RADAR IMAGING AND SOUNDING OF POLAR ICE SHEETS

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We developed a Synthetic Apertur Radar (SAR) for imaging the ice-bed interface, and a wideband radar for measuring ice thickness and fine-resolution mapping of internal layers. We designed the synthetic aperture radar (SAR) to operate in bistatic or monostatic modes for generating two-dimensional reflectivity maps of the bed, which can be used to determine basal conditions. The SAR operates at 80, 150 and 350 MHz. We also developed a compact, wideband, dual-mode radar for measuring ice thickness and mapping internal layers in both shallow and deep ice. For ice thickness measurements and mapping layers at depth, it operates over the frequency range from 50 to 200 MHz, and for fine-resolution mapping of near surface layers it operates over 500 to 2000 MHz [1, 2].

During the 2004 field season, at SUMMIT camp on the Greenland ice sheet, we collected radar data over 3-km lines at 80, 150, and 350 MHz with HH polarization. We aquired data along parallel paths offset by 2-10 m to test the feasibility of an interferometric SAR to generate basal topography. The preliminary results demontrate that the ice-bed interface can be imaged with the SAR operating in monostatic mode at incidence angles between 5 and 15 degrees. Figure 1 shows sample images collected along two offset passes. We believe that these images are the first and only successful demonstration of imaging the ice-bed interface through 3-km thick ice.

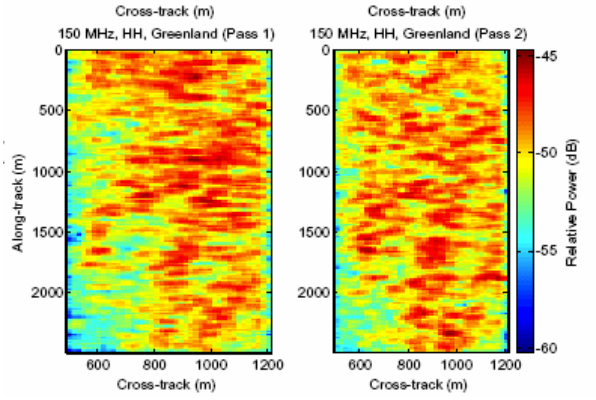

Figure 1: SAR images of ice-bed interface at SUMMIT camp.

Based on the results, we are developing a system that operates over the frequency range from 100 to 300 MHz to image the ice-bed interface with 1-10 m resolution. We will be using this sytem to collect data over a 20-km swath between the GISP and GRIP cores during July 05. The wide frequency range and fine resolution will be useful for unambiguous determination of basal conditions. Such a system will be useful for identifying frozen or liquid water on Mars, and sub-surface characterization of other planets.

We also collected data over a 10 km x 10 km grid with the dual-mode radar. The results demonstrate that we can sound 3-km thick ice and map deep internal layers with about 2 m resolution, and can map near-surface internal-layer echoes to depths of about 150 m with about 15 cm resolution, as shown in Figure 2 [3].

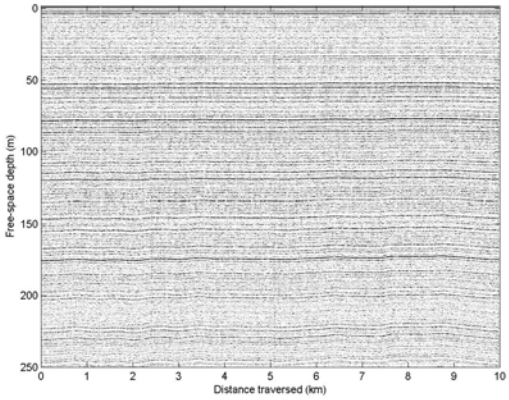

Figure 2: Radar echogram of near-surface internal layers at SUMIMIT.

In this paper we will present design considerations and system characteristics, and show sample results from the imaging and sounder radars from field experiments in the 2004 and 2005 seasons.

References

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[3] S. Gogineni, P. Kanagaratnam, R. Parthasarathy, T. L. Akins, D. Braaten and K. Jezek, "Ultra Wideband Radar Mapping of Near Surface Internal Layers: Systems, Results and Analysis," American Geophysical Union Fall Meeting, Dec. 13-17, San Francisco, CA, 2004.