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Ice Sheet Mapping Using Wide Swath Laser Altimetry

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Surface topographic information of ice surfaces is important for a wide range of applications including mass balance investigations and dynamical modeling. Airborne LIght Detection And Ranging (lidar) uses laser ranging to map surface topography with high precision and accuracy. In 2009 and 2010, NASA's Land, Vegetation and Ice Sensor (LVIS) system imaged areas of Greenland and Antarctica as part of NASA's Operation IceBridge (OIB) on board the P3-B and DC-8 aircrafts from 25,000' to 38,000'. The LVIS is an airborne, medium-footprint ($\sim$25 m diameter), wide swath ($\sim$2 km) full waveform-recording, scanning lidar system that has been used extensively for mapping surface structure. The system digitally records the shape of the returning laser echo, or waveform, after its interaction with the various reflecting surfaces of the earth, providing a true 3-dimensional record of the surface structure within each footprint in the data swath. During the Greenland deployments, LVIS lidar data swaths was collected along several thousand lineal kilometers of ICESat-1 tracks and along data grids in dynamic coastal areas. During the 2009 and 2010 Antarctica deployments, LVIS lidar data swaths were collected over the Antarctic Peninsula, Pine Island Glacier and around the 86S latitude (the southernmost extent of the ICESat-1 mission). We examine the LVIS lidar imaging data, in particular that collected in the Antarctic Peninsula where an 11 hour flight in 2009 enabled the complete mapping of a $\sim$250 km by $\sim$30 km area centered on the Crane Glacier. We present comparisons of the imaging lidar data to existing elevation maps from ASTER and SPOT5 to quantify surface changes within several mapped glacier systems, and the comparison of LVIS and ICESat data at the 86S parallel in order to investigate ICESat-1 intra-campaign biases. This mapping demonstrates the unprecedented spatial coverage and accuracy of the high-altitude lidar data becoming available for cryospheric investigations.