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Influence of the surface slopes at an ice-sheet ridge on the fabric profile

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Polycrystalline ice is one of the most anisotropic natural material. Its anisotropy is strongly related to the distribution of the crystal orientations. Due to the deformation, the crystals turn to preferential orientations depending of the strain-rate and stress history, leading to different types of fabric. For example, in uni-axial compression the crystal c-axes rotate to the compressional axis, leading to one single maximum fabric, whereas in uni-axial tension, the c-axes rotate to a plane perpendicular to the tension axis, leading to girdle type fabrics. Due to the great variety of flow conditions prevailing in ice-sheets, the type of fabrics varies strongly from place to place.
This study focuses on the influence of the longitudinal (along the ridge) and transversal surface slopes at a ridge on the fabric profile. Assuming a simplified three-dimensional domain, anisotropic ice flow, fabric field and surface elevation are computed using the finite element code Elmer/Ice. Along the ridge direction, periodic boundary conditions are prescribed assuming an infinitely long ridge with constant slope, whereas the ridge itself is considered as a symmetry plane. The output flux on the fourth lateral boundary, parallel to the ridge, is prescribed. Various configurations of longitudinal over transversal surface slopes are explored by varying the value of this output flux, the surface accumulation and the ridge slope. With theses various slope configurations, the mean direction of the surface velocities varies from parallel to perpendicular to the ridge. Computed fabric profiles are compared to measured fabric profiles at different locations corresponding to various surface configurations, both in Antarctica and Greenland. The influence of the surface configuration coupled to the fabric evolution on the Raymond bumps below the ridge is discussed.