Rapid Laurentide Ice Sheet mass loss (and associated sea level rise) during the Bølling/Allerød constrained by 10Be elevation transects in the northeastern United States

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PRESENTATION

A lack of empirical data constraining the thinning history of the Laurentide Ice Sheet (LIS) has resulted in uncertainty about the timing of ice volume changes and thus its contribution to deglacial sea-level rise. To provide insight about the timing and rate of LIS thinning and retreat, we sampled 133 bedrock and boulder surfaces for in-situ 10Be cosmogenic exposure dating from a transect of elevations on 12 mountains across the northeastern United States. By calculating ages of exposure at different elevations (i.e., ice sheet "dipsticks"), we reconstruct the lowering paleo-ice surface of the southeastern LIS. Samples collected above 1200 m a.s.l. (n=38) exhibit isotopic evidence of burial with minimal subglacial erosion, consistent with a paleo-ice surface not far above the tops of these mountains. Lower elevation (<1200 m a.s.l.) 10Be samples (n=95) agree with published deglacial chronologies from valley bottoms in all but the southernmost locations in the region and suggest rapid ice thinning during retreat. Mountain-top exposure ages located within 150 km of the terminal moraine indicate that near-margin thinning began early in the deglacial period (~19.5 to 17.5 ka), coincident with the slow initial margin retreat indicated by varve records during Heinrich Stadial 1. Further inland (>400 km north of the terminal moraine), exposure ages collected over ~1000 m elevation ranges suggest rapid ice thinning between 14.5 and 13 ka, occurring at about the same time that varve records indicate accelerated ice margin retreat during the Bølling-Allerød warm period (14.6–12.9 ka). Ages across the inland vertical transects are similar within 1σ internal uncertainties, indicating that ice thinning was instantaneous within the resolution of the chronometer, taking place over hundreds of years at most. These results suggest a sea-level rise contribution from the southeastern LIS of at least 0.5 m during meltwater pulse 1a and more than 2 m over the Bølling-Allerød.