Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Subglacial ice sheet lubrication KATARZYNA N. KOWAL, M. GRAE WORSTER, Institute of Theoretical Geophysics, DAMTP, University of Cambridge — Large-scale ice-sheet dynamics can be greatly affected by glacial slip, enhanced by subglacial meltwater and water-saturated sediment that acts as a lubricant at the ice-bed contact. Ice streams, for example, are generally lubricated by a layer of water and till at their base and slide up to two orders of magnitude faster than the surrounding ice, making them a major source of discharge of ice into the oceans despite them occupying a relatively small fraction of present-day ice sheets. We present a theoretical and experimental study in which we model the ice and the lubricant as two layers of fluid spreading under their own weight over a smooth, rigid, horizontal surface. The resulting flows are driven by buoyancy and viscous coupling between the layers. Although we are primarily interested in the case in which the underlying fluid has a much smaller viscosity than that of the overlying fluid, the applicability of our model extends to two-layer gravity currents with general viscosity ratios. There is excellent quantitative agreement between our theory and a series of laboratory experiments that we have conducted using simple, Newtonian fluids. A novel fingering instability develops at later stages of our experiments.

Katarzyna Kowal
Institute of Theoretical Geophysics, DAMTP, University of Cambridge

Date submitted: 24 Jul 2014 Electronic form version 1.4