The Natural Variability of Glaciers

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Glaciers respond to both the natural variability that is intrinsic to a constant climate and also to the trends and shifts that constitute actual climate change. Over the last ten years a series of studies has shown, for a variety of climatic and glacier settings, that the standard deviation (1 sigma) of natural glacier-length fluctuations may range from 300 to 600 m. By definition of the standard deviation, a glacier will spend approximately 5% of its time outside $\pm 2\sigma$ (and 1% of its time outside of $\pm 3\sigma$). Thus, fluctuations of several kilometers can be expected to occur every few centuries, even without any climate change. Because these magnitudes rival those commonly interpreted as reflecting Holocene climate changes, it is vital to improve our understanding of these natural glacier fluctuations.

The physical basis for this behavior is presented. The magnitude and duration of natural glacier fluctuations depends straightforwardly on the geometry and average climate of the glacier setting, and the probability distribution of interannual climate variability. Such dependence can be demonstrated in a simple linear glacier model. The analyses are supplemented by detailed dynamical flowline modeling of glaciers around Mt. Baker in Washington State, and Franz Josef glacier in New Zealand.