Effects of Forest Disturbances on Forest Structural Parameters Retrieval from Lidar Waveform Data

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Large-footprint lidar system [1], have been developed to provide high-resolution, geo-located measurements of vegetation vertical structure and ground elevations beneath dense canopies. Over the past decade, several airborne and space-borne large-footprint lidar systems have been used to make measurements of vegetation. The lidar waveform signature from large-footprint lidar instruments, such as the Laser Vegetation Imaging Sensor (LVIS) [1] has been successfully used to estimate the tree height and forest above-ground biomass [2-6]. The relationship between forest carbon storage and the vertical structure from Lidar waveform is relatively unexplored. Further studies on the data properties (e.g. the effects of multiple scattering and ground slope on lidar signatures) are needed to verify and improve the retrieval algorithms.

One of the objectives of NASA DESDynI (Deformation, Ecosystem Structure and Dynamics of Ice) Mission is to characterize terrestrial ecosystems with respect to biomass, biodiversity, and disturbance/change through time. Forest degradation, which was defined by the UNFCCC (COP-13) as any forest that has experienced a loss, is an important aspect of forest disturbance. DESDynI, utilizes both lidar and radar to characterize forest 3-D structure to provide accurate estimates of the changes in biomass which is important for monitoring forest degradation. Other forest structural parameters may also be useful and can be mapped for monitoring forest degradation/disturbances.

The forests in the Howland, Maine area consist of undisturbed near-mature forest, and forests with early clear cuts, strip cuts, and recent selective cuts (see Fig. 1). These forest management approaches reduce the biomass, and have different effects on canopy heights. For example, selective harvesting may remove a significant proportion of the biomass without drastically changing height. The effects of this on the lidar waveforms must be understood. In this study, a lidar waveform model will be used to simulate the effects of various forest management practices on the lidar waveform. Fig. 2 shows the lidar waveforms of stands after disturbances simulated using a 3D lidar waveform model [7]. LVIS, UAVSAR, and field measurements will be used to investigate the characteristics of lidar waveforms, identify the significant changes of the waveform, and correlate these changes with the forest structural changes. We will investigate the changes of the prediction models for retrieving canopy height and biomass from lidar waveform due to the changes of forest spatial structure. The results from this study will provide insight and protocols for monitoring forest degradation from lidar waveform data.

References

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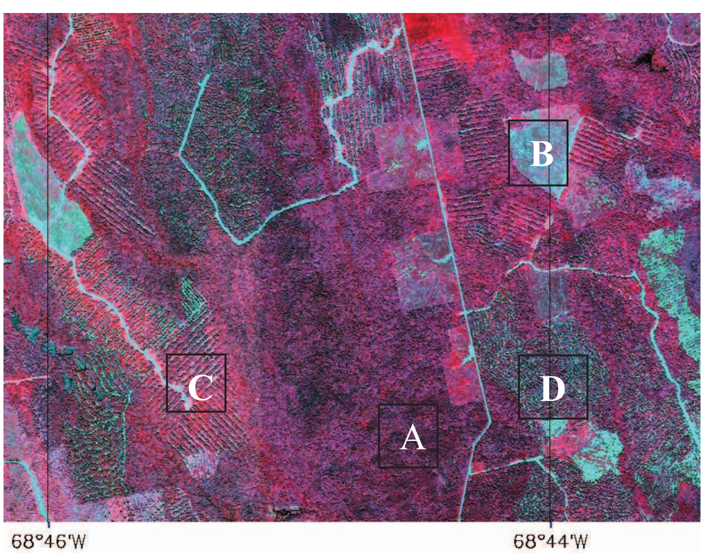

Fig. 1. IKONOS image showing undisturbed forests (A) and those with the clear cut (B), strip cut (C) and selective cut (D).

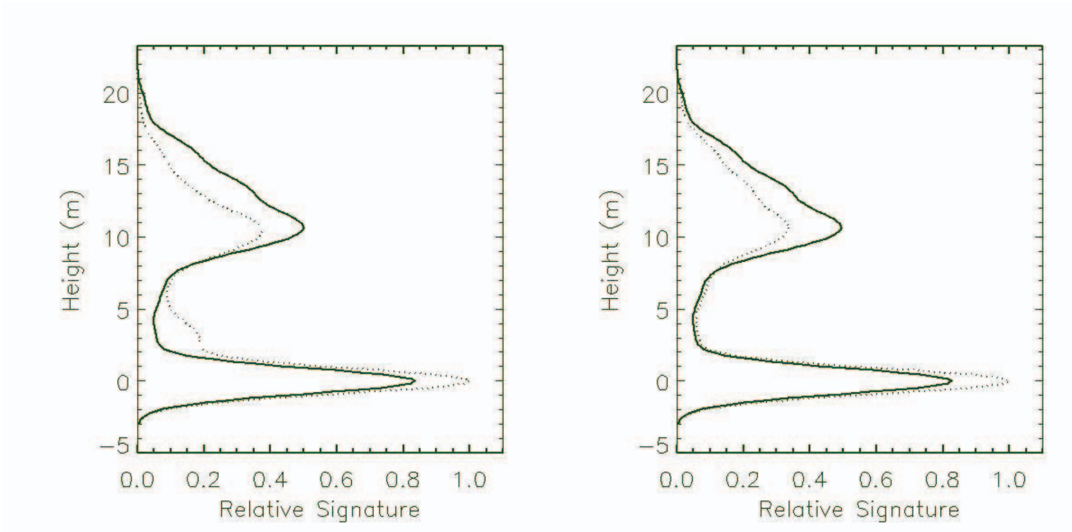

Fig. 2. The solid lines shown in these two figures are waveform of un-disturbed stand, while the dash line in graph at left is the waveform after strip cut happened 10 years ago, and the dash line in the figure at right is the waveform after select cut.