Using CReSIS Radar Data to Determine Ice Thickness and Surface Elevation at Pine Island Glacier

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Abstract— The Pine Island Glacier region of Antarctica is an area under intense scrutiny because of its sensitivity to climate change. Pine Island Glacier is located in Western Antarctica and drains a large portion of the West Antarctic Ice Sheet. Glaciers are made up of snow which accumulates over time and, if it does not melt, eventually compresses into large, thickened ice masses [2]. Repeated snowfall that does not melt, subjects the lower layers to such pressure as to cause the deeper layers of snow to recrystallize into ice. This crystallized ice is much denser than the snow, and air pockets between the crystals are very small.

The Pine Island Glacier has shown to be particularly vulnerable to glacial ablation. Glaciers cycle through budget gains and budget losses. Budget gains are referred to as accumulation, which include all processes that add material, usually snow. Budget losses are termed ablation, which may come in the form of melting with run-off, or calving, as two examples. Calving is the process of large portions of ice breaking off at the terminus of a glacier. The change in overall mass of a glacier over a period of time is referred to as “mass balance” . If a glacier has a net balance of zero for a long period of time then the glacier is said to be in a steady state.

The 2012 Research Experience for Undergraduates (REU), Ocean Marine Polar Science (OMPS), Penn State Team analyzed CReSIS radar data to identify the ice-surface and ice-bottom features. From this, both elevation and ice thickness at Pine Island Glacier were determined. The team utilized MATLAB along with an add-on picker program; The Penn State Environment for Seismic Processing (PSESP), developed at Pennsylvania State University. MATLAB is a programming environment that analyzes data as well as many other technical processing applications. With the picker program the team selected specific, maximum-strength radar peaks on individual radar traces and applied a formula to compute the distance traveled by the signal. The difference between the distance traveled from the surface and bottom features was calculated to produce an ice thickness map.

The team concluded that the data plots correlated directly with CReSIS echogram snapshot images. Ice thickness calculations were performed and also matched with the echogram snapshots. The data plots provided a reliable source to perform the ice thickness calculations and could be used in future modeling of the study area. The team results provided data that will aid in modeling of the Pine Island Glacier. Ice-sheet models are expected to help provide accurate estimates of the contributions of the Antarctic and Greenland ice sheets to climate change, especially sea level rise.