



THE GLOBE PROGRAM

A Worldwide Science and Education Program



Soil (Pedosphere)

Soil Moisture Gravimetric Protocol





A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Overview

This module provides step-by-step instructions in how determine soil moisture. Field samples of soil are collected and weighed, with water content, and after the soil has been dried. The difference is the weight of soil moisture. In this instance, **gravimetric** means determining the amount of moisture in the soil by weight.

Learning Objectives:

After completing this module, you will be able to:

- Explain why soil moisture is worth studying
- Determine a schedule for taking this measurement
- Choose a sampling pattern
- Take soil moisture samples
- Measure gravimetric soil moisture content
- Report these data to GLOBE
- Visualize these data using GLOBE's Visualization Site

Estimated time needed for completion of this module: 1.5 hours



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

The Role of Soil Moisture in the Environment

Soil acts like a sponge spread across the land surface. It absorbs rain and snowmelt, slows run-off and helps to control flooding. The absorbed water is held on soil particle surfaces and in pore spaces between particles. This water is available for use by plants. Some of this water evaporates back into the air; some of this water is transpired by plants; some drains through the soil into groundwater.

Soil Moisture Is Important Because It Affects:



Plant Nutrient Uptake



Water For Plant Use



Water Storage



Atmospheric Humidity



Weathering



Flooding



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Why your measurements matter:

With this measurement, students may investigate how soil moisture:

- Relates to precipitation
- Relates to surface, soil, and/or air temperatures
- How soil moisture varies diurnally and annually as well as over days or weeks
- How soil moisture relates to plant phenology





How your measurements can help us understand interactions of the soil with the rest of the Earth system

A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information



Soil data field campaign, Yanco, Australia. Both field measurements from the ground as well as remote sensing from air craft support our understanding of soil moisture. These are used in combination with satellite data from NASA missions such as GRACE and SMAP. Image credit: Amy McNally, NASA.



The SMAP satellite creates a global soil moisture map every three days. It measures the volumetric soil moisture in the top 5 cm of the soil. See the GLOBE SMAP Soil Moisture Protocol to work with scientists and provided needed on-the-ground measurements to help validate the satellite's soil moisture estimates. Image credit: NASA.



Summary of Protocol

Where	GLOBE Soil Moisture Site
Frequency	Ideally, 12 or more times per year at the same site at daily weekly or monthly intervals
Prerequisites	Site definition using the Site Definition Sheet
Needed Documents	Gravimetric Soil Moisture Protocol and
	Soil Moisture Data Sheet-Star Pattern or
	Soil Moisture Data Sheet-Transect Pattern or
	Soil Moisture Data Sheet- Depth Profile
Time required	<ul style="list-style-type: none"> • 5-10 minutes preparation before sampling 10-15 minutes to collect samples* • 5 minutes to weigh wet samples • 5 minutes to weigh dry samples • Samples dry under heating lamps for 2 days or in a drying oven overnight. <p>*Some sample collection methods may require additional time</p>

- A. Why measure soil moisture?
- B. How your measurements help
- C. Preparation for conducting the protocol
- D. Transect sampling
- E. Star pattern sampling
- F. Depth pattern sampling
- G. Taking Lab measurements
- H. How to report data to GLOBE
- I. Visualize your data
- J. Additional information



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

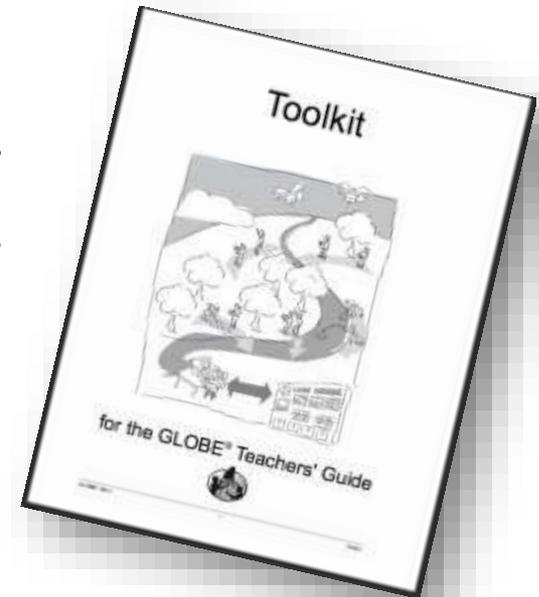
Instrument Specifications

The following resources summarize the measurements associated with each protocol, associated skill level, scientific specifications for the instruments, and how to access the equipment you need (purchase, build, or download).

By using instruments with GLOBE specifications, you ensure your data are accurate and comparable to GLOBE investigations conducted by others.

[Where to find specifications for instruments used in GLOBE investigations](#)

[Where to find scientific instruments used in GLOBE investigations](#)





A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Required Equipment for Fieldwork and Sampling

For all sample patterns:

- A defined Soil Moisture & Temperature Site marked with a permanent marker or flag
- Marker flags (if you can keep them placed permanently)
- Compass
- Trowel (1 per student group)
- Permanent marker
- A device to dry soil (e.g., heat lamps or a soil drying oven & thermometer)

For **Transects**:

- Rulers marked in millimeters (1 per student group)
- 13 soil sample containers (or resealable plastic bags if drying samples under heat lamps)
- 50 meter tape or 50 meter rope marked every 5 meters

For **Star Patterns** :

- 6 soil sample containers
- Meter stick marked in millimeters

For **Depth Profiles**:

- 5 soil sample containers
- A meter stick
- A soil auger

Note: Containers or plastic bags should be weighed and labeled with mass and container number before bringing to the field. Depending on the context, gloves and protective eyewear may be recommended.



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Preparations before you go to the field

Mark your trowel at the 5 cm mark from the tip to ensure you go no deeper when you take samples.

Calibrate the scale or balance according to the manufacturer's directions. If using an electronic balance, check that the balance is measuring in grams and is zeroed properly. Measure and record the mass of each container (without the lid) or plastic bag to the nearest 0.1 g.

Label the each container with:

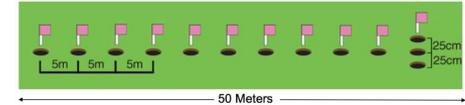
- Mass of the container or plastic bag to the nearest 0.1g
- Container number



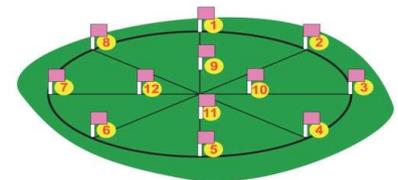


Select your Sampling Strategy Based on Research Goals: Choose One of the Three Options Below

Transect Pattern Sampling This transect sample pattern will measure soil moisture over a large area. SMAP measurement techniques sense moisture contained in the top 5 cm of soil and their measurements are averaged over areas of 100's of square meters or more. **This sampling pattern allows students to see spatial variations in surface soil moisture measurements.** It is also useful for comparison with soil moisture data collected remotely from satellites or aircraft.



The Star Pattern involves collecting soil samples from 12 different locations at twelve different time periods in a 2 m x 2 m star-shaped area. For each of the 12 locations, three spots are chosen within 25 cm of each other. Samples from the top 5 cm and from 10 cm deep are collected at each of the three spots, for a total of 6 samples at each location on the star. **This sampling method can be easily coordinated with the [Soil Temperature Protocol](#),** whereby students collect their soil temperature measurements at the same depths and locations as the soil moisture measurements.



Depth Profile Pattern Sampling. Use the Star Pattern and take samples down a profile. Using an auger takes a bit of extra time, but this effort gathers valuable data and complements the [Soil Characterization Protocol](#) as well as [The Digital Multi-Day Max/Min/Current Air and Soil Temperatures Protocol](#).

A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

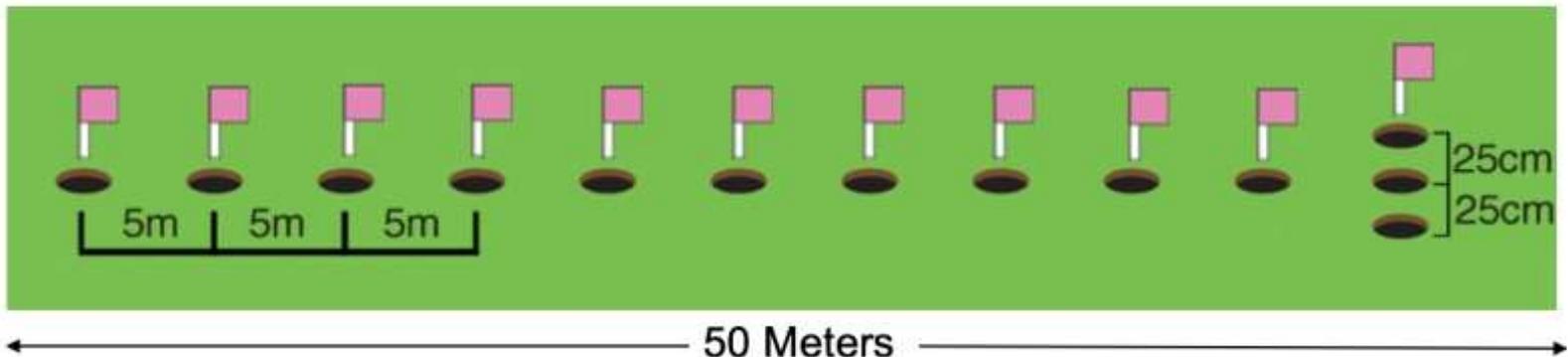
I. Visualize your data

J. Additional information

Option 1. Transect Pattern Sampling

This transect sample pattern will measure soil moisture over a large area. SMAP measurement techniques sense moisture contained in the top 5 cm of soil and their measurements are averaged over areas of 100's of square meters or more. This sampling pattern allows students to see spatial variations in surface soil moisture measurements. It is also useful for comparison with soil moisture data collected remotely from satellites or aircraft.

- Samples are taken every five meters over a 50 meter transect to capture soil moisture variation along a broad swath.
- Each time you visit this transect you collect 13 samples of the top 5 cm of soil.
- Off-set each sample set at least 25 cm from the previous ones.





A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

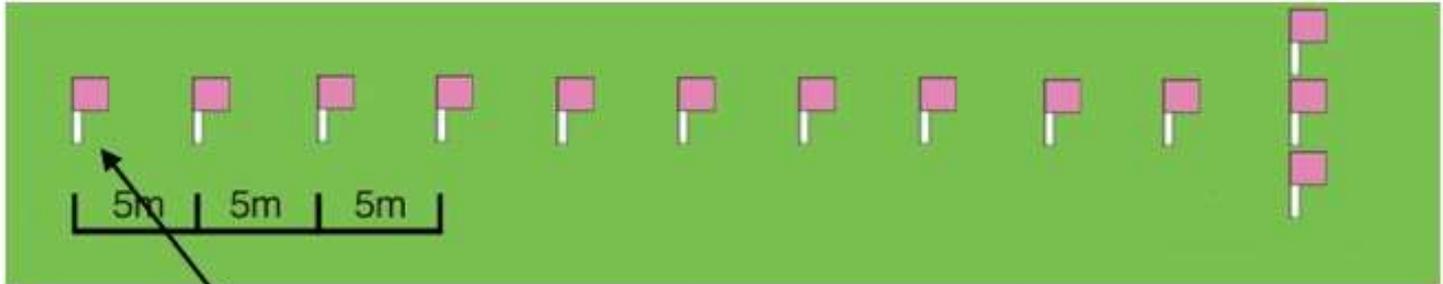
G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Laying out a transect



Sample 1

Stretch out your measuring tape or rope along the transect.

Sample points should be marked every 5 meters along the transect and numbered starting with 1.

Two extra points should be offset 25 cm from the end point as shown and labeled 12 and 13.

Stand at the first sample and take a compass reading looking along the transect.





A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Taking samples along a transect



Sample 1

Cut or pull away any grass or groundcover above every sample point.

Dig a hole 10-15 cm in diameter down to 5 cm.

Leave this soil loose in the hole.

Remove any rocks larger than a pea (about 5 mm), large roots, worms, grubs, and other animals from the loose soil.





A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Collecting samples along a transect



Sample 1

Use your trowel to fill a soil container with at least 100 g of the loose soil.

Immediately seal the container to hold in the moisture.

If you are using resealable bags, label each bag with the date, site name, and location along the transect.





A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

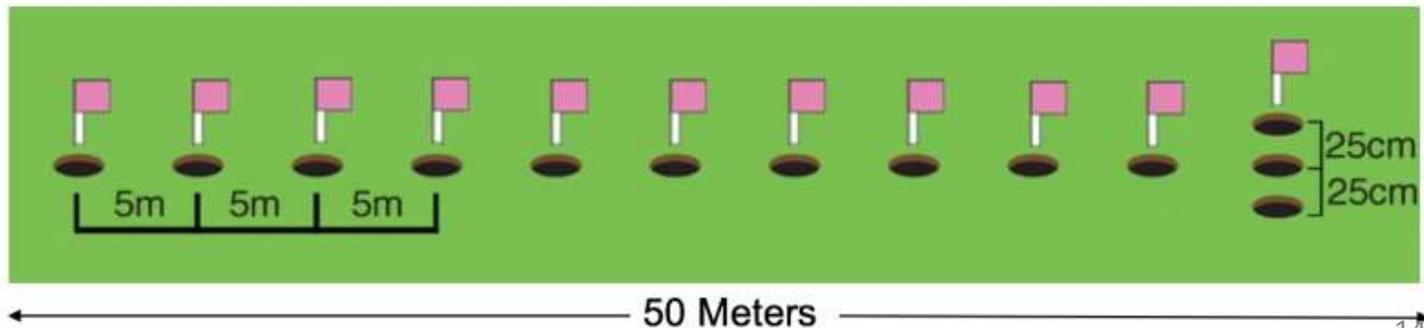
H. How to report data to GLOBE

I. Visualize your data

J. Additional information

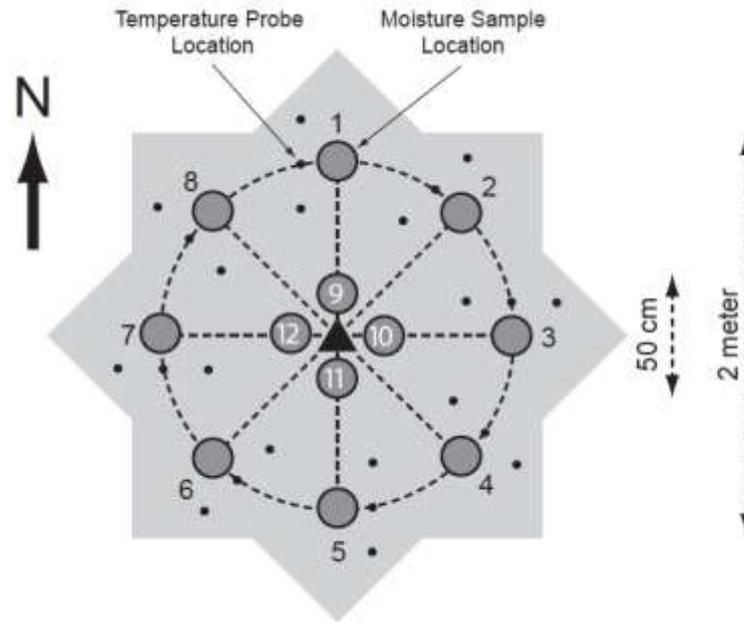
Repeat procedure for all 13 samples along the transect

- Continue to collect a sample at each sampling point along the transect.
- Remember to remove rocks, large roots, and animals.
- Seal each container immediately.
- Record the container number, mass, and distance to the start point of the transect on the Data Entry app or Data Entry Sheet next to the appropriate Sample Number.
- You should have 13 containers of soil 11 taken from along the transect plus two extras at the end. You are done!





Option 2. Star Pattern Sampling Overview



The *Star Pattern* involves collecting soil samples from 12 different locations at twelve different time periods in a 2 m x 2 m star-shaped area. For each of the 12 locations, three spots are chosen within 25 cm of each other. Samples from the top 5 cm and from 10 cm deep are collected at each of the three spots, for a total of 6 samples at each location on the star. This sampling method can be easily coordinated with the *Soil Temperature Protocol*, whereby students collect their soil temperature measurements at the same depths and locations as the soil moisture measurements.

- A. Why measure soil moisture?
- B. How your measurements help
- C. Preparation for conducting the protocol
- D. Transect sampling
- E. Star pattern sampling
- F. Depth pattern sampling
- G. Taking Lab measurements
- H. How to report data to GLOBE
- I. Visualize your data
- J. Additional information



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

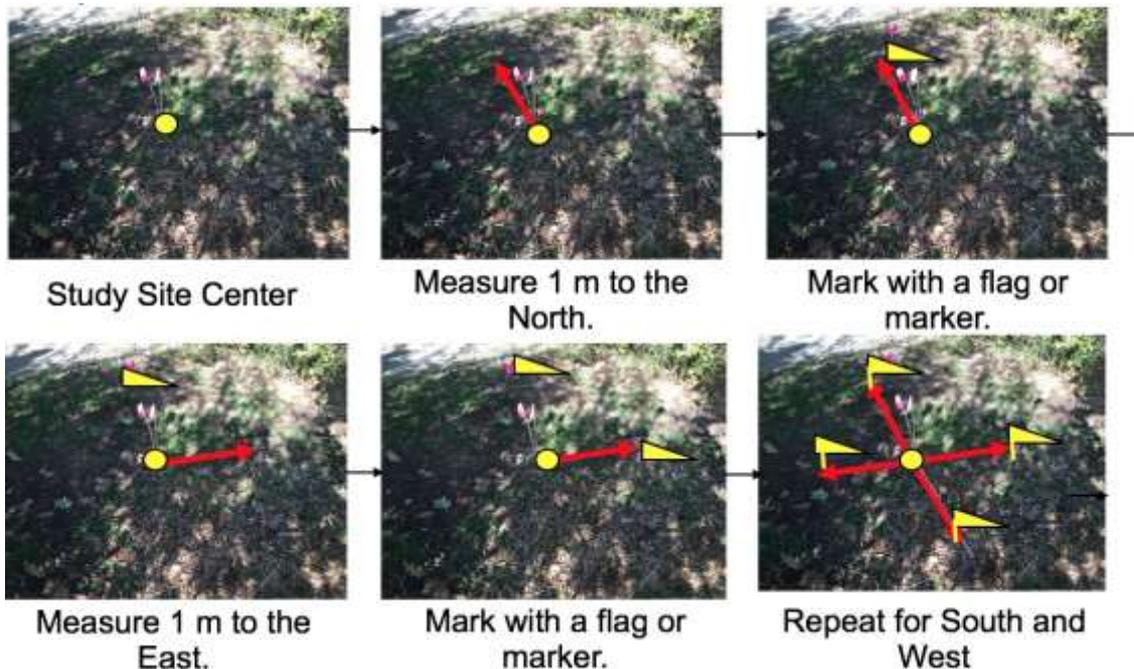
G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Set up the star pattern



- Locate the place where you took the GPS reading as your center spot and mark it with some sort of permanent marker. With the Star Pattern, 1-3 pairs of samples are collected from 0-5 cm & 10 cm depth. (Note: only one pair of samples is needed at each location. Your students may wish to take up to three samples at each location to obtain information about the variation in soil conditions found at the sampling site.)
- Each flag is a site around which soil samples will be taken.
- If you are going to take measurements for only part of a year, time your measurements so they cross a drying/wetting seasonal cycle.



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

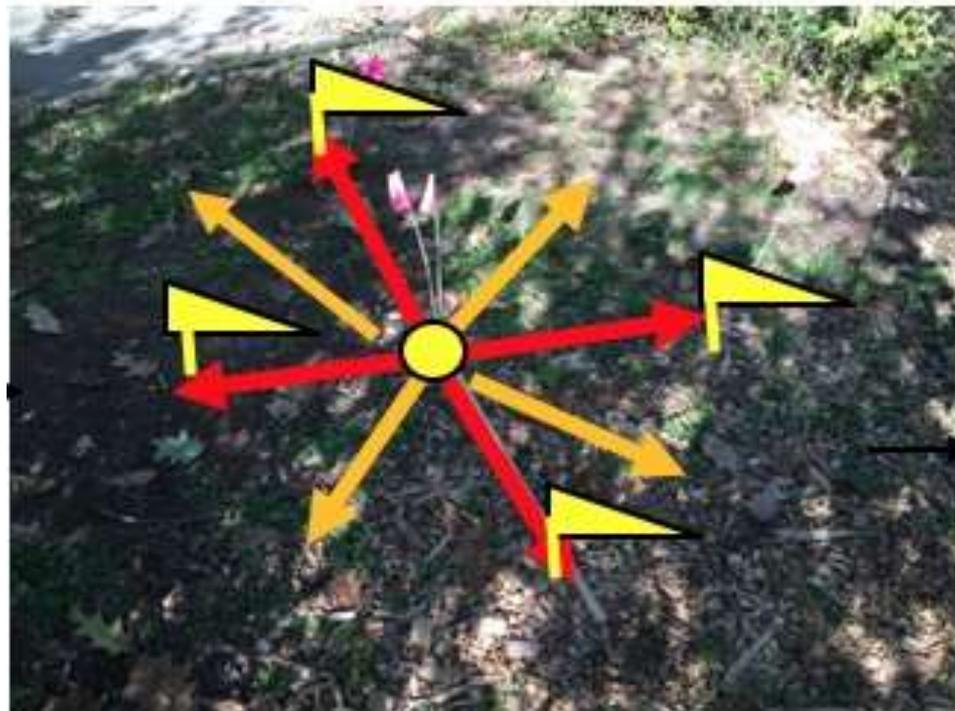
G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Set up the star pattern



Repeat the same process, this time marking out 1 m from the center of your star, using the directions NE, NW, SE and SW (in orange)



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

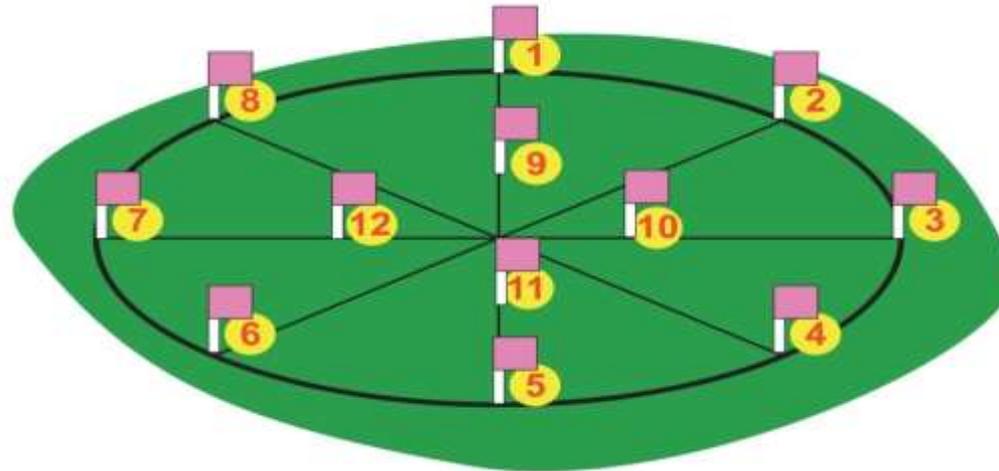
G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Marking the inner ring



In the four cardinal directions, measure 25 cm from the center and place a flag.



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

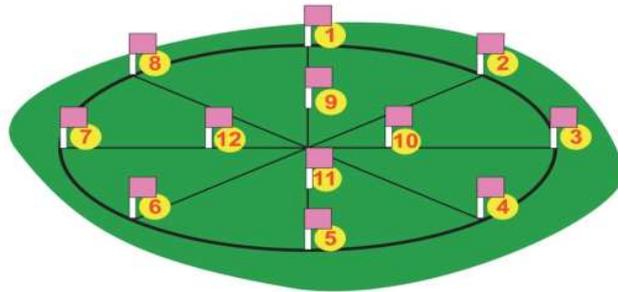
G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Taking samples in a star sampling pattern- 0-5 cm



- Locate a sampling point on your sampling star.
- Cut or pull away any grass or groundcover above every sample point.
- Dig a hole 10-15 cm in diameter down to 5 cm.
- Leave this soil loose in the hole.
- Remove any rocks larger than a pea (about 5 mm), large roots, worms, grubs, and other animals from the loose soil.





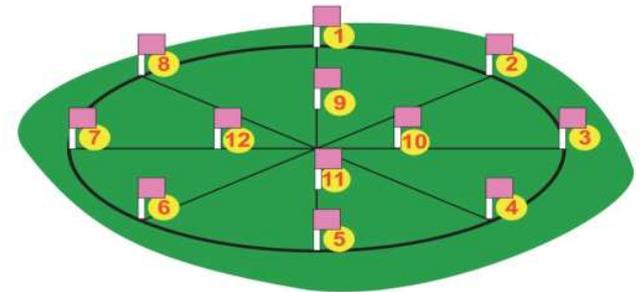
- A. Why measure soil moisture?
- B. How your measurements help
- C. Preparation for conducting the protocol
- D. Transect sampling
- E. Star pattern sampling
- F. Depth pattern sampling
- G. Taking Lab measurements
- H. How to report data to GLOBE
- I. Visualize your data
- J. Additional information

Taking samples at 10 cm depth

Remove all of the soil from the hole down to a depth of 8 cm.

Take a soil sample that contains the soil between 8 and 12 cm.

Remove any rocks larger than a pea (about 5 mm), large roots, worms, grubs, and other animals.





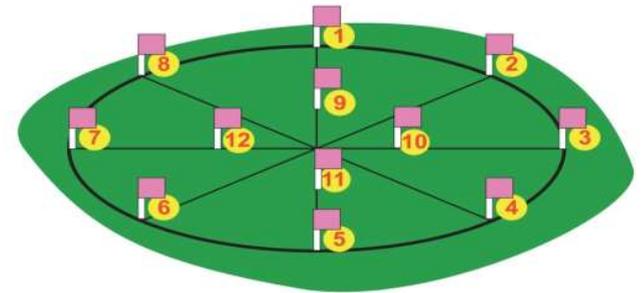
Taking two more sets of samples

Take samples from 0 – 5 cm and 10 cm from two more holes 25 cm from the first.

You should have a total of six soil samples from the three holes

Return remaining soil to the holes.

Replace the soil first out last in to minimize soil disturbance.



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Place samples in containers

Use your trowel to fill a soil container with at least 100 g of the loose soil.

Immediately seal the container to hold in the moisture.

If you are using resealable bags, label each bag with the date, site name, and location within the star sampling grid.

You are done!

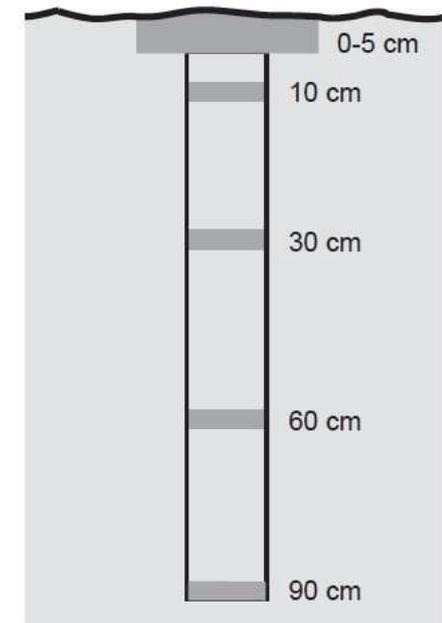




3. Depth Profile Pattern Sampling Overview

The Depth Profile involves taking a sample of the top 5 cm and the use of an auger to take soil samples at depths of 10 cm, 30 cm, 60 cm, and 90 cm. Using an auger takes a bit of extra time, but this effort gathers valuable data and complements the [Soil Characterization Protocol](#) as well as [The Digital Multi-Day Max/Min/Current Air and Soil Temperatures Protocol](#).

For this protocol, use the Star Pattern Sampling.



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

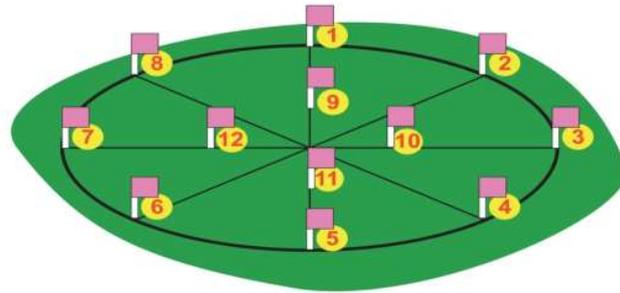
G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Depth profile: star sampling pattern- 0-5 cm



- Locate a sampling point on your sampling star.
- Cut or pull away any grass or groundcover above every sample point.
- Dig a hole 10-15 cm in diameter down to 5 cm.
- Leave this soil loose in the hole.
- Remove any rocks larger than a pea (about 5 mm), large roots, worms, grubs, and other animals from the loose soil.



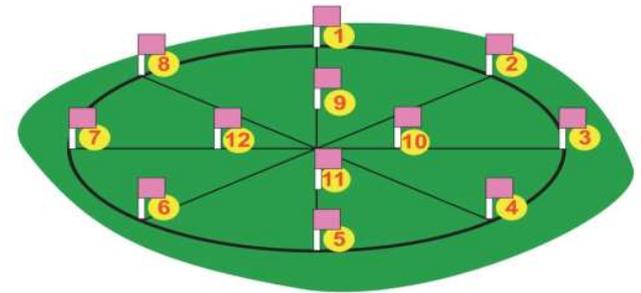


Taking samples at 10 cm depth

Remove all of the soil from the hole down to a depth of 8 cm.

Take a soil sample that contains the soil between 8 and 12 cm.

Remove any rocks larger than a pea (about 5 mm), large roots, worms, grubs, and other animals.



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information



Depth Profile- taking samples at 30, 60, and 90 cm

Use the auger to obtain samples centered at 30, 60, and 90 cm



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Place samples in containers

Use your trowel to fill a soil container with at least 100 g of the loose soil.

Immediately seal the container to hold in the moisture.

If you are using resealable bags, label each bag with the date, site name, and location in your star sample grid.

Return remaining soil to the hole. Replace the soil last out first in to minimize disturbing the soil.

At the end of the sampling process, you should have 5 containers of soil taken from your depth profile.

You are done!





Soil Moisture Gravimetric – Lab Measurements

A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information





Required Materials for Lab Procedures

- Soil drying method (either soil drying oven or approved warming/heat lights)
- Thermometer capable of measuring to 110°C (if using a drying oven)
- Soil Samples in containers suitable for your drying method
- Balance or scale with 0.1g sensitivity and at least 400 g capacity (600 g recommended)
- Hot pads or oven mitts
- GLOBE Data Entry app
- Permanent marker



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information



Required Materials for Lab Procedures

- Soil drying method (either soil drying oven or approved warming/heat lights)
- Thermometer capable of measuring to 110°C (if using a drying oven)
- Soil Samples in containers suitable for your drying method
- Balance or scale with 0.1g sensitivity and at least 400 g capacity (600 g recommended)
- Hot pads or oven mitts
- GLOBE Data Entry app
- Permanent marker



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Soil Moisture Gravimetric Lab Procedure

- If using an electronic balance, check that the balance measures in grams and is zeroed properly
- If you are using sample cans, remove the lids from each soil sample.
- If you are using bags, get the mass with the bag closed.
- Weigh each sample and record the mass to the nearest 0.1 g as the Wet Mass.
- Select the Date Entry page that corresponds to your collection method – Star Pattern, Transect, or Depth Profile.

Note: Calibrate your scale or balance according to the manufacturer's instructions





A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Drying Soil Samples

- If using an oven, place the uncovered sample cans in the soil drying oven.
- Set the temperature so that it doesn't exceed 105°C.
- Samples are often dry after 10 hours at 105°C.
- For cooler ovens, allow more time.
- If using heat lamps, place open sample bags under the lamps.
- Samples can take 2 - 3 days to dry completely.
- If you can't leave the lamps on overnight, turn them back on the next morning.
- Carefully remove the samples from the drying source using the hot mitts.





A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Determine if Samples are Dry

- To test if the sample is dry, weigh it, and then dry it for an additional period of time (e.g. 30 minutes).
- Weigh it again. If the mass of the sample has not changed by more than 0.3 g, the sample may be considered dry.
- Repeat as necessary.
- When your samples are dry, record the drying time and drying method in the Data Entry app. or Data Entry Sheet.
- Weigh and record the **Dry Mass** for each container.





A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

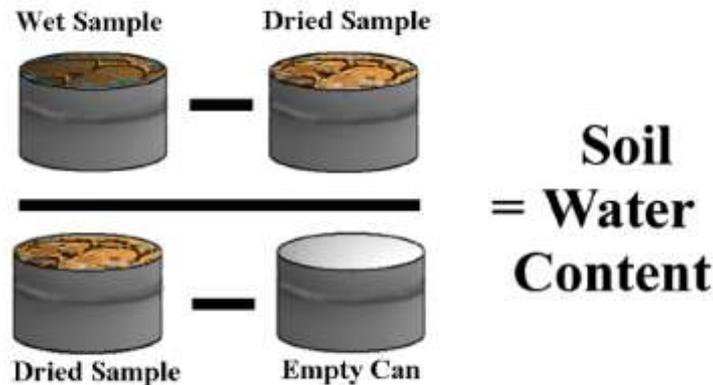
I. Visualize your data

J. Additional information

Determining Soil Water Content

Unless you will use these samples for other lab analyses, return the dried soil to the site to fill in holes so site may be used in future years.

- Empty the soil from the containers.
- Clean and dry each container. You may save the soil samples for further tests.
- Use this formula to calculate Soil Water Content:





A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Reporting Data to GLOBE

Download the Data Entry app from the [App Store](#)

[Live Data Entry](#): These pages are for entering environmental data – collected at defined sites, according to protocol, and using approved instrumentation – for entry into the official GLOBE science database.

[Email Data Entry](#) : If connectivity is an issue, data can also be entered via email.

The GLOBE Program
Science Data Entry

The GLOBE mobile app allows GLOBE users to perform data entry on a large number of GLOBE science protocols. To use this app, you will need a GLOBE account.

I have a GLOBE account!

[Sign In](#)

[JOIN GLOBE](#) | [CONTACT GLOBE](#)



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Soil Moisture Gravimetric Data Entry-

Select “Live Data Entry”

Under Soil Moisture and Temperature, click “New observation”

Soil Moisture And Temperature

Soil Infiltration ★

New observation

Past observations

Soil Moisture – SMAP Block Pattern ★

New observation

Past observations

Soil Temperature ★

New observation

Past observations

Soil Moisture – Gravimetric ★

New observation

Past observations

Soil Moisture Via Sensor ★

New observation

Past observations





A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Transect Sampling Data Entry-1

Soil Moisture - Gravimetric *Creating*

Measured at date and time (24hr)

UTC [Get Current UTC Time](#) Local

Sampling Pattern

Enter the date and time you took the measurements. Be sure to choose Local or UTC time.

Use the drop down menu to choose your sampling pattern (Star, Depth Profile, or Transect). Once you select your sampling pattern, the data entry page will appear.



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Transect Sampling Data Entry-2

Drying

Is the soil saturated?
 Yes No

Drying Method *
 Oven 95 105 Degrees C

Average Drying Time (HH:mm)
 24 : 00

Samples

At least one sample is required. All measurements should be in grams.

Note whether the soil was saturated.

Select the method and temperature at which you dried your samples.

Enter how long you dried your soil samples.

Click to bring up the appropriate 0-5 cm sample soil moisture form. See next slide for an example.

Samples

Enter the data for your samples taken at a depth between 0 and 5 cm (10 single samples plus 1 triple sample).
 At least one sample is required. All measurements should be in grams.

+ Add another sample



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Example of Transect Data Entry- 3

Enter the offset distance (zero)

Sample 1

Offset distance from end of transect: m

Weight of soil & container

Wet soil (a)

Dry soil (b)

Water weight (c)

Empty container weight

Dry soil weight

Gravimetric Soil Moisture

g

g

$a - b = g$

g

$b - d = g$

$c / e = g/g$

Enter the soil moisture data for sample one here.



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Example of Transect Data Entry- 4

Be sure to note the distance from the sample site to the end of the transect.

Sample 1

Offset distance from end of transect: m

Weight of soil & container

Wet soil (a)	Dry soil (b)	Water weight (c)	Empty container weight (d)	Dry soil weight (e)	Gravimetric Soil Moisture (f)
<input type="text" value="146.5"/> g	<input type="text" value="135.4"/> g	$a - b = 11.10 \text{ g}$	<input type="text" value="30.5"/> g	$b - d = 104.90 \text{ g}$	$c / e = 0.11 \text{ g/g}$

Calculated Soil Moisture

+ Add another sample

Comments

Enter any comments specific to this point here.

To enter the data for another sample along the transect, click Add another sample.

When you have entered your soil moisture data, click, "Send Data."



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Example of Star Sampling Pattern Data Entry- 1

Soil Moisture - Gravimetric *Creating*

Measured at date and time (24hr)

2015-12-21 13:01 UTC [Get Current UTC Time](#) Local

Sampling Pattern: Star Gravimetric

Your UTC time converted to Local (EST) time is 2015-12-21 08:01

Enter the date and time you took the measurements. Be sure to choose Local or UTC time.

Use the drop down menu to choose your sampling pattern (Star, Depth Profile, or Transect). Once you select your sampling pattern, the data entry page will appear.



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Example of Star Sampling Pattern Data Entry- 2

Drying

Is the soil saturated?

Yes No

Drying Method *

Oven 95 105 Degrees C

Average Drying Time (HH:mm)

24 : 00

Samples

At least one sample is required. All measurements should be in grams.

Note whether the soil was saturated.

Select the method and temperature at which you dried your samples.

Enter how long you dried your soil samples.

Soil Saturation and Drying Data Entry. Click to bring up the appropriate 0-5 cm sample soil moisture form. See next slide for an example.

Samples

Enter the data for your samples taken at a depth between 0 and 5 cm (10 single samples plus 1 triple sample).

At least one sample is required. All measurements should be in grams.

+ Add another sample



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Example of Star Sampling Pattern Data Entry- 3

0-5 cm data entry

Samples

At least one sample is required. All measurements should be in grams.

0 - 5 cm samples

Weight of soil & container

Wet soil (a)	Dry soil (b)	Water weight (c)
<input type="text" value="146.3"/> g	<input type="text" value="124.5"/> g	$a - b = 21.80 \text{ g}$

Empty container weight (d)	Dry soil weight (e)	Gravimetric Soil Moisture (f)
<input type="text" value="30.8"/> g	$b - d = 87.90 \text{ g}$	$c / e = 0.23 \text{ g/g}$

+ Add another 0-5 cm sample

Click to add another 0-5 cm sample

10 cm samples

+ Add another 10 cm sample

Click to add a 10 cm sample

Calculated Soil Moisture

Empty container weight (d)	Dry soil weight (e)	Gravimetric Soil Moisture (f)
<input type="text" value="30.9"/> g	$b - d = 87.00 \text{ g}$	$c / e = 0.17 \text{ g/g}$

Calculated Dry Soil Weight

Calculated Soil Moisture



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Example of Star Sampling Pattern Data Entry- 4

0-5 cm data entry

Add any metadata here.

Comments

Send Data

Cancel

Reset

When you have entered your soil moisture data, click, "Send Data."



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Soil Moisture Gravimetric-Depth Profile-1

Soil Moisture – Gravimetric *Creating*

Measured at date and time (24hr)

2015-12-15 00:00 UTC [Get Current UTC Time](#) Local

Sampling Pattern: Depth Profile Gravimetric

Your UTC time converted to Local (EST) time is 2015-12-14 19:00

Image: GLOBE website Data Entry selecting soil moisture sampling date and time (with a sample date and time entered) as well as sampling pattern screen grab

Once you select the Sampling Pattern, the data entry page will appear.



Soil Moisture Gravimetric-Depth Profile-2

Soil Saturation and Drying Data Entry

A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Drying

Is the soil saturated?

Yes No

Drying Method *

Oven 95 105 Degrees C

Average Drying Time (HH:mm)

24 : 00

Samples

At least one sample is required. All measurements should be in grams.

Note whether the soil was saturated.

Select the method and temperature at which you dried your samples.

Enter how long you dried your soil samples.



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Soil Moisture Gravimetric-Depth Profile-3

Depth Profile 0 – 5 cm & 10 cm Data Entry Example

Samples

At least one sample is required. All measurements should be in grams.

Samples Between 0 And 5 Cm

Weight of soil & container

Wet soil (a)

Dry soil (b)

Water weight (c)

Empty container weight (d)

Dry soil weight (e)

Gravimetric Soil Moisture (f)

 g g

$a - b = g$

 g

$b - d = g$

$c / e = g/g$

Enter the soil moisture data for the 0-5 cm here.

Samples At 10 Cm

Weight of soil & container

Wet soil (a)

Dry soil (b)

Water weight (c)

Empty container weight (d)

Dry soil weight (e)

Gravimetric Soil Moisture (f)

 g g

$a - b = g$

 g

$b - d = g$

$c / e = g/g$

Enter the soil moisture data for 10 cm here.



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Soil Moisture Gravimetric-Depth Profile-4 Depth Profile 0 – 5 cm & 10 cm Data Entry Example

Samples Between 0 And 5 Cm

Weight of soil & container

Wet soil (a)	Dry soil (b)	Water weight (c)
<input type="text" value="138.5"/> g	<input type="text" value="118.7"/> g	$a - b = 19.80 \text{ g}$

Empty container weight (d)	Dry soil weight (e)	Gravimetric Soil Moisture (f)
<input type="text" value="30.8"/> g	$b - d = 87.90 \text{ g}$	$c / e = 0.23 \text{ g/g}$

Samples At 10 Cm

Weight of soil & container

Wet soil (a)	Dry soil (b)	Water weight (c)
<input type="text" value="132.8"/> g	<input type="text" value="117.9"/> g	$a - b = 14.90 \text{ g}$

Empty container weight (d)	Dry soil weight (e)	Gravimetric Soil Moisture (f)
<input type="text" value="30.9"/> g	$b - d = 87.00 \text{ g}$	$c / e = 0.17 \text{ g/g}$

Calculated Soil Moisture

Calculated Dry Soil Weight

Calculated Soil Moisture



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Soil Moisture Gravimetric-Depth Profile-5

Depth Profile Data Entry 30 cm, 60 cm, 90 cm Example

Samples At 30 Cm

Weight of soil & container

Wet soil (a)

Dry soil (b)

Water weight (c)

Empty container weight

Dry soil weight

Gravimetric Soil Moisture

 g g

$a - b = g$

 g

$b - d = g$

$c / e = g/g$

Samples At 60 Cm

Weight of soil & container

Wet soil (a)

Dry soil (b)

Water weight (c)

Empty container weight

Dry soil weight

Gravimetric Soil Moisture

 g g

$a - b = g$

 g

$b - d = g$

$c / e = g/g$

Samples At 90 Cm

Weight of soil & container

Wet soil (a)

Dry soil (b)

Water weight (c)

Empty container weight

Dry soil weight

Gravimetric Soil Moisture

 g g

$a - b = g$

 g

$b - d = g$

$c / e = g/g$

Enter the data for each of the depths for which you took and dried samples.



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Soil Moisture Gravimetric-Depth Profile-6

Completing Depth Profile Data Entry

Add any metadata here.

Comments

Send Data

Cancel

Reset

When you have entered your soil moisture data, click, "Send Data."



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

GLOBE Data System Response

If your data is within the appropriate ranges for Gravimetric Soil Moisture, you will see the image below.



Image: GLOBE website data entry successful soil moisture screen grab

If your data is not within the appropriate range or has other issues, you will see the following.



Image: GLOBE website data entry unsuccessful soil moisture screen grab

Address the errors it the page details and resubmit your data.

If you don't get data within a certain range, contact GLOBE Community Support.



Soil Moisture Gravimetric 0 - 5 cm Data Visualization

Visualization for the first horizon shows the soil moisture for 0-5 cm.



A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

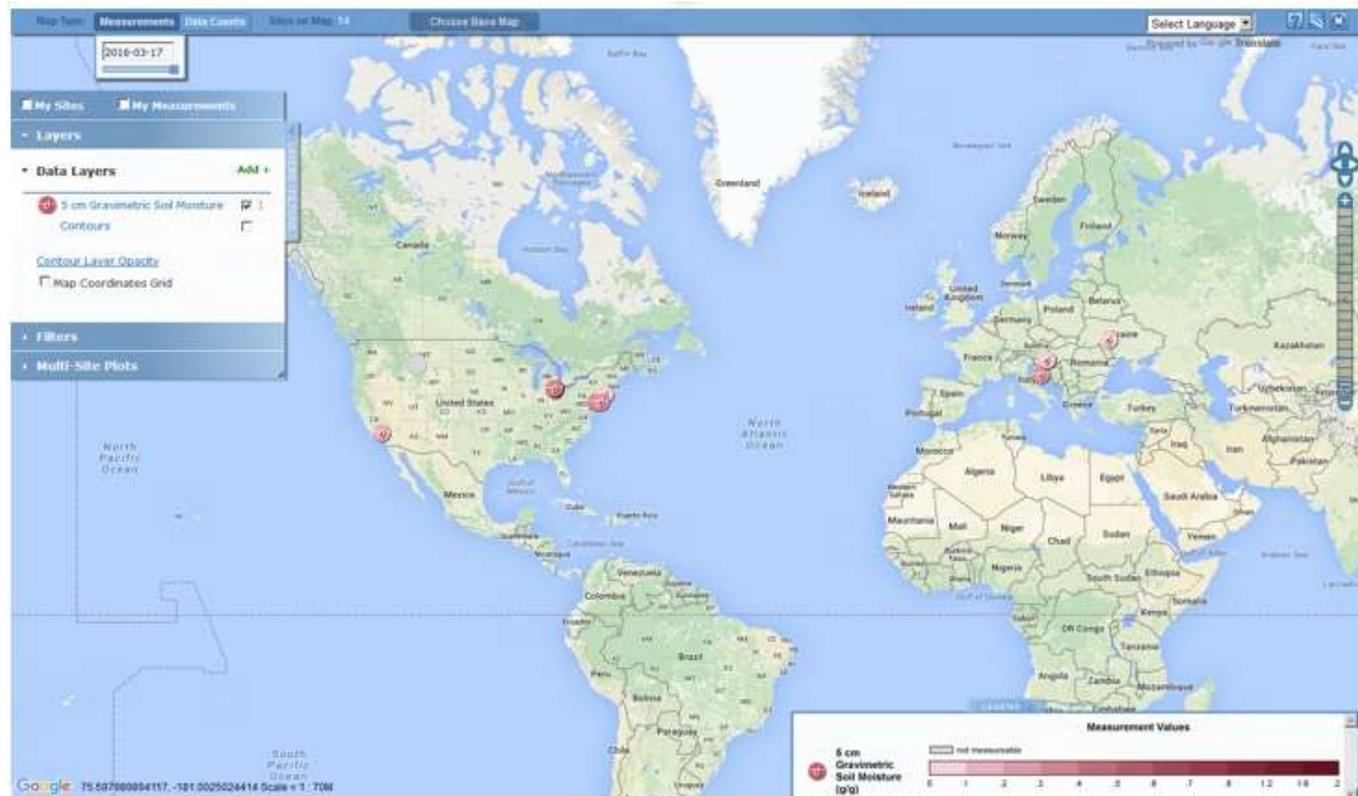
I. Visualize your data

J. Additional information



Soil Moisture Gravimetric 0 - 5 cm Data Visualization

Visualization for the first horizon shows the soil moisture for 0-5 cm. Data from this protocol and the SMAP Protocol are combined.



- A. Why measure soil moisture?
- B. How your measurements help
- C. Preparation for conducting the protocol
- D. Transect sampling
- E. Star pattern sampling
- F. Depth pattern sampling
- G. Taking Lab measurements
- H. How to report data to GLOBE
- I. Visualize your data
- J. Additional information



Questions for Further Investigations

- What other GLOBE schools have patterns of soil moisture similar to yours?
- How many weeks of the year is your soil relatively wet or relatively dry?
- Does soil moisture change during the winter?
- Which areas around your school are usually dry or wet? Why?
- Which holds the most water: clay, sand, or silt? Why?
- Does the type of land cover affect the amount of water that enters the soil? Does it affect the rate at which soil dries out following a rainstorm?
- How are soil moisture and relative humidity related?
- How are soil moisture and soil, surface and air temperature related?
- How does the porosity of a soil horizon relate to the amount of water that horizon can hold?
- How does soil water content change from one horizon to another in the same profile?
- What happens to the downward flow of water if there is a coarse textured (sandy) horizon overlying a horizon with high clay content? What happens to water flow if a clayey horizon is found over a sandy horizon?

A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information



Frequently Asked Questions

A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

1. What should students do if they forgot to weigh the empty soil containers before filling them with samples in the field?

The soil collection containers can be weighed at the end of the soil moisture protocols after emptying the dried soil and cleaning the containers thoroughly. Remember that any dried soil left in the container will lead to an inaccurate container mass.

2. What should students do if the soil is frozen?

Take soil moisture measurements during times when the soil is thawed.

3. What should students do if the site was accidentally watered?

Take the data as usual, but check the flag on the *Data Sheet* to indicate artificially watered site. These data are still useful, and depending on conditions, the soil moisture may be affected by the watering for several days. If a large area, > 1 km² within 3 km of your site is irrigated, record this as metadata and report it to GLOBE. This is important for interpretation of observations.

4. What should students do if the soil is snow covered?

If the soil is not frozen, brush off the snow and proceed with the sample collection.



Soil (Pedosphere)



Soil Moisture Gravimetric

A. Why measure soil moisture?

B. How your measurements help

C. Preparation for conducting the protocol

D. Transect sampling

E. Star pattern sampling

F. Depth pattern sampling

G. Taking Lab measurements

H. How to report data to GLOBE

I. Visualize your data

J. Additional information

Request for your feedback on this module! Please provide us with feedback about this module. This is a community project and we welcome your comments, suggestions and edits! Comment here: [eTraining Feedback](#)

Questions after reviewing this module? Contact GLOBE eTraining: rlow@ucar.edu

Credits

Slides: Izolda Trachtenberg, Dixon Butler, Russanne Low

Photographs: Izolda Trachtenberg

Illustrations: Rich Potter

Cover Art: Jenn Glaser, *ScribeArts*

More Information:

[The GLOBE Program](#)

[NASA Earth Science](#)

[NASA Global Climate Change: Vital Signs of the Planet](#)

The GLOBE Program is sponsored by these organizations:



Version 12/1/16. If you edit and modify this slide set for use for educational purposes, please note "modified by (and your name and date) " on this page. Thank you.