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Supraglacial debris significantly impacts altitudinal ablation gradients in High Mountain Asia

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The behaviour of the glaciers in High Mountain Asia has considerable implications for water resource availability and food security in southern Asia. Therefore, improved understanding of glacier behaviour in this region, as well as the associated factors which control this behaviour, is critical for effective hydrological forecasting and planning. It is generally understood that supraglacial debris cover greater than a critical thickness provides an insulating effect at glacier surfaces, therefore reducing ice ablation rates. However, recent large-scale altimetry studies appear to indicate that there is no significant relationship between debris cover and ice thinning rates in High Mountain Asia. Here, we produce the first region-wide estimates of surface mass balance for 5 regions across High Mountain Asia, based on ice velocities and mass continuity. The results show inverse altitudinal ablation gradients near glacier termini in the regions with greatest debris thickness and percentage cover, indicating that supraglacial debris does indeed play a role in controlling glacial melt rates in High Mountain Asia. The results also indicate that ice dynamics contribute towards balancing the heterogeneous ice thinning rates which result from spatially variable debris cover, providing an explanation for the minimal relationship observed between debris cover and ice surface elevation change. In addition to yielding new insights on altitudinal ablation trends across High Mountain Asia, our findings underscore the importance of including supraglacial debris cover in glaciological models.