ABoVE: Annual Phenology Derived from Landsat across the ABoVE Core Domain, 1984-2014

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Dataset Version: 1

Summary

This dataset provides annual maps of the timing of spring onset with leaf emergence, of autumn onset with leaf senescence, and of peak greenness for each 30 m pixel derived from Landsat time series of Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM+) observations from 1984 to 2014. The ABoVE core domain includes 169 ABoVE grid tiles across Alaska, USA and Alberta, British Columbia, Northwest Territories, Nunavut, Saskatchewan, and Yukon, Canada. The data provided for deriving seasonality includes the total number of cloud-free observations, r-squared values between observed and spline-predicted Enhanced Vegetation Index (EVI), long-term average minimum EVI, long-term average maximum EVI, long-term average spring onset, long-term average autumn onset, annual spring onset, and annual autumn onset. The data provided for peak greenness includes annual peak Normalized Difference Vegetation Index (NDVI), Normalized Burn Ratio (NBR), annual composite red reflectance, annual composite NIR reflectance, annual composite shortwave infrared reflectance (band 6, SWIR1), annual composite shortwave infrared reflectance (band 7, SWIR2), number of dates used to calculate composites, and day of year of associated maximum composite.

The seasonality data were derived from a Landsat phenology algorithm (LPA) used to estimate the long-term averages and the annual day of year (DOY). Peak-summer greenness was derived from both Landsat 5 TM and Landsat 7 Enhanced ETM+ data to calculated NDVI values at each pixel for each growing season.

There are 8,788 data files in this dataset in GeoTIFF (.tif) format. Seasonality: 8 variables x 169 tiles = 1,352 files. Peak greenness: TM, 28 years x 169 tiles = 4,732 files; ETM+, 16 years x 169 tiles = 2,704 files.

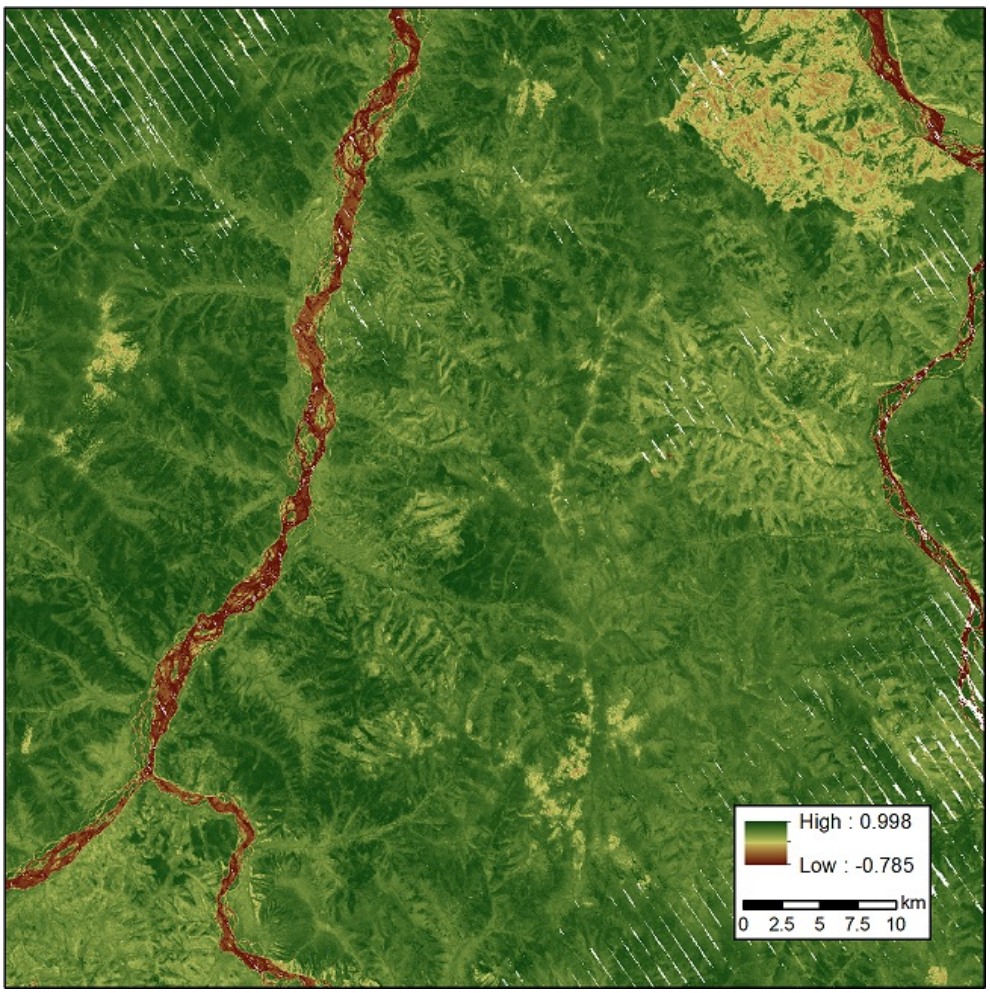

Figure 1. Peak greenness derived from the Normalized Difference Vegetation Index (NDVI) for the year 2010 (Band1) in the ABoVE

grid cell Bh07v07. Source Bh07v07.pkgreen.etm.2010.tif.

Citation

Melaas, E.K., D. Sulla-Menashe, C.E. Woodcock, and M.A. Friedl. 2019. ABoVE: Annual Phenology Derived from Landsat across the ABoVE Core Domain, 1984-2014. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1698

Table of Contents

1. Dataset Overview

This dataset provides annual maps of the timing of spring onset with leaf emergence, of autumn onset with leaf senescence, and of peak greenness for each 30 m pixel derived from Landsat time series of Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM+) observations from 1984 to 2014. The Core Domain includes 169 ABoVE grid tiles across Alaska, USA and Alberta, British Columbia, Northwest Territories, Nunavut, Saskatchewan and Yukon, Canada. The data provided for deriving seasonality includes the total number of cloud-free observations, R2 between observed and spline-predicted Enhanced Vegetation Index (EVI), long-term average minimum EVI, long-term average maximum EVI, long-term average spring onset, long-term average autumn onset, annual spring onset, and annual autumn onset. The data provided for peak greenness includes annual peak Normalized Difference Vegetation Index (NDVI), Normalized Burn Ratio (NBR), annual composite red reflectance, annual composite NIR reflectance, annual composite shortwave infrared reflectance (band 6, SWIR1), annual composite shortwave infrared reflectance (band 7, SWIR2), number of dates used to calculate composites, and day of year of associated maximum composite.

The seasonality data were derived from a Landsat phenology algorithm (LPA) used to estimate the long-term averages and the annual day of year (DOY). Peak-summer greenness was derived from both Landsat 5 TM and Landsat 7 Enhanced ETM+ data to calculated NDVI values at each pixel for each growing season.

Project: Arctic-Boreal Vulnerability Experiment

The Arctic-Boreal Vulnerability Experiment (ABoVE) is a NASA Terrestrial Ecology Program field campaign based in Alaska and western Canada between 2016 and 2021. Research for ABoVE links field-based, process-level studies with geospatial data products derived from airborne and satellite sensors, providing a foundation for improving the analysis and modeling capabilities needed to understand and predict ecosystem responses and societal implications.

Related Datasets:

The datasets below used the same algorithm to detect annual seasonality metrics:

Melaas, E.K., M.A. Friedl, and D. Sulla-Menashe. 2018. Landsat-derived Spring and Autumn Phenology, Eastern US - Canadian Forests, 1984-2013. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1570

Sulla-Menashe, D., M.A. Friedl, C. Woodcock, and E.K. Melaas. 2018. ABoVE: Peak Greenness for Canadian Boreal Forest from Landsat 5 TM Imagery, 1984-2011. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1587

Related Publications:

Melaas, E. K., M. A. Fridel, and D. Sulla-Menashe. 2018. Multidecadal Changes and Interannual Variation in Springtime Phenology of North American Temperate and Boreal Deciduous Forests. Geophysical Research Letters. https://doi.org/10.1002/2017GL076933

Melaas, E. K., Sulla-Menashe, D., Gray, J. M., Black, T. A., Morin, T. H., Richardson, A. D., & Friedl, M. A. (2016). Multisite analysis of land surface phenology in North American temperate and boreal deciduous forests from Landsat. Remote Sensing of Environment, 186, 452–464. https://doi.org/10.1016/j.rse.2016.09.014

Acknowledgements:

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2. Data Characteristics

Spatial Coverage: Alaska, USA and Alberta, British Columbia, Northwest Territories, Nunavut, Saskatchewan and Yukon, Canada

ABoVE Reference Locations:

Domain: Core ABoVE

State/territory: Alaska and Canada

Grid cells: The data are in ‘A’ grid cells Ah0Av0, Ah1Av0, Ah1Av2, Ah2Av0, Ah2Av1, Ah2Av2 and the following ‘B' cells:

Bh01v02	Bh05v05	Bh08v02	Bh09v14	Bh11v14	Bh13v12	Bh15v14
Bh01v03	Bh05v06	Bh08v03	Bh09v15	Bh11v15	Bh13v13	Bh15v15
Bh01v04	Bh06v00	Bh08v04	Bh10v04	Bh11v16	Bh13v14	Bh16v05
Bh01v05	Bh06v01	Bh08v05	Bh10v05	Bh11v17	Bh13v15	Bh16v06

Bh02v02	Bh06v02	Bh08v06	Bh10v06	Bh12v05	Bh13v16	Bh16v07
Bh02v03	Bh06v03	Bh08v07	Bh10v07	Bh12v06	Bh14v05	Bh16v08
Bh02v04	Bh06v04	Bh08v08	Bh10v08	Bh12v07	Bh14v06	Bh16v09
Bh02v05	Bh06v05	Bh08v09	Bh10v09	Bh12v08	Bh14v07	Bh16v10
Bh02v06	Bh06v06	Bh08v10	Bh10v10	Bh12v09	Bh14v08	Bh16v11
Bh03v01	Bh06v07	Bh08v11	Bh10v11	Bh12v10	Bh14v09	Bh16v12
Bh03v02	Bh06v08	Bh08v12	Bh10v12	Bh12v11	Bh14v10	Bh16v13
Bh03v03	Bh06v09	Bh08v13	Bh10v13	Bh12v12	Bh14v11	Bh16v14
Bh03v04	Bh07v00	Bh08v14	Bh10v14	Bh12v13	Bh14v12	Bh17v05
Bh03v05	Bh07v01	Bh09v02	Bh10v15	Bh12v14	Bh14v13	Bh17v06
Bh03v06	Bh07v02	Bh09v03	Bh10v16	Bh12v15	Bh14v14	Bh17v07
Bh04v01	Bh07v03	Bh09v04	Bh10v17	Bh12v16	Bh14v15	Bh17v08
Bh04v02	Bh07v04	Bh09v05	Bh11v05	Bh13v03	Bh15v05	Bh17v09
Bh04v03	Bh07v05	Bh09v06	Bh11v06	Bh13v04	Bh15v06	Bh17v10
Bh04v04	Bh07v06	Bh09v07	Bh11v07	Bh13v05	Bh15v07	Bh17v11
Bh04v05	Bh07v07	Bh09v08	Bh11v08	Bh13v06	Bh15v08	Bh17v12
Bh05v00	Bh07v08	Bh09v09	Bh11v09	Bh13v07	Bh15v09	
Bh05v01	Bh07v09	Bh09v10	Bh11v10	Bh13v08	Bh15v10	
Bh05v02	Bh07v10	Bh09v11	Bh11v11	Bh13v09	Bh15v11	
Bh05v03	Bh08v01	Bh09v12	Bh11v12	Bh13v10	Bh15v12	
Bh05v04	Bh08v02	Bh09v13	Bh11v13	Bh13v11	Bh15v13	

Spatial Resolution: 30 m x 30 m

Temporal Coverage: 1984-01-01 to 2014-12-31

Temporal Resolution: Annual

Study Areas (All latitude and longitude given in decimal degrees)

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Alaska and Alberta, British Columbia, Northwest Territories, Nunavut, Saskatchewan and Yukon, Canada	-170.0058	-98.97401389	75.01385833	50.25900556

Data File Information

There are 8,788 data files in this dataset in GeoTIFF (.tif) format. Seasonality: 8 variables x 169 tiles = 1,352 files. Peak greenness: TM, 28 years x 169 tiles = 4,732 files; ETM+: 16 years x 169 tiles = 2,704 files.

The files are organized by data product type:

- Seasonality: phenology (**pheno**) variables estimated using the Landsat phenology algorithm (LPA)
- Peak greenness (**pkgreen**) derived from NDVI

Missing values: Indicated with -32767. Any missing data denotes that either phenology or peak greenness dates were undetectable due to missing or poor quality Landsat imagery during the greenup, greendown or peak summer periods when dates are typically detected.

Projection: EPSG 102001 (ABoVE standard Alber's equal area projection)

Seasonality data

Each file has 31 bands, one for each of the 31 years (1984-2014). In summary, 8 variables x 169 tiles = 1,352 files.

The files are named as *Bh#v#.pheno.NAME.tif*

Where:

Bh#v# is the ABoVE "B" grid tile designation. There are 169 tiles reported.

NAME is the variable reported in the file. It can be one of the following:

- *nobs* - total number of clear observations
- *rsquare* - coefficient of determination (R2) between observed and spline-predicted EVI
- *minEVI* - long-term average winter minimum EVI
- *maxEVI* - long-term average summer maximum EVI
- *sprLTM* - long-term average spring onset (day of year)
- *autLTM* - long-term average autumn onset (day of year)
- *spr* - annual spring onset (day of year)
- *aut* - annual autumn onset (day of year)

Example file name: *Bh01v02.pheno.minEVI.tif*

Peak Greenness data

Data are provided for both TM and ETM+ sensors with some overlapping years [TM (1984 to 2011) and ETM+ (1999 to 2014)]. In summary, TM has 28 years x 169 tiles = 4,732 files and ETM+ has 16 years x 169 tiles = 2,704 files.

The files are named as *Bh#v#.pkgreen.SSS.YYYY.tif*

Where:

Bh#v# is the ABoVE "B" grid tile designation. There are 169 tiles reported.

SSS is the sensor used: *tm5* for Landsat 5 TM and *etm* for Landsat 7 ETM+

YYYY is the year

Example file name: *Bh14v12.pkgreen.tm5.1995.tif*

Each file has 8 bands:

- Annual peak NDVI magnitude
- Annual NBR magnitude
- Associated red reflectance (band 3) magnitude
- Associated near infrared reflectance (band 4) magnitude
- Associated shortwave infrared reflectance (band 6) magnitude
- Associated shortwave infrared reflectance (band 7) magnitude
- Number of observations used to generate composite (of the above)
- Associated day of year of composite

3. Application and Derivation

The vegetation trends and disturbance data included in this dataset are useful for characterizing the nature and magnitude of greening and browning directly associated with climate change.

Results from this work support the utility of land surface phenology information derived from Landsat for improving information and understanding of ecosystem processes at landscape scales.

4. Quality Assessment

The assessment and validation of remotely sensed estimates of phenology dates with the Landsat phenology algorithm (LPA) was reported in Melaas et al. (2016).

5. Data Acquisition, Materials, and Methods

Study Area

The study domain covered parts of Alaska and Canada in the ABoVE Core Domain.

Seasonality data

The Landsat phenology algorithm (LPA) described by Melaas et al. (2013) and subsequently refined and validated in Melaas et al.

(2016) was used to estimate the long-term average and the annual day of year (DOY) associated with leaf emergence (spring onset) and autumn senescence (autumn onset) at 30-m spatial resolution from time series of Landsat 5 and 7 images. Average spring onset and autumn onset were estimated using the LPA at each pixel based on the day of year when the cubic smoothing spline reached 50% of its amplitude (Melaas et al., 2016).

Peak Greenness data

For each site, 28 years (1984 to 2011) of Landsat 5 Thematic Mapper (TM) data and 16 years of Landsat 7 Enhanced Thematic Mapper (ETM+) data (1999 to 2014) were collected and the maximum greenness observations for each Landsat pixel for that year were identified. Two indices were calculated from the peak-summer greenness observations for vegetated pixels, the Normalized Difference Vegetation Index (NDVI) and the Normalized Burn Ratio (NBR). We then extracted maximum NDVI values at each pixel for each growing season, which we define here as occurring between day of year 180 and 240 (June 29–August 28 in non-leap years) (Sulla-Menashe *et al* 2018).

The Landsat 5 and 7 data were previously stored in HDF format in the WRS2 path/row system in UTM projection. Taking these files as inputs, the tiles were reprojected and each scene was tiled into the ABoVE standard Alber's equal projection and 30-m grid.

6. Data Access

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

ABoVE: Annual Phenology Derived from Landsat across the ABoVE Core Domain, 1984-2014

Contact for Data Center Access Information:

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

7. References

Melaas, E.K., M.A. Fridel, and D. Sulla-Menashe. 2018. Multidecadal Changes and Interannual Variation in Springtime Phenology of North American Temperate and Boreal Deciduous Forests. Geophysical Research Letters. https://doi.org/10.1002/2017GL076933

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