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Field experiments to determine wave propagation principles and mechanical properties of snow

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To understand the release of snow avalanches by explosions one needs to know how acoustic waves travel above and within the snowpack. Hitherto, wave propagation was investigated in the laboratory with small samples or in the field in the shock wave region. We developed a measurement system and layout to derive wave attenuation in snow, wave speeds and elastic moduli on small-scale (1-2 m) field experiments to close the gap between the lab scale (0.1 m) and the scale of artificial release (10-100 m). We used solid explosives and hammer blows to create the load and accelerometers to measure the resulting wave within the snowpack. The strong attenuation we observed indicates that we measured the second longitudinal wave which propagates through the pore space. The wave speeds, however, corresponded to the speeds of the first longitudinal wave within the ice skeleton. The elastic moduli were high on the order of several tens of MPa for lower densities (150 kg m-3) and agreed well with earlier lab studies, in particular for the higher densities 250-400 kg m-3). However, the scatter was rather large as expected for in-situ experiments in the layered snow cover. In addition, we measured accelerations during propagation saw test experiments. The propagation of cracks during this type of snow instability test has mainly been studied by analysing the bending of the slab (due to the saw cut) using particle tracking velocimetry. We used the accelerometers to measure crack propagation speeds. The wave speeds were slightly higher for most experiments than reported previously. Furthermore, in some experiments, we encountered to different wave types with one propagating at a higher speed. This finding may be interpreted as the actual crack propagation and the settling of the weak layer (collapse wave). Our results show that field measurements of propagation properties are feasible and that crack propagation as observed during propagation saw tests may involve different processes that need to be further investigated.