
Ed Bueler
**Computing glacier geometry in nonlinear
complementarity problem form**

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The equations of glacier (and ice sheet) flow are those of a non-Newtonian Stokes flow. Efforts to compute the velocity from such problems, efficiently and at scale, are relatively well-known. But the fundamental nonlinearity associated to glacier geometry simulation and prediction in changing climates would apply even to linearly-viscous fluids! That is because the problem of predicting glacier thickness is subject to the constraint that thicknesses are nonnegative.

One may formulate this problem, of the simultaneous determination of the ice velocity and thickness in a potentially-glaciated region, given the bedrock elevation and the snowfall/melt rates as inputs, as a nonlinear complementarity problem (NCP) or variational inequality (VI). After combining several small improvements to existing structured-grid, shallow-ice methods, I will show how one can apply a reduced-space Newton solver to the NCP/VI. After examining performance in artificial set-ups, I will demonstrate the method as a fully-implicit, high-resolution determination of the geometry of the whole Greenland ice sheet in a steady climate.