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Grain size in polar firn - what can we learn from high resolution images about grain growth in firn?

S. Kipfstuhl (1), J. Freitag (1), M. Horn (1), M.W. Hörhold (1), and S.H. Faria (2)

(1) Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany (sepp.kipfstuhl@awi.de), (2) GZG, University of Göttingen, Göttingen, Germany

Two methods are described to obtain grain (crystal) size from images of firn and ice samples taken in microscopic resolution. Microstructure mapping provides a digital mosaic image of a firn/ice section assembled from single microphotographs (resolution 3.25 μm/pixel). Alternatively, the large area scan macroscope (LASM; Schäfter and Kirchhoff, Hamburg, Germany) scans a section as one single image. The lower resolution (5 μm/pixel) is compensated by the much faster working speed (1 minute versus 1 hour for mapping). The preparation of the samples is identical. Grain size is derived from the network of grain boundary grooves emerging at a carefully microtomed surface.

First results of a 110 m long shallow ice core drilled in Dronning Maud Land, Antarctica, are presented. Average grain sizes were determined over 1 m long intervals every 10 m using the faster LASM. For comparison additional grain sizes were derived from the mosaic images. The main result obtained so far is that average grain size depends on resolution, i.e. on the cut-off grain size taken for the averages. This concerns particularly the average grain sizes below about 30 m depth. If the average grain size is determined from the 100 or 500 largest grains in a section (as sometimes done in the past) there is significant grain growth. However, grain size hardly increases with depth or even vanishes if all grain sizes larger than 50 μm are included in the averages. A first answer to explain this discrepancy comes from the grain size distributions. They show a clear shift to more smaller grains at depths close and across the firn-ice transition which points to formation of new grains and dynamic recrystallization. The question how to derive average grain size from high resolution images and how to interpret these results is discussed.