

# Predawn Leaf Water Potential of Oak-Hickory Forest at Missouri Ozark (MOFLUX) Site: 2004-2020



## Summary:

Measurements of predawn leaf water potential (PLWP) have been made at weekly to biweekly intervals during the 2004 to 2020 growing seasons of the second-growth upland oak-hickory forests at the Missouri Ozark AmeriFlux (MOFLUX) site. The MOFLUX site is located in the University of Missouri Baskett Wildlife Research area (BWREA), situated in the Ozark Border Region of central Missouri, USA. More recent data will be added periodically.

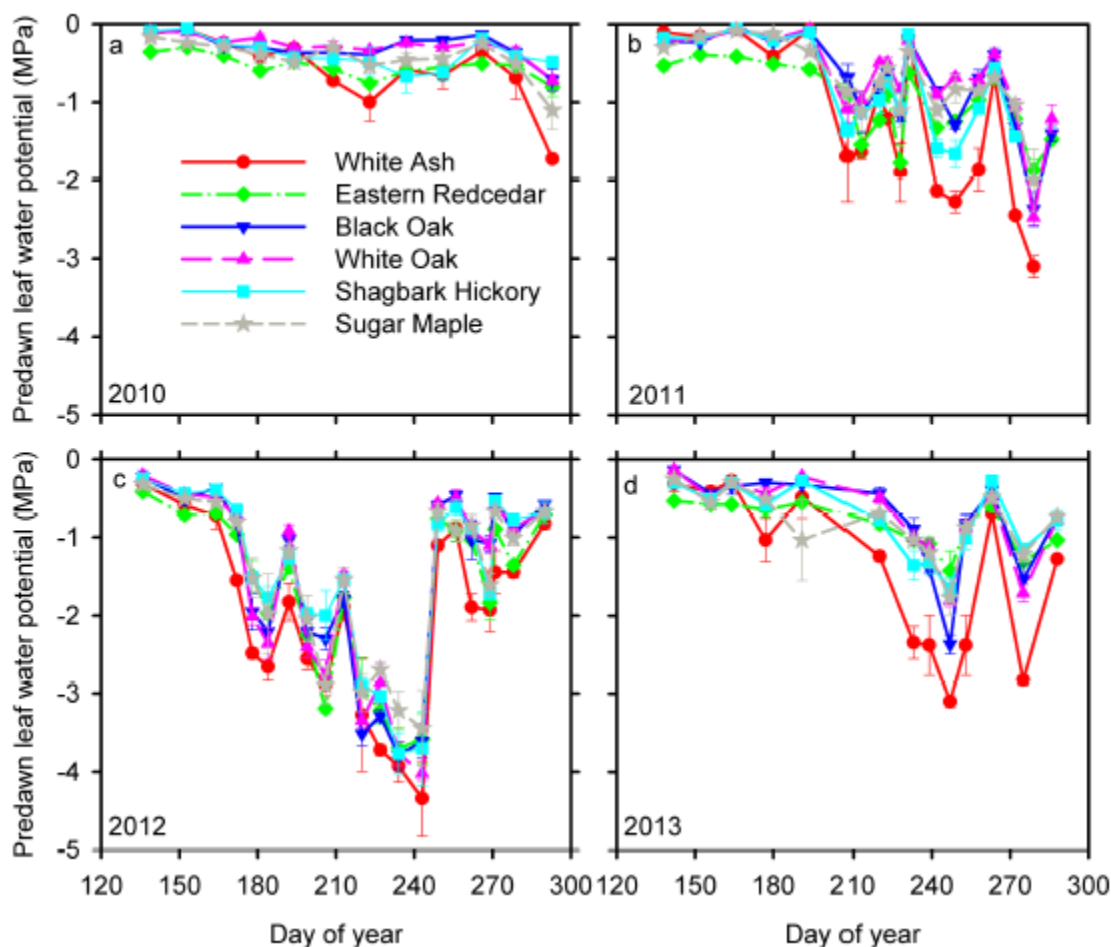
In each year, except for 2004, the first measurements occurred in mid-May. In all years, the last measurements took place in late October. Leaf samples were collected weekly or biweekly before dawn from canopy and sapling individuals of the common tree species at the site. A total of 20–21 samples were obtained each day with 6–7 taken from white oak (*Quercus alba* L.), and the rest, with at least two samples per species, distributed among black oak (*Q. velutina* Lam.), sugar maple (*Acer saccharum* Marsh.), shagbark hickory (*Carya ovata* (Mill.) K. Koch), white ash (*Fraxinus americana* L.), and eastern redcedar (*Juniperus virginiana* L.), roughly in proportion to their relative stem abundance in the stand.

## Data Release History

Release	Description	Data Citation
First release of PLWP data for MOFLUX	Covered the range of June 18, 2004 through October 18, 2014. Now superseded.	Pallardy et al., 2015
Second release	<p>Appends data through October 3, 2017</p> <p>There were <u>no changes to the previously released data</u> and the format and structure of this release are the same.</p> <p><u>Data citation was updated.</u> Now superseded.</p>	Pallardy et al., 2018
Third release January 25, 2021	<p>Appends data through October 16, 2020</p> <p>There were <u>no changes to the previously released data</u> and the format and structure of this release are the same.</p> <p><u>Data citation title was updated to be inclusive of year 2020 data.</u></p>	Pallardy et al., 2018

## Data Provided

There is one comma separated (.csv) data file of PLWP in this data set and the related published article is included as a companion file (Gu, et al., 2015).



**Figure 1.** Seasonal variations in predawn leaf water potential of different species from 2010 to 2013. Note that 2012 was a significant drought year. From Gu, et al., 2015.

## Data Citation:

Cite this data set as follows:

Pallardy, S.G., Gu, L., Wood, J.D., Hosman, K.P., and Sun, Y. 2018. **Predawn Leaf Water Potential of Oak-Hickory Forest at Missouri Ozark (MOFLUX) Site: 2004-2020.** Oak Ridge National Laboratory, TES SFA, U.S. Department of Energy, Oak Ridge, Tennessee, U.S.A.  
<https://doi.org/10.3334/CDIAC/ornlsfa.004>

**Please include this citation to the related publication:**

Gu, L., Pallardy, S. G., Hosman, K. P., and Sun, Y.: Drought-influenced mortality of tree species with different predawn leaf water dynamics in a decade-long study of a central US forest, Biogeosciences, 12, 2831-2845, doi:10.5194/bg-12-2831-2015, 2015.

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## **Data and Documentation Access:**

### **Get Data**

For public access to data please visit the ORNL TES-SFA Web Site: <https://tes-sfa.ornl.gov/home>

**Published Paper included as a companion file:** Gu, et al., 2015.

### **Links to Supplemental Data and Information**

AmeriFlux: Missouri Ozark / US-MOz (<https://ameriflux.lbl.gov/sites/siteinfo/US-MOz>)

### **Related Data Sets:**

TBD

**ORNL TES-SFA Data Policy:** [Archiving, Sharing, and Fair-Use](#)

## Project Description

Investigators have been monitoring the mortality of tree species at the Missouri Ozark AmeriFlux (MOFLUX) site since 2005 and predawn leaf water potential since 2004. The different tree species monitored at the MOFLUX site exhibited a range of drought tolerance. During the study period, a wide range of precipitation regimes from abundant rain to extreme drought occurred at the MOFLUX site, resulting in large inter-annual fluctuations in plant water stress levels and associated tree mortality.

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## 1. Data Set Overview:

This data set reports results measurements of predawn leaf water potential (PLWP) have been made at a weekly to biweekly frequency during the 2004 to 2020 growing seasons of the second-growth upland oak-hickory forests at the Missouri Ozark AmeriFlux (MOFLUX) site. The MOFLUX site is located in the University of Missouri Baskett Wildlife Research area (BWREA), situated in the Ozark region of central Missouri, USA.

## 2. Data Characteristics:

### Spatial Coverage

Predawn samples came from trees within the flux tower footprint within ~200 m of the tower proper. See location in Site boundary table below.

### Spatial Resolution

A total of 20-21 samples were obtained each day within 200 m of the tower and roughly in proportion to their relative stem abundance in the stand.

**Site boundaries:** Latitude and longitude given in decimal degrees.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Elevation (meters amsl)	Geodetic Datum
Missouri Ozark Site (US-MOz)	-92.2000	-92.2000	38.7441	38.7441	212	WGS84

**Source:** AmeriFlux: Missouri Ozark/US-MOz, <http://ameriflux.lbl.gov/sites/siteinfo/US-MOz>

### Temporal Coverage

The data cover the period June 18, 2004 through October 16, 2020.

### Temporal Resolution

Data were collected weekly or biweekly during the growing seasons from May (June in 2004) through October of each year.

## Data File Description

The data are provided in one comma separated (.csv) data file of PLWP. A row is uniquely defined by the Year, DOY, species identifier, and Sample\_Number.

### Data Dictionary:

**Data file MOFLUX\_PredawnLeafWaterPotential\_2017\_20180312.csv**

Column name	Format/Units	Description
Year	YYYY	Year of data collection.
DOY	DDD	Day of year of data collection.
Species_Symbol		Tree species abbreviations. Source: Natural Resources Conservation Service, Plants Database ( <a href="http://plants.usda.gov/java/nrcsStateDownload?statefips=29">http://plants.usda.gov/java/nrcsStateDownload?statefips=29</a> )
Species_Common_Name		Common name
Species_Name		Species name
Sample_Number		Indicates number of samples of a tree species measured on a given day. Samples were collected from multiple trees.
PLWP	MPa	Predawn leaf water potential in megapascal (MPa).

**Tree abbreviations and species names from NRCS source\*.**

NRCS Abbreviation	Species_name	Common_name	Family
CAOV2	<i>Carya ovata</i> (Mill.) K. Koch	shagbark hickory	Juglandaceae
QUAL	<i>Quercus alba</i> L.	white oak	Fagaceae
JUVI	<i>Juniperus virginiana</i> L.	eastern redcedar	Cupressaceae
ACSAS	<i>Acer saccharum</i> Marshall var. saccharum	sugar maple	Aceraceae
QUVE	<i>Quercus velutina</i> Lam.	black oak	Fagaceae
FRAM2	<i>Fraxinus americana</i> L.	white ash	Oleaceae
QUST	<i>Quercus stellata</i> Wengenh.	post oak	Fagaceae

\* Source: Natural Resources Conservation Service, Plants Database,  
<http://plants.usda.gov/java/nrcsStateDownload?statefips=29>

**Example Data Records:**

Year,DOY,Species_Symbol,Species_Common_Name,Species_Name,Sample_Number,PLWP YYYY,DDD,,,,,Mpa
2004,170,QUVE,black oak,Quercus velutina Lam.,1,-0.103
2004,170,QUVE,black oak,Quercus velutina Lam.,2,-0.055
2004,170,QUVE,black oak,Quercus velutina Lam.,3,-0.076
...
2014,291,QUAL,white oak,Quercus alba L.,1,-0.793
2014,291,QUAL,white oak,Quercus alba L.,2,-0.793
2014,291,QUAL,white oak,Quercus alba L.,3,-0.758
...
2017,276,QUAL,white oak,Quercus alba L.,4,-1.447899
2017,276,QUAL,white oak,Quercus alba L.,5,-1.378952
2017,276,QUAL,white oak,Quercus alba L.,6,-1.310004
...
2020,290,QUAL,white oak,Quercus alba L.,4,-0.276
2020,290,QUAL,white oak,Quercus alba L.,5,-0.414
2020,290,QUAL,white oak,Quercus alba L.,6,-0.552

### 3. Data Application and Derivation:

Using these decade-long continuous observations of tree mortality and predawn leaf water potential at the MOFLUX site, authors studied how the mortality of important tree species varied and how such variations may be predicted. Water stress determined interannual variations in tree mortality with a time delay of 1 year or more (Gu et al., 2015).

The exceptional drought of the year 2012 drastically increased the mortality of all species, including drought-tolerant oaks, in the subsequent year. The drought-influenced tree mortality was related to the species position along the spectrum of PLWP regulation capacity with those in either ends of the spectrum being associated with elevated risk of death. Regardless of species and drought intensity, the PLWP of all species recovered rapidly after sufficiently intense rain events in all droughts. This result, together with a lack of immediate leaf and branch desiccation, suggests an absence of catastrophic hydraulic disconnection in the xylem and that tree death was caused by significant but indirect effects.

### 4. Quality Assessment:

These data are considered at **Quality Level 2**. Level 2 indicates a complete, externally consistent data product that has undergone interpretative and diagnostic analyses. The data product has been subjected to quality checks and data management procedures (Level 1). Pallardy et al., 1991 (pp. 41-44), describes in detail the protocols employed for obtaining accurate estimates of water potentials with the pressure chamber.

### 5. Data Acquisition Materials and Methods:

#### Site Description

The MOFLUX site is located in the University of Missouri Baskett Wildlife Research area (BWREA), situated in the Ozark region of central Missouri. The site is uniquely located in the ecologically important transitional zone between the central hardwood region and the central grassland region of the US. The land has been publically owned since the 1930s and is on a land tract that was forested with the same dominant species before settlement in the early 1800s.

BWREA is within the Ozark Border Region of central Missouri. Second-growth upland oak-hickory forests constitute the major vegetation type at the BWREA (Rochow, 1972; Pallardy et al., 1988). Major tree species include white oak (*Quercus alba* L.), black oak (*Q. velutina* Lam.), shagbark hickory (*Carya ovata* (Mill.) K. Koch), sugar maple (*Acer saccharum* Marsh.), and eastern redcedar (*Juniperus virginiana* L.). Although these species co-occur in MOFLUX forests, there are differences in which species dominate in particular locations.

## Additional Site Measurements

The MOFLUX site is an active AmeriFlux site (<https://ameriflux.lbl.gov/>) providing long term monitoring of carbon dioxide and water vapor concentrations, above canopy and sub-canopy energy fluxes, characterization of meteorological and environmental conditions, soil respiration, sap flow, canopy phenology, and leaf-level photosynthetic biochemistry.

Meteorological measurements include precipitation, temperature and relative humidity made at the top of the 30 m flux tower and used to formulate potential meteorologically based predictors for tree mortality. Precipitation was measured with a recording tipping bucket rain gauge. Data were totaled over 30 min periods. Atmospheric vapor pressure deficit (VPD) was computed from temperature and relative humidity. At the MOFLUX site, routine meteorological measurements are made with plenty of redundant sensors to minimize the risk of measurement gaps. The full complement of AmeriFlux core site measurements are available at <https://ameriflux.lbl.gov/>.



View of the forest from the top of the MOFLUX tower looking west.



View of the forest from the ground looking to the southeast from near the base of the MOFLUX tower.



View of the forest near the base of the MOFLUX tower that is located inside the fenced area at right.

### **Predawn leaf water potential (PLWP)**

Since early June of 2004, measurements of PLWP have been made periodically (weekly to biweekly) during the growing seasons. In each year, except for 2004, the first measurements occurred in mid-May. In all years, the last measurements took place in late October. Leaf samples were collected before dawn for canopy and sapling individuals of common tree species at the site.

A total of 20–21 samples were obtained each day with 6–7 taken from *Quercus alba*, and the rest, with at least two samples per species, distributed among *Q. velutina*, *Acer saccharum*, *Carya ovata*, *Fraxinus americana* L. (white ash), and *Juniperus virginiana*, roughly in proportion to their relative stem abundance in the stand.

Leaves or leaflets (both oak species, shagbark hickory, and white ash) or shoots (sugar maple and eastern redcedar) were sampled from lower branches (<2 m height) thus rendering any gravitational component minimal. After excision with a razor blade, samples were immediately placed in humidified bags in a chest cooler until measurement promptly after sample collection was complete. PLWP was measured with a pressure chamber (Turner, 1981; Pallardy et al., 1991).

## 6. References:

Gu, L., Pallardy, S. G., Hosman, K. P., and Sun, Y.: Drought-influenced mortality of tree species with different predawn leaf water dynamics in a decade-long study of a central US forest, *Biogeosciences*, 12, 2831-2845, <https://doi.org/10.5194/bg-12-2831-2015>, 2015.

Gu L, Pallardy SG, Hosman KP, Sun Y. Impacts of precipitation variability on plant species and community water stress in a temperate deciduous forest in the central US, 2016. *Agricultural and Forest Meteorology*, 217, 120-136. <https://doi.org/10.1016/j.agrformet.2015.11.014>.

Pallardy, S. G., Pereira, J. S., and Parker, W. C.: Measuring the state of water in tree systems, in: *Techniques and Approaches in Forest Tree Ecophysiology*, edited by: Lassoie, J. P. and Hinckley, T. M., CRC Press, Boca Raton, FL, 28–76, 1991.

Pallardy, S. G., Gu, L., Hosman, K. P., and Sun, Y. 2015. Predawn Leaf Water Potential of Oak-Hickory Forest at Missouri Ozark (MOFLUX) Site: 2004-2014. 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/ornlsfa.004> **Superseded by new release of PLWP data in Pallardy et al. 2018.**

Pallardy, S.G., Gu, L., Wood, J.D., Hosman, K.P., and Sun, Y. 2018. **Predawn Leaf Water Potential of Oak-Hickory Forest at Missouri Ozark (MOFLUX) Site: 2004-2017.** Oak Ridge National Laboratory, TES SFA, U.S. Department of Energy, Oak Ridge, Tennessee, U.S.A. <https://doi.org/10.3334/CDIAC/ornlsfa.004> **Superseded by new release of PLWP data in Pallardy et al. 2018. (Release date January 25, 2021)**

Rochow, J. J.: A vegetational description of a mid-Missouri forest using gradient analysis techniques, *Am. Midland Nat.*, 87, 377–396, 1972.

Turner, N. C.: Correction of flow resistances of plants measured from covered and exposed leaves, *Plant Physiol.*, 68, 1090–1092, 1981.

## 7. Data Access:

For public access to ORNL TES SFA data please visit the TES SFA Web Site: <https://tes-sfa.ornl.gov/home>

**Contact for Data Access Information:** <https://mnspruce.ornl.gov/contact>

## Appendix

### Data Release Notes

1. The first release of PLWP data for MOFLUX. Covered the range of June 18, 2004 through October 18, 2014. Now superseded.
2. This second release appends data through October 3, 2017. Now superseded.
  - There were no changes to the previously released data and the format and structure of this release are the same.
  - The data citation has been updated.
    - Addition of author J.D. Wood
    - Year published is now 2018
    - Update of title for extended date range (2004-2017)
    - Change of publisher (Oak Ridge National Laboratory, TES SFA)
    - No change to the DOI (10.3334/CDIAC/ornlsfa.004)
  - Please use the updated citation when referencing any or all the PLWP data.
3. This third release (January 25, 2021) appends data through October 16, 2020.
  - The data citation has been updated.
    - Update of title for extended date range (2004-2020)
    - No change to the DOI (10.3334/CDIAC/ornlsfa.004)
  - Please use the updated citation when referencing any or all the PLWP data.