A viscoelastic flowline model applied to tidal forcing of Bindschadler Ice Stream, Antarctica

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The motion of Bindschadler Ice Stream, West Antarctica, is dominated by sliding over a weakly velocity-strengthening (nearly plastic) bed, according to analysis of kinematic GPS data with a new viscoelastic flowline model. Inversions of time-averaged velocity data with viscous ice-flow models can be consistent with multiple sliding laws, but propagation of velocity perturbations in a viscoelastic model can distinguish between sliding laws with different exponents. We develop such a model and apply it to a time series of velocity for the tidally modulated flow of Bindschadler Ice Stream (formerly Ice Stream D). Observed velocity perturbations are found to be consistent with a flow-law exponent $m \geq 8$, which indicates basal motion with a relatively weak till bed; lower exponents consistent with motion dominated by deformation within the ice over a hard or frozen bed are found to be unlikely. This result suggests that Bindschadler Ice Stream would respond rapidly to any future loss of buttressing from the Ross Ice Shelf.