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Long-term subglacial sliding patterns based on a sliding law with cavitation

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In ice-sheet models and glacial landscape evolution models, subglacial sliding rates are often related to basal shear stress by a power-law. However, the power-law relationship implies that the subglacial bed can provide unlimited levels of basal drag as sliding rates increases, which is recognized as an inadequate assumption, particularly when the effects of subglacial cavities are considered (Schoof 2005).

We have implemented a glacial sliding law suggested by Schoof (2005) in a depth-integrated higher-order ice-sheet model (Egholm et al. 2011) and coupled this to a model for glacial hydrology. The sliding law includes an upper bound to the basal drag and depends on the effects of longitudinal and transverse stress components for obtaining force balance along the glacier bed.

Computational experiments indicate that high annually averaged sliding rates concentrate along valley sides when basal melt-water pressures are relatively low, whereas fast sliding spreads to the valley bottoms when melt-water pressure increases. We couple equations for glacial sliding to a model for subglacial bedrock erosion and test the implications of the sliding law for long-term glacial landscape evolution.

References

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