A Survey of Techniques for Detecting Layers in Polar Radar Imagery

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The Earth's rise in temperature can cause significant consequences and affect the subsurface dynamics of the Polar Regions. In an effort to investigate the stratigraphy and basal conditions in Greenland and Antarctica, the Center for Remote Sensing of Ice Sheets (CReSIS) has used instruments capable of recording the rapidly changing polar ice sheets. The acquired data are manually analyzed with subjective and highly time consuming approaches, especially when considering large amounts of data. As instrument accuracy improves, automatic methods to support objective and extraction of results matching a 1cm (snow) to 50cm (bed) improvement are needed.

The development of automatic techniques for the analysis of data acquired from Earth's Polar Regions will allow for reliable tools, which could analyze a large quantity of data in a timely manner for the scientific community. We will present a comprehensive survey of suitable techniques for identifying layers from varying classes of radar imagery, each from snow (over polar firm and sea ice) and accumulation radars as well as the multichannel coherent radar depth sounder. General-purpose image segmentation has been used for a variety of problems, but more concretely, methods for tracing near surface internal layers have been studied using snakes and dynamic time warping while bedrock and surface layers have benefited from both snakes and level sets approaches. Progress towards identifying ice interfaces in snow radar over sea ice using a classification technique, called support vector machines, has also been studied. There still exists, however, an opportunity for more innovative techniques. By discussing current techniques in detail, new approaches can be readily envisioned. Our data domain is in radar remote sensing of polar ice sheets, but understanding automatic approaches could be easily adopted for finding layers in other remotely sensed data.