ICE-SHEET SURFACE TOPOGRAPHY FROM
SEASAT RADAR ALTIMETRY
(Abstract only)

by

H. J. Zwally and R. Bindschadler,

(Goddard Laboratory for Atmospheric Sciences, NASA/Goddard Space Flight Center,
Greenbelt, Maryland 20771, U.S.A.)

R. H. Thomas

(OAO Corporation, 7500 Greenway Center Drive, Greenbelt, Maryland 20770, U.S.A.)

and Tom Martin

(EG and G Washington Analytical Services Center Inc., 6801 Kenilworth Avenue, Riverdale,
Maryland 20840, U.S.A.)

ABSTRACT

Greenland and Antarctic ice-sheet surface elevations have been obtained from Seasat radar altimeter data after computer retracking of the return waveforms. The height of the altimeter above the surface is determined from the measured time between transmission of radar pulses and their return. The altimeter servo-tracking circuit attempted to maintain the midpoint of the ramp of the return waveform in the center of 60 time gates, each equivalent to 0.47 m in range. Waveforms representing an average of 100 pulse returns were recorded each 0.1 s, corresponding to a distance interval of 662 m on the surface. Deviations of the midpoint of the waveform ramp from the central-gate position were caused by changes in range larger than the design limits of the servo-circuit, thereby producing errors in the height indicated by the altimeter. If the deviation was greater than about 25 gates (13 m range), the waveform ramp moved outside the time gates and the servo-tracking was temporarily interrupted. These larger deviations resulted in a loss of about 30% of the data over the ice sheets. Both surface undulations and the steeper slopes near the ice-sheet edge produced range velocities sufficient to cause interruption of altimeter tracking. Waveforms that remained within the 60 gates have been corrected by a computer curve-fitting procedure applied to each waveform.

Preliminary contour maps of surface elevation at 100 m contour intervals have been created for much of the East Antarctic ice sheet north of 72°S and the Greenland ice sheet south of 72°N. The standard deviation of the difference in elevation at 1 032 crossover points in the retracked Greenland elevation profiles is 1.9 m, which is largely due to radial errors in determination of the satellite position. Adjustment of the radial components of the orbits to minimize the crossover differences in select regions reduces the difference to 0.25 m, which is indicative of the optimum obtainable precision over the ice sheets. This precision is comparable to the value of 0.05 to 0.10 m obtained over the oceans where waveform averages of 1 s are used. The data are sufficiently dense to permit contouring at smaller intervals (2 to 10 m) only in the regions near the maximum latitudes of ±72°. Contouring at the smaller intervals illustrates the three dimensional characteristics of some of the observed undulations.

Several methods were tested for correcting slope-induced displacements, which are typical of reflection-range measurements using a wide-angle beam. The slope-induced displacement $h\alpha^2/2$ is about 40 m for a satellite altitude h of 800 km and a surface slope α of 10^{-2}. In a simulation experiment, an apparent surface profile was created by computer simulation of the altimeter measurement of an actual ice-surface profile and was then corrected for slope-induced displacement. The results show that the residual error between reconstructed and actual surfaces is about 15% of the displacement. Along the sub-satellite track the data are sufficiently dense to permit such correction for along-track slope-induced displacements caused by both undulations and regional slopes, but in the other dimension the data are generally only sufficient to permit across-track correction for regional slopes.