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EBSD observations of dynamic recrystallization mechanisms in ice.

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Dynamic recrystallization (DRX) strongly affects the evolution of microstructure (grain size and shape) and texture (crystal preferred orientation) in materials during deformation at high temperature. Since texturing leads to anisotropic physical properties, predicting the effect of DRX in metals is essential for industrial applications, in rocks for interpreting geophysical data and modeling geodynamic flows, or in ice for predicting ice sheet flow and climate evolution.
Owing to its high viscoplastic anisotropy, ice has long been considered as a "model material". This happens to be particularly true in the case of the understanding of the fundamental of DRX mechanisms as they occur under a relatively easily controlled environment.
Creep compression experiments were performed on polycrystalline ice samples in the laboratory in order to observe the evolution of the fabrics and microstructures during DRX. During the tests, performed at temperatures of -5°C and -7°C, under 0.8 MPa compressive stress, dynamic recrystallization was initiated after 1% macroscopic strain and could be followed up to 18% strain on separated samples.
Fabrics and microstructures were analysed post-mortem using an Automatic Ice Texture Analyser (AITA, Russell-Head and Wilson 2001) and EBSD measurements with the Crystal Probe of Géosciences Montpellier. Both techniques enable high resolution observations, both in space and orientation (5 to 50 microns, EBSD: 0.7° - AITA: 3°), which is new for DRX observations in ice. While AITA provides only the c-axis orientations, EBSD provides full orientations (c- and a-axes). In particular, we could access to an estimate of a relative dislocation density (from the Nye tensor obtained with EBSD) and its evolution with strain.
Fabric evolution with strain is very similar to what was measured by Jacka and Maccagnan (1984) with a strong strengthening toward a few maxima for c- and a-axes. The c-axes maxima are oriented about 30° from the compression direction. Within our condition range, the grain boundary migration highly dominates the DRX mechanisms and induces strongly serrated grain boundaries. This is to be associated with a highly heterogeneous state of stress and strain that is not "homogenised" by DRX mechanisms. Indeed, higher resolution observations (5 microns) reveal highly distorted areas close to grain boundaries and triple junctions.

T. H. Jacka and M. Maccagnan (1984). Ice crystallographic and strain rate changes with strain in compression and extension. Cold Reg. Sci. Technol. Vol. 8 pp 269-286
D. S. Russell-Head and C. J. L. Wilson (2001). Automated fabric analyser system for quartz and ice.
J. Glaciol. Vol. 24 Num 90 pp 117-130