ABoVE: White Spruce Photosynthetic and Leaf Traits, Alaska and New York, 2017

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Documentation Revision Date: 2023-03-17

Dataset Version: 1

Summary

This dataset provides measurements of gas exchange (light response curves, Kok curves and ACi curves), leaf traits (carbon, nitrogen, and specific leaf area), leaf pigments (Chlorophyll a, Chlorophyll b and Carotenoids), the photochemical reflectance index (PRI), and average photosynthetic photon flux density as collected from hemispherical photographs. Data were collected on white spruce trees (Picea glauca (Moench) Voss) growing at the northern edge of the species' distribution in Alaska and at the southern edge of the species' distribution in Black Rock Forest (BRF), New York. Measurements were taken at high and low canopy positions on each tree at both sites during the 2017 growing season (2017-06-19 to 2017-07-20). Gas exchange, leaf trait, pigment and spectral measurements were obtained using a portable photosynthesis system (LI-6800, LI-COR, Lincoln, NE). Photochemical reflectance index was determined using a spectroradiometer, and hemispherical photographs were taken with a digital camera. These data were collected to better understand how vertical canopy gradients in photosynthetic physiology change from the southernmost to the northernmost range extremes of white spruce. The data are provided in comma-separated value (CSV) format.

This dataset contains one data file in comma-separated values (*.csv) format.

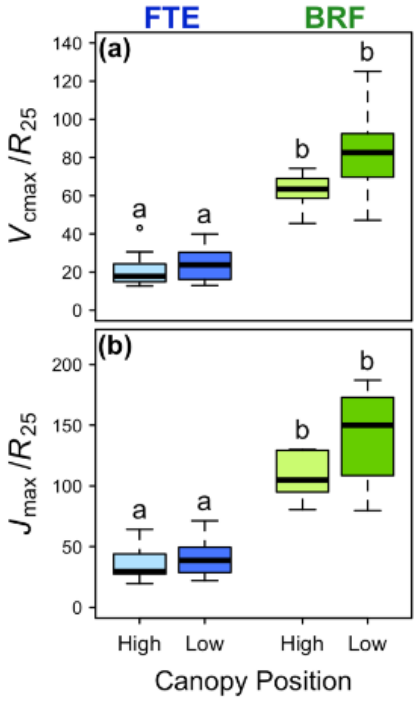

Figure 1. Ratios of (a) maximum rate of carboxylation to respiration at 25 degrees C from Griffin et al. (2022) (Vcmax /R25) and (b) maximum electron transport rate to respiration at 25 degrees C from Griffin et al. (2022) (Jmax /R25) of white spruce from high and low canopy positions at the Forest Tundra Ecotone (FTE, blue), Alaska, and Black Rock Forest (BRF, green), New York. Boxplots show the median and first and third quartiles. Whiskers display the range of groups with individual points representing outliers falling outside 1.5 times the interquartile range. Different letters represent significant differences between locations and canopy positions.

Citation

Schmiege, S.C., K. Griffin, N.T. Boleman, L. Vierling, S.G. Bruner, E. Min, A.J. Maguire, J. Jensen, and J. Eitel. 2023. ABoVE: White Spruce Photosynthetic and Leaf Traits, Alaska and New York, 2017. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2124

Table of Contents

1. Dataset Overview

This dataset provides measurements of gas exchange (light response curves, Kok curves and *ACi* curves), leaf traits (carbon, nitrogen, and specific leaf area), leaf pigments (Chlorophyll *a*, Chlorophyll *b* and Carotenoids), the photochemical reflectance index (PRI), and average photosynthetic photon flux density as collected from hemispherical photographs. Data were collected on white spruce trees (*Picea glauca* (Moench) Voss) growing at the northern edge of the species' distribution in Alaska and at the southern edge of the species' distribution in Black Rock Forest (BRF), New York. Measurements were taken at high and low canopy positions on each tree at both sites during the 2017 growing season (2017-06-19 to 2017-07-20). Gas exchange, leaf trait, pigment and spectral measurements were obtained using a portable photosynthesis system (LI-6800, LI-COR, Lincoln, NE). Photochemical reflectance index was determined using a spectroradiometer, and hemispherical photographs were taken with a digital camera. These data were collected to better understand how vertical canopy gradients in photosynthetic physiology change from the southernmost to the northernmost range extremes of white spruce. The data are provided in comma-separated value (CSV) format.

Project: Arctic-Boreal Vulnerability Experiment

The Arctic-Boreal Vulnerability Experiment (ABoVE) is a NASA Terrestrial Ecology Program field campaign being conducted in Alaska and western Canada, for 8 to 10 years, starting in 2015. 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 to, and societal implications of, climate change in the Arctic and Boreal regions.

Related Publication

Schmiege, S.C., K.L. Griffin, N.T. Boelman, L.A. Vierling, S.G. Bruner, E. Min, A.J. Maguire, J. Jensen, and J.U.H. Eitel. 2022. Vertical gradients in photosynthetic physiology diverge at the latitudinal range extremes of white spruce. Plant, Cell & Environment https://doi.org/10.1111/pce.14448

Related Datasets

Eitel, J., A.J. Maguire, K. Griffin, N. Boelman, J.E. Jensen, S.C. Schmiege, and L. Vierling. 2020. ABoVE: Photochemical Reflectance and Tree Growth, Brooks Range, Alaska, 2018-2019. ORNL Distributed Active Archive Center. https://doi.org/10.3334/ORNLDAAC/1781.

Griffin, K., S.C. Schmiege, S.G. Bruner, N. Boelman, L. Vierling, J. Eitel, and Z.M. Griffin. 2022. Spruce Leaf, Tree Traits, and Respiration at Range Extremes, AK and NY, USA, 2018. ORNL Distributed Active Archive Center. https://doi.org/10.3334/ORNLDAAC/1948.

Maguire, A.J., J. Eitel, L. Vierling, N. Boelman, K. Griffin, J.S. Jennewein, and J.E. Jensen. 2020. ABoVE: Terrestrial Lidar Scanning Forest-Tundra Ecotone, Brooks Range, Alaska, 2016. ORNL Distributed Active Archive Center. https://doi.org/10.3334/ORNLDAAC/1782.

Acknowledgement

This work was supported by the NASA ABoVE program, grant number NNX15AT86A.

2. Data Characteristics

Spatial Coverage: The Forest Tundra Ecotone (FTE) in Alaska (northern treeline in the Brooks Range of Alaska, south of Chandalar Shelf and Atigun Pass on the east side of the Dalton Highway), and Black Rock Forest (BRF) New York, US.

Temporal Resolution: One-time measurements

Temporal Coverage: 2017-06-19 to 2017-07-20

Study Area: Latitude and longitude are given in decimal degrees.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Forest Tundra Ecotone (FTE), Alaska	-149.754	-149.754	67.9947	67.9947
Black Rock Forest (BRF), New York	-74.0246	-74.0246	41.4011	41.4011

Data File Information:

This dataset contains one data file: *WhiteSpruce_Leaf_Traits_Alaska_NewYork.csv*. The file contains measurements of gas exchange (light response curves, Kok curves and ACi curves), leaf traits (carbon, nitrogen and specific leaf area), leaf pigments (Chlorophyll *a*, Chlorophyll *b* and Carotenoids), the photochemical reflectance index (PRI), and average photosynthetic photon flux density as collected from hemispherical photographs.

No data values are indicated by -9999.

Note: FTE data were collected from six plots spaced along a north-south 5.5 km transect; however the same coordinates are used for all FTE measurements. At BRF data were collected from a single site location.

Table 1. Data dictionary for *WhiteSpruce_Leaf_Traits_Alaska_NewYork.csv*.

Variable	Units	Description

location		Forest Tundra Ecotone, Alaska (AK); or Black Rock Forest, NY (BRF)
plot		Plot number: in Alaska 1-6; at BRF only one plot called plot 7
tree		Tree identifier at each plot: in Alaska A-F; at BRF 1-6
latitude	degrees north	Latitude of study sites
longitude	degrees east	Longitude of study sites
canopy		Canopy position: low or high
leaf		Leaf identifier if more than one was measured per tree
licor_rep	1	Replication number in case any curves were remeasured
licor_date_collected	YYY-MM-DD	Date of licor measurements (all gas exchange data and carbon, nitrogen data)
respiration_light	μmol m^{-2} s^{-1}	Respiration in the light
apparent_quantum_yield		Apparent quantum yield
respiration_dark	μmol m^{-2} s^{-1}	Respiration in the dark
light_comp_point	μmol m^{-2} s^{-1}	Light compensation point
photosynthesis_1500	μmol m^{-2} s^{-1}	Photosynthesis at 1500 μmol m^{-2} s^{-1}
light_sat_point	μmol m^{-2} s^{-1}	Light saturation point
max_carboxylation_rate	μmol m^{-2} s^{-1}	Maximum carboxylation rate
max_electron_transport	μmol m^{-2} s^{-1}	Maximum electron transport
nitrogen	percent	% Nitrogen
carbon	percent	% Carbon
carbon_nitrogen_ratio		Carbon to nitrogen ratio
carbon_perleaf_area	mg C cm^{-2}	Carbon per leaf area
nitrogen_perleaf_area	mg N cm^{-2}	Nitrogen per leaf area
specific_leaf_area	cm^2 g^{-1}	Specific leaf area
photo_reflectance_index		Photochemical reflectance index
chlorophyll_a_area	μg cm^{-2}	Area-based chlorophyll a content
chlorophyll_b_area	μg cm^{-2}	Area-based chlorophyll b content
sum_chlorophyll_ab_area	μg cm^{-2}	Sum of area-based chlorophyll a and b contents
carotenoid_content_area	μg cm^{-2}	Area-based carotenoid content
ratio_chlorophyll_carotenoids		Ratio of total chlorophyll to carotenoids
ratio_chlorophyll_a_to_b		Ratio of chlorophyll a to chlorophyll b
unique_tree		Concatenation of location, plot and tree columns
av_photo_photonflux_density	mol m^{-2} day^{-1}	Average photosynthetic photon flux density

3. Application and Derivation

This dataset provides measurements of gas exchange (light response curves, Kok curves and *AC*i curves), leaf traits (carbon, nitrogen and specific leaf area), leaf pigments (Chlorophyll *a*, Chlorophyll *b* and Carotenoids), the photochemical reflectance index (PRI) and average photosynthetic photon flux density as collected from hemispherical photographs. The data were collected to better understand how vertical canopy gradients in photosynthetic physiology change from the southernmost to the northernmost range extremes of white spruce. See Schmiege et al. (2022) for details.

4. Quality Assessment

Data were manually edited by the data provider to remove spurious data.

5. Data Acquisition, Materials, and Methods

Study Sites:

Two areas located at the northern and southern range limits of white spruce were chosen for this study. At the northern range limit, data were collected from six sites located in the forest tundra ecotone along a north south 5.5 km long transect on the east side of the Dalton Highway in the Brooks Range in northern Alaska (67°59’40.92” N latitude, 149°45’15.84” W longitude; Eitel et al., 2019). White spruce is the dominant tree species. Deciduous shrubs and

sedges are present in the understory. The site is underlain by continuous permafrost. During the Alaska measurement campaign in July 2017, photoperiod ranged from 22 to 24 hours.

At the southern range limit of white spruce, data were collected from Black Rock Forest, New York (BRF; 41°24'03.91" N latitude, 74°01'28.49" W longitude). BRF is a northern temperate deciduous forest that is dominated by oaks (Schuster et al. 2008). The photoperiod was approximately 15 hours during the measurement campaign in June 2017.

Methodology:

At the FTE, three white spruce trees with DBH greater than 10 cm were chosen at each of the six sites for a total of 18 study trees. At BRF, six white spruce trees with DBH greater than 10 cm were chosen at a single site. On each tree, measurements were taken at a high (approximately 1 m below the apical meristem) and low (at approximately 1.37 m, i.e. diameter at breast height) south-facing canopy positions. Because there were fewer trees at BRF, three measurements per canopy position per tree were taken.

Light environment measurements: Hemispherical photographs were taken at the high and low canopy positions on each tree with a digital camera (CoolPix 4500, Nikon Corporation, Tokyo Japan) and an attached fisheye lens to assess canopy openness. The camera was positioned immediately adjacent to the branch chosen for measurements, with the camera pointing north for the photograph. Light environment was assessed and modeled using the free R code and documentation of ter Steege (2018).

Gas exchange, leaf trait, pigment and spectral measurements: Gas exchange was measured at high and low canopy positions on each tree at the two locations. At both locations, measurements were taken on a branch tip inserted into the cuvette. CO_2 (A-C_i), light response (A-Q) and Kok curves were collected using two portable photosynthesis systems (LI-6800, LI-COR, Lincoln, NE).

After gas exchange measurements, leaf area was measured and leaves were dried to gain estimates of specific leaf area. Leaves were then ground for analysis of leaf carbon and nitrogen content. Pigment concentrations were assessed on needles adjacent to those chosen for gas exchange and carbon and nitrogen analyses. The Photochemical Reflectance Index was also measured using a spectroradiometer.

For additional details on methods, please see Schmiege et al. (2022).

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

Eitel, J., A.J. Maguire, K. Griffin, N. Boelman, J.E. Jensen, S.C. Schmiege, and L. Vierling. 2020. ABoVE: Photochemical Reflectance and Tree Growth, Brooks Range, Alaska, 2018-2019. ORNL Distributed Active Archive Center. https://doi.org/10.3334/ORNLDAAC/1781.

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