Characterizing ICESat-2's response to snow and ice surfaces; theory and experiment

Mahsa S. Moussavi[1,2], Waleed Abdalati[1,2], Ted Scambos[3], John A. Smith[1,4], Xinzhao Chu[1,4]

CIRES, University of Colorado at Boulder
Geography Department, University of Colorado at Boulder
National Snow and Ice Data Center (NSIDC)
Aerospace Engineering Sciences, University of Colorado at Boulder

NASAôs Ice, Cloud and Land Elevation Satellite-2 (ICESat-2), programmed to be launched late in this decade, is expected to extend the time series of ICESat observations to characterize the trend of change in the Greenland and Antarctic ice sheets, and the thickness characteristics of Arctic and Antarctic sea ice. Adopted by the current mission design, the instrument will be a high repetition rate (10 KHz), low energy (25-100 μJ), photon-counting multi-beam laser altimeter system. In order to assess the capability of the ICESat-2 to achieve its science objectives, several studies have been designed to model the expected performance of the ATLAS[1] instrument on-board ICESat-2. In this poster, a research plan is proposed to evaluate the ICESat-2ôs response to different terrestrial surfaces, most importantly those in Polar Regions. The objectives are to investigate the impacts of surface characteristics such as small to medium scale roughness and slope on laser echo pulses under different realistic measurement scenarios and to assess how optical properties of ice/snow including reflectivity and angular scattering distribution, affect the statistics of photon return from the surface. This is of great significance since one of the issues the original ICESat mission experienced was detector saturation due to the assumption of Lambertian scattering on the ice/snow surface. This resulted in many echo pulses exceeding the linear dynamic range of the GLAS[2] instrument and consequently saturation of the detector electronics. If not corrected, this could cause a significant bias in the elevation measurements. The study will encompass both theoretical simulations using radiative transfer models and laboratory measurements on laser light scattering off of the ice/snow covered surfaces. Simulations aid in exploring the relationship between the instrument configuration, the expected performance and the terrain characteristics. As a complimentary approach, Bidirectional Reflectance Distribution Function (BRDF) measurements of the ice surface will be conducted by simulating the photon-counting laser altimeter concept in the laboratory. Furthermore, the analysis of ATLAS-like data provided by the MABEL[3] instrument will be another component of this study to develop algorithms for surface tracking over the ice sheets. The results of this work will aid in developing data processing and analysis methods for future ICESat-2 measurements in order to maximize its application to its science objectives.

[1] Advanced Topographic Laser Altimeter System
[2] Geoscience Laser Altimeter System
[3] Multiple Altimeter Beam Experimental Lidar