

Selecting and Documenting Your Atmosphere Study Site

Site Selection and Set-up

Choosing the location for your Atmospheric Study Site and correctly setting up your rain gauge, instrument shelter, and ozone measurement station are critical to your successful implementation of this investigation. Atmosphere measurements are taken frequently, so students need to be able to get to the site and return in a short amount of time. Figure AT-SS-1 shows the ideal placement of the Instrument Shelter and Rain Gauge.

The ideal site for taking atmospheric measurements is open, away from trees, buildings and other structures. The open area helps because nothing blocks precipitation creating rain or snow shadows, air is free to flow around the instruments, heat from individual buildings doesn't affect the data significantly, and most of the sky can be seen. In choosing your site, some compromise may be necessary between the ideal for scientific observations and the logistical constraints of the school grounds and their surroundings. The key to ensuring the value of your students' data is to document the nature of your Atmosphere Study Site and its surroundings.

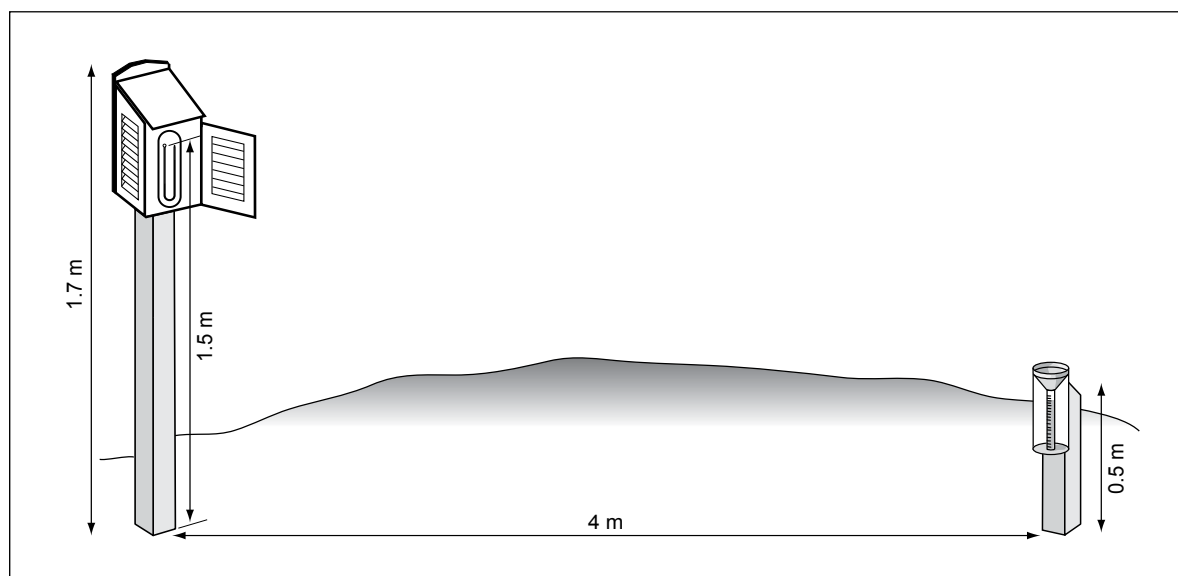
Figure AT-SS-2 shows the ideal site. Trees, buildings, and other structures are all at least

four times as far away as they are tall. For example, if your site is surrounded by trees or buildings that are 10 meters tall, place your instruments at least 40 meters from these trees. At such distances, trees, bushes, or buildings can be useful by breaking the wind and actually make your rainfall and snowfall readings more accurate

Cloud, Contrail, and Aerosol Observations

Measurements of cloud and contrail amounts, cloud type, and aerosols require an unobstructed view of the sky but do not require the installation of any equipment. The middle of a sports field is an excellent location. The site where you take your cloud, contrail, and aerosol measurements does not have to be the same as the location of your rain gauge, hygrometer, ozone measurement station, and instrument shelter. If you choose to take cloud, contrail, and aerosol observations from a separate site located more than 100 m from the shelter, define two Atmosphere Study Sites and report the data from the different protocols separately. To pick a good spot from which to take these measurements, simply walk around your school until you come to an area where you have the most unobstructed view of the sky. If you live in a city, you may not be able to find a completely unobstructed

Figure AT-SS-1





view of the sky. Choose the most open site available.

For sites that have substantial obstacles such as tall trees or large buildings which prevent a view of the entire sky, it will be helpful to take three observations of cloud and contrail cover and cloud and contrail type, spaced 5 minutes apart. In these situations, report to GLOBE the average cloud and contrail cover and all cloud types observed, rather than a single observation.

Precipitation, Relative Humidity, Temperature, and Ozone Instrument Placement

The ideal placement for both the rain gauge (and/or snowboard) and the instrument shelter, which will house the thermometers and digital hygrometer instrument, is a flat, open area with a natural (e.g., grassy) surface. Avoid building roofs and paved or concrete surfaces if at all possible; these can become hotter than a grassy surface and may affect instrument readings. Hard surfaces can cause errors in precipitation measurements due to splash-in. Also avoid placing the instruments on steep slopes or in sheltered hollows unless such terrain represents the surrounding area.

Measurements of soil moisture and temperature are much more valuable to scientists and more usable in student research projects if data on precipitation and air temperature are available from a site that is within 100 meters of the Soil Moisture or Soil Temperature Study Site. These soil measurements involve digging, placing instruments in the ground, taking samples of soil, and sticking soil thermometers in the ground. If it is possible for your school to take these soil measurements, even if you don't plan to do so for several years, you should take into consideration the requirements for the [Soil Moisture](#) and [Soil Temperature Protocols](#) given in the *Soil Investigation*.

Rain Gauge Placement

Since wind is one of the greatest causes of error in rain gauge measurements, the best placement for the rain gauge is on a post as low to the ground as practical. Wind blowing across the top of the gauge creates an effect that causes raindrops to be deflected around the gauge. Because wind speed generally

increases with height above the ground, the lower the rain gauge, the less effect the wind should have on it. In Figure AT-SS-1, note that the instrument shelter and the rain gauge are mounted on separate posts. The top of the rain gauge is about 0.5 meters above the ground and is located 4.0 meters away from the instrument shelter so that the shelter does not block rain from collecting in the gauge.

If it is not practical to place the rain gauge and instrument shelter on separate posts, they may be mounted on a single post, with the rain gauge mounted on the opposite side from the shelter. Regardless of whether the rain gauge shares a post with the instrument shelter or is mounted on its own post, make sure the top of the rain gauge is about 10 cm higher than the top of the post, to avoid splash-in of rain from the post top. If possible, cut the top of the post at a 45° angle sloping away from the rain gauge so that drops will splash away from the gauge.

Snowboard Placement

Place the snowboard on relatively level ground where the snow depth best represents the average depth of the surrounding area. For a hillside, use the slope with an exposure away from the sun (this means a northerly exposure in the Northern Hemisphere and a southerly exposure in the Southern Hemisphere). The site should be free from trees, buildings, and other obstructions that may affect wind flow or the melting of snow. Remember that after each new snow fall, the snowboard will be moved to a new, undisturbed location. Also remember to place a flag where the snowboard is located so that you can find it following a snow fall.

Instrument Shelter and Thermometer Placement

The instrument shelter should be mounted so that the maximum-minimum thermometer mounted inside is 1.5 meters above the ground (or 0.6 meters above the average maximum snow depth). This will help prevent heat from the ground from affecting your temperature reading. The instrument shelter should be mounted on the side of the post that faces away from the equator. That is, the instrument shelter should be placed on the north-facing side of the post in the Northern Hemisphere, and on the south-facing side of the post in the Southern Hemisphere. This



placement helps protect the thermometer from direct sunlight when the shelter door is opened to take a reading.

The post on which the instrument shelter is mounted should be secured in the ground as firmly as possible. This will help minimize vibrations caused by strong winds which may cause the indicators in the maximum/minimum thermometer to move. Locking the instrument shelter is customary to prevent tampering with the thermometer between readings.

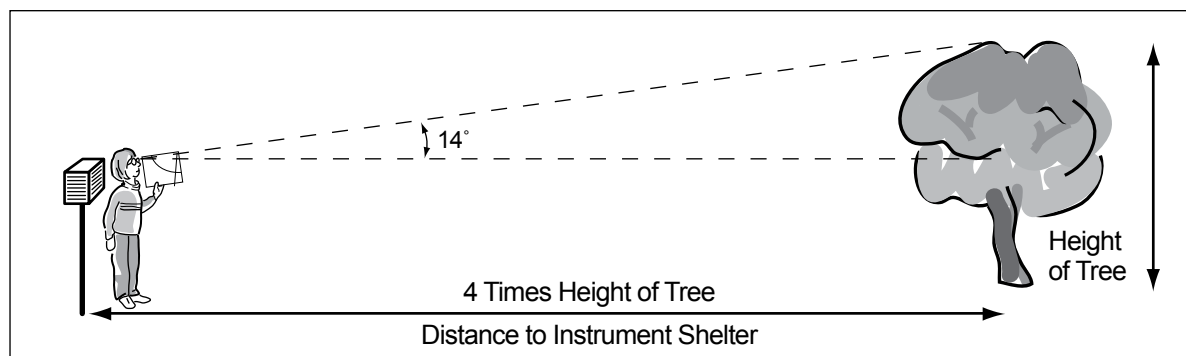
The shelter protects the thermometer from radiation from the sun, sky, ground, and surrounding objects, but allows air to flow through so the air temperature inside the shelter is the same as the air temperature outside the shelter. Mount the maximum/minimum thermometer in the instrument shelter so that there is air flow all around the thermometer case. This is usually accomplished by using blocks or spacers between the thermometer and the rear wall of the shelter. See Figures AT-ICIS-3 and AT-ICIS-4. No part of the thermometer should touch the walls, floor, or ceiling of the shelter.

The probe of the digital multi-day maximum/minimum thermometer should hang in the air in the air inside the shelter and not touch the walls. The read-out unit may be mounted on the back wall.

Ozone Measurement Station

The measurement station is mounted on a permanent post and located in an open area to allow air to flow freely around the chemical strip. It should be located near the GLOBE Instrument Shelter to enable students to collect required current temperature data easily. Thus, the Ozone Measurement Station is part of the Atmosphere Study Site.

Figure AT-SS-2



The unit that holds the chemical test strip should be attached to a 5-cm diameter by 2-meter long wooden pole. Once the pole is permanently placed 60 cm into the ground, the top of the monitoring station will be at 1.4 meters above ground placing the chemical strip at about 1.3 meters above the ground. This will place the paper clip that holds the ozone sensitive strip at a good height for middle grade students. The pole may be shorter to locate the monitoring station at a convenient level for younger students or they can stand on the same step stool used to put their eyes level with the maximum/minimum thermometer in the instrument shelter. The plastic disk protects the chemically sensitive strip from light rain or snow.

Security of Your Instruments

Some schools have reported vandalism problems at their GLOBE study sites, particularly with the rain gauge and the instrument shelter. Each school must determine what security measures work best for them. Some schools place their instrument shelter in a very prominent place where the whole community can appreciate it and keep a watch on it. Other schools have put fences around their atmosphere sites. This is perfectly acceptable, providing that the fencing does not interfere in any way with the instruments. This means that a fenced enclosure must be large enough so that the rain gauge is completely free from obstruction. A fenced enclosure should not have a top of any kind, even a fenced top, as this will interfere with precipitation measurements. If there is simply no secure area around your school where instruments can safely be left outside for extended periods of time, there are alternate GLOBE protocols that you can use for measuring current temperature, and the ozone measurement station may be portable.



Documenting Your Atmosphere Study Site

To start reporting atmosphere measurements to GLOBE, you must define your Atmosphere Study Site in the GLOBE data system. To enable your students to get a quick start, you may initially define the site by giving it a name and assigning it the same coordinates as your school location. Later, when you have measured the latitude, longitude, and elevation using a GPS receiver, you can edit the study site definition to supply this information. There are many other characteristics of your study site which may be important to various data users. These include the heights of your rain gauge, maximum/minimum thermometer, ozone test strip hanger, the slope at your site and the slope's direction, and any ways in which your site differs from ideal conditions. All of these items may be added when you edit the site description.

At many GLOBE schools the ideal atmosphere study site doesn't exist. Scientists can still make good use of the data from these schools, but information is needed about all the ways in which your site is not ideal. This information is called metadata and is reported as part of the Atmosphere Study Site definition. It is important for scientists to know any local conditions which could affect the temperature at the instrument shelter, the amount of rain reaching the rain gage or snow accumulating on the snowboard, the ability of students to see the whole sky, etc.

What might affect temperature readings?

Buildings that are heated or cooled put out heat. If a building is within 10 meters of the instrument shelter, this should be noted in your metadata. Surfaces such as pavement and bricks absorb sunlight and radiate heat into the surrounding air as they warm. If the instrument shelter is mounted on a paved surface or a roof, a good description of this surface should be reported including the material of which the surface is made and its color. The desired surface under the atmosphere shelter is grass. If the natural surface cover in your area is generally bare soil because you live in a arid or semi-arid region, this should be reported as well.

What might affect precipitation or cloud observations?

Both the amount of precipitation collected and the amount of the sky that can be seen are affected by buildings, trees, hills, etc. surrounding the Atmosphere Study Site. For GLOBE, any obstacle which is four times as far away as it is tall is not a problem. Obstacles that are closer need to be reported as part of your site definition.

If you look at the top of an obstacle through a clinometer, and it is exactly four times as far away as it is tall, the angle you read will be 14° . Every obstacle at an angle greater than 14° is too close and should be reported as part of your site description unless it is not a substantial object. For instance, a 7 meter tall flag pole 7 meters away that is ten centimeters in diameter won't significantly affect your measurements while a 20 meter tall tree 40 meters away may create a bit of a wind break and will certainly hide part of the sky.



Documenting Your Atmosphere Study Site

Field Guide

Task

To describe and locate your Atmosphere Study Site

What You Need

- | | |
|---|--|
| <input type="checkbox"/> Site Definition Sheet | <input type="checkbox"/> GPS Receiver |
| <input type="checkbox"/> GPS Protocol Field Guide | <input type="checkbox"/> 50-meter Tape |
| <input type="checkbox"/> Compass | <input type="checkbox"/> Clinometer |
| <input type="checkbox"/> Pen or pencil | <input type="checkbox"/> Camera |

In the Field

1. Fill in the information on the top of your *Site Definition Sheet*.
2. Locate your Study Site following the *GPS Protocol Field Guide*.
3. Describe all obstacles surrounding your site. (A building, tree, etc. is an obstacle if when you sight its top through a clinometer, the angle is $> 14^\circ$.)
4. Describe any buildings or walls closer to your site than 10 meters.
5. If you recorded any trees or buildings in steps 3 or 4, take photographs of the surroundings of your site looking North, East, South, and West. Identify the number of the picture for each photograph on your *Site Definition Sheet*.
6. Choose a partner whose eyes are at the same height as yours.
7. Ask them to stand 5 meters away from you going up hill on the steepest slope at your site.
8. Look at their eyes through the clinometer and record the angle. This is the slope at your site.
9. Record the compass direction to your partner.
If you have installed a rain gauge, ozone measurement station, or instrument shelter at your site, do the following steps:
10. Measure the height of the top of the rain gauge above the ground in centimeters.
11. Measure the height of the bulb of the maximum-minimum thermometer above the ground in centimeters.
12. Measure the height of the clamp for the ozone strip above the ground in centimeters.
13. Record the type of ground cover that is under the instrument shelter.



Frequently Asked Questions

1. Is it okay to put our rain gauge and instrument shelter in a fenced area?

This is fine, as long as the fence doesn't block the rain gauge or cause rain to splash into the gauge.

2. We live in a city where there is not a good area on the school grounds to place our rain gauge and instrument shelter. Can we put these instruments on the roof of the school?

Although this is not the best location for weather instruments, if your choice is between putting the instruments on the roof or not participating in the Atmosphere Investigation, put the instruments on the roof. This has several disadvantages, both to students and scientists.

- Someone will need daily access to the roof to take the readings unless automated equipment is used.
- At the height of even a single-story building, the wind effect on your rain gauge is going to be worse than it would be on the ground.
- You must take care that structures on the roof don't block the rain gauge.
- The roof of a building is likely to be much warmer than its surroundings. The heat coming off the roof is likely to affect your temperature measurements. One way to cut down on this effect may be to put some kind of material like artificial or real grass down on the area underneath your instrument shelter.
- By putting the weather instruments on the roof, the measurements made will not be easily comparable to schools where the instruments are located on the ground. However, this does not mean that the measurements aren't useful. Eventually your school will develop a data record that will show if there are any changes in precipitation or temperature over time.

For cloud and aerosols observations, the roof can be an excellent location if your school is among the tallest buildings around.

Any time you are unable to strictly follow the protocol for placing your instruments, be sure to make a note of this in your site description.



This way other students and scientists who use your data will be aware that there are special circumstances.

3. Is it okay to mount our instrument shelter on a tree?

While this may seem to be a reasonable place for the shelter, since a tree will protect the thermometer from sun and precipitation, a tree is NOT a good place for the instrument shelter. Why? Because a tree is a living thing. This means that in the process of making food and growing, a tree gives off heat and moisture that may affect your temperature reading. Also, a large tree may provide too much shelter and not allow wind to flow freely through the instrument shelter.

4. We can't find a location on the school grounds which is four times as far from the school building as the height of the building. What should we do?

It is often difficult to find an IDEAL location for the atmosphere instruments on your school grounds. Place the instruments in as good a location as possible. Remember to complete the [Site Definition Sheet](#), and report the metadata about your site to the GLOBE Data Archive as part of defining your Study Site.

5. Can we put our rain gauge on the ground?

To minimize effects of the wind, placing the rain gauge at ground level will help reduce errors, but whether or not this is a good idea in practice depends on several factors. Most of all, the rain gauge must be stable. You don't want to just place it on a surface where it may get blown over by the wind or accidentally knocked over. That is, even if you want to put your rain gauge at ground level, you must still be certain that it is firmly attached to a post that will keep the gauge upright. Another consideration is the type of surface on which you are placing the gauge. A hard surface, such as concrete or asphalt, may increase the chance that rain will splash into the gauge from the ground. In this case, it would be best to have the top of the gauge at least 50 centimeters above the ground. However, if the surface is a porous natural surface, the gauge can be placed very close to the ground with little problem of splash-in.

6. We don't have a manufactured rain gauge. Can we use a soft drink bottle or some other kind of container?

The challenge with using a container other than a manufactured rain gauge that meets GLOBE specifications is obtaining an accurate measurement that is comparable to other data. Accurate measurements of rainfall involve more than just putting a ruler in a container and measuring the depth of rainwater. In addition, most containers are not straight-sided making it difficult to get consistent measurements. All of these difficulties indicate that the best possible container to measure rainfall is a gauge that meets the GLOBE specifications.

If you must use something other than an official rain gauge, please make a note of this as part of your Atmosphere Study Site definition.

The first requirement of a homemade rain gauge is that the top opening be round, level when it is mounted and have a diameter that meets GLOBE specifications. You should follow a special procedure to obtain the depth of rain that has fallen. Measure the diameter of your container's top opening in centimeters. After rain has accumulated in the gauge, pour it into the 100 mL graduated cylinder that you use in the hydrology and soil protocols. Measure the volume of rain that has collected in mL (which are equal to cubic centimeters). If more than 100 mL of rain has accumulated, fill the graduated cylinder to the 100 mL mark, empty it into a clean container and fill it again. Add up the volumes you measure in this way to get the total volume. The depth of rainfall is calculated as shown in the box below:

Report the value to the nearest tenth of a millimeter. Be sure to use a container that will not affect the pH of the rain water and use a clean graduated cylinder to measure the volume.

7. Why does the instrument shelter have to face away from the equator?

When you go outside on a sunny day, it is quickly obvious that you feel much warmer standing in direct sunshine than standing in the shade. For GLOBE temperature measurements, we want to measure the temperature of the air, without the influence of direct sunshine. In order to get an accurate measurement of air temperature, we need to make sure that the thermometer is protected from direct sunshine. This means that in the Northern Hemisphere the instrument shelter should face north, and in the Southern Hemisphere the instrument shelter should face south. In this way, sunlight will not shine directly onto the instruments in the shelter when the shelter door is opened to take a reading.

8. Mounting the instrument shelter so that our maximum-minimum thermometer is 1.5 meters off the ground makes it difficult for our youngest students to read the thermometer. Can we place it lower to the ground?

In the same way that placing the instrument shelter too close to a building or tree can influence temperature readings, placing the instrument shelter too close to the ground can influence the temperature reading. As the ground heats up during the day, it emits more energy. By putting the instrument shelter about 1.5 meters above the ground, the heat from the ground has a chance to dissipate into the atmosphere, so that we end up measuring air temperature and not ground temperature. For smaller students, provide a sturdy step (or set of steps) that will allow them to be at eye-level with the thermometer so that they can read it accurately.

$$\text{Radius of rain gauge opening (cm)} = \frac{\text{Diameter of rain gauge opening (cm)}}{2}$$

$$\text{Area of the rain gauge opening (cm}^2\text{)} = \pi \times [\text{Radius of rain gauge opening (cm)}]^2$$

$$\text{Rain Depth (mm)} = 10 \frac{\text{mm}}{\text{cm}} \times \frac{\text{Volume of rain (mL or cm}^3\text{)}}{\text{Area of the rain gauge (cm}^2\text{)}}$$



9. The mountains around our school partially block our view of the sky. What should we do?

In some cases, schools on hillsides or in valleys may have mountains or hills that block at least part of the horizon. Treat the surrounding hills or mountains as obstacles and describe them in your metadata. Use the clinometer to measure the angle when you are looking at the hilltops or ridge lines and include this in your description. In this situation, also remember that local solar noon is the time when the sun is at the highest point in the sky that it will reach today. The time of apparent sunset and sunrise may be affected by the surrounding terrain, and so, you cannot simply average the times of local sunrise and sunset that you observe to calculate local solar noon.

10. The conditions at our Atmosphere Study Site have changed; what should we do?

You should report the new conditions to GLOBE using the “edit a study site” feature. Be sure to choose the setting indicating that you are reporting a change rather than supplying missing data or correcting data. It is important that the date you report be the first day when conditions changed or the day when you first observed the change. The metadata you enter will be associated with all data reported for this site beginning with this date.

11. We don’t have access to a GPS receiver at present to define the location of our Atmosphere Study Site; what should we do?

You should define your Atmosphere Study Site and choose for its location the coordinates of your school. Later, when you have access to a GPS receiver, use it to measure the latitude, longitude, and elevation of your site and report these data to GLOBE by editing the definition of your Site. Information about obstacles, the heights of the various instruments, etc. can also be reported after data collection and reporting have begun by editing the definition of your Site.

