Fusion of Multi-sensor Data for Forest Structural Parameter Retrieval Using 3D Radiative Transfer Modeling

Sun, G., guoqing.sun@nasa.gov, Department of Geography, University of Maryland, College park, MD 20742, United States
Rubio, J., jrubio@umd.edu, Department of Geography, University of Maryland, College park, MD 20742, United States
Ranson, K. J., kenneth.j.ranson@nasa.gov, Biospheric Sciences Branch, NASA, Goddard Space Flight Center, Greenbelt, MD 20771, United States
Kimes, D., Daniel.Kimes@nasa.gov, Biospheric Sciences Branch, NASA, Goddard Space Flight Center, Greenbelt, MD 20771, United States
Koetz, B., bkoetz@geo.unizh.ch, Remote Sensing Laboratories (RSL), Department of Geography, University of Zurich, Zurich, CH-8057, Switzerland
Gastellu-Etchegorry, J., gastellu@cesbio.cnes.fr, Centre d'Etude Spatiale de la Biosphere (CESBIO), Universite Paul Sabatier, 18 Av. Edouard Belin, Toulouse, 31401, France

ABSTRACT

The multi-angle/multi-spectral data provided by imaging spectrometers, backscattering coefficient data from imaging radar, and the waveform from large-footprint laser altimeter (or lidar) are now available for vegetation studies. Data from these sensors contain information relevant to different aspects of the biochemical and biophysical properties of the vegetation canopy. By combined use of these capabilities, the potential and accuracy of extracting forest structural information using remote sensing technology will be significantly improved. A simultaneous exploitation of the information dimensions observed by these sensors based on radiative transfer modeling will optimize the retrieval of forest biophysical parameters and the canopy structure.

This study relies on radiative transfer models (RTM) (imaging spectrometer reflectance, radar backscatter and lidar waveform models) based on the same 3D canopy structure. These models have been validated, and employed in developing algorithms for retrieving forest properties from remote sensing data separately (Gastellu-Etchegorry and Gascon, 2004; Sun and Ranson, 1995; 2000). As these models are based on the same basic physical concept and share common input parameters, an interface between these models was established, which allowed for the generation of a Look Up Table (LUT) consisting of the simulated signatures of these sensors. The realistic natural forest stands from the forest growth model (ZELIG) (Urban 1990) simulations were used as input to these models to generate the look-up table. The invertibility of the RTM was investigated for every sensor and model separately and then for various combinations of the sensors. The forest canopy parameters considered in the inversion include tree height, fractional crown cover, LAI, and above-ground biomass. The remote sensing data simulated from models include data from multi-angle sensor CHRIS, L-band radar (ALOS PALSAR), and airborne laser vegetation imaging system (LVIS).

First, the simulated sensors signatures of additional forest stands not included in the look-up table were used to test the inversion of forest parameters using the look-up table. Several levels of noises were introduced into the simulated signature, and the results were evaluated. The preliminary results from CHRIS/LVIS and LVIS/PALSAR data inversions showed promising effects in accuracy improvement.

Second, the look-up table was calibrated before it was used for inversion using real CHRIS, LVIS and PALSAR data. In a 200m by 150m stem map in our study area, the position, species, dbh were measured for every tree. The heights and crown dimensions of several hundreds of trees were also measured for developing relations for estimation of height, crown length and width from dbh. These data were used as inputs to RTM models and the simulated signatures were compared with real CHRIS, LVIS and PALSAR data. The biases from model simulations were quantified and considered in inversion procedures using real data.

Finally, the CHRIS, LVIS and PALSAR data of the stem map (twelve 50m pixels), and 20 sampled stands will be used to test the inversion procedures. The results will be presented in the paper.

Reference

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