SPRUCE S1-Bog Phenology Movies, 2010-2015

Summary:

This data set provides annual movies created from daily and twice daily images of vegetation stands in the S1 Bog showing the seasonal changes of vegetation and appearance and disappearance of snow for the period June 2010 through December 2015.

Compiled movies are useful for examining the phenology of the bog and the changes to the landscape as experimental facilities have been constructed. Each of the provided files is an iMovie (Version 9.0.9) of compiled daily photos for the respective timeframe and camera view. See Table 1.

Figure 1. Screen captures from SPRUCE_Trees2014 movie compiled from twice daily still images.

Cameras are positioned at the southern end of the bog and co-located with monitoring Stations 1 and 2.

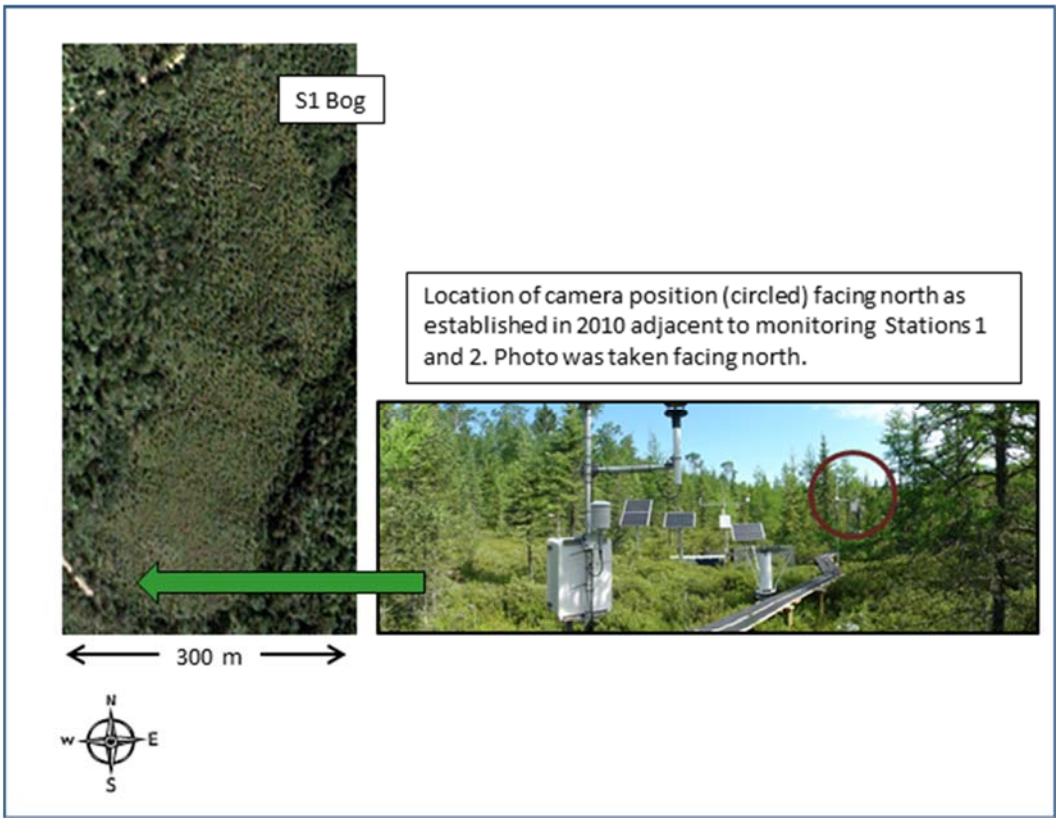

Figure 2. Location of camera positions and environmental monitoring stations in the S1 Bog. Photo of Stations 1 (in background) and 2 (EM1 and EM2) taken looking north. Photos taken in 2010.

The types (resolution) and number of cameras, direction of image, and positions of the cameras have changed over time.

Figure 3. Camera as installed in 2010 with a tree image frame as shown in Table 1.

In 2012, the current Tree and Shrub view high resolution cameras were added and the lower resolution camera was repositioned for the Instrument view.

Figure 4. Tree (upper) and Shrub (lower) view cameras installed in 2012.

Site Description

The site is the 8.1-ha S1 bog, a *Picea mariana* [black spruce] – Sphagnum spp. ombrotrophic bog forest in northern Minnesota, 40 km north of Grand Rapids, in the USDA Forest Service Marcell Experimental Forest (MEF). The S1 bog was harvested in successive strip cuts in 1969 and 1974 and the cut areas were allowed to naturally regenerate. Stations 1 and 2 are located in a 1974 strip that is characterized by a medium density of 3-5 meter black spruce and larch trees with an open canopy. The area was suitable for siting a monitoring station for representative meteorological conditions on the S1 bog. Station 3 is located in a 1969 harvest strip that is characterized by a higher density of 3-5 meter black spruce and larch trees with a generally closed canopy. Measurements at this station represent conditions in the surrounding stand.

SPRUCE Project Description

The SPRUCE (Spruce and Peatland Responses Under Climatic and Environmental Change) is an experiment to assess the response of northern peatland ecosystems to increases in temperature and exposures to elevated atmospheric CO2 concentrations. It is the primary component of the Terrestrial Ecosystem Science Scientific Focus Area of ORNL's Climate Change Program, focused on terrestrial ecosystems and the mechanisms that underlie their responses to climatic change. The experimental work is to be conducted in a *Picea mariana* [black spruce] – Sphagnum spp. bog forest in northern Minnesota, 40 km north of Grand Rapids, in the USDA Forest Service Marcell Experimental Forest (MEF). The site is located at the southern margin of the boreal peatland forest. It is an ecosystem considered especially vulnerable to climate change, and anticipated to be near its tipping point with respect to climate change. Responses to warming and interactions with increased atmospheric CO2 concentration are anticipated to have important feedbacks on the atmosphere and climate, because of the high carbon stocks harbored by such ecosystems.

Experimental work in the 8.1-ha S1 bog will be a climate change manipulation focusing on the combined responses to multiple levels of warming at ambient or elevated CO2 (eCO2) levels. The experiment provides a platform for testing mechanisms controlling the vulnerability of organisms, biogeochemical processes and ecosystems to climatic change (e.g., thresholds for organism decline or mortality, limitations to regeneration, biogeochemical limitations to productivity, the cycling and release of CO2 and CH4 to the atmosphere).

The manipulation will evaluate the response of the existing biological communities to a range of warming levels from ambient to +9°C, provided via large, modified open-top chambers. The ambient and +9°C warming treatments will also be conducted at eCO2 (in the range of 800 to 900 ppm). Both direct and indirect effects of these experimental perturbations will be analyzed to develop and refine models needed for full Earth system analyses.

Marcell Experimental Forest

Streamflow, weather, and well data collection began on the Marcell Experimental Forest in 1960. This 898-ha site has six calibrated watersheds, each consisting of a mineral soil upland and organic soil peatland; an intermittent or perennial stream drains each peatland and its larger watershed. Formally established in 1962, the Marcell contains two units on land owned by the USDA Forest Service, Chippewa National Forest, State of Minnesota, Itasca County, and a private individual. Previous and ongoing research addresses the ecology and hydrology of peatland. Research concerns typical upland/wetland watersheds in the Lake States, atmospheric chemistry, nutrient cycling, soil quality, tree-stand dynamics, and a variety of watershed treatments applied to upland or bogs to investigate impacts on water yield, peak streamflow, water quality and nutrient processing.

SPRUCE Sponsor

Research sponsored by the Office of Biological and Environmental Research within the U.S. Department of Energy's Office of Science.

The SPRUCE experiment is a multi-year cooperative interaction among scientists of the Oak Ridge National Laboratory operated by UT-Battelle, LLC and the U.S. Forest Service, Northern Research Station, Marcell Experimental Forest.

Data Citation:

Cite this data set as follows:

Hanson, P.J., J.S. Riggs, L.A. Hook, and W.R. Nettles. 2015. SPRUCE S1-Bog Phenology Movies, 2010-2015. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, U.S.A. http://dx.doi.org/10.3334/CDIAC/spruce.011.

Data and Documentation Access:

Get Data

For public and project-only access to SPRUCE data please visit the SPRUCE Web Site:
http://mnspruce.ornl.gov/

Description and Links to Companion Files and Supplemental Information

Marcell Experimental Forest Website: /http://www.nrs.fs.fed.us/ef/locations/mn/marcell/

SPRUCE Project Website with plans and additional information: http://mnspruce.ornl.gov/

SPRUCE Data Policy - Sharing, Access, and Use Recommendations:
http://mnspruce.ornl.gov/content/spruce-data-policies

Related Data Sets:

The PhenoCam Network

The PhenoCam Network provides automated, near-surface remote sensing of canopy phenology across the northeastern United States and adjacent Canada. A digital camera will be installed in each experimental chamber to track shifts in plant phenology driven by elevated carbon dioxide and elevated temperature, and then we will use these data to develop predictive phenological models. A test camera has been installed adjacent to the Tree and Shrub cameras. Images are available on the PhenoCam Network web site: http://phenocam.sr.unh.edu/webcam/sites/ (scroll down to “spruce *”)

Figure 5. Screen capture of the PhenoCam Network web page for “sprucetest”.

Table of Contents:

1. Data Set Overview:

This data set provides annual movies created from daily images of vegetation stands in the S1 Bog showing the seasonal changes of vegetation and appearance and disappearance of snow for the period June 2010 through December 2015. Cameras are positioned at the southern end of the bog and co-

located with monitoring Stations 1 and 2. Compiled movies are useful for examining the phenology of the bog and the changes to the landscape as experimental facilities have been constructed.

The types (resolution) and number of cameras, direction of image, and positions of the cameras have changed over time. See Table 1.

The site is the S1 bog, a *Picea mariana* [black spruce] – Sphagnum spp. bog forest in northern Minnesota, 40 km north of Grand Rapids, in the USDA Forest Service Marcell Experimental Forest (MEF).

2. Data Characteristics:

This data set provides movies created from daily images of vegetation stands in the S1 bog showing the seasonal changes of vegetation and appearance and disappearance of snow in the S1 bog for the period June 2010 through December 2015.

Spatial Coverage

All measurements were made at the 8.1-ha S1 bog forest site in northern Minnesota, 40 km north of Grand Rapids, in the USDA Forest Service Marcell Experimental Forest (MEF). These coordinates are the central location of the S1 bog.

Site boundaries: Latitude and longitude given in decimal degrees.

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Elevation (meters amsl)	Geodetic Datum
S1 Bog, Marcell Experimental Forest	-93.48283	-93.48283	47.50285	47.50285	418	WGS84

Temporal Coverage

The initial cameras and data loggers were installed and became operational in June 2010. We are currently operating 3 cameras: one with a tree view, a second focusing on shrub-level vegetation, and a third viewing the EM instrument footprint for diagnostic and data review reasons.

Time period: The data set covers the period 2010/06/10 to 2015/12/31, but not all cameras were in operation in the beginning.

Movie File Description

Each of the stored files is an iMovie (Version 9.0.9) of compiled daily photos for the respective timeframe and camera view. Images are collected at 9:00 and 12:00 standard time for the bog location. Missing images are noted in the movie files.

Table 1. Index to phenology movies. Note that cameras may have been moved during the year and the image frame and resolution may have been adjusted. The pixel resolution (width x height) for the majority of the year's images is listed under the Year. In 2012, the current Shrub and Tree cameras were added and the lower resolution camera was repositioned for the Instrument view.

Year (W x H)	Phenology Movie File	Image View
2010 (640 x 480)	SPRUCE_Tree2010Rev2.m4v	
2011 (640 x 480)	SPRUCE_Tree2011Rev.m4v	

2012 (640 x 504)	SPRUCE EMInst 2012Rev2.m4	
2012 (1280 x 992)	SPRUCE_Shrub2012Rev.m4v	
2012 (1280 x 992)	SPRUCE_Tree2012Rev3.m4v	
2013 (640 x 504)	SPRUCE_EMInst2013Rev2.m4v	

2013 (1280 x 992)	SPRUCE_Shrub2013Rev.m4v	
2013 (1280 x 992)	SPRUCE_Tree2013Rev.m4v	
2014 (640 x 504)	SPRUCE_EMInst2014Rev.m4v	
2014 (1280 x 992)	SPRUCE_Shrubs2014Rev2.m4v	

2014 (1280 x 992)	SPRUCE_Trees2014Rev.m4v	
2014 Construction Photos* (1296 x 960)	SPRUCE_Plot4SheetPiles.m4v	
2015 (640 x 504)	SPRUCE_EMInst2015.m4v	
2015 (1280 x 992)	SPRUCE_Shrubs2015.m4v	

2015 (1280 x 992)	SPRUCE_Trees2015.m4v	

*Source of construction images: http://phenocam.sr.unh.edu/webcam/browse/sprucetest/2014/12/22/

3. Data Application and Derivation:

Compiled movies are useful for examining the phenology of the bog and the changes to the landscape as experimental facilities have been constructed.

4. Quality Assessment:

These data are considered at **Quality Level 1**. Level 1 indicates an internally consistent data product that has been subjected to quality checks and data management procedures

5. Data Acquisition Materials and Methods:

Station Locations:

This data set provides annual movies created from daily images of vegetation stands in the S1 Bog showing the seasonal changes of vegetation and appearance and disappearance of snow for the period June 2010 through December 2015.

Data Collection:

From 2010 until May 2014, data files were collected manually each week from the attendant Campbell Scientific data loggers. Each data logger used a flash card memory as a data back-up. Phenology photographs were automatically taken twice a day with one, later two and finally three cameras. The types (resolution) and number of cameras, direction of image, and positions of the cameras have changed over time.

Beginning in May 2014, images were automatically acquired from the data logger over a network and files stored on data acquisition servers.

Preventative Maintenance:

Routine camera software upgrades and preventive maintenance, such as replacing packages of desiccant within the camera housing, were performed as need.

Data Processing:
From 2010 until May 2014, data files are downloaded weekly from the Campbell Scientific data loggers at each Station by US Forest Service or ORNL Staff and forwarded to ORNL per our established data transfer protocol. Beginning in May 2014, images were accessible from the data server.

Movie Creation:

Available images for the selected timeframe were loaded into iMovie (Version 9.0.9). Each of the stored files is an iMovie (Version 9.0.9) of compiled daily photos for the respective timeframe and camera view. Images are collected at 9:00 and 12:00 standard time for the bog location. Missing images are noted in the movie files.

6. References:

Hanson PJ, Childs KW, Wullschleger SD, Riggs JS, Thomas WK, Todd DE, Warren JM (2011) A method for experimental heating of intact soil profiles for application to climate change experiments. Global Change Biology 17:1083-1096. DOI: 10.1111/j.1365-2486.2010.02221.x

7. Data Access:

This data is available through the Oak Ridge National Laboratory (ORNL) Carbon Dioxide Information Analysis Center (CDIAC)

Data Archive Center:

Contact for Data Center Access Information:

E-mail: http://cdiacservices.ornl.gov/feedback.cfm