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Initial Analysis of Internal Layers in the Snow Cover of the Ross Island Region using Ground Penetrating Radar Measurements

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In snow and ice, internal layers are created by changes in the ambient conditions at the time of deposition, and represent contrasts in density, electrical conductivity, and ice crystal orientation. By identifying and tracing internal layers in ground penetrating radar (GPR) measurements of the Antarctic snow cover, these layers can be used to measure snow accumulation over time. This is particularly relevant for determining the Antarctic mass balance, as the areal coverage can be greatly expanded from the common, but potentially unrepresentative, point measurements from firn-cores, snow pits, or stake farms. This presentation discusses high-resolution GPR data acquired at three research sites in the vicinity of Scott Base (Antarctica), each site being characterised by different snow and surface properties. The first two sites examined, are located on the flat McMurdo Ice Shelf in zones with significantly different wind and accumulation patterns. The final site is located on the lower slopes of Mt. Erebus (Ross Island), in the dry snow zone, at approximately 350m above sea level.

Using a pulseEKKO PRO GPR system, data was acquired at two frequencies simultaneously (500MHz and 1GHz; wavelength in dry snow: 40cm and 20cm, respectively). At the first two sites, transects were collected in an 800m x 800m grid at 100m intervals. Due to difficult terrain, the third site was restricted to a 400m x 400m domain. Radar shots were taken at 5cm intervals along each transect. This both provides a very high horizontal data resolution, and facilitates internal horizon tracking. The acquisition time-window of 135ns allows horizon detection down to a depth of approximately 12m. In order to convert layer depth to accumulation, information on snow density derived from snow pit- and CMP-measurements was also collected.

The acquired data provides high-resolution ground-truth information required for the validation of CRYOSAT-2 satellite data (launch date in 2009). An additional reason for obtaining such large-scale, high-resolution measurements, relates to our desire to test newly developed retrieval methods based on complexity measures. Complexity measures have been previously utilised in other geophysical fields and have been shown to be sensitive indicators of transient regions. The results will be compared with conventional signal-processing techniques for layer identification. Furthermore, the utility of cross-recurrence plots (which could be explained as nonlinear cross-correlation functions), which have been used for correlating data sets of different quality, is tested for relating snow morphology information from snow pits to radar features.