Geophysical Research Abstracts, Vol. 7, 10349, 2005
SRef-ID: 1607-7962/gra/EGU05-A-10349
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# ICESat Geolocation Accuracy Assessment and influence of Atmospheric Effects from Waveform Simulations of Within-footprint Structure

## 1 Claudia C. Carabajal (1) , D. J. Harding (2), S. B. Luthcke (1) , D. D. Rowlands (1), J.M.Sauber (2) and T.A.Williams (1)

1. **NASA/GSFC Space Geodesy Lab. , (2) NASA/GSFC Planetary Geodynamics Lab.**

**Claudia@bowie.gsfc.nasa.gov**

Laser altimetry waveforms measure within-footprint relief due to ground slope and roughness, structures and vegetation cover. In order to validate waveform-derived elevation parameters and footprint geolocation results, we have developed a grid-based waveform simulation capability to compare observed ICESat waveforms to synthetic waveforms produced from high resolution (1-5 m) Digital Elevation Models (DEMs). We simulate the instrument's response to complex topographic surfaces, including the laser far-field energy pattern, boresight field-of-view alignment, and detector impulse response. Comparison to synthetic waveforms derived from high-resolution airborne laser mapping data demonstrates that ICESat waveforms provide detailed and accurate information on the within-footprint distribution of surface heights. The location of maximum correlation between observed and computed waveforms provides a high-resolution assessment of geolocation accuracy on a footprint-by-footprint basis. Using DEMs produced from Airborne Topographic Mapper (ATM) data acquired in Greenland and Antarctica, and the best geolocation estimates for ICESat data obtained after applying corrections for long-period (orbital to seasonal) pointing biases, we apply this simulation capability to assess geolocation accuracy and ranging errors due to waveform distortion introduced by atmospheric forward scattering and saturation.