We thank Dr. William Colgan for his valuable comments. Suggestions and comments are indicated by *blue colored italic* and our replies are denoted by a header [Reply].

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).

[Reply] The presence of debris cover principally affects the ablation regime of the underlying ice by altering the surface energy balance and imposing a barrier between the atmosphere and the ice. In other words, beneath a thin debris, additional energy from the enhanced absorption of short-wave radiation due to the lower albedo of the debris cover is transmitted efficiently to the ice, with the consequence that melt rate is accelerated relative to that of bare ice; whereas debris mantles of more than a few centimeters in thickness reduce melt rates by insulating it from atmospheric heat and insolation (e.g., Østrem, 1959; Nakawo and Young, 1981; Mattson et al., 1993). Such role of debris cover in the ice melting is mentioned in the section of INTRODUCTION of the manuscript. Consequently, based on the significant role of debris cover, it is difficult to speculate that the debris cover will affect the mean annual air temperature.

As the manuscript shown, debris cover accelerates the trend of faster ice melting on ~10.2% of the total ablation area on Mount Gongga, due to the widespread of thin debris in thickness < 3cm. As previous studies shown, ice melt rate is accelerated beneath the debris in thickness < 2-3cm (Østrem, 1959; Mattson et al., 1993) because of additional energy from the enhanced absorption of short-wave radiation resulting from the lower albedo of the debris cover, compared to that of debris-free ice. As Dr. William Colgan said, the ice surface temperature is expected to be affected by a relative increase in meltwater production and subsequent latent energy availability, rather than the influence of debris cover.

References

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