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TITLE: Retrieving Leaf Area Index and Foliage Profiles Through Voxelized 3-D Forest Reconstruction Using Terrestrial Full-Waveform and Dual-Wavelength Echidna® Lidars

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ABSTRACT BODY: Measuring and monitoring canopy biophysical parameters provide a baseline for carbon flux studies related to deforestation and disturbance in forest ecosystems. Terrestrial full-waveform lidar systems, such as the Echidna® Validation Instrument (EVI) and its successor Dual-Wavelength Echidna® Lidar (DWEL), offer rapid, accurate, and automated characterization of forest structure. In this study, we apply a methodology based on voxelized 3-D forest reconstructions built from EVI and DWEL scans to directly estimate two important biophysical parameters: Leaf Area Index (LAI) and foliage profile.

Gap probability, apparent reflectance, and volume associated with the laser pulse footprint at the observed range are assigned to the foliage scattering events in the reconstructed point cloud. Leaf angle distribution is accommodated with a simple model based on gap probability with zenith angle as observed in individual scans of the stand. The DWEL instrument, which emits simultaneous laser pulses at 1064 nm and 1548 nm wavelengths, provides a better capability to separate trunk and branch hits from foliage hits due to water absorption by leaf cellular contents at 1548 nm band.

We generate voxel datasets of foliage points using a classification methodology solely based on pulse shape for scans collected by EVI and with pulse shape and band ratio for scans collected by DWEL. We then compare the LAIs and foliage profiles retrieved from the voxel datasets of the two instruments at the same red fir site in Sierra National Forest, CA, with each other and with observations from airborne and field measurements. This study further tests the voxelization methodology in obtaining LAI and foliage profiles that are largely free of clumping effects and returns from woody materials in the canopy. These retrievals can provide a valuable “ground-truth” validation data source for large-footprint spaceborne or airborne lidar systems retrievals.

KEYWORDS: 0428 BIOGEOSCIENCES Carbon cycling, 0480 BIOGEOSCIENCES Remote sensing, 0452 BIOGEOSCIENCES Instruments and techniques.

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