

Comparison of Surface Elevation Changes of the Greenland and Antarctic Ice Sheets from Radar and Laser Altimetry

H. Jay Zwally, Anita C. Brenner, Kristine Barbieri, John P. DiMarzio, Jun Li, John Robbins, Jack L. Saba, and Donghui Yi

A primary purpose of satellite altimeter measurements is determination of the mass balances of the Greenland and Antarctic ice sheets and changes with time by measurement of changes in the surface elevations. Since the early 1990's, important measurements for this purpose have been made by radar altimeters on ERS-1 and 2, Envisat, and CryoSat and a laser altimeter on ICESat. One principal factor limiting direct comparisons between radar and laser measurements is the variable penetration depth of the radar signal and the corresponding location of the effective depth of the radar-measured elevation beneath the surface, in contrast to the laser-measured surface elevation. Although the radar penetration depth varies significantly both spatially and temporally, empirical corrections have been developed to account for this effect. Another limiting factor in direct comparisons is caused by differences in the size of the laser and radar footprints and their respective horizontal locations on the surface. Nevertheless, derived changes in elevation, dH/dt , and time-series of elevation, $H(t)$, have been shown to be comparable. For comparisons at different times, corrections for elevation changes caused by variations in the rate of firn compaction have also been developed. Comparisons between the $H(t)$ and the average dH/dt at some specific locations, such as the Vostok region of East Antarctic, show good agreement among results from ERS-1 and 2, Envisat, and ICESat. However, Greenland maps of dH/dt from Envisat and ICESat for the same time periods (2003-2008) show some areas of significant differences as well as areas of good agreement. Possible causes of residual differences are investigated and described.