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Interactive comment on "Spatial debris-cover effect on the maritime glaciers of Mount Gongga, south-eastern Tibetan Plateau" *by* Y. Zhang et al.

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Dr. Zhang –

I am interested in the implications of Himalayan Glacier debris-cover on thermo-mechanical ice flow models. Your paper suggests that debris-cover significantly decreases surface mass balance (i.e. causes more ablation) in comparison to debris-free glaciers. I am interested in the effect of debris-cover on the effective surface ice temperature of the glacier (i.e. the imposed upper boundary condition in a thermo-mechanical model). As you may be aware, the thermal boundary condition prescribed at the ice surface is of equal importance to the prescribed mass balance condition.

I recently collaborated in some thermo-mechanical modeling of a partially debris-

covered Himalayan Glacier (Zhang et al., 2013), which suggested that the glacier was right on the "thermal knife-edge" between being cold and warm based. Due to the high elevation of the Himalaya, geothermal heat flux was minimal at the site (i.e. < 20 mW/m2), and velocities (and subsequent deformational heating) were quite low primarily due to ice thickness (i.e. < 20 m/a). These conditions (which I understand to be fairly common in the Himalaya) made calculated ice temperature relatively sensitive to the boundary temperature prescribed at the ice surface.

Is it possible for you to speculate whether Himalayan debris cover possibly biases/offsets the mean annual ice surface temperature by a non-trivial amount (i.e. > 1 C) from the mean annual air temperature? Or does debris simply attenuate the annual temperature signal with depth, and thereby does not influence the underlying mean annual ice surface temperature?

Your suggestion that debris cover significantly increases ablation at the regional scale gives me the impression that, with all factors equal, the ice surface temperature of a debris-covered glacier is expected to be slightly elevated over that of a neighboring debris-free glacier, due to a relative increase in meltwater production and subsequent latent energy availability. Imposing a 1 or 2 C warmer surface temperature boundary condition significantly increases the probability that glaciers such as East Rongbuk can sustain a core of temperate ice (thereby facilitating a variety of processes that are not possible under cold-based conditions).

I realize this is far off the topic of your paper, but I thought your paper might be a good point to possibly start a discussion.

Zhang, T.; Xiao, C.; Colgan, W.; Qin, X.; Du, W.; Sun, W.; Liu, Y. & Ding, M. 2013. Observed and modelled ice temperature and velocity along the main flowline of East Rongbuk Glacier, Qomolangma (Mount Everest), Himalaya. Journal of Glaciology. 59: 438-448. doi:10.3189/2013JoG12J202.

Interactive comment on The Cryosphere Discuss., 7, 2413, 2013.