Polar Ice Sounding using Multi-Frequency, Polarization Ground Penetrating Radars

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Ground penetrating radar systems have been providing critical boundary condition information for ice-sheet modeling. Nevertheless, more detailed ice bed topography data, finer resolution internal layer representation and higher sensitivity ice melting rate measurements are still necessary to further constraint ice sheet models to minimize the variance in current sea level change projection. To measure a wide variety of ice properties, we developed four multiple-input-multiple-output (MIMO) ground penetrating radar ice-sounders working at multiple frequency bands (170 – 230 MHz, 180 – 340 MHz, 600 – 900 MHz and 1.2 – 1.4 GHz), with different polarization and azimuth angles. All of the radar systems share the same 8-channel digital system and they have a loop sensitivity of more than 200 dB. The VHF system (170 – 230 MHz) is equipped with a linear antenna array and has a peak-power of 1.2 kW per channel. This radar system has the best penetration capability among four systems due to the lower ice scattering loss. The ultra-wideband (UWB) system (180 – 340 MHz) has a wider bandwidth of 160 MHz and it is equipped with a 2.8 m x 2.8m dual-polarized antenna array. The dual-polarized configuration is aimed to provide additional information on the internal fabric of ice and its relationship to ice flow dynamics. These two radar systems can provide fine resolution internal layer mapping down to more than 3 km under the Greenland ice sheets. To further improve the sensitivity to basal and internal layer properties change, we have developed two high frequency radar systems, operating at the UHF band (600 – 900 MHz) and L-band (1.2 – 1.4 GHz). Due to the shorter operating wavelength, these radar systems are more sensitive to ice mixing at the boundary layer as well as any thin water film presence at the ice-bed interface. These radars are developed to achieve the required sensitivity while maintaining sufficient penetration. The UHF system has a peak transmit-power of 800 W per channel and is equipped with a lightweight 16 m x 17 m Mills Cross antenna array. The L-band system has a peak-power of 500 W per channel and it is equipped with a high-gain Yagi-Uda antenna array. All four radar systems were deployed to the East Greenland Ice-core Project (EGRIP) camp during the 2019 Summer field season. The radar electronics design, system integration, antenna array design and the processed data will be presented at the EGU 2020 conference.