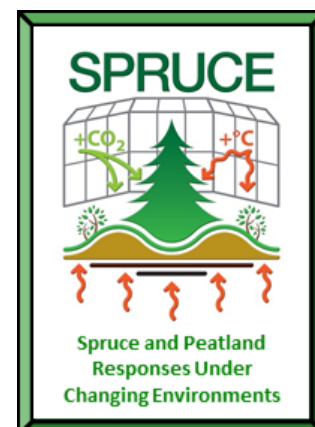


SPRUCE Ground Observations of Phenology in Experimental Plots, Spring 2016

Summary:

This data set consists of springtime (April-June 2016) phenological transition dates, as derived from direct observations recorded by a human observer, from the SPRUCE experiment during the first year of whole-ecosystem warming (Hanson et al. 2017).



Beginning in April 2016, human observers have been directly tracking the phenology of both woody and herbaceous species on a weekly schedule within the SPRUCE experimental chambers. The observed date report here is the first survey date on which an event/phenophase was definitively observed.

The data have been analyzed and reported on in the following paper:

Andrew D. Richardson, Koen Hufkens, Thomas Milliman, Donald M. Aubrecht, Morgan E. Furze, Misha B. Krassovski, John M. Latimer, W. Robert Nettles, Jeffrey M. Warren, and Paul J. Hanson. **Ecosystem warming extends growing season but heightens cold temperature vulnerability.** Submitted.



Figure 1. Observations of phenology in SPRUCE experimental plots.

Data Citation:

Cite this data set as follows:

Richardson, A.D., J.M. Latimer, W.R. Nettles, J.M. Warren, and P.J. Hanson. 2017. **SPRUCE Ground Observations of Phenology in Experimental Plots, Spring 2016**. 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.044>

DOI Note: This DOI has not been registered so it will not resolve to the landing page. It will be registered when the submitted paper is published.

Data and Documentation Access:

Get Data:

For public access to SPRUCE data please visit the SPRUCE Web Site:

<http://mnspruce.ornl.gov/>

Description and Links to Supplemental Information:

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

SPRUCE Project Website with project 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:

TBD

SPRUCE Project Description

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 a key 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* [peat moss] 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 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 peatlands.

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 enclosures. All temperatures, ambient through the +9°C warming treatment, 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 1100-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](#).

1. Data Set Overview:

Beginning in April 2016, human observers have been directly tracking the phenology of both woody and herbaceous species within the SPRUCE experimental chambers.

2. Data Characteristics:

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.

Temporal Coverage

The data reported in were collected in April through June 2016.

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

Data Dictionary

Missing Values -- Missing values are represented by "N/A".

Data File: SPRUCE Ground phenology observations Spring 2016.csv

File format

The data set (text file, comma delimited) is arranged by phenophase and species, with the following columns:

- **Species:** Plant species name (Latin binomial)
- **Enclosure:** SPRUCE plot number
- **Temperature treatment (delta T):** The enclosure air temperature differential, relative to the two unheated control plots (6, 19)
- **Observer:** The initials of the person conducting the observations, either WRN or JML
- **Phenophase:** The phenological event being observed
- **Calendar Date:** The calendar date at which the phenological event was observed to occur. Formatted as YYYY-MM-DD
- **DOY:** The day of year of the reported calendar date

3. 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. Established calibration procedures were followed.

4. Methods and Materials:

Site Description

The SPRUCE experiment is located within the S1 peat bog at the Marcell Experimental Forest, approximately 40 km north of Grand Rapids in north-central Minnesota, USA. The historic climate at the site is subhumid continental: mean annual temperature is 4°C, mean annual precipitation is 750 mm, and extreme temperatures range from –38 °C to +30 °C.

Canopy vegetation at SPRUCE is dominated by the tree species *Picea mariana* (Mill.) B.S.P. (black spruce), with additional contributions from *Larix laricina* (Du Roi) K. Koch (eastern tamarack or larch). The SPRUCE understory is dominated by the evergreen shrubs *Rhododendron groenlandicum* (Oeder) Kron & Judd (Labrador tea) and *Chamaedaphne calyculata* (L.) Moench. (leatherleaf), and is underlain by a bryophyte layer dominated by *Sphagnum* spp. moss. Other common plant species include the evergreen shrub *Kalmia polifolia* Wangenh. (bog laurel), the deciduous shrub *Vaccinium angustifolium* Aiton 1789 not Benth. 1840 (lowbush blueberry), the sedge *Eriophorum* spp. (cottongrass), and the perennial herb *Maianthemum trifolium* (L.) Sloboda (false Solomon's seal).

Methods

Beginning in April 2016, human observers have been directly tracking the phenology of both woody and herbaceous species within the SPRUCE experimental chambers.

Ground observations of spring phenology were made at approximately weekly intervals by WRN and JL.

WRN's protocol involved recording, on a pre-printed form for each of the 10 enclosures and the two ambient environment plots, whether or not ("Yes" or "No") specific phenophases (buds breaking, shoots elongating, leaves growing, flowering, and fruiting) for woody species (the trees *Picea* and *Larix*; the evergreen shrubs leatherleaf, bog laurel, Labrador tea, and lowbush blueberry), a sedge (cottongrass), and a perennial herb (false Solomon's seal).

ADR transcribed the data by taking as the observed date the first survey date on which an event was definitively observed (i.e., "No" through week 4, followed by "Yes" in week 5: the event occurred in week 5). Not all phenophases were observed for all species, and in some difficult-to-observe cases, the data were deemed not reliable because of some inconsistencies in the recorded data (e.g. blank cells rather than "No", or "No" followed by "Yes" followed by "No" again) or poor representation of the species in question in some of the plots (e.g., bog laurel and lowbush blueberry are sparsely distributed). We resolved as many issues as possible by consulting high-frequency phenocam imagery recorded for each enclosure, and by referring to a more limited set of phenological notes recorded by JMW. All transcribed data of questionable reliability have been excluded from this data set.

JL's protocol involved recording the first date at which *Larix* leaf buds were observed to be just beginning to break (data recorded for all 10 enclosures, plus the two ambient environment plots), and the first date at which flowers of leatherleaf, bog laurel, and Labrador tea were observed in each enclosure (data recorded in only half of the treated enclosures, plus one or both of the ambient environment plots).

5. References:

Hanson, P. J., J. S. Riggs, W. R. Nettles, J. R. Phillips, M. B. Krassovski, L. A. Hook, L. Gu, A. D. Richardson, D. M. Aubrecht, D. M. Ricciuto, J. M. Warren, and C. Barbier. 2017. Attaining whole-ecosystem warming using air and deep-soil heating methods with an elevated CO₂ atmosphere. *Biogeosciences* 14:861–883.

6. 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>