Performance Considerations for the SIMPL Single Photon, Polarimetric, Two-color Laser Altimeter as applied to Measurements of Forest Canopy Structure and Composition

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Abstract

The Slope Imaging Multi-polarization Photon-counting Lidar (SIMPL) is a multi-beam, micropulse airborne laser altimeter that acquires active and passive polarimetric optical remote sensing measurements at visible and near-infrared wavelengths. SIMPL was developed to demonstrate advanced measurement approaches of potential benefit for improved, more efficient spaceflight laser altimeter missions. SIMPL data have been acquired for wide diversity of forest types in the summers of 2010 and 2011 in order to assess the potential of its novel capabilities for characterization of vegetation structure and composition. On each of its four beams SIMPL provides highly-resolved measurements of forest canopy structure by detecting single-photons with 15 cm ranging precision using a narrow-beam system operating at a laser repetition rate of 11 kHz. Associated with that ranging data SIMPL provides eight amplitude parameters per beam unlike the single amplitude provided by typical laser altimeters. Those eight parameters are received energy that is parallel and perpendicular to that of the plane-polarized transmit pulse at 532 nm (green) and 1064 nm (near IR), for both the active laser backscatter retro-reflectance and the passive solar bi-directional reflectance.

This poster presentation will cover the instrument architecture and highlight the performance of the SIMPL instrument with examples taken from measurements for several sites with distinct canopy structures and compositions. Specific performance areas such as probability of detection, after pulsing, and dead time, will be highlighted and addressed, along with examples of their impact on the measurements and how they limit the ability to accurately model and recover the canopy properties. To assess the sensitivity of SIMPL's measurements to canopy properties an instrument model has been implemented in the FLIGHT radiative transfer code, based on Monte Carlo simulation of photon transport (North 1996, North *et al* 2010). SIMPL data collected in 2010 over the Smithsonian Environmental Research Center, MD are currently being

modelled and compared to other remote sensing and in situ data sets. Results on the adaptation of FLIGHT to model micropulse, single-photon ranging measurements are presented elsewhere at this conference.

NASA's ICESat-2 spaceflight mission, scheduled for launch in 2016, will utilize a multi-beam, micropulse, single-photon ranging measurement approach (although non-polarimetric and only at 532 nm). Insights gained from the analysis and modelling of SIMPL data will help guide preparations for that mission, including development of calibration/validation plans and algorithms for the estimation of forest biophysical parameters.

References

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