SHIFT: Laboratory Foliar Chemical Analysis Results for Field Samples, CA, 2022

Documentation Revision Date: 2024-04-25

Dataset Version: 1

Summary

This dataset holds laboratory foliar chemical analyses results for field samples collected during the 2022 NASA Surface Biology Geology (SBG) High Frequency Time series (SHIFT) campaign in Santa Barbara County, California, USA. Leaf samples were collected from plots within the Dangermond Preserve, Sedgwick Reserve, and Carpinteria Salt Marsh Reserve during the period of 2022-02-23 to 2022-09-27 and dried for later analysis. This project collected field data contemporaneously with weekly flights of the NASA's Airborne Visible-Infrared Imaging Spectrometer-Next Generation (AVIRIS-NG) facility instrument over the study areas. Sixteen chemical traits from two different lab analyses are provided. (a) Elemental analysis: foliar nitrogen (%), phosphorus (%), magnesium (%), potassium (%), calcium (%), sulfur (%), boron (ppm), iron (ppm), manganese (ppm), copper (ppm), zinc (ppm), aluminum (ppm), and sodium (ppm). (b) AnkomFiber analysis: foliar hemicellulose and bound protein (%), cellulose (%), and lignin (%). Related data packages contain additional plot-level characterization, biogeochemical, reflectance, and foliar data. These data are provided in comma separated values (CSV) format.

There are four files in comma separated values (CSV) format that contain laboratory chemistry results for both flash-frozen-freeze-dried (FF) and oven-dried (OD) ground foliar materials.

Figure 1. Scanned image of black mustard (Brassica nigra) leaves. Source: 001_LMA.jpeg from Chadwick et al. (2024).

Citation

Zheng, T., N. Queally, K.D. Chadwick, J. Cryer, P. Reim, C. Villanueva-Weeks, P. Townsend, M. Berg, Z. Breuer, N. Burkard, A. Hanson, E. Johnson, E. Kanski, D. Lacey, C. Lapinskas, A. Lee, E. Lisenbee, E. Marsh, L. Pfau, I. Shifrin, B. Skalitzky, S. Stroschein, J. Van beek, C. Vanden heuvel, and A.

Williams. 2024. SHIFT: Laboratory Foliar Chemical Analysis Results for Field Samples, CA, 2022. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2337

Table of Contents

1. Dataset Overview
2. Data Characteristics
3. Application and Derivation
4. Quality Assessment
5. Data Acquisition, Materials, and Methods
6. References

1. Dataset Overview

This dataset holds laboratory foliar chemical analyses results for field samples collected during the 2022 NASA Surface Biology Geology (SBG) High Frequency Time series (SHIFT) campaign in Santa Barbara County, California, USA. Leaf samples were collected from plots within the Dangermond Preserve, Sedgwick Reserve, and Carpinteria Salt Marsh Reserve during the period of 2022-02-23 to 2022-09-27 and dried for later analysis. This project collected field data contemporaneously with weekly flights of the NASA's Airborne Visible-Infrared Imaging Spectrometer-Next Generation (AVIRIS-NG) facility instrument over the study areas. Sixteen chemical traits from two different lab analyses are provided. (a) Elemental analysis: foliar nitrogen (%), phosphorus (%), magnesium (%), potassium (%), calcium (%), sulfur (%), boron (ppm), iron (ppm), manganese (ppm), copper (ppm), zinc (ppm), aluminum (ppm), and sodium (ppm). (b) AnkomFiber analysis: foliar hemicellulose and bound protein (%), cellulose (%), and lignin (%). Related data packages contain additional plot-level characterization, biogeochemical, reflectance, and foliar data. These data are provided in comma separated values (CSV) format.

Project: Surface Biology and Geology High-Frequency Time Series (SHIFT)

The Surface Biology and Geology (SBG) High Frequency Time Series (SHIFT) was an airborne and field campaign during February to May, 2022, with a follow up activity for one week in September, in support of NASA's SBG mission. Its study area included a 640-square-mile (1,656-square-kilometer) area in Santa Barbara County and the coastal Pacific waters. The primary goal of the SHIFT campaign was to collect a repeated dense time series of airborne Visible to ShortWave Infrared (VSWIR) airborne imaging spectroscopy data with coincident field measurements in both inland terrestrial and coastal aquatic areas, supported in part by a broad team of research collaborators at academic institutions. The SHIFT campaign leveraged NASA's Airborne Visible-Infrared Imaging Spectrometer-Next Generation (AVIRIS-NG) facility instrument to collect approximately weekly VSWIR imagery across the study area. The SHIFT campaign 1) enables the NASA SBG team to conduct traceability analyses related to the science value of VSWIR revisit without relying on multispectral proxies, 2) enables testing algorithms for consistent performance over seasonal time scales and end-to-end workflows including community distribution, and 3) provides early adoption test cases to SHIFT application users and incubate relationships with basic and applied science partners at the University of California Santa Barbara Sedgwick Reserve and The Nature Conservancy's Jack and Laura Dangermond Preserve.

Related datasets:

Queally, N., F.W. Davis, K.D. Chadwick, C. Ade, L. Anderegg, Y. Angel, B. Baker, I. Boving, R.K. Braghiere, P. Brodrick, P. Campbell, J. Cryer, K.C. Cushman, P.D. Dao, A. Dibartolo, R. Eckert, K. Grant, B. Heberlein, M. Johnson, J. Joutras, K. Kerr, C. Kibler, M. Klope, K. Kovach, A. Kreisberg, P. Lovegreen, A.J. Maguire, C. Mcmahon, K. Miner, C. Nickles, F. Ochoa, J.P. OcÃ³n, A. Ongjoco, E. Ordway, M. Park, R. Pavlick, A.M. Raiho, D.A. Roberts, C.M. Saiki, F.D. Schneider, K. Thompson, P. Townsend, E. Vermeer, C. Villanueva-Weeks, N. Vinod, T. Zheng, K. Zumdahl, and D.S. Schimel. 2023. SHIFT: Vegetation Plot Characterization, Santa Barbara County, CA, 2022. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2295

- Provides SHIFT plot locations, descriptions, species, fractional cover, phenophase, and sample identifier data. Plot identifiers are consistent across datasets.

Chadwick, K.D., N. Queally, T. Zheng, J. Cryer, C. Vanden Heuvel, C. Villanueva-Weeks, C. Ade, L. Anderegg, Y. Angel, B. Baker, I. Boving, R.K. Braghiere, P. Brodrick, P. Campbell, K.C. Cushman, F. Davis, P.D. Dao, A. Dibartolo, R. Eckert, K. Grant, B. Heberlein, M. Johnson, J. Joutras, C. Kibler, M. Klope, K. Kovach, A. Kreisberg, P. Lovegreen, A.J. Maguire, C. Mcmahon, K. Miner, C. Nickles, F. Ochoa, J.P. Ocón, A. Ongjoco, E. Ordway, M. Park, R. Pavlick, A.M. Raiho, D.A. Roberts, D.S. Schimel, F.D. Schneider, K. Thompson, P. Townsend, E. Vermeer, N. Vinod, and K. Zumdahl. 2023. SHIFT Photosynthetic and Leaf Traits, Santa Barbara County, 2022. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2233

- Provides leaf images and measurements of leaf traits (area, wet weight, dry weight, leaf mass per area, leaf water content) and leaf pigments (chlorophyll) and species information

Queally, N., F.W. Davis, K.D. Chadwick, C. Ade, L. Anderegg, Y. Angel, B. Baker, L. Baskaran, I. Boving, R.K. Braghiere, P. Brodrick, P. Campbell, J. Cryer, K.C. Cushman, P.D. Dao, A. Dibartolo, R. Eckert, K. Grant, B. Heberlein, M. Johnson, J. Joutras, K. Kerr, C. Kibler, M. Klope, K. Kovach, A. Kreisberg, P. Lovegreen, A.J. Maguire, C. Mcmahon, K. Miner, C. Nickles, F. Ochoa, J.P. OcÃ³n, A. Ongjoco, E. Ordway, M. Park, R. Pavlick, A.M. Raiho, D.A. Roberts, C.M. Saiki, F.D. Schneider, K. Thompson, P. Townsend, E. Vermeer, C. Villanueva-Weeks, N. Vinod, T. Zheng, K. Zumdahl, and D.S. Schimel. 2024. SHIFT: Vegetation Plot Photos, Santa Barbara, CA, USA, 2022. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2334

- Provides photographs of the plots where field vegetation sampling was conducted during the 2022 NASA Surface Biology Geology (SBG) High Frequency Time series (SHIFT) campaign

Zheng, T., N. Queally, K.D. Chadwick, J. Cryer, P. Reim, P. Townsend, E. Marsh, M. Berg, Z. Breuer, N. Burkard, A. Hanson, E. Johnson, D. Lacey, A. Lee, L. Pfau, I. Shifrin, B. Skalitzky, S. Stroschein, J. Van beek, C. Vanden heuvel, and A. Williams. 2023. SHIFT: Reflectance Measurements for Dried and Ground Leaf Materials. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2244

- Provides spectra of dried and ground leaf material

2. Data Characteristics

Spatial Coverage: Plots within Dangermond Preserve, Sedgwick Reserve, and Carpinteria Salt Marsh Reserve in Santa Barbara County, California, U.S.

Temporal Resolution: One-time measurements

Temporal Coverage: 2022-02-23 to 2022-09-27

Study Areas: Provided in decimal degrees

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Dangermond Preserve	-120.50	-120.35	34.58	34.44
Sedgwick Reserve	-120.07	-120.01	34.74	34.68
Carpinteria Salt Marsh Reserve	-119.55	-119.53	34.41	34.39

Data File Information:

There are four files in comma separated values (CSV) format that contain laboratory chemistry results for both flash-frozen-freeze-dried (FF) and oven-dried (OD) ground foliar materials.

- ***FF_elemental_daac.csv***: Elemental results for FF foliar samples
- ***OD_elementa_daac.csv***: Elemental results for OD foliar samples
- ***FF_AnkomFiber_daac.csv***: AnkomFiber results for FF foliar samples
- ***OD_AnkomFiber_daac.csv****:* AnkomFiber results for OD foliar samples

Missing data are denoted by "NA" for text fields and -9999 for numeric fields.

User Note: In ***FF_elemental_daac.csv*** and ***OD_elemental_daac.csv****,* the value -8888 denotes measurements with low concentrations in the *Copper_ppm*, *Aluminium_ppm*, and *Sodium_ppm* fields. See *<element>_ppm_note* field for a comment about the estimated concentration, where <element> is "Copper", "Aluminium", or "Sodium".

Table 1. Data dictionary for *FF_elemental_daac.csv* and *OD_elemental_daac.csv*

Variable	Units	Description
plot_event_ID		Unique sampling visit to plot
species_or_type		Leaf species or sample type
sample_number		Identifier for each sample (unique)
sample_date	YYYY-MM-DD	Date that sample was taken in the field
latitude	degrees north	Latitude of study sites
longitude	degrees east	Longitude of study sites
plot_name	-	Plot name
phenophase	-	Phenological phase of the plant when sampled
fractional_cover	-	Binned fractional cover category visually estimated, from Queally et al. (2023a)
Nitrogen_perc	percent	Foliar nitrogen concentration in percent dry mass
Phosphorus_perc	percent	Foliar phosphorus concentration in percent dry mass
Magnesium_perc	percent	Foliar magnesium concentration in percent dry mass
Potassium_perc	percent	Foliar potassium concentration in percent dry mass
Calcium_perc	percent	Foliar calcium concentration in percent dry mass
Sulfur_perc	percent	Foliar sulfur concentration in percent dry mass
Boron_ppm	1e-6	Foliar boron concentration in ppm
Iron_ppm	1e-6	Foliar iron concentration in ppm

Manganese_ppm	1e-6	Foliar manganese concentration in ppm
Copper_ppm	1e-6	Foliar copper concentration in ppm
Zinc_ppm	1e-6	Foliar zinc concentration in ppm
Aluminum_ppm	1e-6	Foliar aluminum concentration in ppm
Sodium_ppm	1e-6	Foliar sodium concentration in ppm
note	-	Duplicates handling details
Copper_ppm_note	-	Notes for samples with low concentrations for the respective elements
Aluminum_ppm_note	-	
Sodium_ppm_note	-	

Table 2. Data dictionary for *FF_AnkomFiber_daac.csv* and *OD_AnkomFiber_daac.csv*

Variable	Units	Description
plot_event_ID	-	Unique sampling visit to plot
species_or_type	-	Leaf species or sample type
sample_number	-	Identifier for each sample (unique)
sample_date	YYYY-MM-DD	Date that sample was taken in the field
latitude	degrees north	Latitude of study sites
longitude	degrees east	Longitude of study sites
plot_name	-	Plot name
phenophase	-	Phenological phase of the plant when sampled
fractional_cover	-	Binned fractional cover category visually estimated, from Queally et al. (2023a)
hemicellulose_protein_perc	percent	Foliar concentration of hemicellulose and bound proteins in percent dry mass
cellulose_perc	percent	Foliar concentration of cellulosein percent dry mass
lignin_perc	percent	Foliar concentration of ligninin percent dry mass
note		Duplicates handling details

Note: ***plot_event_ID*** is related field in dataset Queally et al. 2023 https://doi.org/10.3334/ORNLDAAC/2295

3. Application and Derivation

This dataset provides measurements of sixteen leaf traits, and species information as sampled from meadow, shrub, and tree sites. The data were collected for the purposes of supporting the SBG SHIFT campaign in efforts to provide accurate information on plant communities over a large region of Santa Barbara County, California.

4. Quality Assessment

All samples were prepared consistently and assessed before sending out to different labs for further analysis.

5. Data Acquisition, Materials, and Methods

Study sites were located in Santa Barbara County, California (Quelly et al., 2023a). For meadow and shrub plots, individual plots were approximately 8 meters squared in area. For tree plots, the ground area of a single tree canopy was sampled. Sunlit leaves were collected from the meadow, tree, or shrub species in each plot.

After field collection, each leaf sample was divided into two portions: one portion with ~10 g fresh weight was oven dried and another portion with ~5 g fresh weight was flash frozen. Both samples were ground and homogenized (20-mesh, 833 µm) following Serbin et al. (2014). The oven dried samples were then re-dried in oven at 70 degrees C for 24 h. The flash frozen samples were dried using a Virtis Model 24DX48 specimen freeze dryer. Oven dried materials from 1468 samples were sent out for the chemical analyses. For 38 samples, both oven-dried and flash-frozen-freeze-dried materials were analyzed for comparison. Methods followed recommendations of Gavlak. et al. (1994).

Elemental Analysis

Approximately, 2 g +/- 0.3 g of dried materials for each sample were sent to Brookside laboratory (https://www.blinc.com/) for elemental analysis. Dried samples were ground into a leaf powder using a Cyclotech Mill with a 0.50-mm screen, weighed out into a teflon tube, then digested with 12-N nitric acid and hydrogen peroxide 30% solution. After digestion, samples were microwaved in a CEM Mars Microwave then analyzed on a Thermo 6500 Duo ICP vacuum spectrometer to determine the percentage of P, K, Ca, Mg, Na, Al, B, Zn, Mn, Cu, Mo, S, and Fe.

AnkomFiber Analysis

Approximately ~1 g of dried materials was sent to the Hobbie Lab at the University of Minnesota (https://cbs.umn.edu/hobbie-lab) to determine the concentration of hemicellulose, cellulose, and lignin using sequential extraction in a neutral detergent solution, a hot acid-detergent solution and 72% H_2SO_4 solution in an Ankom 200 Fiber Analyzer (Ankom Technology, Macedon, New York, USA).

6. References

Queally, N., F.W. Davis, K.D. Chadwick, C. Ade, L. Anderegg, Y. Angel, B. Baker, I. Boving, R.K. Braghiere, P. Brodrick, P. Campbell, J. Cryer, K.C. Cushman, P.D. Dao, A. Dibartolo, R. Eckert, K. Grant, B. Heberlein, M. Johnson, J. Joutras, K. Kerr, C. Kibler, M. Klope, K. Kovach, A. Kreisberg, P. Lovegreen, A.J. Maguire, C. Mcmahon, K. Miner, C. Nickles, F. Ochoa, J.P. OcÃ³n, A. Ongjoco, E. Ordway, M. Park, R. Pavlick, A.M. Raiho, D.A. Roberts, C.M. Saiki, F.D. Schneider, K. Thompson, P. Townsend, E. Vermeer, C. Villanueva-Weeks, N. Vinod, T. Zheng, K. Zumdahl, and D.S. Schimel. 2023. SHIFT: Vegetation Plot Characterization, Santa Barbara County, CA, 2022. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2295

Chadwick, K.D., N. Queally, T. Zheng, J. Cryer, C. Vanden Heuvel, C. Villanueva-Weeks, C. Ade, L. Anderegg, Y. Angel, B. Baker, I. Boving, R.K. Braghiere, P. Brodrick, P. Campbell, K.C. Cushman, F. Davis, P.D. Dao, A. Dibartolo, R. Eckert, K. Grant, B. Heberlein, M. Johnson, J. Joutras, C. Kibler, M. Klope, K. Kovach, A. Kreisberg, P. Lovegreen, A.J. Maguire, C. Mcmahon, K. Miner, C. Nickles, F. Ochoa, J.P. Ocón, A. Ongjoco, E. Ordway, M. Park, R. Pavlick, A.M. Raiho, D.A. Roberts, D.S. Schimel, F.D. Schneider, K. Thompson, P. Townsend, E. Vermeer, N. Vinod, and K. Zumdahl. 2023. SHIFT Photosynthetic and Leaf Traits, Santa Barbara County, 2022. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2233

Queally, N., F.W. Davis, K.D. Chadwick, C. Ade, L. Anderegg, Y. Angel, B. Baker, L. Baskaran, I. Boving, R.K. Braghiere, P. Brodrick, P. Campbell, J. Cryer, K.C. Cushman, P.D. Dao, A. Dibartolo, R. Eckert, K. Grant, B. Heberlein, M. Johnson, J. Joutras, K. Kerr, C. Kibler, M. Klope, K. Kovach, A. Kreisberg, P. Lovegreen, A.J. Maguire, C. Mcmahon, K. Miner, C. Nickles, F. Ochoa, J.P. OcÃ³n, A. Ongjoco, E. Ordway, M. Park, R. Pavlick, A.M. Raiho, D.A. Roberts, C.M. Saiki, F.D. Schneider, K. Thompson, P. Townsend, E. Vermeer, C. Villanueva-Weeks, N. Vinod, T. Zheng, K. Zumdahl, and D.S. Schimel. 2024. SHIFT: Vegetation Plot Photos, Santa Barbara, CA, USA, 2022. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2334

Zheng, T., N. Queally, K.D. Chadwick, J. Cryer, P. Reim, P. Townsend, E. Marsh, M. Berg, Z. Breuer, N. Burkard, A. Hanson, E. Johnson, D. Lacey, A. Lee, L. Pfau, I. Shifrin, B. Skalitzky, S. Stroschein, J. Van beek, C. Vanden heuvel, and A. Williams. 2023. SHIFT: Reflectance Measurements for Dried and Ground Leaf Materials. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2244

Gavlak, R.G., D.A. Horneck, R.O. Miller, Western Rural Center, and Far West Fertilizer and Agrichemical Association. 1994. *Plant, Soil and Water Reference Methods for the Western Region.* Western Rural Development Center; Corvallis, Oregon, U.S.

Serbin, S.P., A. Singh, B.E. McNeil, C.C. Kingdon, and P.A. Townsend. 2014. *S*pectroscopic determination of leaf morphological and biochemical traits for northern temperate and boreal tree species. Ecological Applications 24:1651–1669. https://doi.org/10.1890/13-2110.1