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Inversion for firn density-depth profile using phase-sensitive radar.

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Translating satellite measurements of ice sheet volume change into sea level contribution requires knowledge of the profile of density as a function of depth within the ice sheet, and how this profile changes over time. This paper describes an interferometric method of inverting ground-penetrating radar returns for the profile of firn density as a function of depth. The method is an interferometric implementation of the common-midpoint approach, performed using a phase sensitive ground-penetrating radar. By recording the phase difference of returns with a range of antenna separations, the different path lengths through the firn allow a unique recovery of parameters that describe the density profile. Our results suggest that the use of a phase sensitive radar can recover differences in two-way travel time to an accuracy about twenty times greater than has been reported for conventional processing of ground-penetrating radar returns. In a test of the method performed at Summit station in Greenland, the recovered density-depth profile agreed with ice core data to within 5% root-mean-square error.