

**Accompanying Worksheets:** Soil Temperature as a Function of Depth and Sunlight (W-S-03), Soil Temperature over One Day (W-S-04), and Long-Term Soil Temperature Measurements (W-S-05)

**Objective:** Students will measure the temperature of the soil at depths of 5 cm and 10 cm. They will evaluate temperature variations as they relate to depth, sun vs shade, time of day, and time of year. They will also have the opportunity to graph their findings and think critically about the variables involved.

**Considerations:**

1. The Globe Protocol requires that measurements be taken daily or weekly. However, we realize this is not always feasible, so we have created three separate protocols: the first can be done in a single session, as it focuses on the differences created by variances in depth and sunlight. The second takes measurements over a single day. While not necessarily feasible in a classroom environment, students can do this on their own over a weekend or break. The third takes measurements over the course of a year, at whatever intervals are convenient for you.
2. We recommend that this protocol be performed in conjunction with the Soil Site Selection and Soil Characterization protocols, though it can be used unaccompanied.

**Protocol 1: Soil Temperature as a Function of Depth and Sunlight**

**Materials:**

- \_\_\_ Worksheet W-S-03
- \_\_\_ Soil Thermometers
- \_\_\_ Nails (or Bamboo Skewers or similar)
- \_\_\_ ruler

**Instructions:**

1. Prepare the soil thermometer by measuring two points: one 5cm from the tip, and the other 10cm from the tip. Mark these points in permanent marker.
2. Note the site location and identifier on the worksheet.
3. Record the amount of sunlight that the site is receiving. We suggest choosing sites that are consistently in the shade or sun, respectively, to further illustrate differences in temperature as a result of sunlight.
4. Use the thermometer to measure the ambient air temperature at the site, and record it on the worksheet.
5. Measure the soil temperature at the site
  - a. If the soil is hard, use the nail or skewer to make a pilot hole for the thermometer. This is to prevent unnecessary damage to the thermometer.

- b. Submerge the thermometer up to the 5cm mark and measure the temperature. Wait 2 minutes for the reading to stabilize before recording on the worksheet.
  - c. Submerge the thermometer to the 10cm mark (again puncturing the soil with the nail or skewer if necessary). Wait 2 minutes before recording the temperature on the worksheet.
  - d. Repeat the 5cm and 10cm measurements on two more sites within 25 cm of the original measurement, and record on the worksheet. Here, you may want to stress the importance of larger sample sizes to proper science.
6. Repeat at as many sites as desired, though it is necessary to measure at least one site in the sun and one in the shade.
  7. Use the worksheet and the graphs provided to evaluate variables such as depth and sunlight.

### **Protocol 2: Soil Temperature over One Day**

#### **Materials:**

- \_\_\_ Worksheet W-S-04
- \_\_\_ Soil Thermometers
- \_\_\_ Nails (or Bamboo Skewers or similar)
- \_\_\_ Ruler

**Instructions:** \*This protocol requires measurements outside normal school hours, so we recommend it as a take-home project for students over a weekend or break.

1. Prepare the soil thermometer by measuring two points: one 5cm from the tip, and the other 10cm from the tip. Mark these points in permanent marker.
2. Locate two independent sites: one that is in constant sunlight (ie in the middle of an open field) and one in constant shade (ie under a tree or alongside a building).
3. Record the time of sampling on the worksheet.
4. Use the thermometer to measure the ambient air temperature at the site, and record it on the worksheet.
5. Measure the soil temperature at the first site.
  - a. If the soil is hard, use the nail or skewer to make a pilot hole for the thermometer. This is to prevent unnecessary damage to the thermometer.
  - b. Submerge the thermometer up to the 5cm mark and measure the temperature. Wait 2 minutes for the reading to stabilize before recording on the worksheet.
  - c. Submerge the thermometer to the 10cm mark (again puncturing the soil with the nail or skewer if necessary). Wait 2 minutes before recording the temperature on the worksheet.
  - d. Repeat the 5cm and 10cm measurements on two more sites within 25 cm of the original measurement, and record on the worksheet.
6. Repeat the measurement at the second site.
7. The first measurement should take place before sunrise, and all subsequent measurements should be taken at 2 hour intervals from the initial.
8. Use the worksheet to graph the progression of temperatures throughout the day.

### Protocol 3: Long-Term Soil Temperature Measurements

#### Materials:

\_\_\_ Soil Thermometers

\_\_\_ Nails (or Bamboo Skewers or similar)

\_\_\_ Worksheet W-S-05

\_\_\_ Ruler

**Instructions:** \*This is intended as a short, repeated activity at one site. Because of this, you may wish to have your sample site located on or near your school grounds. You may also wish for this to be a rotational daily or weekly assignment for your students, where after a significant amount of data have been collected (after a month or several), you create plots on the changes in temperature over time.\*

1. Prepare the soil thermometer by measuring two points: one 5cm from the tip, and the other 10cm from the tip. Mark these points in permanent marker.
2. Note the site location and identifier on the worksheet.
3. Record the amount of sunlight that the site is receiving. We suggest choosing sites that are consistently in the shade or sun, respectively, to further illustrate differences in temperature as a result of sunlight.
4. Use the thermometer to measure the ambient air temperature at the site, and record it on the worksheet.
5. Measure the soil temperature at the site
  - a. If the soil is hard, use the nail or skewer to make a pilot hole for the thermometer. This is to prevent unnecessary damage to the thermometer.
  - b. Submerge the thermometer up to the 5cm mark and measure the temperature. Wait 2 minutes for the reading to stabilize before recording on the worksheet.
  - c. Submerge the thermometer to the 10cm mark (again puncturing the soil with the nail or skewer if necessary). Wait 2 minutes before recording the temperature on the worksheet.
  - d. Repeat the 5cm and 10cm measurements on two more sites within 25 cm of the original measurement, and record on the worksheet. Here, you may want to stress the importance of larger sample sizes to proper science.
6. Repeat at as many sites as desired.
7. Use the worksheet to plot the changes in temperature over time.

Adapted from GLOBE Protocol:

<http://www.globe.gov/documents/352961/353769/soiltemp.pdf>

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