4. Monitoring Microclimates

Driving Questions

Air temperature, relative humidity, barometric pressure, and dew point measurements are collected worldwide from thousands of weather stations and processed by computers to produce global weather and climate information.

- What are the instruments used to collect weather and climate measurements, and where are they located?
- What local factors must be considered in choosing sites for the weather stations?
- What features comprise the ideal site for a weather station?

Background

Where does the data used by climatologists and weather forecasters originate? Until the arrival of satellite measurement capabilities, all data came from thousands of weather stations located across countrysides worldwide and on buoys scattered across the oceans. Today, data originating from both satellite observations and ground measurements are merged through complex computerized algorithms. These produce comprehensive results, for example, the low and high temperatures for a day for a particular area, the average temperature for a year in a given area, or the average global temperature for a year.

The features of a site for a weather station must be standardized across weather stations to minimize error introduced by particular aspects of the surrounding area. Inconsistencies can be caused by shade trees, heat reflected from buildings or parking lots, heat added from heating or air conditioning vents, proximity to a large body of water, the type of housing surrounding the weather sensors, and so on. The error introduced by these differences in microclimates can be considerable.

Materials and Equipment

For each student or group:

- Weather Sensor
- Cardboard box, 20 cm^3 or larger
- Scissors
- Marking pen

Safety

Follow your normal outdoor class procedures.

Procedure

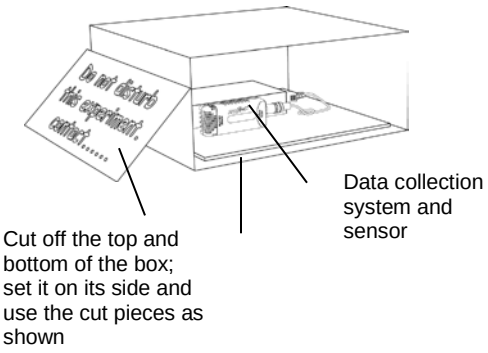
After you complete a step (or answer a question), place a check mark in the box (☐) next to that step.

Set Up

1. ☐ Using a cardboard box 20 cm by 20 cm by 20 cm or larger, cut the box so that it has no top or bottom, only the four connected sides.

2. ☐ Using the top or bottom cut from the cardboard box, make a sign that says, "Do not disturb this experiment. Contact [your teacher's name]."

   Note: This step is necessary only if you are going to leave the weather station unattended.



3. ☐ Use the top or bottom cut from the cardboard box as a mat that you will set inside this "housing" for the weather station.

4. ☐ Find a location outside with unusual characteristics, especially one that is unlike what anyone else has chosen. Here are some examples:

   - ♦ Well shaded by trees
   - ♦ Close to a big parking lot
   - ♦ Close to a pond or lake
   - ♦ In the middle of a field
   - ♦ Next to the vent of an air conditioner
   - ♦ In a sheltered, sunny area on the south side of a building
   - ♦ In a sheltered, shaded area on the north side of a building

5. ☐ Check with your teacher to be sure it is safe and otherwise acceptable to set up a weather station in the location you chose.

6. ☐ Start a new experiment on the data collection system.

7. ☐ Connect a sensor to your data collection system

   Note: If you are going to collect data for longer than 20 minutes, set the sensor sampling rate to once per minute.

8. ☐ Display temperature data in a table on the data collection system.

9. ☐ Place the cardboard housing in the accepted location so that air can circulate through the two open ends and direct sunlight is least likely to shine on the equipment. (See the illustration above.)

10. ☐ Place the cardboard mat on the floor of the cardboard housing.

11. ☐ Place the data collection system and sensor on the mat.

12. ☐ Why are you protecting your weather sensor and other electronics from direct sunlight?

_____

_____

Collect Data

13. ☐ Collect data for the amount of time your teacher specifies.

Note: For the database of all data collected by the class, data collection for all weather stations should be for the same time period.

14. ☐ Start data recording.

15. ☐ Adjust the scale of the graph to show all data.

16. ☐ Record the following in Table 1 in the Data Analysis section:

- ♦ Starting time
- ♦ Primary physical characteristics of the site, especially anything that might affect temperature
- ♦ Prevailing weather conditions (such as cloudy, sunny, windy, or calm)

17. ☐ Will the maximum, minimum, and average temperatures of your site be higher or lower than the average temperature of all the sites? Why?

_____

_____

_____

18. ☐ Stop data recording when instructed by your teacher to do so.

Note: For data collection lasting hours, make appropriate arrangements with other class teachers so you can stop the data recording at the specified time.

19. ☐ Record the time you stopped recording data in Table 1 of the Data Analysis section.

20. ☐ Save your experiment and clean up according to your teacher's instructions.

Data Analysis

1. ☐ Open a graph display and display the temperature data on a graph of temperature (°C) versus time (s).

2. ☐ Adjust the scale of the graph to show all data.

3. ☐ Find the minimum, maximum, and mean values and record these values in Table 2.

4. ☐ Repeat this procedure for the barometric pressure, relative humidity, and dew point measurements.

5. ☐ Record your data for the individual weather station (from Table 2) on a table of class data your teacher has provided.

6. ☐ After every group has recorded its data on the class data table, complete Table 2.

Table 1: Weather station and data collection information

Date and time collection started	
Date and time collection ended	
Description of physical characteristics of the site, especially anything that might affect temperature	
Prevailing weather conditions (such as cloudy, sunny, windy, or calm)	

Table 2: Individual and class weather station data

	Individual Weather Station			Average for All Class Stations		
	Minimum	**Maximum**	**Mean**	**Minimum**	**Maximum**	**Mean**
Temperature (°F)						
Barometric Pressure (in Hg)						
Relative Humidity (%)						
Dew Point (°F)						

Analysis Questions

1. **How did your data compare with the class data?**

_____

_____

_____

2. **Compare your actual statistics with your predictions.**

_____

_____

Synthesis Questions

Use available resources to help you answer the following questions.

Use available resources, and the following ideal characteristics for a climate monitoring station (according to the United States Climate Reference Network of the National Oceanic and Atmospheric Administration (NOAA)), to help you answer the following questions.

- Flat and horizontal ground
- Surrounded by a clear surface with a slope less than 1/3 (less than 19 degrees)
- Grass or other low vegetation ground cover, less than 10 centimeters high
- Sensors located at least 100 meters from artificial heating or reflecting surfaces, such as buildings, concrete surfaces, and parking lots
- Far from large bodies of water, except if it is representative of the area, and then located at least 100 meters away

♦ No shading when the sun elevation is greater than three degrees

1. **How does the site you chose compare with the characteristics from the NOAA?**

_____

_____

2. **Do your statistics or the average statistics from the class best describe the weather conditions in your area? Why?**

_____

_____

_____

3. **Which sites used in class would best contribute to the national climatology database? Why?**

4. **Besides making sure sensors are calibrated and functioning properly, what site conditions should be monitored regularly to ensure collections of valid data?**

Multiple Choice Questions

Select the best answer or completion to each of the questions or incomplete statements below.

1. **Respectively, what are the short-term and long-term atmospheric conditions in a local area known as?**

   A. Weather, patterns
   B. Climate, weather
   C. Weather, current
   D. Patterns, weather
   E. Weather, climate

2. **What main environmental factors form the climate of an area?**

   A. Average temperature
   B. Average precipitation
   C. Average humidity
   D. A and B only
   E. All of the above

3. **Why do weather stations need to be level?**

   A. The sensors do not work well if they are not level.
   B. They are more likely to fall over if they are not level.
   C. Accurate precipitation data require collection chambers that are level.

4. **In order for a weather station site to provide useful and reliable data that represents the local climate and not a microclimate, what site characteristics must be satisfied?**

A. It is not near a pond or small lake.

B. It does not have high vegetation growing in the surrounding area.

C. I is not shaded.

D. It is not close to buildings, paving, or artificial or reflected heat sources.

E. All of the above

5. **Which of the following apply to the calibration and regular maintenance of modern weather sensor equipment?**

A. It does not have to be done as often as in earlier times because of advances in technology

B. It has to be done more often than in previous times because of the tendency of electronic equipment to drift off calibrated settings over time.

C. It needs to be done as often today as in the 1800s when data was first being collected for climate studies.