Towards a reliable, efficient model of how ice crystal orientations affect the flow of ice sheets

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Ice fabrics – the alignment of crystal orientations - can cause the ice viscosity to vary by an order of magnitude, consequently having a strong impact on the large-scale flow of ice sheets and glaciers. Because of this, there is a need for fabric models which are computationally efficient enough to be included in large-scale ice sheet models. We examine a range of existing models in this class and show they can be combined into a common equation which is a function of 2-3 parameters. The results reveal a very different set of parameters and physical assumptions to what is needed at laboratory strain rates. By comparing with observations from the Greenland ice sheet, we get the best model predictions by assuming the ice deforms close to the Sachs hypothesis – that all grains experience the same stress. As these fabric predictions also depend on the flow law used, we provide a test of competing anisotropic flow laws for the first time, making a step towards reliably incorporating the effect of fabric and viscous anisotropy in ice sheet flow models.