

# Frost Tube Protocol at Air Temperatures Colder Than $-20^{\circ}\text{C}$

## Field Guide

### Task

Observe and record the depth of freezing in the ground's active layer (where there is permafrost) when air temperatures are colder than  $-20^{\circ}\text{C}$  (determined by a GLOBE Atmosphere site nearby or from another reliable source).

or

Observe and record the depth of freezing in the ground (where there is no permafrost) when air temperatures are colder than  $-20^{\circ}\text{C}$  (determined by a GLOBE Atmosphere site nearby or from another reliable source).

### What You Need

- A properly installed Frost Tube
- Pen or pencil
- [Frost Tube Data Sheet](#)
- Meter stick

Students will measure the depth of freezing as the ground cools.

- Depth of Freezing = distance in the Frost Tube from the soil surface to the boundary between the ice layer and unfrozen water in the inner tube. This represents the depth of freezing between the soil surface and the underlying unfrozen soil.

### In the Field

#### First time only/getting started

1. Complete the upper portion of your data sheet.

#### Every visit

1. Record the date on the [Frost Tube Data Sheet](#).
2. If you have a GLOBE Atmosphere site nearby, record the current air temperature on the [Frost Tube Data Sheet](#). Otherwise, consult a reliable source (e.g., local Weather Service station) for this information. If the air temperature is warmer than  $-20^{\circ}\text{C}$  then use the [Frost Tube Protocol for Temperatures Warmer than  \$-20^{\circ}\text{C}\$  Field Guide](#). If the air temperature is colder than  $-20^{\circ}\text{C}$  then continue with the following procedure.
3. Walk to the Frost Tube site using the same path to reduce impact on the snow conditions.
4. Use a meter stick to record the depth of snow in three undisturbed locations near the Frost Tube. Enter these data on the [Frost Tube Data Sheet](#).
5. Working quickly to reduce impact of colder than  $-20^{\circ}\text{C}$  temperatures, remove the PVC cap and pull the inner tube (containing the colored water) out just far enough to note the depth of freezing or thawing. Be sure to hold the outer PVC tube to prevent it from lifting

out of the hole as well.

6. Determine the depth of freezing:

- Locate the soil surface mark (0 cm) on the water-filled inner tubing. Hold the meter stick by this inner tube.
- Find the boundary between the ice at the top of the clear tubing and the water below it. The ice appears relatively clear while the water is colored. (*Note: Sometimes the ice will be mottled with some color still left in it from the food coloring.* This happens when freezing occurs so quickly that some of the dye crystals are trapped in the ice.) There should still be a distinct boundary evident between such partially colored ice and the unfrozen water, which will have a homogeneous color.
- Read off the depth of this boundary to the nearest centimeter (by holding the meter stick by the inner tube).

7. Record the depth of freezing on the *Frost Tube Data Sheet* and the observer names.

8. Because the extremely cold air temperature may cause some of the unfrozen water in the tube to freeze during the time it is pulled out of the assembly, you will need to remove the clear tubing from the Frost Tube and carry it inside to completely thaw it out for at least 24 hours. After removing the inner tubing, be sure to replace the cap on the outer PVC pipe.

9. The following day replace the clear tubing in the Frost Tube:

- Carefully coil up the tubing and place it under your coat before you go outside. This will help to reduce the influence of the cold air.
- Walk to the Frost Tube site, remove the cap and quickly place the clear tubing back into the Frost Tube. Replace the cap immediately.
- Note the date that the Frost Tube was removed for thawing out and the date it was replaced on the *Frost Tube Protocol Data Sheet* in the Comments section.
- Do not disturb the Frost Tube until it is time to take the next measurement.

10. Repeat the measurements **once each week at the same time**, ideally within one hour of solar noon. If the cold weather continues, you will need to repeat this procedure each time you read the Frost Tube (depth of freezing is observed and recorded).

11. If possible, for each time the Frost Tube is read, note the current air temperature and depth of snowpack (if present) in three representative locations at the Frost Tube site where there is minimal disturbance.