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Automatic Detection of the Holocene Transition in Radio-Echo Sounding Data from the Greenland Ice Sheet

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Radio-echo sounding has provided important insights into the subsurface properties of the Greenland Ice-Sheet. Recent years have seen increasing interest in englacial radio reflectors (or internal layers) because their stratigraphy reflects both mass balance rates and flow dynamics. Thus patterns of internal layers contain information about the past behaviour of an ice mass. Unfortunately retrieving this information often relies on a large amount of user interaction and can be very time consuming. As the amount of radio-echo sounding data increases, the development of quantitative techniques for digitising internal layers in radar data is a logical step forward.

In this study we present an automated method for estimating the elevation of the Holocene transition in radio-echo sounding data from Greenland. The data was collected by the Center for Remote Sensing of Ice Sheets (CReSIS), University of Kansas. The automated method is based on the observation that the CReSIS radio-echo data often display a characteristic appearance: the upper half of the radio-echo data contains numerous internal layering and appears much darker than the lower, older part, where only a few visible layers can be seen. Compared to the depth-age relationship from the NorthGRIP ice core this change in the radar-echo data coincides with the transition to the Holocene period.

The method obtains a good match with manually traced data and also returns an estimate of the confidence in its output. The depth of the Holocene transition will provide insight into the large-scale variation of mass balance and basal melt rate over the Greenland Ice Sheet and will assist in efforts to model the past evolution of the ice sheet.