Title: **Identifying Climate Trends in the Annual Snow Accumulation Record of the Greenland Ice Sheet Revealed by Remote Sensing**

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Purpose

I seek to identify trends in the annual snow accumulation record of northern Greenland by analyzing radar images of Greenland's layered ice sheets. Accumulation rates are a direct reflection of local climate conditions at that time and place. Understanding climate patterns in the past will shed light on trends that may continue into the future. Such information is especially important in the case of Greenland as previous and ongoing research work confirms fears that the landmass's ice sheet is shrinking and contributing to sea level rise.

Background

The radar sensing of ice sheets is a relatively new method of data acquisition that has exponentially expanded our understanding of ice sheet dynamics. We can now detect the physical annual layers of ice preserved in the sheets, layers previously revealed only by drilling an ice core or digging snow pits. By visualizing the thickness of each ice layer, a year-by-year record of snow accumulation can be constructed.

This study works with a radar 'traverse' preformed in 2007 from NGRIP (an ice core station located along the Greenland ice ridge: the dividing point of the ice sheet's east and west slopes) to NEEM (an ice core drilling station some 350 kilometers to the north). Since the radar data covers this 350km traverse north-south, both temporal as well as spatial patterns can be analyzed. Concerning distance, Greenland has two distinct climate systems: in the south wet, humid air from the Atlantic provides fuel for storms and precipitation, while in the north cold, dry air from the Arctic blasts the ice sheet with winds. As a result, the south of Greenland receives notably more snow fall than the north. Also, through time accumulation rates may be influenced by cyclic phenomena such as the North Atlantic Oscillation (NAO) and global trends such as the effects of climate change. Analyzing how accumulation changes from layer to layer will reveal the influence of these phenomena through time.

Methodology

Analyzing the radar data involves visualizing the ice layers in an 'echogram': a vertical 'slice' of the ice sheet plotted with MATLAB software, where the y-axis is ice depth (an ice sheet of more than 2km in depth), the x-axis is distance (350km from NGRIP to NEEM), and each plotted point shows the strength of the radar return signal. This project is interested in the first 110 meters below the surface in depth; deep enough to trace annual layers back to 1600. I have processed and filtered the radar data so that a strong radar return is visible around the January of each yearly layer. Using a MATLAB program built by Anthony Hoch of CReSIS, I will 'trace' each annual layer by following its unique band of radar return on the echogram plot from NGRIP to NEEM, recording the depth of the layer for every increment of distance. As traversing upwards in the ice sheet moves 'forward' in time, the difference between the depth of, say, a 1958 trace and a 1959 trace gives the thickness of 1958's accumulation layer. Converting this thickness into water-equivalent by a calculation involving the ice's compacted density, I am able to determine the water equivalent accumulation for 1958 at any area between NGRIP and NEEM.

With a complete snow accumulation record constructed, I will identify accumulation trends through statistical analysis. To address the imprecision of the tracing software I will analyze the record by complete decades. Also, I will include documentation of my layer tracing methodology as well as error analysis of the final results. These steps will aide in the continuation of trend identification in future work.