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Effects of nonlinear rheology and anisotropy on the relationship between age and depth at ice divides

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Through numerical modelling using a full-system Stokes thermomechanical model, we investigate the effects of nonlinear rheology and strain-induced anisotropy on the age versus depth relation at ice divides. We do this my comparing calculated depth profiles obtained using an isotropic flow law with depth profiles based on anisotropic flow models. Anisotropic flow models contain a number of rheological parameters that are currently rather poorly constrained by lab measurements. Values for model parameters and the set of possibly anisotropic models are therefore constrained by comparing modelling results with observations of ice flow and ice geometry around ice divides in Antarctica. We find that a number of qualitative aspects of the internal layering and surface geometry of ice divides can only be explained by including the effects of anisotropy on ice flow. Hence, realistically shaped ice-divides cannot be produced unless the effects of anisotropy are included. Furthermore, anisotropic flow profoundly affects the age distribution with depth and caution must be exercised when estimating age of ice from ice cores with an isotropic age-depth model or simple analytical approximation.