PhenoCam Dataset v2.0: Digital Camera Imagery from the PhenoCam Network, 2000-2018

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Dataset Version: 2

Summary

This dataset provides a time series of visible-wavelength digital camera imagery collected through the PhenoCam Network at each of 393 sites predominantly in North America from 2000-2018. The raw imagery was used to derive information on phenology, including time series of vegetation color, canopy greenness, and phenology transition dates for the PhenoCam Dataset v2.0.

There are 38,624 files included in this dataset; 19,312 tar.gz files and 19,312 metadata files. PhenoCam images, in *.jpg format, are packaged by Phenocam site, year, and month into compressed (*.tar.gz) directories. There is also one metadata file (plain text format with a *.meta extension) for each *.tar.gz file.

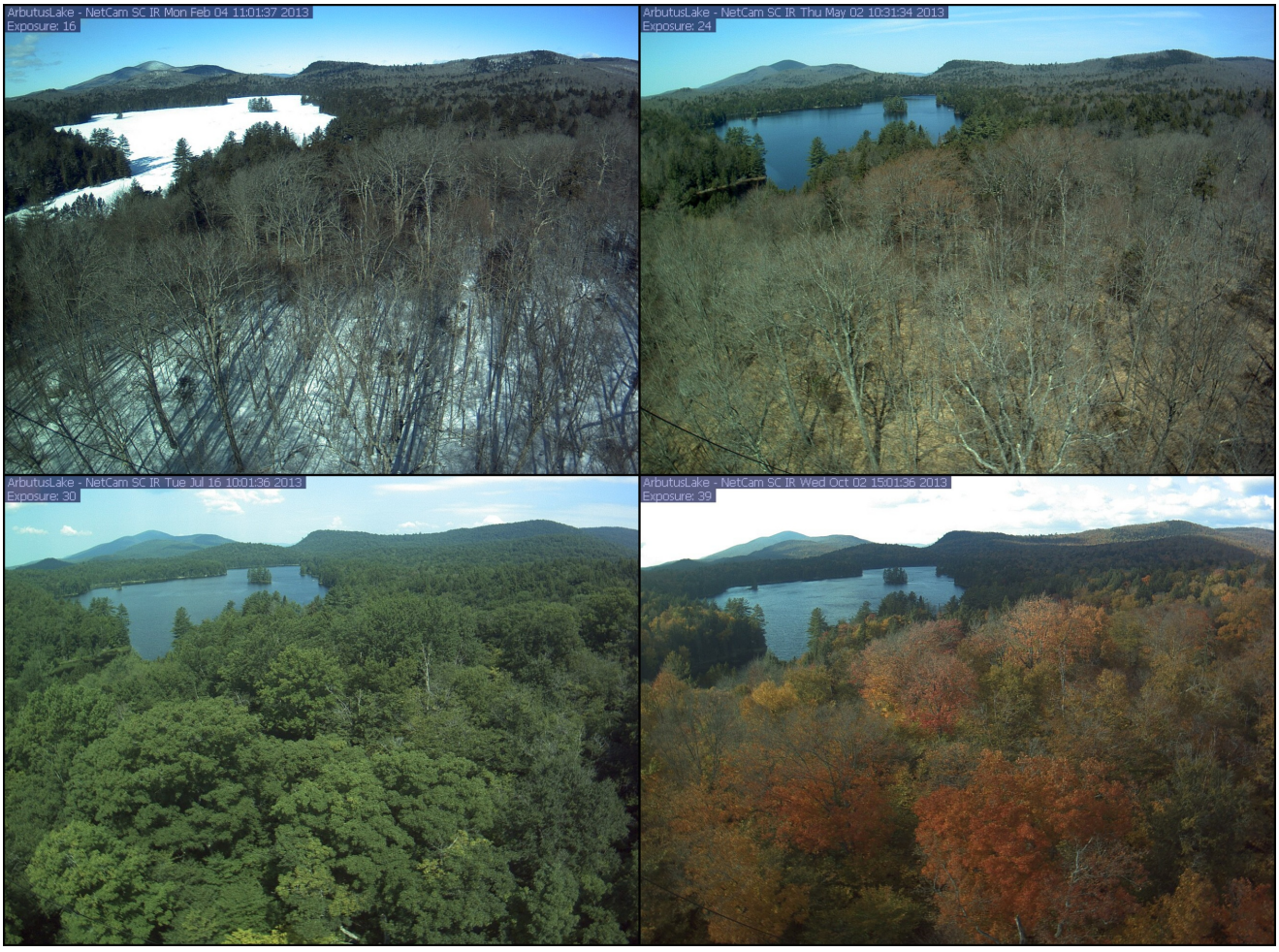

Figure 1: A series of PhenoCam images from February, May, July, and October 2013 at the Arbutus Lake site in New York.

Citation

Milliman, T., B. Seyednasrollah, A.M. Young, K. Hufkens, M.A. Friedl, S. Frolking, A.D. Richardson, M. Abraha, D.W. Allen, M. Apple, M.A. Arain, J. Baker, J.M. Baker, D. Baldocchi, C.J. Bernacchi, J. Bhattacharjee, P. Blanken, D.D. Bosch, R. Boughton, E.H. Boughton, R.F. Brown, D.M. Browning, N. Brunsell, S.P. Burns, M. Cavagna, H. Chu, P.E. Clark, B.J. Conrad, E. Cremonese, D. Debinski, A.R. Desai, R. Diaz-Delgado, L. Duchesne, A.L. Dunn, D.M. Eissenstat, T. El-Madany, D.S.S. Ellum, S.M. Ernest, A. Esposito, L. Fenstermaker, L.B. Flanagan, B. Forsythe, J. Gallagher, D. Gianelle, T. Griffis, P. Groffman, L. Gu, J. Guillemot, M. Halpin, P.J. Hanson, D. Hemming, A.A. Hove, E.R. Humphreys, A. Jaimes-Hernandez, A.A. Jaradat, J. Johnson, E. Keel, V.R. Kelly, J.W. Kirchner, P.B. Kirchner, M. Knapp, M. Krassovski, O. Langvall, G. Lanthier, G.I. Maire, E. Magliulo, T.A. Martin, B. McNeil, G.A. Meyer, M. Migliavacca, B.P. Mohanty, C.E. Moore, R. Mudd, J.W. Munger, Z.E. Murrell, Z. Nesic, H.S. Neufeld, W. Oechel, A.C. Oishi,

W.W. Oswald, T.D. Perkins, M.L. Reba, B. Rundquist, B.R. Runkle, E.S. Russell, E.J. Sadler, A. Saha, N.Z. Saliendra, L. Schmalbeck, M.D. Schwartz, R.L. Scott, E.M. Smith, O. Sonnentag, P. Stoy, S. Strachan, K. Suvocarev, J.E. Thom, R.Q. Thomas, A.K. Van den berg, R. Vargas, J. Verfaillie, C.S. Vogel, J.J. Walker, N. Webb, P. Wetzel, S. Weyers, A.V. Whipple, T.G. Whitham, G. Wohlfahrt, J.D. Wood, J. Yang, X. Yang, G. Yenni, Y. Zhang, Q. Zhang, and D. Zona. 2019. PhenoCam Dataset v2.0: Digital Camera Imagery from the PhenoCam Network, 2000-2018. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1689

Table of Contents

1. Dataset Overview

This dataset provides a time series of visible-wavelength digital camera imagery collected through the PhenoCam Network at each of 393 sites predominantly in North America from 2000-2018. The raw imagery was used to derive information on phenology, including time series of vegetation color, canopy greenness, and phenology transition dates for the PhenoCam Dataset v2.0.

Related Publication with Full Documentation:

Please refer to, and cite, the following publication when you cite this dataset:

Richardson, A.D., Hufkens, K., Milliman, T., Aubrecht, D.M., Chen, M., Gray, J.M., Johnston, M.R., Keenan, T.F., Klosterman, S.T., Kosmala, M., Melaas, E.K., Friedl, M.A., Frolking, S. 2018. Tracking vegetation phenology across diverse North American biomes using PhenoCam imagery. *Scientific Data* 180028. DOI: https://doi.org/10.1038/sdata.2018.28

Seyednasrollah, B., A.M. Young, K. Hufkens, T. Milliman, M.A. Friedl, S. Frolking, and A.D. Richardson. 2019. Tracking vegetation phenology across diverse biomes using PhenoCam imagery: The PhenoCam Dataset v2.0. Manuscript submitted to *Scientific Data*.

Related Dataset:

Seyednasrollah, B., et al. 2019. PhenoCam Dataset v2.0: Vegetation Phenology from Digital Camera Imagery, 2000-2018. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1674

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2. Data Characteristics

Spatial Coverage: Multiple points mostly over North America, some sites in Panama, Hawaii, Europe, Brazil and China

Spatial Resolution: Point

Temporal Resolution: Variable. Generally every 30 minutes, but in some cases only once-daily.

Temporal Coverage: All available data between January 2000 to December 2018 is provided here, but temporal coverage varies by site.

Spatial Extent: (All latitude and longitude given in decimal degrees)

Sites	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Global	-158.15	119.22	71.2801	-22.97

Data File Information

The Phenocam image data are packaged into a series of 19,312 compressed directories (*.tar.gz) based on the site, year, and month. In addition, metadata about each compressed directory is provided in plain text format with a *.meta extension. The 19,312 *.meta files contain information on the site name, year, month, number of images, and checksum information for the corresponding *.tar.gz.

The **.tar.gz* and **.meta* files are named with the same file naming convention: *site_yyyy_mm.ext*

where:

site = site name

yyyy = year

mm = month

ext = extension, either tar.gz or meta

Example file names for data from the ARM site in Oklahoma from May 2004:

armoklahoma_2004_05.tar.gz

armoklahoma_2004_05.meta

Once uncompressed, the tar.gz file contains a series of nested directories for the site, year, and month, and then the series of *.jpg images for that month

The jpg images are named as: *site_yyyy_mm_dd_hhmmss.jpg*

where: *site* = site name, *yyyy* = year, *mm* = month, *dd* = day, *hhmmss* = time in the local standard time at the site

(See the related dataset at https://doi.org/10.3334/ORNLDAAC/1674 for information on local time offset from UTC time.)

Phenocam sites

A list of Phenocam sites, locations, and dates of operation, is available at https://phenocam.sr.unh.edu/webcam/network/table

3. Application and Derivation

Data derived from PhenoCam imagery can be used for phenological model validation and development, evaluation of satellite remote sensing data products, understand relationships between canopy phenology and ecosystem processes, to study the seasonal changes in leaf-level physiology that are associated with changes in leaf color, benchmarking earth system models, and studies of climate change impacts on terrestrial ecosystems (Richardson et al., 2018; Seyednasrollah et al. 2019).

4. Quality Assessment

Quantitative analysis through automated quality control routines (e.g. filtering and outlier detection, described in Richardson et al., 2018; Seyednasrollah et al. 2019) and visual evaluation of each time series has been vetted for consistency and overall quality (Richardson et al., 2018; Seyednasrollah et al. 2019).

5. Data Acquisition, Materials, and Methods

PhenoCam Network

The PhenoCam network is a cooperative network, established in 2008, that uses digital camera imagery to monitor ecosystem dynamics over time. It serves as a long-term, continental-scale, phenological observatory with cameras deployed within North America, from Alaska to Texas, and from Maine to Hawaii, and some on other continents.

The data presented here are visible-wavelength, automated digital camera imagery from 393 camera sites, together totaling almost 1783 years of data across different ecoregions, climate zones, and vegetation types. Vegetation types such as deciduous broadleaf forests (643 site-years of data in the dataset), grasslands (280 site-years), and evergreen needleleaf forests (265 site-years) are the best-represented.

Image Analysis

For each archived image, RGB (red, green, blue) color channel information, with means and other statistics calculated across a region-of-interest (ROI) delineating a specific vegetation type, was extracted. From the high-frequency (typically, 30 minute) imagery, time series characterizing vegetation color, including canopy greenness (canopy greenness index -- the green chromatic coordinate, *Gcc*), processed to 1- and 3-day intervals was derived. The processing was conducted using scripts coded in Python. The scripts used for image processing, including extraction of colour information, and generation of 'all-image' and 'summary' time series data product files, are available at https://github.com/tmilliman/python-vegindex/ with an open source license agreement.

See https://doi.org/10.3334/ORNLDAAC/1674 and Seyednasrollah et al. (2019) for more details.

6. Data Access

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

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Contact for Data Center Access Information:

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

7. References

Richardson, A.D., Hufkens, K., Milliman, T., Aubrecht, D.M., Chen, M., Gray, J.M., Johnston, M.R., Keenan, T.F., Klosterman, S.T., Kosmala, M., Melaas, E.K., Friedl, M.A., Frolking, S. 2018. Tracking vegetation phenology across diverse North American biomes using PhenoCam imagery. Scientific Data 180028. DOI: https://doi.org/10.1038/sdata.2018.28

Seyednasrollah, B., A.M. Young, K. Hufkens, T. Milliman, M.A. Friedl, S. Frolking, and A.D. Richardson. 2019. Tracking vegetation phenology across diverse biomes using PhenoCam imagery: The PhenoCam Dataset v2.0. Manuscript submitted to Scientific Data.