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Stability of lubricated ice sheets. KATARZYNA N. KOWAL, M. GRAE WORSTER, Institute of Theoretical Geophysics, DAMTP, University of Cambridge — A significant amount of the Antarctic ice sheet drains towards the ocean through a network of ice streams, fast-flowing regions of ice that are generally well lubricated at their base by a layer of water-saturated, sub-glacial sediment known as till. Although till has a complex, nonlinear rheology, it deforms viscously over large spatial scales with an effective viscosity much lower than that of ice. Its dynamical interaction with the overlying ice can initiate a spontaneous instability of ice flow resulting in the formation of ice streams. We examine this interaction both mathematically and experimentally by considering the viscous coupling between two layers of fluid spreading under gravity. A series of our recent fluid-mechanical experiments reveal a novel cross-flow fingering instability if the lower layer is less viscous. We perform a linear stability analysis and explain the instability mechanism in terms of a jump in hydrostatic pressure gradient, stabilised by horizontal shear at large wave numbers, and assess the possibility of this mechanism leading to ice-stream formation.

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