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A 600-year record of snow accumulation at Eclipse Icefield, St. Elias Mountains, Yukon, Canada

Content

The sensitivity of glacier surface mass balance processes to climatic behavior makes surface mass balance measurements a useful metric for evaluating glacier responses to changes in climate. Surface mass balance, or the net gain or loss of ice on a glacier that is in direct contact with the atmosphere, is dominated by snow accumulation and surface melt. The balance between glacier accumulation and surface melt runoff determines the long term viability of glaciers as a water resource for downstream systems. Changes in surface mass balance therefore have implications for both human and ecological communities, as well as for global sea level rise. The Alaska/Yukon region contains over 40 mm of potential sea level rise in its many glaciers and icefields, which are losing ice mass at some of the highest rates globally (-66.7 Gt y-1). The sensitivity of these glaciers to a changing climate is therefore of concern. Ice cores record past changes in surface mass balance processes likely tied to changes in climate. For example, an ice core recovered from the surface plateau of Mt. Hunter (central Alaska) shows a doubling of snow accumulation over the past ~200 years, as well as an increase in surface melt corresponding to a temperature increase of >1.7°C over the same period. However, the spatial coverage of paleo accumulation records in the Alaska/Yukon region remains limited. Here we present a 600-year snow accumulation record from Eclipse Icefield (St. Elias Mountains, Yukon, Canada). We compare the Eclipse record to two other accumulation records from the Alaska/Yukon region (Mt. Hunter, Mt. Logan), as well as to a suite of local and regional weather stations records and downscaled climate reanalysis products. We show that accumulation at Eclipse shows patterns of variability distinct from those at Mt. Logan or Mt. Hunter. Notably, the Eclipse and Logan accumulation records lack coherence despite the proximity of the two sites (45 km lateral distance, 2 km elevation). Out of the ten local and regional weather stations that overlap with the Eclipse ice core record by at least ten years, only Yakutat (on the coast south of Eclipse) shows a significant correlation with the Eclipse accumulation record. Finally, we examine a variety of downscaled ERA5 climate reanalysis outputs (total precipitation, 2 m temperature, SST, mean sea level pressure, precipitable water, 250 hPa geopotential height, 500 hPa geopotential height, 850 hPa geopotential height, 250 hPa moisture transport, 500 hPa moisture transport, 850 hPa moisture transport), and find that accumulation at Eclipse correlates most strongly with high temperatures (2 m and SST) in the central north Pacific, and high sea level pressure in the Pacific west of the Mexican coast. Our results suggest that Eclipse is sensitive to different climate influences than nearby Mt. Logan, but continued work is needed to tease out sources of variability in accumulation across the Alaska/Yukon region.

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