

# **Development of Vegetation Structure Inputs From ICESat, SRTM and MODIS Satellite Data for a Mixed Canopy Dynamic Global Terrestrial Ecosystem Model**

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## **State of the Problem**

Lidar remote sensing provides measurements of horizontal and vertical vegetation structure of ecosystems which will be critical for estimating global carbon storage and assessing ecosystem response to climate change and natural and anthropogenic disturbances. However, no consistent approach currently exists to derive the lidar based vegetation structure information required by terrestrial ecosystem models. Further, when available, this information has rarely been incorporated into ecosystem models. This goal of this study is to derive vegetation structure from the ICESat (Ice Cloud and Land Elevation Satellite) and Shuttle Radar Topography Mission (SRTM) data and generate structure datasets compatible with the Ent Dynamic Global Terrestrial Ecosystem Model (DGTEM) constrained by MODIS land cover for improved estimates of terrestrial carbon stocks and fluxes.

## **Methodology**

We developed a physical approach to derive accurate vegetation structure including height and foliage profile from archived ICESat and National Elevation Data (NED, US only) or SRTM, (globally) slope data for Ent Dynamic Global Terrestrial Ecosystem Model (DGTEM) constrained by MODIS land cover. We will present the methodology, the comparison results of ICESat footprint level vegetation height with airborne lidar data. We will also show the use of ICESat fullwaveforms for photosynthesis/conductance estimation by comparing ICESat-based Photosynthetic Active Radiation profiles absorbed by green vegetation with field measurements in different vegetation biomes.

We used the physical approach described in Yang et al. (2010) to remove the slope effect from ICESat waveform extent to retrieve vegetation height. We will present some of preliminary evaluation results by comparing ICESat vegetation height data using our

approach with airborne small-footprint and large footprint Lidar Vegetation Imaging Sensing (LVIS) collected in White Mountain National Forest, NH, USA (see Figure 1). Currently this scheme is being evaluated using airborne lidar and field data collected conifer forest of Sierra Nevada, CA, USA.

We are using an analytical foliage-clumped radiative transfer scheme based on the Geometric Optical Radiative Transfer (GORT) theory (Ni-Meister et al., 2010 and Yang et al., 2010) to develop an analytical scheme to transfer the nadir-pointing ICESat lidar waveforms to vertical foliage profiles and then to the profiles of Photosynthetic Active Radiation (APAR) absorbed by green vegetation from different incident angles. This scheme is being evaluated using in deciduous forests of Morgan-Monroe State Forests (MMSF), IN and Harvard Forests, MA and boreal conifer forests in central Canada.

Ent-DGTEM structure inputs within each Ent cell include patches and cohorts within each patch. A patch refers to a mixture of cohorts of different Plant Function Types (PFTs). MODIS land cover could provide rough estimate of patches (Figure 2). Cohorts will be estimated by statistical analysis of ICESat height data (Figure 3). Canopy radiative transfer and photosynthesis/conductance modules are run for each cohort. ICESat foliage profiles are used to define the canopy photosynthetic radiation profile for each cohort. We will present a map of Ent patches and cohorts and PAR profiles for each Ent grid in New England.

### **Central Conclusions**

This study presents a physical approach to derive vegetation height and vertical PAR profiles absorbed by vegetation using ICESat and SRTM and MODIS data. Vegetation height derived from ICESat waveform data were compared well with airborne LVIS data and the vertical PAR absorption profiles were compared well field data in different forest biomes. Fusion of ICESat and MODIS data provides Ent structure inputs for each Ent model grid. Future work will continue to expand our method to large regions and use these vegetation structure inputs to drive Ent-DGVM to evaluate the improvement of carbon stock and fluxes estimation.

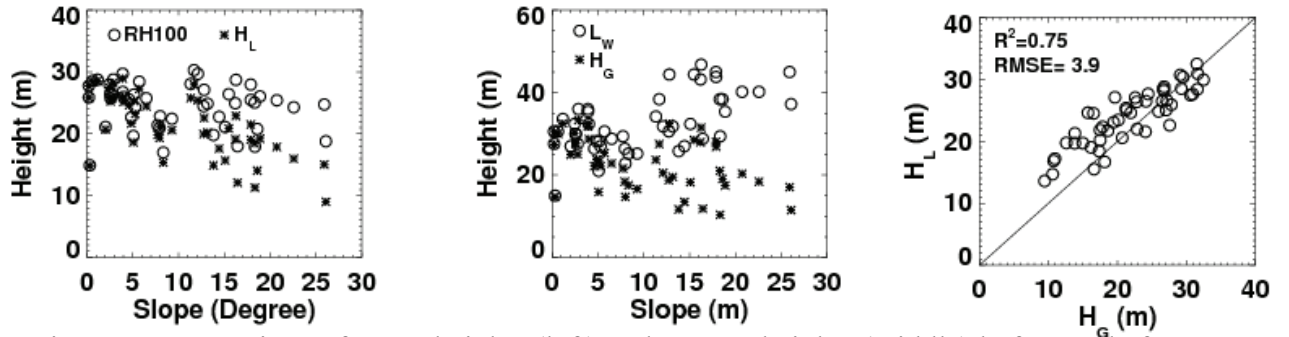


Figure 1. Comparison of LVIS heights (left) and ICESat heights (middle) before and after slope correction and between ICESat and LVIS vegetation heights after slope correction in southern White Mountain Nantion Forest, NH.

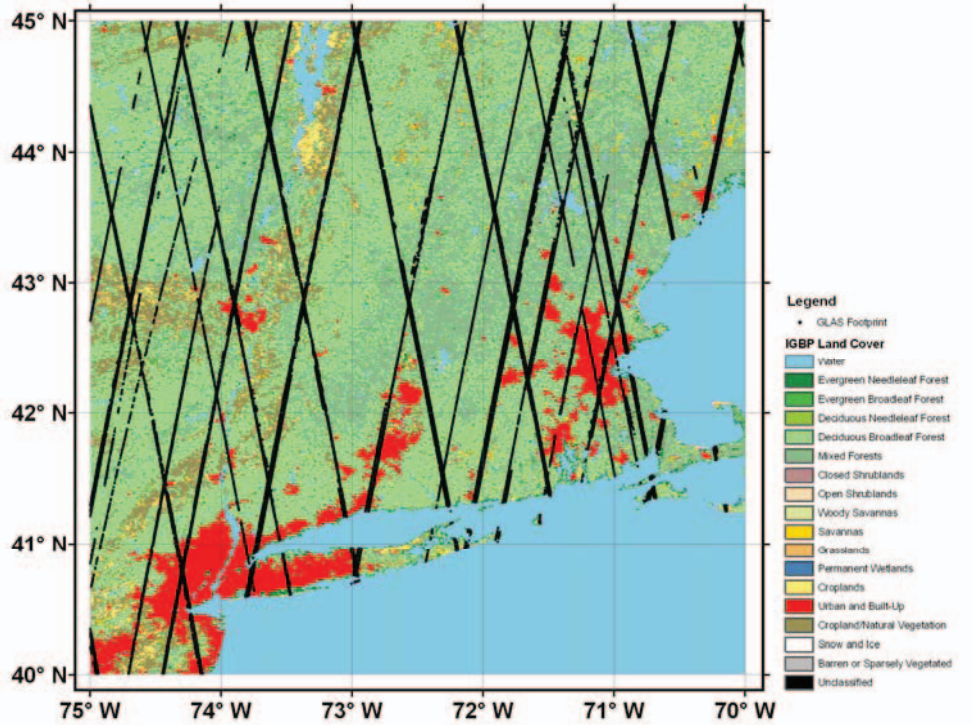


Figure 2. MODIS 1km land cover map overlaid with ICESat paths in New England.

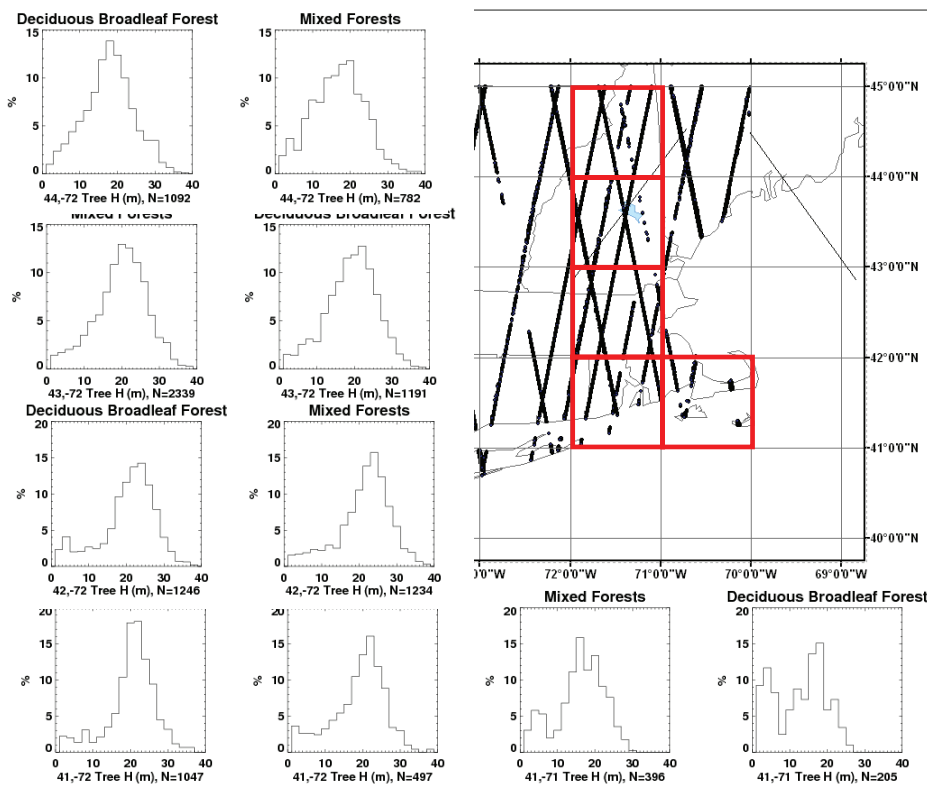


Figure 3. ICESat vegetation height histogram for first two dominant MODIS land cover types within 1x1 degree grids in New England.

## References

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