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ICESat based elevation change estimates of Greenland's ice sheet

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Since 2003 the GLAS laser altimeter on board the ICESat satellite is measuring elevation of the Greenland ice sheet. Repeated observations between 2003 and 2007 can be used to estimate the rate of volume change of the Greenland ice sheet. We have developed a data processing strategy that exploits differences in observed elevations from repeated measurements at geometrically overlapping footprints. Over the total measurement period, a data set consisting of 1 000 000 elevation differences was obtained in this way.

Even after cleaning of this data set using quality flags defined by the GLAS science team, many unreasonably large elevation differences remain. We have investigated possible causes of these differences. A number of case studies are conducted to find an explanation for large systematic signals that seem unrelated to accumulation or ablation processes. In particular, it is shown and quantified how a non-zero surface slope in combination with non-perfectly overlapping footprints is causing a systematic bias in the derived elevation differences. The magnitude of this bias allowed us to suggest that it may have a non-negligible influence on the estimated volume change rates. Therefore an independent DEM was used in an attempt to compute the corresponding corrections.

Two alternative processing strategies are developed to compute the volume change rates over six drainage systems, further subdivided into a region above and below 2000 meter. The results show that only small biases of maximal $\sim$4 km^3/year are introduced in the estimates per region that average out in the estimate over the whole

of Greenland. With the corrections applied, the total volume change rate becomes -152 km^3/year. Locally the effect of such a slope effect is severe and can strongly influence physical interpretation.