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AirMOSS: L2 Hourly In-Ground Soil Moisture at AirMOSS Sites, 2011-2015

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Data Set Version: V1

Summary

This data set provides level 2 (L2) hourly volumetric (cm³/cm³) soil moisture profiles from in-ground sensors at seven North American sites as part of the Airborne Microwave Observatory of Subcanopy and Subsurface (AirMOSS) project. Three profiles were installed at each site, sampling at seven different depths per profile (2 cm to 80 cm). Initial sampling began at three sites in September 2011 and additional sites were added during 2012 and 2013. All sampling concluded in December 2015. The AirMOSS project used an airborne radar instrument to estimate root-zone soil moisture at 10 study sites across North America. These in-ground soil moisture data were collected to calibrate and validate the AirMOSS data.

There are 29 files in NetCDF v4 (*.nc4) format with this data set.

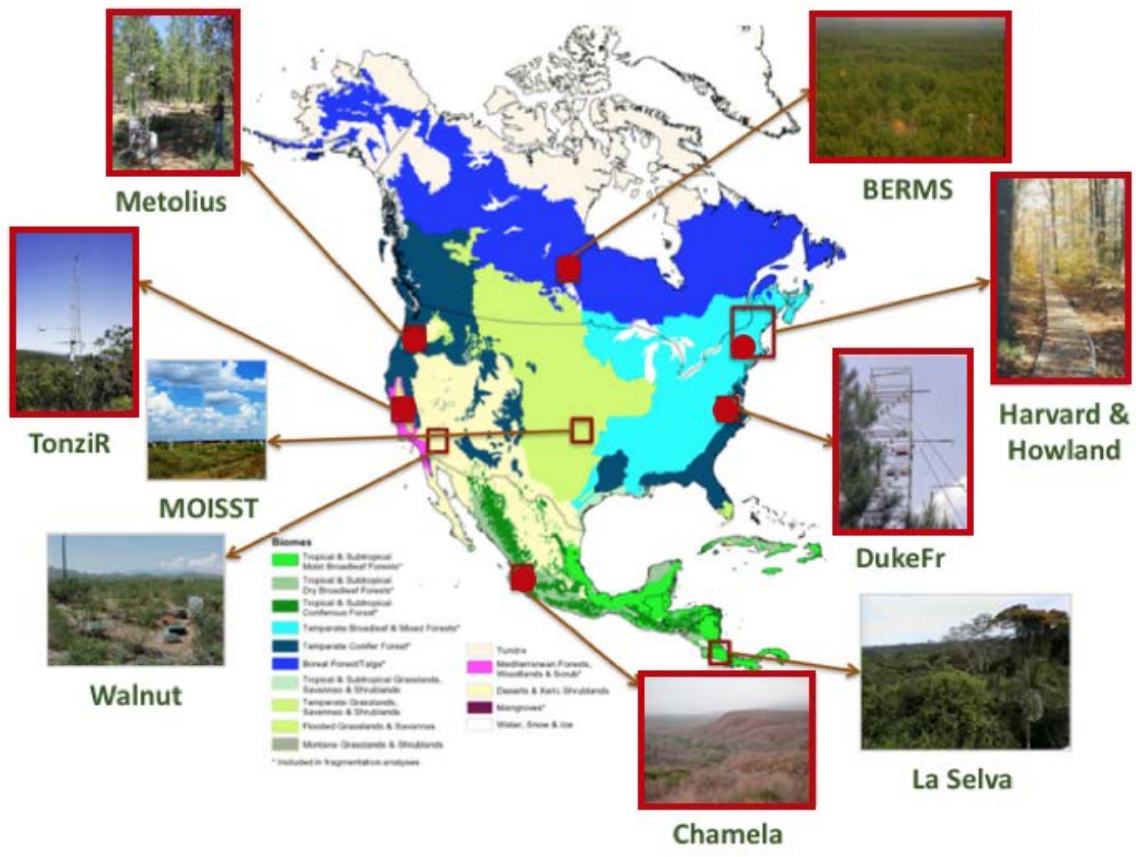


Figure 1: In-ground soil moisture measurements were taken at six of the ten AirMOSS sampling sites, highlighted here in red.

Citation

Hagimoto, Y., R. Cuenca, and AirMOSS Science Team. 2016. AirMOSS: L2 Hourly In-Ground Soil Moisture at AirMOSS Sites, 2011-2015. ORNL DAAC, Oak Ridge, Tennessee, USA. <http://dx.doi.org/10.3334/ORNLDAAC/1416>

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1. Data Set Overview

This data set provides level 2 (L2) hourly volumetric (cm³/cm³) soil moisture profiles from in-ground sensors at seven North American sites as part of the Airborne Microwave Observatory of Subcanopy and Subsurface (AirMOSS) project. Three profiles were installed at each site, sampling at seven different depths per profile (2 cm to 80 cm). Initial sampling began at three sites in September 2011 and additional sites were added during 2012 and 2013. All sampling concluded in December 2015. The AirMOSS project used an airborne radar instrument to estimate root-zone soil moisture at 10 study sites across North America. These in-ground soil moisture data were collected to calibrate and validate the AirMOSS data.

Project: Airborne Microwave Observatory of Subcanopy and Subsurface (AirMOSS)

The goal of NASA's Airborne Microwave Observatory of Subcanopy and Subsurface (AirMOSS) investigation is to provide high-resolution observations of root-zone soil moisture over regions representative of the major North American climatic habitats (biomes), quantify the impact of variations in soil moisture on the estimation of regional carbon fluxes, and extrapolate the reduced-uncertainty estimates of regional carbon fluxes to the continental scale of North America.

- The AirMOSS campaign used an airborne ultra-high frequency synthetic aperture radar flown on a Gulfstream-III aircraft to derive estimates of soil moisture down to approximately 1.2 meters.
- Extensive ground, tower, and aircraft in-situ measurements were collected to validate root-zone soil measurements and carbon flux model estimates.

The AirMOSS soil measurements can be used to better understand carbon fluxes and their associated uncertainties on a continental scale. Additionally, AirMOSS data provide a direct means for validating root-zone soil measurement algorithms from the Soil Moisture Active & Passive (SMAP) mission and assessing the impact of fine-scale heterogeneities in its coarse-resolution products.

Related Data:

[Soil Moisture Profiles and Temperature Data from SoilSCAPE Sites, USA](#)

[AirMOSS: L2 Hourly Precipitation at AirMOSS Sites, 2011-2015](#)

A full list of AirMOSS data products is available at: <https://airmoss.ornl.gov/dataproducts.html>.

2. Data Characteristics

Spatial Coverage: Seven sites across the USA, Canada, and Mexico

Spatial Resolution: Point locations

Temporal Coverage: 20110901 to 20151231

Temporal Resolution: Hourly

Study Area (coordinates in decimal degrees)

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Selected AirMOSS sites	-121.5583	-72.1712	53.9169	19.5086

Data File Information

There are 29 files in NetCDF v4 (*.nc4) format with this data set.

File-naming convention

L2IGSM_calibrated_SITE_yyyymmdd_vv.nc4

where:

L2IGSM_calibrated = data product name

SITE = six character site name (see Table 1)

yyymmdd = start date of data file

vv = data version number

Example file names: L2IGSM_calibrated_DUKEFR_20150101_03.nc4

L2IGSM_calibrated_BERMSP_20140101_03.nc4

Table 1. AirMOSS sites where in-ground soil moisture (IGSM) was recorded. The seven standard sampling depths were: 2, 5, 10, 20, 40, 60, 80 cm.

Site name	Site description	Start date	End date	IGSM profile	Latitude	Longitude	Sampling depths
BERMSA	BERMS (Boreal Ecosystem Research and Monitoring Sites), Old Aspen site, Saskatchewan, Canada.	20130714	20151231	1	53.6289	-106.1979	standard
				2	53.6287	-106.1983	standard
				3	53.6284	-106.1985	standard
BERMSP	BERMS (Boreal Ecosystem Research and Monitoring Sites), Old Jack Pine site, Saskatchewan, Canada.	20120622	20151231	1	53.9167	-104.6922	standard
				2	53.9167	-104.6916	standard
				3	53.9169	-104.6911	standard
CHAMEL	Chamela Biological Station, Jalisco, Mexico.	20130303	20150930	1	19.5095	-105.0402	2, 5, 10, 15, 25, 35, 50 cm
				2	19.5089	-105.0407	2, 5, 10, 15, 25, 35, 50 cm
				3	19.5086	-105.041	2, 5, 10, 15, 25, 35, 45 cm
DUKEFR	Duke Forest site, North Carolina, USA.	20110907	20150923	1	35.9733	-79.1001	standard 2, 5, 10,

				2	35.9733	-79.0994	20, 30, 50, 70 cm
				3	35.9732	-79.1008	2, 5, 10, 10, 20, 20, 30 cm
HARVRD	Harvard Forest site, Massachusetts, USA.	20110905	20151231	1	42.5378	-72.1714	standard
				2	42.5381	-72.1712	standard
				3	42.5385	-72.1718	standard
METOLI	Metolius site, Oregon, USA.	20110923	20151231	1	44.4523	-121.5517	standard
				2	44.4521	-121.5575	standard
				3	44.4519	-121.5583	standard
TONZIR	Tonzi Ranch site, California, USA.	20120109	20151231	1	38.43119	-120.9667	standard
				2	38.4309	-120.9659	2, 5, 10, 20, 30, 50, 70 cm
				3	38.4301	-120.9661	2, 5, 10, 20, 30, 45, 65 cm

Table 2. Data fields in the IGSM data files (e.g. *L2IGSM_calibrated_DUKEFR_20150101_03.nc4*)

Data Field	Units	Description
level	cm	Depth below ground surface of soil moisture sensor
SP01	cm ³ /cm ³	Hourly volumetric soil water content for Profile 1
SP02	cm ³ /cm ³	Hourly volumetric soil water content for Profile 2
SP03	cm ³ /cm ³	Hourly volumetric soil water content for Profile 3
time	hours since 2011-01-01 00:00:00 UTC	Date and time of the data collection

3. Application and Derivation

The Level 2 in-ground soil moisture data were collected to calibrate and validate other, higher-level, AirMOSS data products including the Level 2/3 Root Zone Soil Moisture estimates for each AirMOSS flight (Cuenca et al, 2015).

4. Quality Assessment

These data are provided with no QA information. The in-situ data were subjected to calibration procedures described in detail in Cuenca et al. (2015).

5. Data Acquisition, Materials, and Methods

The goal of the Airborne Microwave Observatory of Subcanopy and Subsurface (AirMOSS) investigation is to provide high-resolution observations of root-zone soil moisture over regions representative of the major North American climatic habitats (biomes), quantify the impact of variations in soil moisture on the estimation of regional carbon fluxes, and extrapolate the reduced-uncertainty estimates of regional carbon fluxes to the continental scale of North America. See Chapin et al. (2012) for more details.

AirMOSS Flights

These Level 2 in-situ data are one set of products generated by the AirMOSS campaign.

For AirMOSS, NASA's Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) was flown on a Gulfstream-III aircraft, making frequent flights over ten sites (given in Table 3) in 9 different biomes of North America over the course of four years. In-ground soil moisture was not measured at all sites.

Table 3. AirMOSS sites

Site name	North latitude	South latitude	East longitude	West longitude	Fluxnet Site ID	Description
BermsP	54.125	53.501	-103.626	-107.125	CA-Ojp & CA-Oas	BERMS (Boreal Ecosystem Research and Monitoring Sites), Saskatchewan, Canada. Landcover: Mixed boreal forest. Elevation: 518m.
Chamel	20.326	19.316	-104.22	-105.29	MX-Cha	Chamela Biological Station, Jalisco, Mexico. Landcover: Seasonally dry tropical forest. Elevation: 58m.
DukeFr	36.368	35.437	-78.694	-79.849	US-Dk1,US-Dk2, US-Dk3	Duke Forest site, North Carolina, USA. Landcover: Mature oak-hickory dominated hardwood forest. Elevation: 169m.
Harvr	43.376	42.293	-71.839	-72.389	US-Ha1 & US-Ha2	Harvard Forest site, Massachusetts, USA. Landcover: Temperate deciduous forest. Elevation: 353m.
Howlnd	45.778	44.669	-68.336	-69.086	US-Ho1, US-Ho2, US-Ho3	Howland Forest site, Maine, USA. Landcover: boreal - northern hardwood transitional forest. Elevation 72m.
LaSelv	10.878	9.92	-83.519	-84.57	CR-Lse	La Selva Biological Station, Costa Rica. Landcover: tropical rain forest. Elevation 93m.
Metoli	45.242	43.38	-120.363	-123.283	US-Me1 to US-Me6	Metolius site, Oregon, USA. Landcover: evergreen needleleaf forest. Elevation 1237m.
Oklaho or Moisst	36.880	35.775	-96.824	-98.996	US-ARM	The Marena, Oklahoma In Situ Sensor Testbed (MOISST) is located in Oklahoma, USA. Landcover: temperate grasslands, crops. Elevation: 312m.
TonziR	38.625	37.501	-120.001	-121.25	US-Ton	Tonzi Ranch site, California, USA. Landcover: oak savanna and grazed grassland. Elevation 170m.
Walnut	32.125	31.501	-109.376	-111.5	US-Wkg & US-Whs	Walnut Gulch site, Arizona, USA. Landcover: warm season C4 grassland with a few shrubs. Elevation 1524m.

Beginning in September 2012, the AirMOSS instrument flew 215 flight campaigns. A summary of flight campaigns by year and site is found in Table 4. Typically, the aircraft made repeat visits to sites in the same region in a single week and then proceeded to another region. Most sites had at least three campaigns per year. The Harvard and Howland forest sites were flown together in a single day. In 2012, Chamela, La Selva, and Tonzi were not surveyed.

Table 4. Summary of AirMOSS flight campaigns.

Year	Site									
	BermsP	Chamel	DukeFr	Harvrd	HowInd	LaSelv	Metoli	Oklaho	TonziR	Walnut
2012	3	0	3	3	3	0	4	3	0	3
2013	6	3	9	9	9	6	7	8	5	6
2014	7	3	10	9	9	3	9	9	6	5
2015	9	2	5	5	5	3	9	6	5	6
Total	25	8	27	26	26	12	29	26	16	20

A complete list of AirMOSS flights can be found at: <https://airmoss.ornl.gov/flights.html>.

AirMOSS Level 2 In Ground Soil Moisture Data

The objective of the in situ soil profile instrumentation was specifically to monitor soil water content over a depth representative of that which will have an impact on the P-band radar signal. Each of the seven AirMOSS sites sampled (Table 1) had three monitored soil profiles installed approximately 40 to 50 m apart along a “representative” (in terms of soil texture and vegetation) transect within the footprint of the flux tower. The in-situ observation system for the NASA AirMOSS project used 5-TE and 5-TM sensors by Decagon Devices (Pullman, WA) to observe volumetric SWC. Standard installation depths for these sensors at these sites were 2, 5, 20, 40 60 and 80 cm depths. In addition to volumetric SWC and temperature, the 5-TE is capable of measuring electrical conductivity in soil. These sensors determine volumetric water content by measuring the apparent (or bulk) dielectric permittivity (E_b) of the media (e.g. soils and peat) using capacitance/frequency domain technology. Since 5-TE and 5-TM sensors were installed in various soils in different biomes for this project, verification and calibration of these sensors was critical. Calibration of 5- TE and 5-TM sensors consists of two steps: 1) sensor specific calibration and 2) site specific calibration. Calibration methods and additional details are available in Cuenca et al. (2015).

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

[AirMOSS: L2 Hourly In-Ground Soil Moisture at AirMOSS Sites, 2011-2015](#)

Contact for Data Center Access Information:

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7. References

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