Fabric analysis and modelling along the Talos Dome ice core

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- Fabrics have been measured along the Talos Dome ice core using the Automatic Ice Texture Analyser of D. Russel-Head (Russel-Head and Wilson, 2001 J. Glaciol. 24). Fabric data are available high in the firm, from 1150 m depth. The fabric evolution is compared with climatic signals and analysed regarding the thinning function extracted from the TALDICE-1 chronology (Buiron et al. 2011 Clim. Past 7).

- Using the second order VPSC scheme (Lebensohn et al. 2007 Phil. Mag. 87), we modelled the fabric evolution under compression, with a constant strain rate consistent with the one expected along the Talos Dome ice core. The Talos Dome chronology TALDICE-1 is used to obtained the accumulated compressive strain as a function of depth along the core, from the thinning function.

- A reasonably good fit is obtained over the global trend. From area of mismatch between data and model results, hypotheses can be given about the influence on flow conditions of shear stress and changes of ice viscosity due to climatic conditions.

- The best fit is obtained using a non isotropic initial fabric confirming the influence of the initial conditions on the fabric evolution all along the core.

- From the modelling tool, data were inversed to predict a thinning function in the case of an ideal dome. Comparison will be helpful in the future to better constraint the dating scenario of the inverse method used to obtain the chronology (Lemieux-Dudon et al. 2010 Quater. Sc. Rev. 29).

Experimental procedure:
- The Automatic Ice Texture Analyser

Fabric data:
- Fabric measurements in the firn, from 18 m depth
- Anisotropy: 18 m a0.39, 28 m a0.45, 38 m a0.39.
- Evidence of dynamic recrystallization from 1171 m depth, strong impact on texture below 1400 m depth.

Modelling the fabric evolution using the VPSC second order scheme
- Accumulated compressive strain = 1 – thinning.
- The data are represented via the 3 eigenvalues of the tensor a1, a2 and a3 which can be seen as the lengths of the axis of the ellipsoid that best fit the density distribution of the grain orientations.
- For an isotropic fabric a1 = a2 = a3 = 1/3
- For a simple maximum fabric a2 = a3 < 1/3
- For a girdle type fabric a1 > a2 > 1/3
- The parameters are calculated on each valuable pixel, the grain area is then taken into account as a statistical weight.

TO SUMMARIZE:
- Global trend of fabric evolution comparable with the GRIP or EPICA Dome C core: uniaxial compression as the main deformation mode. Clear departure from this trend in relation with climatic transitions.
- Non isotropic fabrics in the firm, with a clear impact on the fabric evolution along the core. Must be associated with firm densification processes (strain concentration at junction between ice aggregates).
- Strong evidence of dynamic recrystallization processes from 1400 m depth, and higher on isolated samples (1171 m for instance): signature of a highly heterogeneous state of strain.
- Comparison with simulation of an ideal uniaxial compression: departure from the ideal case associated with climatic transitions. Impact of shear associated with changes of viscosity. Role of such changes on the thinning function irregularities.
- Possible signature of dome movement in the past and / or changes in firm anisotropy associated with abrupt changes in dust content (Delmonte et al. 2010 J. Quater. Sc.).

PERSPECTIVES:
- Model simulation can be used to inverse the fabric data to provide adjustment parameters to constrain the error matrix of the dating inverse modelling (Lemieux-Dudon et al. 2010 Quater. Sc. Rev. 29)
- Quantify the role of debris layers on changes in ice viscosity (Narcisi et al. 2010 J. Quater. Sc. 25)