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# Disturbance History and Forest Biomass from Landsat for Six US Sites, 1985-2014

## Get Data

Documentation Revision Date: 2020-02-06

Dataset Version: 1

## Summary

This dataset provides derived disturbance history and predicted annual forest biomass maps at 30-m resolution for six selected Landsat scenes across the Conterminous United States (CONUS) for the period 1985-2014. The focus sites are in the following states: Colorado, Maine, Minnesota, Oregon, Pennsylvania, and South Carolina. These scenes were selected to represent a wide range of forest ecosystems, which ensured that a diversity of forest type groups and forest change processes (e.g., harvest, fire, insects, and urbanization) were included. Disturbance history was derived from a Landsat time-series for each site. Each disturbance is represented by year of detection, duration, and magnitude. The cause of the disturbance was not identified. Forest biomass was measured at field plots within each of the six sites and combined with airborne LiDAR data from each site to create land validation maps. Site biomass at 30-m resolution was estimated by developing Random Forest models that include site disturbance history with the land validation maps.

There are 12 total data files, with two data files for each of 6 focal sites, in netCDF (\*.nc) format.

Forest Biomass in Minnesota study area, 1985

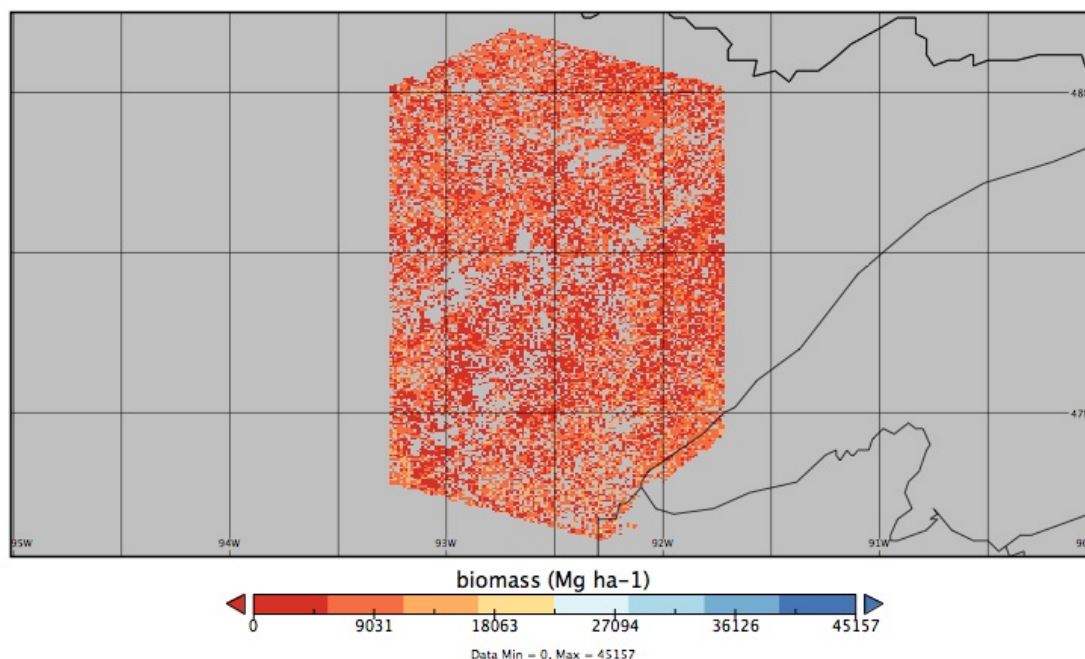


Figure 1. Biomass (Mg ha<sup>-1</sup>) for the northern Minnesota site. Source: biomass\_MN.nc

## Citation

Cohen, W.B., Z. Yang, S.P. Healey, and H.E. Andersen. 2019. Disturbance History and Forest Biomass from Landsat for Six US Sites, 1985-2014. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/1679>

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## 1. Dataset Overview

This dataset provides derived disturbance history and predicted annual forest biomass maps at 30-m resolution for six selected Landsat scenes across the Conterminous United States (CONUS) for the period 1985-2014. The Landsat focus sites are in the following states: Colorado, Maine, Minnesota, Oregon, Pennsylvania, and South Carolina. These scenes were selected to represent a wide range of forest ecosystems, which ensured that a diversity of forest type groups and forest change processes (e.g., harvest, fire, insects, and urbanization) were included. Disturbance history was derived from a Landsat time-series for each site. Each disturbance is represented by year of detection, duration, and magnitude. The cause of the disturbance was not identified. Forest biomass was measured at field plots within each of the six sites and combined with airborne LiDAR data from each site to create land validation maps. Site biomass at 30-m resolution was estimated by developing Random Forest models that include site disturbance history with the land validation maps.

**Project:** [Carbon Monitoring System \(CMS\)](#)

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.

### Acknowledgments

This work was funded by NASA CMS grant NNH13AW621.

## 2. Data Characteristics

**Spatial Coverage:** Six sites in the United States: Colorado, Maine, Minnesota, Oregon, Pennsylvania, South Carolina

**Spatial Resolution:** 30 m

**Temporal Coverage:** 1985-01-01 to 2014-12-31

**Temporal Resolution:** annual

**Study Area:** (all latitudes and longitudes given in decimal degrees)

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Full extent	-123.2346889	-68.48086389	48.28861389	32.26540833
Colorado (CO)	-108.4012306	-106.344375	41.28273056	39.38385
Maine (ME)	-71.200375	-68.48086388	47.077675	44.94391944
Minnesota (MN)	-93.33940833	-91.622066	48.28861389	46.60993611
Oregon (OR)	-123.234688	-120.5346166	44.28075278	42.08694444
Pennsylvania (PA)	-76.1217722	-73.6485	41.39416944	39.27103889
South Carolina (SC)	-81.1655722	-79.01473611	34.21445	32.26540833

### Data File Information

There are 12 total data files, with two data files for each of 6 focal sites, in netCDF (\*.nc) format with the file names as follows:

six files of "disturbance\_XX.nc" -- provide disturbance history in each site

six files of "biomass\_XX.nc" -- provide a 30 year time series of aboveground biomass in each site

Where XX is the state abbreviation (CO, ME, MN, OR, PA, SC)

### Data File Details

For all netCDF files, coordinates are provided for Geographic (EPSG: 4326) and Albers Conical Equal Area projections and the no data value is -9999.

**Table 1.** Variable description for disturbance\_XX.nc. Note there may be up to 6 disturbance events per pixel.

variable	units	description
duration	years	number of years disturbance lasted
endYear	YYYY	year disturbance ended
postBrightness	mixed decimal	brightness after disturbance ended; the magnitude of change from disturbance startYear to endYear*
postGreenness	mixed decimal	greenness after disturbance ended; the magnitude of change from disturbance startYear to endYear
postWetness	mixed decimal	wetness after disturbance ended; the magnitude of change from disturbance startYear to endYear

preBrightness	mixed decimal	brightness before disturbance occurred; the magnitude of change from disturbance startYear to endYear
preGreenness	mixed decimal	greenness before disturbance occurred; the magnitude of change from disturbance startYear to endYear
preWetness	mixed decimal	wetness before disturbance occurred; the magnitude of change from disturbance startYear to endYear
startYear	YYYY	year disturbance began

\*Synthetic tasseled cap images were used to derive the disturbance magnitude: the delta change of tasseled cap brightness (TCB), greenness (TCG), and wetness (TCW) between the pre-disturbance and post-disturbance images. Disturbance history for a pixel was represented by up to six disturbances (i.e., events).

**Table 2.** Variable descriptions for biomass\_XX.nc.

variable	units	description
biomass	Mg ha-1	aboveground forest biomass estimates
biomass_SD	Mg ha-1	standard deviation of aboveground forest biomass estimates

### 3. Application and Derivation

Much of what we know about forest disturbance comes from disparate monitoring efforts that produce estimates that are challenging to compare and synthesize across disturbance agent classes, regions, and time periods. This research uses Landsat satellite remote sensing to estimate the effects of forest disturbance. Landsat imagery is capable of quantifying diverse patterns and dynamics of forests at sub-stand scales and at sub-annual temporal resolution over the last several decades.

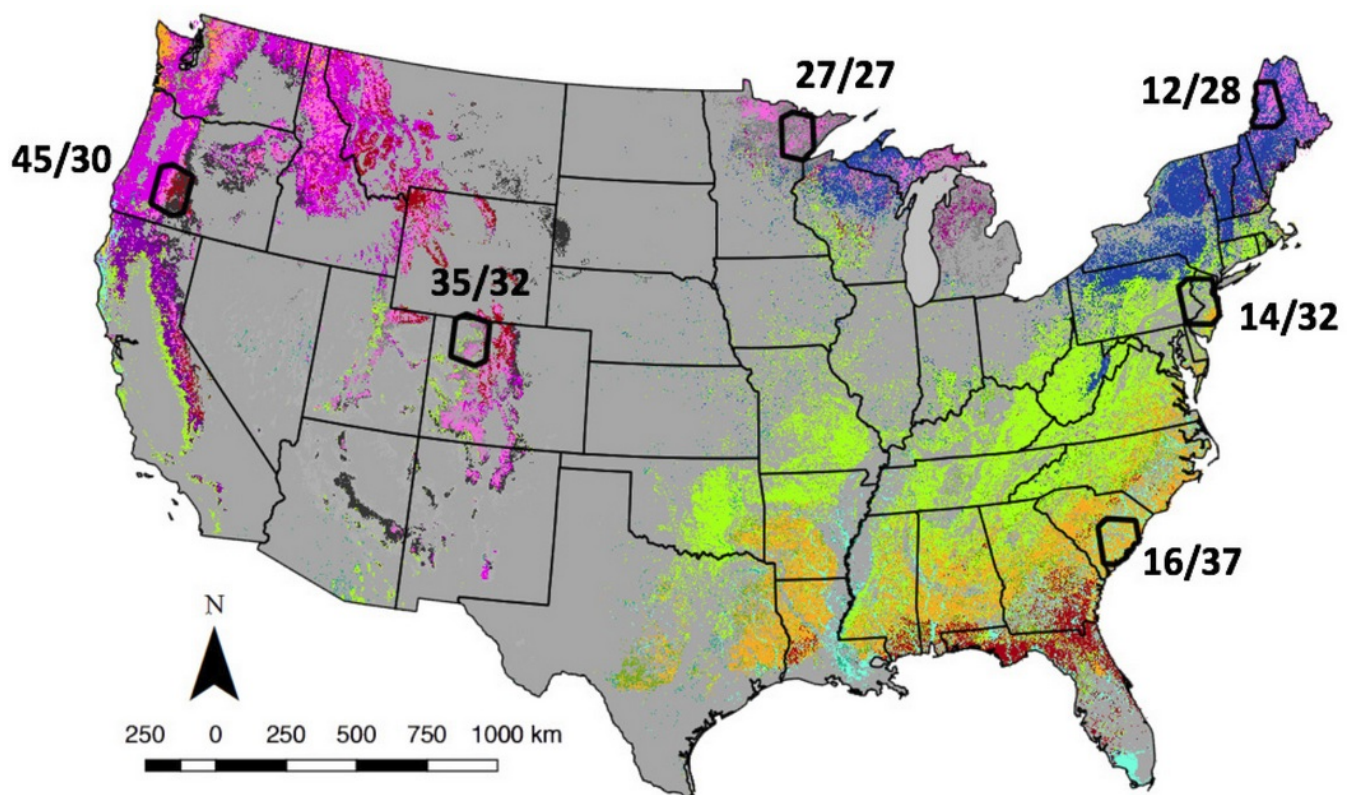
### 4. Quality Assessment

Uncertainty was represented as Random Forest prediction probability.

### 5. Data Acquisition, Materials, and Methods

#### Study Sites

The Landsat focus sites are in the following states: Colorado, Maine, Minnesota, Oregon, Pennsylvania, and South Carolina. These scenes were selected to represent a wide range of forest ecosystems, which ensured that a diversity of forest type groups and forest change processes (e.g., harvest, fire, insects, and urbanization) were included.



**Figure 2.** These areas were defined as the non-overlapping portions of six individual, Landsat frames, known as TSAs (Thiessen Scene Areas, from the second World Reference System (WRS-2) grid. The six scenes (given by numeric WRS-2 Path/Row) included: 12/28 in northern Maine; 14/32 in eastern Pennsylvania and New Jersey; 16/37 in coastal South Carolina; 27/27 in northern Minnesota; 35/32 in northwestern Colorado; and 45/30 in western Oregon (Cohen et al., 2017)

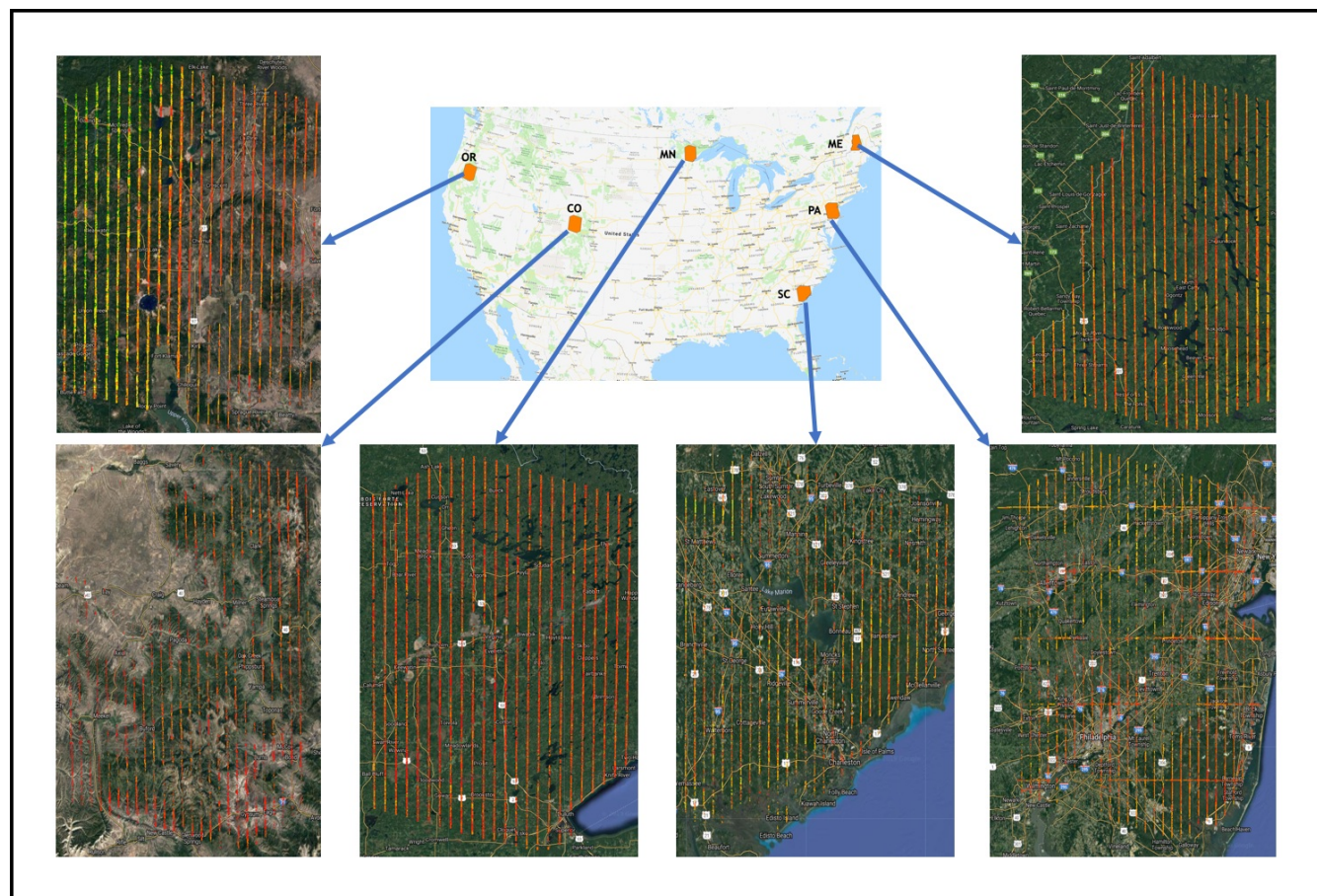
#### Disturbance History

Disturbance history was derived from a Landsat time-series for 1973-2015 using the method described in Cohen et al. (2018). In brief, the LandTrendr algorithm was applied separately to the six Landsat reflectance bands and seven Landsat spectral indices, then the results were combined using a Random Forest (RF) ensemble. The training data used for the RF model were collected using the TimeSync visualization and data collection tool (Cohen et al. 2010). The RF model was applied independently to each year of the Landsat time-series to detect forest disturbance. For each year of the Landsat time-series, a method composite (Flood 2013) and the 2011 National Land Cover Database (NLCD) forest cover data (USGS 2011) were used to mask non-forest areas. Any disturbance event

that had an extent less than 0.5 ha in a given year was disregarded. However, to allow for detection of chronic declines in forest health, smaller patches were permitted if neighboring pixels were detected as disturbed in adjacent years and the final patch size was at least 0.5 ha. A synthetic tasseled cap image was generated using the disturbance start and end year as the vertices, then the synthetic tasseled cap images were used to derive the disturbance magnitude: the delta change of tasseled cap brightness, greenness, and wetness between the pre-disturbance and post-disturbance images. Disturbance history for a pixel was represented by up to six disturbances (i.e., events).

### Biomass Estimates

Forest biomass was collected at field plots within each of the six sites and then combined with LiDAR data (Legner et al., 2020) to create land validation maps. RF models for biomass were developed for the years 1985-2014 using the validation maps, the year since the disturbance, the tasseled cap image for the year being modeled and for the year 1984, and the NLCD forest cover data. Relative to the year being modeled, only the two most recent disturbances were included in model development. To build the RF biomass model, stratified random samples were selected from the validation maps. For each site, 10 data bins for biomass were calculated using the 5th and 95th percentile. In addition, the number of detected disturbances were combined with the biomass bins to create additional strata. Within each stratum, 500 random pixels were selected as training data. The derived RF model of biomass for each site was then applied to all years from 1985 to 2014.



**Figure 3.** Example of LiDAR data retrieved for field plots at each site.

## 6. Data Access

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

### [Disturbance History and Forest Biomass from Landsat for Six US Sites, 1985-2014](#)

Contact for Data Center Access Information:

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

## 7. References

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