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Observing Evolving Subglacial Conditions with Mutitemporal Radar Sounding

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Airborne radar sounding is the primary geophysical method for directly observing conditions beneath ice sheet and glaciers at the catchment to continent scale. From single flow-lines to regional surveys to ice-sheet wide gridded topographic datasets, radar sounding profiles provide information-rich constraints on the englacial and subglacial environment. This can include roughness, lithology, hydrology, thermal state, melt, fabric, and structure for both grounded and floating ice. However, the snap-shot view provided by one-time soundings fails to capture subsurface processes across the time-scales over which they evolve and control ice flow. Doing so requires advancing multi-temporal radar sounding instruments, platforms, and data analysis. For example, point-measurements by ground-based or stationary sounder can be used produce local time-series observations of englacial and subglacial conditions. However, low-cost, low-power active and/or passive radar-sounder networks can dramatically extend the reach and scope of such measurements. Further, repeat surveys by sled-drawn or airborne sounders can capture seasonal and interannual subsurface variations. However, digitization of archival radar film are extending the temporal baseline for such comparison by decades, making multi-decadal studies of subsurface changes possible. Finally, the development of autonomous rover, drone, and satellite sounding platforms and systems promise to enable pervasive, stable, and frequent monitoring of subglacial conditions. Here, we discuss the advances, challenges, and the path forward to observing subsurface conditions across the full range spatial and temporal scales at which they occur.