LIDAR MODELING WITH THE DART 3D MODEL

J. Rubio[1,2], E. Grau[1], J.P. Gastellu-Etchegorry[1], G. Sun[2], K.J. Ranson[3]

[1]Centre d'Etude Spatiale de la Biosphere (CESBIO), 18 Av. Edouard Belin, Toulouse, 31401, France.
[2]Department of Geography, University of Maryland, College park, MD 20742, United States.
[3]Biospheric Sciences Branch, NASA/Goddard Space Flight Center, Greenbelt, Md. 20771.

A new lidar waveform module is introduced in the optical-thermal model DART (Discrete Anisotropic Radiative Transfer), a 3D radiative transfer model in the optical and thermal domains [1] . It takes advantage of the DART's detailed representation of the landscape that can be natural and urban, with the possibility to include atmosphere and topography. It relies on a Monte Carlo Ray tracing approach that was previously used for checking the accuracy of the iterative ray tracing approach of DART. A major point is that it inherits major features of the DART model, i. e. the possibility to combine different vegetation species, etc. It permits to calculate the resulting lidar waveform, using 1st order of scattering or including multiple scattering. It is suited for both small and large footprints with an emphasis on large footprint lidar.

For validation of the DART lidar model, comparisons took place with the 3D lidar waveform model of Sun and Ranson [2] . Due to the flexibility of the DART model, the two lidar models can share common input parameters. Moreover, they are based on the same physical principles. Then, the potential of the models were further assessed using LVIS (Laser Vegetation Imaging Sensor) [3] data acquired in the northern experimental forest in 2003 (Howland, Maine, USA). The two lidar waveform models were used to simulate the 89 LVIS shots comprised within an area of 150 by 200 meters where a stem map had been established. The stem map provided the location, specie, dbh (diameter at breast height) and crown dimensions for 7989 trees with a dbh of above 3 cm. A comparison at the level of the waveform is shown in Fig. (1). The comparison at the level of the single waveform gives us the possibility to better understand the factors (structure parameters, optical properties of forest elements, soil condition, geolocation of the waveform, footprint size …) that influence the shape and the ratios (canopy/ground) of the LVIS lidar waveform. The large difference between LVIS waveform and simulated waveforms at location (b) may be a result of incorrect surface reflectance used in the model. Preliminary results show that the DART lidar modeling gave similar multiple scattering as shown in LVIS waveform. Finally, the DART lidar model is used for investigating the importance of multiple scattering within canopy and between the ground and canopy. The results will be presented in the paper.

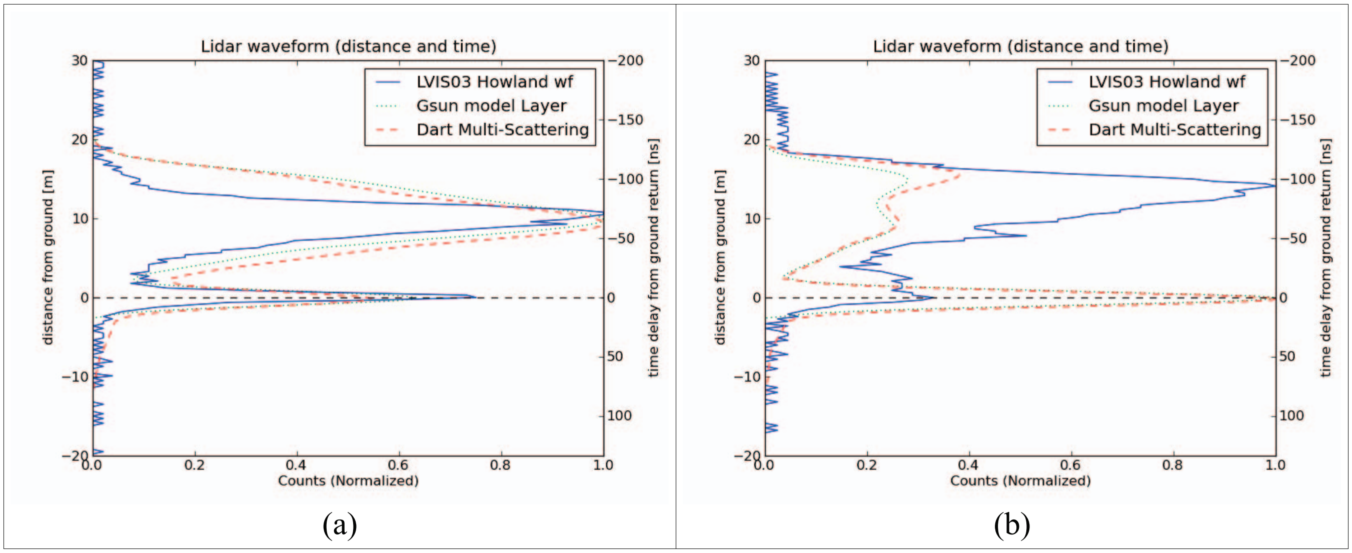

Fig. 1. Comparisons of waveforms at two different locations in the Howland stem map. (a) Ratio of ground return to canopy return is similar between the 3 waveforms at location (a). (b) Waveforms are significantly different at location (b). The solid purple lines are LVIS waveform after the mean noise was removed. d\Dotted green lines are the waveforms at the same location simulated using Sun's Lidar waveform model. The dashed red lines are the waveforms from the DART lidar waveform model.

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