Title: Wideband Radars for Imaging the Bed and Mapping Internal Layers

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We designed and developed a wideband coherent radar (120-300 MHz) for imaging the ice-bed interface, measuring ice thickness, and mapping layers at depth with fine resolution. The radar utilizes a phased-array with 10 elements for digitally forming multiple beams. Two off-nadir beams are generated for imaging about 700 m on either side of the track. One beam, pointed at nadir, is used to measure ice thickness and map layers at depth. We successfully operated this radar along with an ultra-wideband radar (500-2000 MHz) at Summit, Greenland (72.5789N, 38.4597W) in July 2005. The ultra-wideband radar is used to map near-surface internal layers to a depth of about 150 m with 10 cm range resolution. We mounted the two radars on a Tucker Sno-Cat vehicle and collected data along a 6.5-km swath over a distance of 25 km between the GISP2 and GRIP boreholes.

The results from these experiments show that we can map internal layers to a depth of 2800 m and these layers can be tracked between the GISP2 and GRIP boreholes. The observed resolution of the system is about 1 m and a strong bedrock return was seen at all locations in the grid. We will present the depth sounder results from the grid and the corresponding ice thickness map. Figure 1 shows preliminary results from the radar depth sounder. The data are taken as we drove away from the GRIP borehole towards the GISP2 borehole. The image on the left shows the data from the surface to the bedrock and the image on the right shows a magnified view from a depth of about 2550 m to 2850 m.

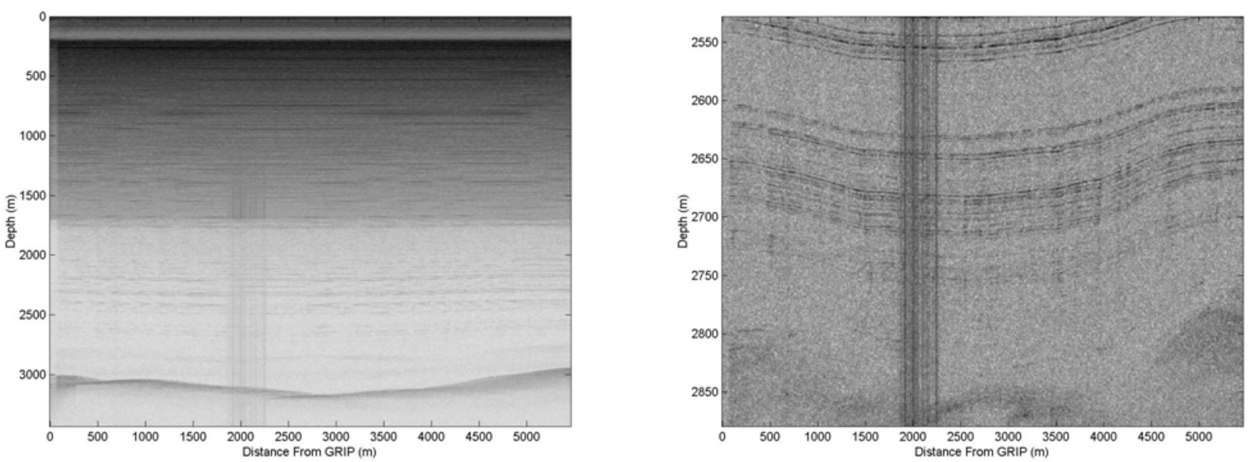

Figure 1. Radar depth sounder results near the GRIP borehole from data collected in July 2005.

During the 2004 field season, we collected data with a prototype radar to test the concept of synthetic aperture radar (SAR) imaging of the ice-bed interface [1]. We collected these data with a radar that operated at 80, 150, and 350 MHz with HH polarization. Figure 2 and 3 show sample SAR images obtained with the prototype radar. This system has a much lower bandwidth, signal-to-noise ratio, and fixed antenna beams, but follows the same fundamental operations as the newer radar. Sample images from data collected this year will be presented at this WAIS summit.

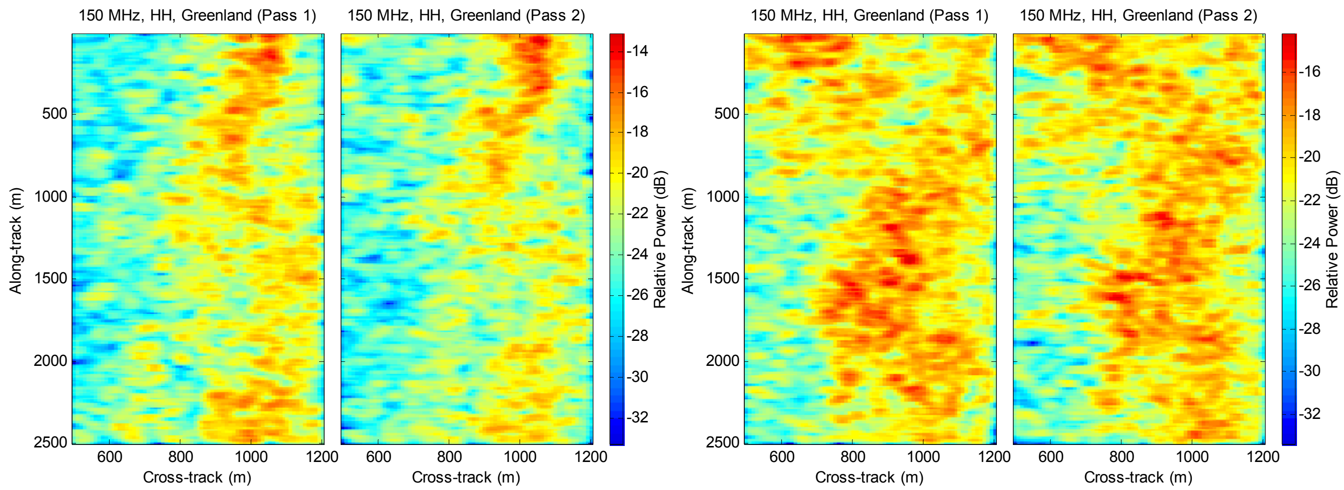

Figure 2. Shows two pairs of 150-MHz, HH-polarized, monostatic SAR backscatter maps from the base of the ice sheet near Summit, Greenland from data collected in 2004. Passes 1 and 2 refer to separate data collection passes over the same terrain.

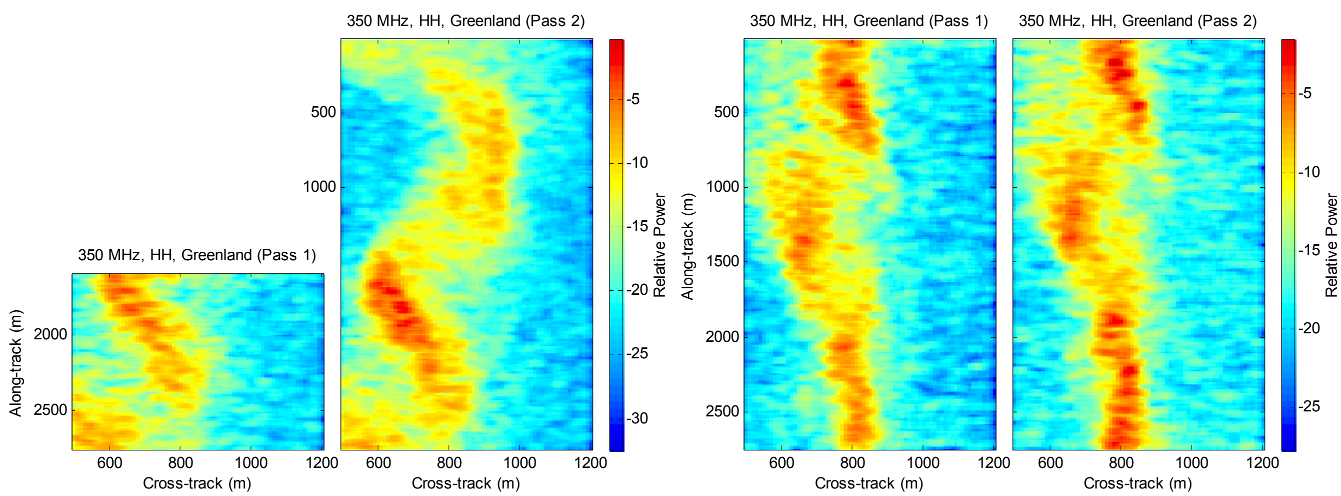

Figure 3. Shows two pairs of 350-MHz, HH-polarized, monostatic SAR backscatter maps from the base of the ice sheet near Summit, Greenland from data collected in 2004. Passes 1 and 2 refer to separate data collection passes over the same terrain.

Additionally, we will show results from the ultra wideband radar along with a comparison to layers found in nearby snow pits excavated during this field season. We plan to collect data with both these radar systems at the new WAIS ice core site during the 2005 to 2006 field season.

References

[1] Paden, J., S. Mozaffar, D. Dunson, C. Allen, P. Gogineni, and T. Akins, "Multiband multistatic synthetic aperture radar for measuring ice sheet basal conditions", IEEE Geoscience and Remote Sensing Symposium, 2004 (IGARSS '04), vol. 1, 20-24 Sept. 2004, pp. 136-9.