Microtomography of layered snow samples and weak layers

Margret Matzl, Martin Schneebeli, Daniel Steinfeld, and Stephen Steiner
WSL Institute for Snow and Avalanche Research SLF, Davos Dorf, Switzerland (matzl@slf.ch)

During the last 10 years X-ray microtomography (micro-CT) has proven to be the first efficient method to measure the true three-dimensional (3-D) structure of snow on the ground. Micro-CT is used to reconstruct 3-D microstructures as a source for numerical simulations, to conduct long-term observations of metamorphism or the behavior of snow under stress and to derive macroscopic parameters describing the microstructure of snow like specific surface area (SSA) or density. However, micro-CT was confined to small and predominantly homogeneous samples with a typically evaluated size of 5 x 5 x 5 mm^3. One reason for the small size was the limited computational power, the other the sample preparation. Based on the replica method for 3-D micro-CT samples introduced by Heggli et al. (2009), we are now able to visualize snow samples up to 70 mm height, and about 10 mm diameter, with a resolution of 10 ìm. Because inclusion of small air bubbles during the casting process can not be avoided, we make two scans, one before and one after sublimation, the two scans are then registered and subtracted. After image segmentation and morphological image processing the replica can be analysed in the same way as direct snow measurements. We reconstructed highly fragile snow packs, like new snow, buried surface hoar and other weak layers. The observable structure is 10-15 times longer than in previous samples. The samples show a fascinating new image of how complex snow layers are. For layered samples the parameters like SSA are calculated using a sliding window. This results in a high resolution vertical SSA-profile of the snow sample instead of one averaged value. We think that such 3-D reconstructions of the snow microstructure could be a useful tool both for practitioners and researchers to improve the understanding of snow properties, snow metamorphism, and fracture processes during avalanche formation.

Heggli, M.; Frei, E.; Schneebeli, M., 2009: Instruments and Methods. Snow Replica method for three-dimensional X-ray microtomographic imaging. J. Glaciol. 55, 192: 631-639.