Internal Ice layer Mapping and Geophysical Analysis of Jakobshavn Glacier, Greenland

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Abstract

Located on the West coast of Greenland, Jakobshavn Isbræ currently has the highest mass flux of any outlet glacier on the ice sheet. Its velocity has more than doubled in just a decade[1], coincident with rapid retreat and thinning. In order to improve predictions of future ice sheet behavior, it is important to understand the long-term dynamics of large outlet glaciers. In this study, we use CReSIS 2008 Airborne Radar Survey data of Jakobshavn and its catchment. We traced twelve layers throughout the survey grid. These layers were used to produce digital elevation models (DEMs) of isochrones at various depths, from which we calculated thickness changes between adjacent layers, and large-scale zonal thickness trends.

Our results show that bed topography features are visible in all internal ice layers, but are more prominent deeper in the ice column. Thickness maps reveal consistently thicker ice over bed channels than in regions outside the channels. We also observe distinct variations in thickness patterns at different depths: In the upper quarter of the ice column (approximately 0 – 700 m) there is progressive layer thickening from South to North; intermediate layers (roughly 700 m – 1300 m) display thicker internal layers from West to East; the deep layers (~1300 m – 1650 m) show thicker layers from Northwest to Southeast (the deepest layers of the ice column does not show any coherent internal layers and was not included in the analysis). Preliminary investigation using GRIP ice core data suggests the interface between the intermediate and deep zones defined above, coincide with the end of the Younger Dryas; the shift in layer thickness may be due to large-scale changes in accumulation patterns.

This work demonstrates that high resolution 3D radar imaging is critical for quantifying spatial relationships of glacier internal structures and for gaining insights about ice deformation, climate variability and ice flow that can improve models of ice sheet dynamics.

Keywords: cryosphere, geophysics, Jakobshavn, remote sensing

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[1] Thomas, R. H. Force-perturbation analysis of recent thinning and acceleration of Jakobshavn Isbræ Greenland. Journal of Glaciology, vol. 50, no. 168, pp. 57–66, 2004.