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WeatherHawk Weather Station Protocol

Purpose

To log atmosphere data using a WeatherHawk™ weather station

Overview

A weather station is setup to measure and record atmospheric measurements at 15 minute intervals. These measurements are transferred to your school's computer and then submitted to GLOBE via email data entry.

Student Outcomes

Students can view data for their school that are continuous and show variations within a day. The data collected includes wind speed and direction and pressure thereby supporting a more complete study of meteorology using GLOBE. Students pursue a more extensive set of research investigations.

Science Concepts

Earth and Space Science

- Weather can be described by quantitative measurements.
- Weather changes from day to day and season to season.
- Weather varies on local, regional, and global spatial scales.

Geography

- The temperature of variability of a location affects the characterization of Earth's physical geographic system.

Scientific Inquiry Abilities

Scientific inquiry abilities are gained through analyzing the data collected with the weather station. Refer to the *Looking at Your Data* sections of the protocols that correspond to the measurements taken with your weather station for guidance on performing this data analysis. Consult the *Scientific Inquiry Abilities* listed in the gray boxes for these protocols to learn about the inquiry abilities that will be gained.

Time

2 hours for site definition and set-up

15 minutes to use spreadsheet data entry to prepare and submit data to GLOBE periodically

Level

Middle and Secondary

Frequency

Data reporting approximately once every week

Materials and Tools

- Weather station with data logger
- Computer capable of running weather station software
- Calibration thermometer
- Rain gauge

Preparation

Set up the weather station.

Prerequisites

None

Automated Weather Stations

Using automated weather stations that record data can allow students to take environmental measurements at much shorter time intervals than collecting data by hand. The large volume of data that can be collected at uniform time intervals allows for the study of weather phenomena that can change quickly (such as wind) and so cannot be monitored through measurements taken with longer sampling periods.

The weather stations used in this protocol are manufactured by WeatherHawk Inc. (http://www.WeatherHawk.com). These weather stations have a display screen that shows current weather readings, such as temperature, humidity, barometric pressure, wind speed and direction and rainfall, measured by sensors attached to the station either through cables, or wirelessly. The type of measurements taken depends on the model of weather station and the types of sensors purchased.

Besides displaying current readings on the display screen, the weather station also records data over a long period of time using a data logger. This data logger is sold in a kit that also includes software that lets you download the data onto your computer and visualize it, and is required for this protocol.

Once the data are downloaded from the weather station to your computer you can export them to a text file, ingest them to a spreadsheet program, and manipulate them to conform to the format required for GLOBE email data entry. Software is available for some models to export text files in GLOBE's email data entry format.

The following atmospheric data can be taken with this protocol and reported to GLOBE: average wind speed and direction over the 15-minute sampling interval, maximum wind speed and direction over the sampling interval, wind run integrated over the 15-minute period, temperature, relative humidity, barometric pressure, rain rate and total rainfall. Cloud, Snow, Precipitation pH, Aerosol, and Ozone measurements must still be done following the appropriate other protocols.

Measurement Logistics

1. Review background in the *Atmosphere Chapter*.
2. Setup the weather station console and connect to your computer according to manufacturer's directions.
3. Install your atmospheric weather sensors according to the *Weather Station Atmospheric Sensors Installation Field Guide*.
4. Define your measurement site as an atmosphere site with *WeatherHawk Weather Station* selected for thermometer type
5. Log readings at 15-minute intervals and transfer data to your computer according to the directions included with your software.
6. When you are ready to report the data to GLOBE (recommended once a week) export the data stored in your computer to a text file in the format for GLOBE email reporting following the *Logging and Reporting Weather Station Data Lab Guide*
7. Paste the text in this file into the body of an email and send it to GLOBE following email data entry instructions available in the "Data Entry" section of the GLOBE Web site.
8. Engage students in looking at the data.
9. Every year recalibrate your weather station.

Teacher Support

The instructions given in this protocol are specific to one brand of weather station. However, they may be adapted to other equipment that meets the same specifications. If you have questions or require assistance with adapting these instructions to other instruments, contact your Country Coordinator or in the US, the GLOBE Help Desk. The essential elements of this protocol, which must remain the same regardless of the equipment model, are the placement of the station, the precision and accuracy of the sensors, and the sampling interval.

Once a year you should recalibrate your weather station using the GLOBE Recalibration Procedures outlined in this protocol. This will help assure the accuracy of the readings that you report to GLOBE.

Before starting students on the installation of your weather station, review the material provided in the *Site Selection and Setup Protocol* for information on important considerations in selecting an area to take atmospheric measurements.

Data Recording

The GLOBE database requires weather station data logged at 15-minute intervals, so make sure that the sampling interval in your weather station is set to 15 minutes. Also, the read-out should happen on the quarter-hour (e.g., 10:00, 10:15, 10:30, 10:45, etc.) Ensure that measurements are being displayed and reported in the appropriate units (i.e., millimeters for rain, degrees Celsius for temperatures, percent for relative humidity, meters/second for wind speed, and kilometers for wind run).

The time associated with each data point reported to GLOBE needs to be in Universal Time (UT). If you choose to have your weather station set to local time you will need to make sure that you adjust the times reported to GLOBE.

Due to the quantity of data, weather station data is reported to GLOBE only via email data entry. Software provided by WeatherHawk may allow data to be exported directly into the correct GLOBE email data entry format (see *Frequently Asked Questions* for information on the availability of this software), using the "*Export Records (GLOBE Format)*" option from the *Browse* menu option in the export data pull-down menu. This software can automatically adjust the times to UT. If you have an older version of the software that does not have this option, export your data to a text file, import the text file into your spreadsheet program, manipulate the columns to match the requirements for email data entry, and cut and paste the resulting values into an email data entry message.

GLOBE Recalibration Procedures

The GLOBE recalibration procedures outlined in this protocol involve determining a correction offset for the tipping bucket and performing a check of the temperature sensor. The offset for tipping bucket is equivalent to the difference in the readings taken by the weather station and readings taken by a rain gauge, which serves as a calibration instrument of known accuracy. This correction offset helps account for drift in the readings taken by the tipping bucket that can occur over time. Once reported to GLOBE, this offset will be applied automatically to all subsequent data you report and the adjusted values are displayed on the GLOBE Web site. Do not report offsets to GLOBE and then apply them to the data yourself before submitting the data to GLOBE as this will cause the offsets to be applied twice!

For some of the measurements taken by the weather station, such as wind, there are no measurement protocols in GLOBE to use for calibration so there are no current methods available for their calibration.

The complete GLOBE weather station calibration consists of the following:

- Check the temperature sensor following the *Weather Station Temperature Sensor Recalibration Field Guide*.
- Calibrate the tipping bucket rain gauge following the *Weather Station Tipping Bucket Rain Gauge Recalibration Field Guide*.

Helpful Hints

- During set-up, be sure to choose the right value for the volume of your tipping bucket or all rain data will be in error.

Questions for Further Investigations

Are the patterns of weather variables over a day the same every day? What causes this?

Which season has the greatest range of temperatures? Why?

What are the latitudes and elevations of other GLOBE schools with annual precipitation and temperature patterns similar to yours?

Is your local environment affected more by average temperature or temperature extremes?

How do changes in wind speed and direction and pressure relate to changes in temperature and relative humidity and to the occurrence of rain?

Weather Station Atmospheric Sensors Installation

Field Guide

Task

Install the atmospheric sensors for your weather station.

What You Need

- ❑ The sensors that you are going to install
- ❑ Manufacturer's instructions
- ❑ The tools necessary to make the installation
- ❑ Compass
- ❑ GLOBE site definition sheet

Note: Actual installation may vary significantly depending on which sensors you are using and the location where you are installing them.

In the Field

1. Scout for a location(s) for the placement of your instrument shelter. If you are using an anemometer (to measure wind) that can be mounted separately from the rest of the sensor suite, consider mounting it in a different location. If the anemometer is attached to the rest of the sensors, then preferably mount them in a location most appropriate for the thermometer (step 4). If you are using wireless sensors, make sure that they are mounted close enough to your station console to allow for proper communication.
2. If possible, mount your sensor suite so that the temperature sensor is at a height of 1.5 meters above the ground (or 60 cm above average maximum snow depth), preferably in a flat open area with a natural surface (grassy in most places). Try to avoid having buildings within 10 meters.
3. If possible, mount the anemometer where it is above the height of nearby trees and buildings. If you mount it on top of a building, try to keep it at least 1.2 meters above the roofline.
4. Report your site definition data to the GLOBE Web site as an atmosphere site with *WeatherHawk Weather Station* selected for thermometer type.

Logging and Reporting Weather Station Data

Lab Guide

Task

Log and report data collected with your weather station.

What You Need

- ❑ A setup and operating weather station
- ❑ A suitable computer with email access

In the Field

1. Set your weather station to log data at 15 minute intervals on the quarter hour (e.g., 15:15).
2. Download your weather station data to your computer following the instructions for your weather station. **Note:** some weather stations can be set-up to transfer these data automatically.
3. Export a text file of your data. Save this file on your computer. (If your software has the ability to export a text file in the GLOBE email data entry format, skip to step 5).
4. Use spreadsheet or other software to edit the exported file into the GLOBE email data entry format. Save this spreadsheet file on your computer.
5. Copy and paste your data in GLOBE email data entry format into the body of a GLOBE email data entry message.

Weather Station Temperature Sensor Recalibration

Field Guide

Task

Compare the temperatures recorded by your weather station with readings from a calibration thermometer.

What You Need

- ❑ Calibration thermometer that has been checked following the instructions in the *Thermometer Calibration Lab Guide*
- ❑ *Weather Station Calibration Data Sheet*

In the Field

1. Hang the calibration thermometer in the shade within 30 cm of the temperature sensor of your weather station.
2. Wait three minutes and then read the temperature from the calibration thermometer as well as the temperature from your weather station. Wait one more minute to see if the calibration thermometer reading is changing. If it is, continue until it stops changing. If the digital display for your weather station is located well away from the calibration thermometer, this may require two students cooperating. Record these readings on your *Weather Station Calibration Data Sheet*.
3. Repeat step 2 four more times, waiting at least one hour between each set of readings. Try to space out the five sets of readings over as much of the day as possible.
4. Report your new calibration data to the GLOBE Web site.

Weather Station Tipping Bucket Rain Gauge Calibration

Field Guide

Task

Record a rain event (of 2 cm or more) with a rain gauge and then compare the rainfall measured with this rain gauge to the rainfall recorded by the tipping bucket of your weather station.

What You Need

- ❑ A rain gauge that meets GLOBE specifications
- ❑ *Weather Station Calibration Data Sheet*

In the Field

1. Hang the plastic rain gauge in an open area within 15 m of and at the same height as the tipping bucket of your weather station. Take caution to ensure that the plastic rain gauge is placed so that it will not interfere with, or be affected by, the weather station.
2. Wait for a rain event to occur and then take your reading for rainfall from the rain gauge, following the *Rainfall Protocol Field Guide*. If the rainfall reading is more than 2 cm, record it on your W*eather Station Calibration Data Sheet* and continue.
3. Add all the rainfall values recorded by your weather station for this rain event. Record this sum on your W*eather Station Calibration Data Sheet.*
4. Repeat this process for two other rain events.
5. Report your calibration data to the GLOBE Web site.

Frequently Asked Questions

1. What should I do if there is frozen precipitation that my weather station registers as rain?

Frozen precipitation and melting snow can cause the tipping bucket of your weather station to tip, and may therefore register as rainfall on your station. The tipping bucket is calibrated exclusively for rainfall so any measurements caused by frozen precipitation are erroneous. Please report any frozen precipitation in your metadata and if possible edit your data record to remove any rainfall readings that were caused by frozen precipitation before reporting data to GLOBE.

2. I am using a WeatherHawk weather station, but my software does not include the option to export GLOBE data. What can I do?

The *Virtual Weather Station* software packaged designed by Ambient, LLC, includes the option to export GLOBE data. This requires Version 12.06p14 or newer of this software. To download and install the latest version and user's manual, visit http://www.ambientweather.com/Products/Descriptions/Download.asp.

Atmosphere Investigation

Weather Station Calibration Data Sheet

School Name _____ Study Site: ATM-_____

Air Temperature Sensor Recalibration

Reading Number	Date (year/month/day)	Local time (hour:min)	Universal time (hour:min)	Calibration Thermometer Reading (°C)	Digital Temperature Sensor (°C)
1					
2					
3					
4					
5					

Rain Gauge Recalibration

Reading Number	Date (year/month/day)	Local time (hour:min)	Universal time (hour:min)	Rain Gauge Reading* (mm)	Digital Tipping Bucket Total Reading (mm)
1					
2					
3					
4					
5					

* must be greater than 20 mm for recalibration