SMAPVEX19-22 Massachusetts Vegetation Optical Depth Version 1

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

Holtzman, N., A. G. Konings, A. Roy, M. Cosh, and A. Colliander. 2020. *SMAPVEX19-22 Massachusetts Vegetation Optical Depth, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/2PZJDURUJLWF. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/SV19MA_VOD

National Snow and Ice Data Center

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1 DATA DESCRIPTION

The goal of this experiment was to study the sensitivity of L-band vegetation optical depth (VOD) to changing vegetation water potential over a growing season. As part of the SMAPVEX19-22 campaign, an L-band radiometer was deployed atop a tower in the Harvard Forest, in Petersham, Massachusetts, looking down upon a stand of red oak. Additional instruments were installed within the radiometer's field of view to measure soil moisture and temperature, air temperature, tree xylem apparent dielectric permittivity at 70 MHz, tree xylem water potential, and canopy wetness throughout the same time frame. The radiometer collected data in V-polarization from late April to mid-October 2019. Also, over four days in early July 2019, the water potential and L-band complex dielectric constant of canopy leaves were measured at various times of day.

1.1 Parameters

This data set includes the following parameters for ground-based observations:

- Air temperature
- Brightness Temperature
- Soil Temperature
- Surface Soil Moisture
- Vegetation Optical Depth
- Vegetation Water Potential
- Xylem Dielectric Permittivity

1.2 File Information

1.2.1 Format

ASCII text available as Comma Separated Values (.csv) files. Total data volume of 412kB

1.2.2 File Contents

The following describes the content and data fields of each .csv file:

1.2.2.1 SV19MA_VODhydr_continuous_data.csv

File Contents: all continuously-measured variables relevant to the study: VOD and the data used to retrieve it, xylem water potential, xylem dielectric permittivity, and canopy wetness.

Table 1. File Contents

Variable	Description
Index	Row number in table
DateTime	Year-month-day; Hour; UTC -4:00 or EDT
Soil temperature	K, mean of 2 sensors
Air temperature	K, mean of 2 sensors
V-pol L-band brightness temperature	K
Soil moisture	m3/m3, mean of 2 sensors
VOD	Vertical optical depth (unitless)
Precipitation	mm/hr
Xylem apparent dielectric permittivity at 70 MHz	Unitless value*
Stem xylem water potential, Tree 11	MPa
Stem xylem water potential, Tree 12	MPa
Stem xylem water potential, Tree 13	MPa
Canopy wetness	0-1 scale, where 0 equals zero percent and 1 equals 100%, mean of 5 sensors
*Complex-valued relative permittivity (relative to the dielectric permittivity of free space).	

1.2.2.2 SV19MA_VODhydr_leaf_dielectric.csv

File Contents: L-band measurements of leaf complex dielectric constant from July 2019

Table 2. File Contents

Variable	Description
Date/Time	Month/Day/Year; Hour:Minute
espRe	Real*
espIm	Imaginary*
TreeNumber	Integer
*Real and imaginary parts of the complex-valued leaf relative dielectric permittivity, measured at 1.4 GHz frequency.	

1.2.2.3 SV19MA_VODhydr_leaf_potential.csv

File Contents: measurements of leaf water potential from July 2019

Table 3. File Contents

Variable	Description
Date	Month/Day/Year
Time	Hour:Minutes
Tree	Tree Number (integer)
Leaf Water Potential	MPa

1.2.2.4 SV19MA_VODhydr_pressure_volume.csv

File Contents: measurements of leaf and branch water, water potential and relative water content, as the samples were dried in air, used to construct pressure-volume curves.

Table 4. File Contents

Variable	Description
Water Potential	MPa
Relative Water Content	0-1 where 0 equals zero percent and 1 equals 100%
Sample ID	Branch/Leaf Number (integer)

1.2.3 Naming Convention

Example filename: SV19MA_VODhydr_leaf_potential.csv

Field campaign: SV19; SMAPVEX 2019-2022 campaign
Site: MA; Massachusetts
Experiment: VODhydr; VOD and plant hydraulics experiment within field campaign
Data set: continuous_data, leaf_dielectric, leaf_potential, pressure_volume

1.3 Spatial Information

1.3.1 Coverage

Latitude: 42.54 N
Longitude: 72.17 W
Site size or footprint: 20 m x 25 m
Coordinate Reference System: WGS 84

1.3.2 Resolution

N/A

1.4 Temporal Information

1.4.1 Coverage

Start Date: 28 April 2019
End Date: 17 October 2019

1.4.2 Resolution

Continuous data captured hourly. Additional leaf properties captured at single points in time.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

The goal of this experiment was to study the sensitivity of L-band vegetation optical depth (VOD) to changing vegetation water potential over a growing season.

2.2 Acquisition

As part of the SMAPVEX19-22 campaign, an L-band radiometer was deployed atop a tower in the Harvard Forest, in Petersham, Massachusetts, looking down upon a stand of red oak. Additional instruments were installed within the radiometer's field of view to measure soil moisture and temperature, air temperature, tree xylem apparent dielectric permittivity at 70 MHz, tree xylem water potential, and canopy wetness throughout the same time frame. The radiometer collected data in V-polarization from late April to mid-October 2019. Also, over four days in early July 2019, the water potential and L-band complex dielectric constant of canopy leaves were measured at various times of day.

2.3 Processing

To calculate VOD all data was aggregated to an hourly time step. The median value of brightness temperature within each hour was used because of the presence of outliers due to radio frequency interference. For all other data sources, the mean value within each hour was used.

Soil dielectric constant was estimated based on the Mironov dielectric mixing model, as a function of measured in-situ soil moisture assuming a 9% clay content. The air temperature at one meter above ground level, beneath the tree canopy study site, was used as a proxy for canopy temperature, based on its close match to infrared canopy temperature data from a nearby NEON site.

Given hourly values of brightness temperature, soil dielectric constant, soil temperature, and canopy temperature, the tau-omega model equation was solved for vegetation optical depth.

2.4 Quality, Errors, and Limitations

Table 5. Instrument & Data Limitations

Instrument/Variable	Accuracy
Radiometer	brightness temperature approximately 1 K
Soil moisture	± 0.01 volumetric units
Leaf water potential	0.025 MPa
Xylem dielectric permittivity	± 1

2.5 Instrumentation

2.5.1 Description

L-band radiometer: Potter Horn PR-1475, Radiometrics Inc.
Stem xylem dielectric probe: TEROS 12, METER Environment
Leaf dielectric sensor: Custom time-domain reflectometer
Leaf wetness sensor: LWS, METER Environment
Leaf water potential: M1000 pressure chamber, PMS Instruments
Stem water potential: PSY-1 psychrometer, ICT Instruments
Soil moisture and temperature: Hydraprobe, Stevens Water
Air temperature: Campbell Scientific 109 Air Temperature sensors

3 SOFTWARE AND TOOLS

Access data with software applications used to view comma separated value, .csv, documents.

4 RELATED DATA SETS

SMAP Validation Data

5 RELATED WEBSITES

SMAP Overview

6 CONTACTS AND ACKNOWLEDGMENTS

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7 REFERENCES

Holtzman, N., Anderegg, L. D. L., Kraatz, S., Mavrovic, A., Sonnentag, O., Pappas, C., Cosh, M. H., Langlois, A., Lakhankar, T., Tesser, D., Steiner, N., Colliander, A., Roy, A., & Konings, A. G. (2020). L-band vegetation optical depth as an indicator of plant water potential in a temperate deciduous forest stand. Copernicus GmbH. https://doi.org/10.5194/bg-2020-373

8 DOCUMENT INFORMATION

8.1 Publication Date

November 2020

8.2 Revision Date

August 2024