Discovery and Mapping of a Near Surface Water Layer within the Greenland Ice Sheet with Airborne Radar

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Liquid water retained throughout the winter in the southeast Greenland ice sheet firn layer was discovered while drilling two firn cores in April 2011. Ground penetrating radar traces the top of this water table to lie between 8 and 25 m. A radar segment driven over the core sites matches the in situ water depth measurements. Airborne radar data from NASA's Operation IceBridge (OIB) Accumulation Radar acquired 11 days prior to the ground observations and in subsequent years are used to outline the extent of the water layer. This perennial firn aquifer (PFA) is concentrated in the southern ice sheet areas where snow accumulation rate and melt intensity are high. The PFA represents a new storage mechanism for the ice sheet, and needs to be considered in future ice sheet hydrology, mass, and energy budget calculations.

The Accumulation Radar (AR) is a combined stepped-chirped system built by the Center for Remote Sensing of the Ice Sheets (CReSIS), operates from 550 to 900 MHz when flown on a P3 aircraft typically 500 m above surface with a vertical resolution in ice of 28 cm over an effective footprint of approximately 30 m (https://www.cresis.ku.edu/). All of the AR radar images from the NASA OIB flightlines were manually inspected for presence of a water layer representing the top of the PFA. This was characterized by a strong subsurface horizon with no internal layers below. The top of the PFA along with the snow surface was screen-digitized on the corresponding radar images. The time difference between the surface and reflection horizon was converted to depth to the top of the PFA using the same wave velocity of 1.94×10^8 m s^{-1} as was used for the GPR depth calculations.