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Spaceborne laser altimetry from ICESat

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A new spaceborne geodetic tool was placed into a 600 km, near polar Earth orbit in January 2003. Although the laser altimeter carried on ICESat, known as the Geoscience Laser Altimeter System (GLAS), was designed to generate high accuracy profiles of the polar ice sheets to enable detection of surface change, many other applications of the instrument have been demonstrated, such as land topography, vegetation canopy height, hydrology and atmospheric characteristics. With a laser pulse repetition rate of 40 Hz and a 60 meter laser footprint on the surface, successive illuminated laser spots (footprints) are separated on the surface by 170 meters. The GLAS instrument has been shown to produce an altitude measurement of 2-3 cm precision, depending on the surface characteristics within the illuminated laser footprint. ICESat instrumentation enables determination of the direction of the laser pulse, which in turn supports the determination of the geodetic location of the laser footprint centroid (geodetic latitude, longitude and ellipsoidal height). A variety of tests have been applied to validate the accuracy of the resulting laser altimeter surface profiles. Current accuracy estimates of the laser footprint location are decimenter level in geodetic height and 15 meters in horizontal position (latitude/longitude). The agile satellite allows pointing the laser at targets of opportunity as well. With ongoing calibration/validation efforts these accuracies of the footprint location are expected to improve. With the current demonstrated accuracy, it is evident that the laser profiles can serve as geodetic control points for other instrumentation, such as SRTM-derived topography. In some areas, it is shown that the SRTM topography is offset by several meters with respect to the laser-derived profiles. Using a variety of global examples ranging from ice sheet, land topography, rivers, lakes and ocean, the high accuracy of the GLAS instrument will be illustrated.