

Modeling of glacial stagnation vs. glacial retreat

*David Vacco, Richard Alley, Todd Dupont, and Byron Parizek
Pennsylvania State University, State College PA*

Terminus response of glaciers and ice sheets to climate forcing can lead to stagnation or retreat, with implications for contribution to sea-level change and for effects on landforms. When the mass balance of a glacier becomes negative, it returns to equilibrium by losing mass either by retreating or stagnating. Glacial retreat is the process whereby the glacier loses mass as the terminus recedes up-valley, and the glacier remains whole. Stagnation occurs when a mass of ice in the ablation zone becomes detached from the main glacier during a negative mass-balance state. This modeling effort seeks to understand the parameters that control whether a glacier stagnates or retreats during a state of negative mass balance.

Results of a 1-d flowline model will be presented. This model is based on conservation of mass, where the glacier is driven only by vertical shear stress. We attempt to determine the extent that bed geometry controls glacial stagnation. For a suite of bed geometries (sinusoids), a steady state profile was established. The glacier terminus location was shown to have a weak dependence on the specific bed geometry. Glacier termini prefer to span a sinusoidal overdeepening as opposed to residing in the crest or trough. The steady-state profiles were subjected to a warming to start negative mass balance. The results show that bed geometry controls whether or not ice in the ablation zone can be pinched off from the main glacier, resulting in stagnation.

Future modeling efforts will explore the many parameters that control glacier flow. Specifically, experiments will be run to include flowline geometry, heterogeneous basal geology, subglacial water, longitudinal stresses, and dynamic bed-geometries. We anticipate that the results will yield insight into the physical mechanism of paleo- and modern glacial stagnation such that we better understand observations of modern glaciers, and the forcings that left stagnation deposits in the geologic record.