hypothesis could be that most of the debris-covered glacier tongues in the Karakoram exhibit a slower flow than debris-free ones, so that surface ablation is balanced only by the small ice flux from upstream"

* Kääb et al. attempted to minimize the influence of ice dynamics by comparing pairs of ICESat measurements within a short distance: "Glacier elevation changes at a specific location are the combined effect of surface mass balance and ice flux budget. Given that our pairs of neighbouring footprints (the mean distance between them is approximately 1 km) typically occur on the same glacier, differences in ice flux budget within a pair are expected to be small. Thus, we assume that the comparison between clean and debris-covered ice elevation trends at least partly reflects differences in ablation rates of the two." But they do not rule out the ice flow hypothesis. . .

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