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Micro-structure of the NEEM deep ice core: towards quantifying stratigraphic disturbances

Denis Samyn (1), Ilka Weikusat (2), Anders Svensson (3), Nobuhiko Azuma (4), Maurine Montagnat (5), and Sepp Kipfstuhl (2)

(1) University of Uppsala, Geocentrum, Earth Sciences, Uppsala, Sweden (denis.samyn@geo.uu.se), (2) Alfred Wegener Inst., Glaciology, Bremerhaven, Germany, (3) Niels Bohr Institute, Ice and Climate Research, University of Copenhagen, Denmark, (4) Nagaoka University of Technology, Nagaoka, Japan, (5) Laboratoire de Glaciologie et Géophysique de l'Environnement, Grenoble, France

During the last field season of the NEEM drilling project in Greenland, several hundreds of thin sections have been prepared and analyzed on site, and the ice core stratigraphy has been continuously scanned at very high resolution, making it one of the few deep ice drilling program with a continuous survey of (micro-)physical properties. It appears clearly from these analyses that the last few hundred meters of the core have been disturbed to a limited extent in various ways and at various scales. It is also remarkable that, despite these disturbances, the ice core has probably kept most of its integrity in terms of chemical (and thus palaeo-environmental) signal. There is thus a need now to clarify the extent of the deformation processes that have led to discontinuous flow in order to take full advantage of this new ice core that is potentially spanning all the Eemian period and beyond.

One of the fundamental microstructural issues that remain unsolved regarding ice core physical properties deals with the dynamics of discontinuous recrystallization (DR) *. Related ice crystallographic studies are lacking, and the reasons why deep ice fabrics fluctuate (sometimes dramatically at short scales) and the role played by these fluctuations on ice sheet dynamics are still poorly constrained.

Amongst the flow inhomogeneities observed at NEEM are band dipping or micro-folds. These features are of importance for the treatment of the local ice flow behaviour as well as for the interpretation of high-resolution chemical data. In the first case, a vertically homogeneous flow profile is generally considered in current global ice flow models, and, in the second case, a strictly horizontal band layering is considered when interpreting vertical trace element profiles (e.g. from Continuous Flow Analysis). Quantifying and characterizing such flow disturbances is thus particularly relevant to the ice core community, especially in the vicinity of the base of the ice core, where the thickness of annual layers and the dating resolution are strongly reduced.

In order to gain insight into these fields, we investigate here, through the analysis of folded ice microstructures and visual stratigraphy (line scan) markers, the causes for DR in the deep part of the NEEM ice core. It is shown that discontinuous flow/folding is associated with DR, the latter having the potential to significantly alter the outline and orientation of ice fabrics, reflecting in some way the flow organization and history at various scales.

* Samyn, D., Svensson, A. and Fitzsimons, S. 2008. Discontinuous recrystallization in cold basal ice from an Antarctic glacier: dynamic implications. Journal of Geophysical Research, 113, F03S90, doi:101029/2006JF000600.