CMS: Aboveground Biomass from Penobscot Experimental Forest, Maine, 2012

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Documentation Revision Date: 2016-05-05

Data Set Version: V1

Summary

This data set includes estimates of aboveground biomass (AGB) in 2012 from the Penobscot Experimental Forest (PEF) in Bradley, Maine. The AGB was modeled using LiDAR data gathered with the LiDAR Hyperspectral & Thermal Imager (G-LiHT) operated by Goddard Space Flight Center and field inventory data from 604 permanent Forest Inventory and Analysis (FIA) plots within the PEF. The estimates were produced through a novel modeling approach that accommodates temporal misalignment between field measurements and remotely sensed data by including multiple time-indexed measurements at plot locations to estimate changes in AGB.

The PEF has been closely monitored since the 1950s, providing a large inventory of calibration data for fitting AGB models using LiDAR. It contains 50 management units that are subjected to different silvicultural treatments, e.g., unregulated harvest, shelterwood, diameter limit cutting, or natural regeneration.

The data are provided at 13 meter resolution as a single GeoTIFF (.tif) with two bands corresponding to 2012 AGB estimates and the 95% confidence interval, respectively.

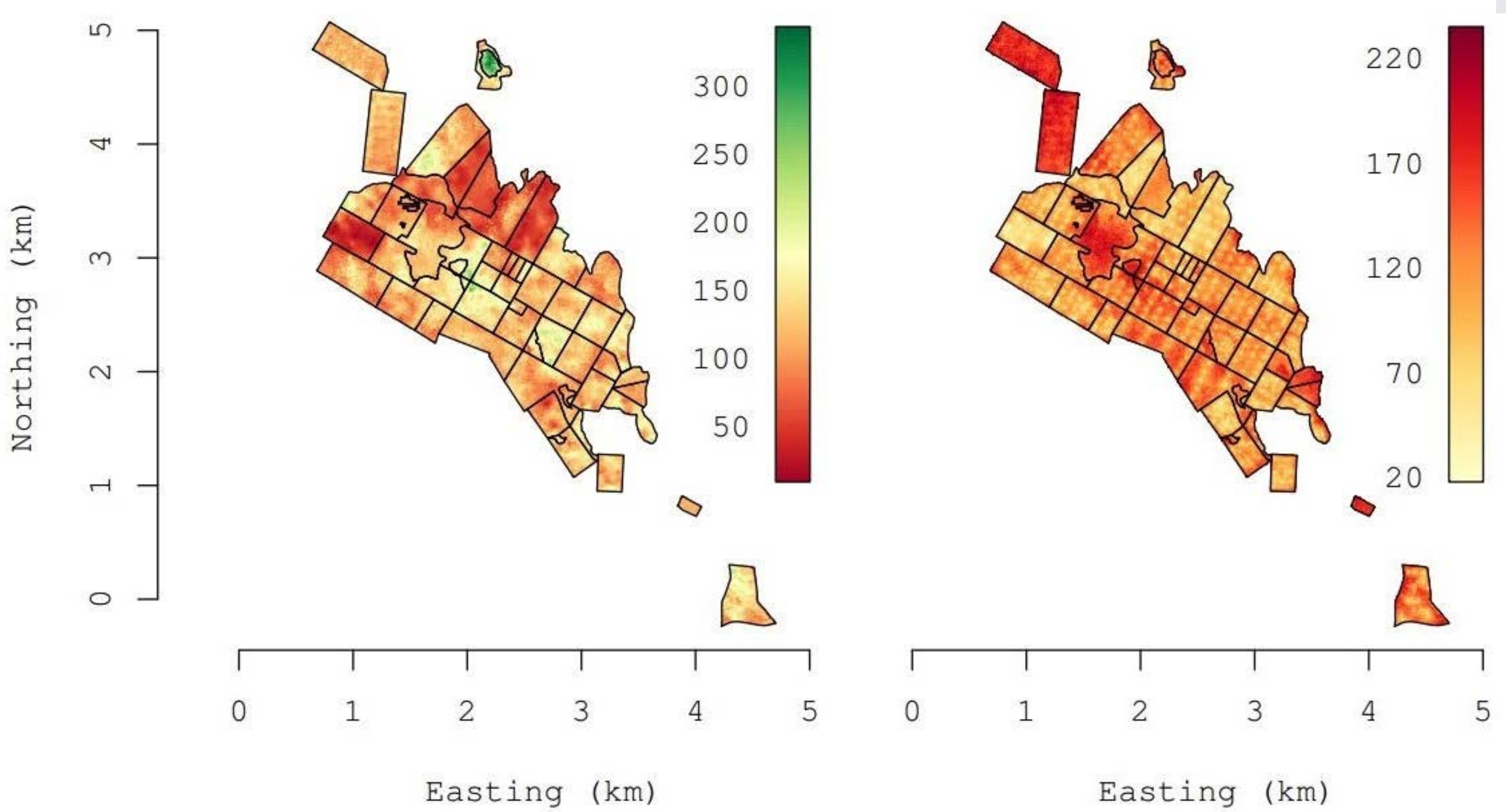

Figure 1. Predicted 2012 AGB (left) and associated 95% credible interval width (right) in Mg/ha for the PEF (from Babcock et al. 2016).

Citation

Babcock, C., A.O. Finley, B.D. Cook, A. Weiskittel, and C.W. Woodall. 2016. CMS: Aboveground Biomass from Penobscot Experimental Forest, Maine, 2012. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1318

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1. Data Set Overview

Project: Carbon Monitoring System (CMS)

This data set includes estimates of aboveground biomass (AGB) in 2012 from the Penobscot Experimental Forest (PEF) in Bradley, Maine. The AGB was modeled using LiDAR data gathered with the LiDAR Hyperspectral & Thermal Imager (G-LiHT) operated by Goddard Space Flight Center and field inventory data from 604 permanent Forest Inventory and Analysis (FIA; Smith, 2002) plots within the PEF. The estimates were produced through a novel modeling approach that accommodates temporal misalignment between field measurements and remotely sensed data by including multiple time-indexed measurements at plot locations to estimate changes in AGB.

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The NASA Carbon Monitoring System (CMS) is designed to make significant contributions in characterizing, quantifying, understanding, and predicting the evolution of global carbon sources and sinks through improved monitoring of carbon stocks and fluxes. The System will use the full range of NASA satellite observations and modeling/analysis capabilities to establish the accuracy, quantitative uncertainties, and utility of products for supporting national and international policy, regulatory, and management activities. CMS will maintain a global emphasis while providing finer scale regional information, utilizing space-based and surface-based data and will rapidly initiate generation and distribution of products both for user evaluation and to inform near-term policy development and planning.

Related Data: LiDAR data sets from the 2012 G-LiHT airborne campaign over Penobscot Experimental Forest in Bradley, Maine can be accessed through the G-LiHT Data Center Webmap: http://gliht.gsfc.nasa.gov/

2. Data Characteristics

Spatial Coverage: Selected areas in the Penobscot Experimental Forest, Bradley, Maine.

Spatial Resolution: 13 meter

Temporal Resolution: Data represents modeled aboveground biomass for the year of 2012.

Temporal Coverage: The data cover the period 2012-01-01 to 2012-12-31.

Spatial Extent:

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Penobscot Experimental Forest, Bradley, Maine	-68.6443	-68.5862	44.8726	44.8269

Data File Information:

PEF_predicted_AGB.tif

Band1: Predicted AGB in Mg per hectare

Band2: 95% confidence interval in Mg per hectare

Spatial Data Properties:

Spatial Representation Type: Raster
Pixel Depth: 32 bit
Pixel Type: Float

Number of Bands: 2
Raster Format: GeoTIFF
Source Type: continuous

NoData Value: -9999
Number Columns: 312
Column Resolution: 13 meter
Number Rows: 408
Row Resolution: 13 meter

Extent in the items coordinate system
North: 4969037.5
South: 4963733.5
West: 528042.5
East: 532098.5

Spatial Reference Properties:

Projection: UTM Zone 19N
False_Easting: 500000
False_Northing: 0
Central_Meridian: -69
Scale_Factor: 0.9996
Latitude_Of_Origin: 0
Linear Unit: Meter

Geographic Coordinate System: GCS_WGS_1984
Datum: D_WGS_1984
Prime Meridian: Greenwich
Angular Unit: Degree

3. Application and Derivation

This data set was used to evaluate the performance of a novel approach to modeling AGB and AGB growth that accounts for temporal misalignment of field measurements and remotely sensed data. The results suggest that future large scale AGB models informed using remotely sensed data, such as LiDAR, may be improved by incorporating multiple time-indexed measurements at plot locations distributed throughout the area of observation. This data set may help researchers implement the novel modeling framework presented in the paper by Babcock et al. (2016).

High resolution maps of AGB like the one included in this data set can be used to calculate spatially explicit estimates of AGB change and inform conclusions regarding carbon sink or source status with associated uncertainty.

4. Quality Assessment

The modeled AGB estimates included in this data set were compared with estimates from two benchmark models to validate the proposed time-incorporated model framework. The test model was found to outperform the benchmark models in predictive performance as indicated by a substantial reduction in root mean squared error for modeled AGB.

5. Data Acquisition, Materials, and Methods

Aboveground biomass estimates for the Penobscot Experimental Forest (PEF) were modeled through a novel approach coupling spatially-explicit, long-term forest inventory and a high resolution LiDAR data set. Model calibration used 2203 field measurements from 604 FIA (Smith, 2002) permanent sample plots (PSPs; Figure 2). Thirty-three measurements from 2012 were set aside for model validation. Only PSPs with post-harvest measurements taken between 1999 and 2011 were included. Diameter at breast height was measured from a sample of trees within each PSP and the measurements were used to calculate species specific estimates of AGB using allometric equations provided by Jenkins et al. (2003).

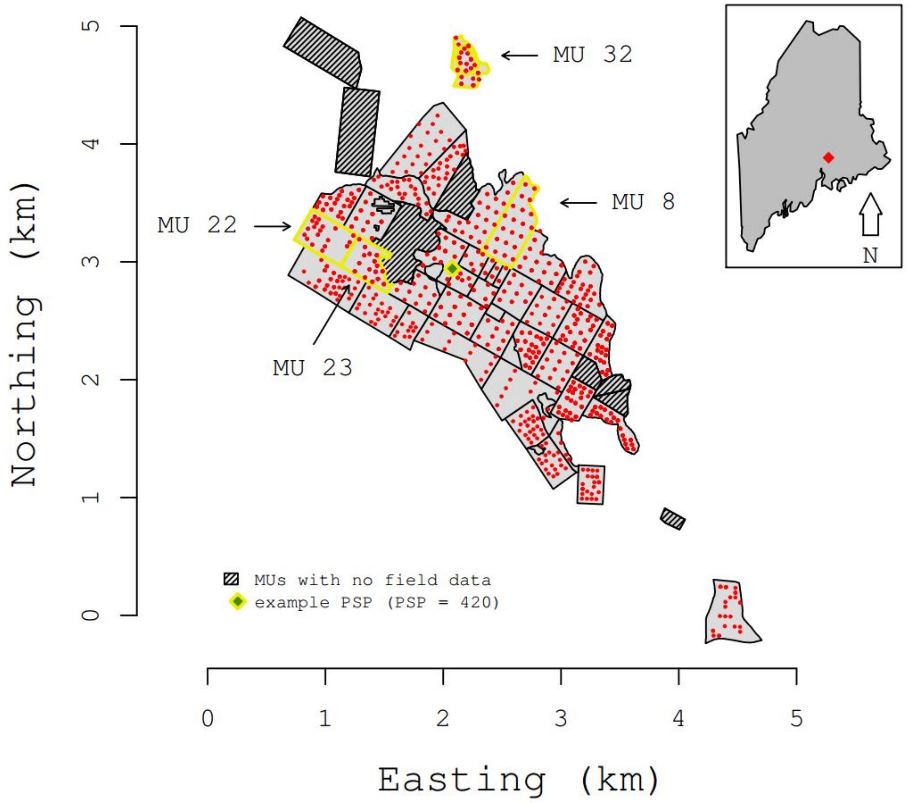

Figure 2. Map of Penobscot Experimental Forest (PEF). Permanent sample plots are highlighted in red. Black polygon boundaires outline different management units (MUs) on the PEF. Hashed out polygons identify MUs with no inventory data. Select MUs are labeled and highlighted in yellow. MU 8 and MU 22 were clear cut in 1984 and 1989, respectively. MU 32 is an old-growth stand that has experienced very limited management activity since 1954. MU 23 is a stand undergoing a three-stage shelterwood harvesting technique. The inset map in the upper right corner shows the location of the PEF with respect to Maine.

The LiDAR data was collected for the PEF in 2012 using the LiDAR, Hyperspectral & Thermal Imager (G-LiHT) operated by the Goddard Space Flight Center (Cook et al., 2013). Pseudo-waveforms were created over the PEF's 604 PSPs by aggregating G-LiHT LiDAR returns and weighting return heights using a Gaussian shaped 25 meter diameter footprint (Blair & Hofton, 1999). The pseudo-waveforms were then used to calculate percentile heights at 5% intervals between 5% and 100% (Figure 3).

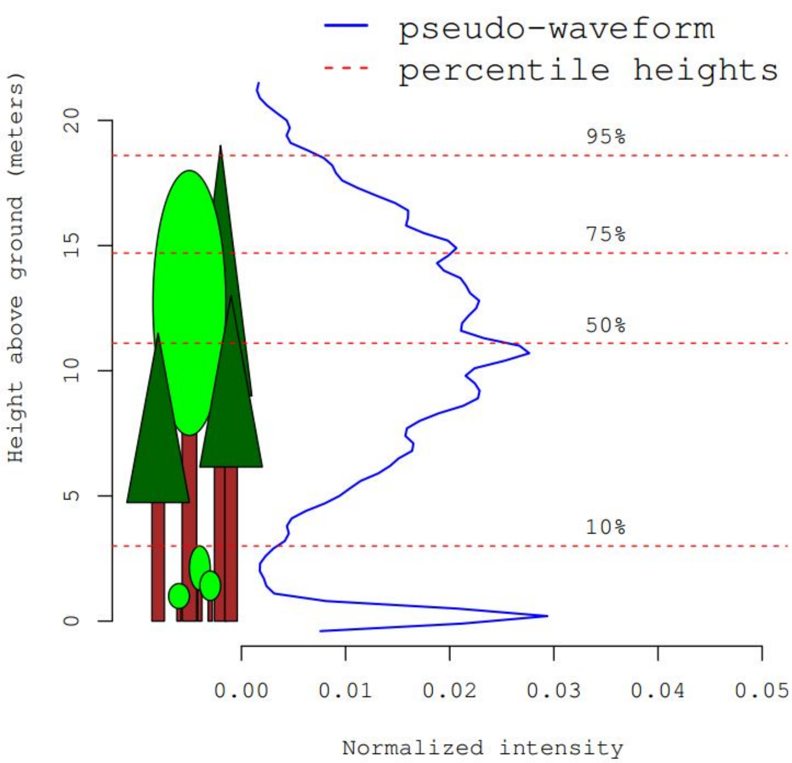

Figure 3. Illustration showing the normalized G-LiHT pseudo-waveform intensity of return energy height profile (blue) along with example percentile height values (red). Return intensity is greater at heights where the forest canopy is encountered. The energy spike at 0 meters signifies energy returning from ground.

As described in the forthcoming paper by Babcock et al. (Accepted 2016), principal components analysis via eigen decomposition of the percentile height variables correlation matrix was used to reduce the dimension of the data set and ensure the variables used as covariates in the subsequent regression analysis were uncorrelated. Two principal components are evident in the cumulative sum of eigen values plot (Figure 4) as the first two eigenvectors account for greater than 85% of the variation in the percentile height data.

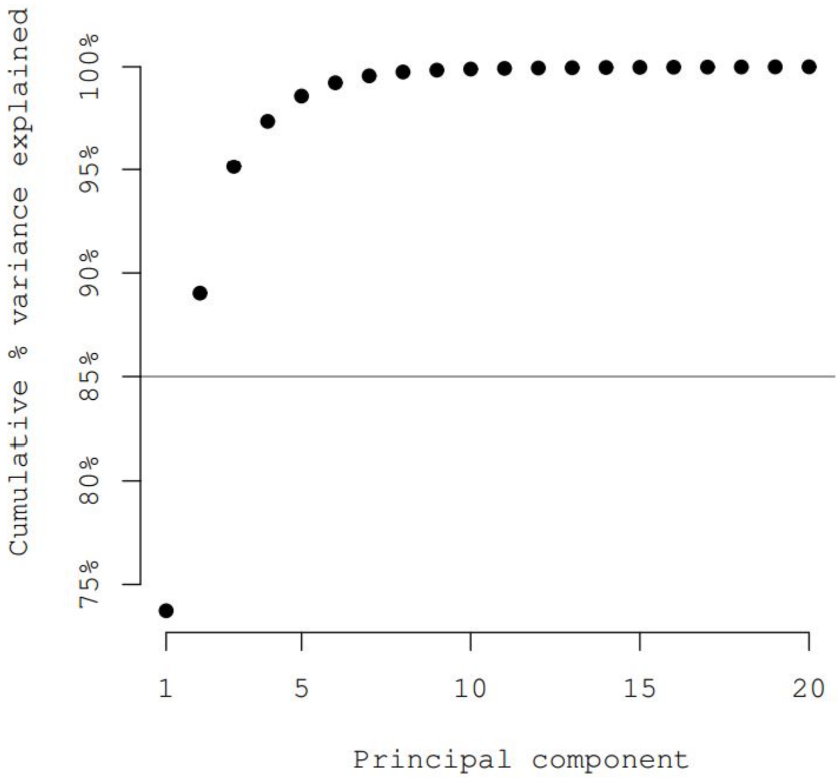

Figure 4. Plot depicting the cumulative percentage of variance explained by the principal components. Principal components are ordered from the greatest proportion of variance explained to least. The two left most components were retained because they explain the highest proportion of variance.

The scores generated from the two principal components were used as covariates for model fitting. Pseudo-waveforms were also generated within a grid of 13 meter cells over the PEF. PCA scores were calculated for each grid cell and used for subsequent prediction and mapping of AGB.

6. Data Access

This data is available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

CMS: Aboveground Biomass from Penobscot Experimental Forest, Maine, 2012

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

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