

Thickness changes on Whillans and Kamb ice streams derived from airborne and spaceborne laser altimetry

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To map mass balance changes of major drainage basins over a relatively short period, ICESat is designed to measure surface elevation changes with an accuracy of 1.5 cm/year for spatial averages of measurements over areas of 100 km². To achieve this accuracy different post-launch calibration-validation (CV) approaches are used to identify and to remove the non-geophysical artifacts from the data products. As part of the CV effort detailed surface topography was mapped by NASA's Airborne Topographic Mapper (ATM) scanning laser over sites in Greenland, western US and the Dry Valleys in Antarctica. We used the detailed surface topography, derived from ATM data over the Dry Valleys, to verify the accuracy the ICESat products. ATM surveys were conducted over the Dry Valleys in December 2001 in collaboration with NSF and USGS. In addition to survey candidate calibration/validation sites for the ICESat mission, the campaign was going to support NSF projects and to provide data to evaluate the potential of the use of laser altimetry in the Antarctica. The survey resulted "blanket" coverage over several sites. We have developed a procedure using robust estimation techniques to remove the outlier observations and to interpolate the data into regular grids (DEMs). The ICESat elevation and waveform products were verified by comparing them with the DEMs and with simulated waveforms. Surface reflectivity, necessary for the waveform simulation, was derived from satellite imagery. The stable terrain of the site makes it ideal for serving as benchmark surface throughout the ICESat mission.

Ice sheet surface elevations, mapped by airborne laser altimetry surveys, may serve as baselines for the ICESat mission. Precise repeat laser altimetry survey was conducted by the Support Office of Aerogeophysical Research (SOAR, UTIG) in 1997/98 and 1999/2000 over portions of the van der Veen, Whillans and Kamb ice streams in West Antarctica. These ice streams are undergoing substantial changes in length, width, thickness and speed at decadal and shorter time scales. We combined ICESat measurements with the results of the SOAR airborne laser altimetry survey to study surface changes over the last five years. The spatial pattern of recent surface changes is consistent with earlier observations. However, areas on the Van der Veen and Whillans ice streams, where thinning was detected previously, are now very close to being in balance. The Kamb ice stream continues to build up with average thickening rates reaching 0.5 m/year. Our result provides a new evidence for the overall positive mass balance of the region suggested by recent studies. The SOAR survey detected thinning of almost 1 meter/year over the upstream part of Van der Veen and Whillans ice streams. ICESat measurements show significantly reduced thinning rates suggesting that these ice streams are closer to balance and maybe building up again. The Kamb ice stream continues to thicken almost uniformly at the surveyed area. The estimated error of the surface elevation rates measured by the SOAR survey is 0.15 m/year. We believe that ICESat achieves an elevation accuracy of 0.2 m or better in clear atmospheric conditions. Other errors, such as interpolation error and interannual variability are comparable or smaller.