Towards repeat-track elevation rate estimates using ICESat data

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Analysis of elevation differences between repeat-track ICESat elevation measurements has begun to produce a picture of elevation changes in the Siple Coast ice streams on an extraordinarily small scale. Rapid changes, with rates on the order of decimeters per year, can be detected by differencing raw ICESat elevations from the same reference track. However, because the ice streams have relatively rugged surface topography, with short-scale surface slopes on the order of a half-degree, small displacements between repeat tracks can lead to large errors in the apparent elevation differences. To measure subtle changes, it is important to model local surface slopes to take into account the effects of the repeat-track displacement.

In this talk I will describe a procedure for deriving elevation rates from repeat-track elevation differences. This procedure fits a plane to short segments of data from several cycles of ICESat data, and constrains the slope of the plane based on an analysis of the statistical properties of ice sheet surface textures

The elevation-rate estimates derived with this procedure are self-consistent to within about 7 cm/a; formal errors are of a similar magnitude. Analysis of the covariance between recovered surface slope and elevation rate allows the elevation-rate and slope estimates to be divided into three major categories: (1) Those in which the slope and elevation rate are both well constrained, (2) those in which the elevation rate is well constrained regardless of the slope, and (3) those in which slope errors prevent accurate estimates of the elevation rate. The majority of models based on 500 m segments of data fall into category (2), with category (3) making up a bare majority of the remainder. Although the prevalence of category (3) failures prevents mapping of elevation change everywhere in WAIS, improved processing of ICESat data and further data collection are expected to improve coverage over the next year.