Geophysical Research Abstracts
Vol. 13, EGU2011-3374, 2011
EGU General Assembly 2011

Measurements and numerical simulation of fabric evolution along the Talos Dome ice core

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Fabric evolution was measured along the 1620 m depth Talos Dome ice core, drilled in East Antarctica in the framework of the TALDICE project (www.taldice.org) between 2004 and 2008. The Talos Dome coring site is located near the dome summit and is characterised by a mean annual temperature of -41°C and a current accumulation rate of 85 mm ice equivalent per year (Frezzotti et al. 2007). The whole core provides a paleoclimatic record covering at least 250ky BP (Buiron et al. 2010).

The fabric evolution was measured using an automatic ice fabric analyser (Russell-Head and Wilson, 2001), from 18 m depth (firn) down to the bottom at about 1620 m depth, every 20 m approximately. The fabric is represented via the orientation tensor eigenvalues following Durand et al. (2006). The global evolution is coherent with an uniaxial compression as the main strain along the core, with a progressive c-axis concentration toward the vertical direction. From the overall evolution, some remarkable observations can be done. First of all, the initial fabric measured in the firn as high as 18 m depth is far from being isotropic. Then, a clear change in the evolution slope is observed from about 700 m depth, which corresponds to the climatic transition to the last glacial period. Nearly constant orientation tensor eigenvalues are measured between 1000 m and 1200 m depth followed by an abrupt change to very concentrated and constant eigenvalues. Such high concentrated values can not be obtained with uniaxial compression, a shear component is then required. Then, from about 1450 m depth down to the bottom, big grains appear whose orientation is departing from the concentrated single maximum. This is a clear evidence of the occurrence of dynamic discontinuous recrystallization.

A ViscoPlastic Self-Consistent (VPSC) modeling approach was used to evaluate, from an inverse method, the thinning function expected from the measured fabric with the assumption of uniaxial compression as the only deformation mode. A comparison with the thinning function extracted from the official chronology performed by Buiron et al. (2010) then provides areas where shear component of the deformation, together with changes in ice viscosity, must strongly influence overall flow. From these results, we discuss the opportunity to use fabric data as a constraint for the inverse modeling approach providing the ice core chronology. Such a constraint, complementary to age markers currently extracted from gaz and isotope measurements, would indirectly take into account the flow conditions.