EGU22-3743, updated on 19 Aug 2022
https://doi.org/10.5194/egusphere-egu22-3743
EGU General Assembly 2022

Numerical modelling of ice stream fabrics: Implications for recrystallization processes and basal slip conditions

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Accurately predicting ice crystal fabrics is key to understanding the processes and deformation in ice-sheets. Here we use SpecCAF, a continuum fabric evolution model validated against laboratory experiments, to predict the fabric evolution with an active ice stream. This is done by predicting the fabrics at the East Greenland Ice core Project (EGRIP) site. We do this using satellite data and inferred particle paths, combined with the shallow ice approximation (with basal slip) to infer a leading order approximation for the deformation through the ice sheet. We find that SpecCAF is able to predict the patterns observed at EGRIP - a girdle/horizontal maxima fabric perpendicular to the flow direction. By reducing the rate of rotational recrystallization in the model we are also able to predict the fabric strength at EGRIP. This suggests the effect of rotational recrystallization on the fabric may be primarily strain-rate/stress dependent. These results show SpecCAF can be applied to real-world conditions and provide insights into the deformation and basal-conditions of the ice sheet. As the model only considers deformation and recrystallization through dislocation creep, the results imply that - for the ice stream modelled - no other process is significantly influencing both the produced ice fabric and the deformation. We find that the model gives best results for full slip at the base of the ice sheet, implying that the level of sliding at the base of the ice sheet in the North Greenland Ice stream may be very high. The methodology used here can be extended to other ice core locations in Greenland and Antarctica.