Instructional Opportunities for Using the Hobo Weather Station in Earth Science Labs

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Introduction

The Long Island Central Pine Barrens is an ecologically diverse region comprised of pitch pine woodlands, dwarf pine and pine-oak forests, coastal plain ponds, swamps, marshes, bogs and streams. The rich ecological diversity of the Pine Barrens supports a large number of rare and endangered species including the Pine Barrens themselves which are a globally rare and threatened ecosystem. Preservation efforts in the Pine Barrens depend on an accurate understanding of the critical factors that affect sustainability of the ecosystem. Stony Brook University is engaged in an effort to better understand these factors, in part, by establishing long term microclimate monitoring using Hobo data logger weather stations.

The project, titled PINES, will use Hobo data loggers configured to collect long term measurements of temperature, relative humidity, barometric pressure, precipitation and soil moisture. One of the objectives of the PINES monitoring project is to make the monitoring data available for use in secondary school classrooms. The data will provide opportunities for learning using real world data while increasing awareness of this rare ecosystem located in the heart of Long Island.

The data provided by the Hobo monitors can be used to address many of the New York State Earth Science Education Standards. The following are two ideas for implementing Hobo data into Earth Science curricula and their connection to the New York State Standards.

Instructional Uses

The Hobo weather station can be used to conduct inquiry based investigations into weather (forecasting) and historical case studies of significant weather events while introducing students to remote sensing technology and software. Students will gain access to actual field data and have the opportunity to construct and interpret graphs of weather variables. Appendix A lists the relevant standards addressed by the inquiry and case study labs.

Inquiry Based Investigations

By conducting inquiry investigations, students learn scientific ways of thinking that involve constructing explanations of observable phenomena and developing methods to test these explanations. A component of the Earth Science curricula includes understanding weather variables that result in the formation of cyclones. Important concepts in the formation of cyclones include air masses and fronts, wind patterns, barometric pressure, and precipitation. Students can use their knowledge of cyclone formation to form hypotheses involving weather variables measurable by the Hobo and test their hypotheses through observation of weather conditions along with data collection and analysis of Hobo information.

Students can make predictions regarding each sensor on the Hobo unit, including temperature, relative humidity, barometric pressure, precipitation and soil moisture. Although soil moisture is not a weather parameter, it can be used to extend the lesson to the hydrologic cycle and the role of the Pine Barrens as a recharge basin for Long Island's freshwater aquifers. Students can also gather additional weather information from internet sources such as Brookhaven National Laboratory's weather page (http://wx1.bnl.gov/weather/WxMaps.jsp) which provides a variety of weather data sources and maps for Long Island including data from seven local field weather stations. Students should make predictions about the behavior of each variable as the storm passes through and after the storm has passed. Table 1 provides an example of the kind of predictions that might be made.

Table 1
Hobo Sensor Cyclone Predictions

Variable	During Storm	After Storm
Temperature	Increase	Decrease
Relative Humidity	Increase	Decrease
Barometric Pressure	Low	High
Precipitation	Present	Not Present
Soil Moisture	Moderate	High

As a storm approaches Long Island, students can begin collecting data from Brookhaven's site and track variable behavior as the storm reaches the Hobo. Once the storm has passed, students can download Hobo data and conduct an analysis to determine whether their predictions were supported by the Hobo data. Hobo data is automatically graphed by Hobo software; however, teacher's can choose to have student construct their own graphs by utilizing the data files without the graphs.

Case Study Investigation

The inquiry based investigation described above is limited in that the lab must be timed with a cyclonic event. This may not be possible. An alternative would be to conduct a similar investigation retrospectively. Students can make the same predictions as described above for a storm that has already passed. They can access Hobo data for the dates of interest along with other weather products from the NOAA Daily Weather Map site (http://www.hpc.ncep.noaa.gov/dailywxmap/index_20061029.html)

Below is a series of Hobo data graphs and NOAA synoptic maps constructed from data gathered during a cyclone that passed through Long Island beginning on October 27, 2006 and lasting through October 28, 2006. The Hobo weather station was located in Greenlawn, NY. The data captions reveal how the data can be used to support the objective of the case study lab.

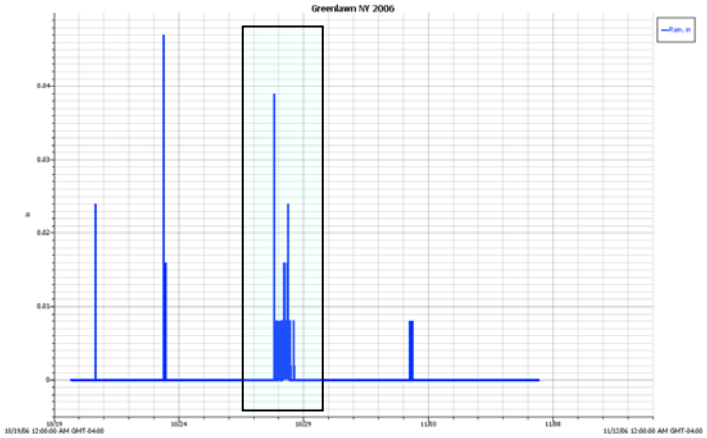


Figure 1
Hobo Precipitation Graph

This graph shows rain accumulation beginning the night of October 27th and ending on October 28th.

Figure 2
Hobo Relative Humidity Graph

This graph shows relative humidity sharply increasing as the storm approaches and then sharply dropping once the storm has passed consistent with the cyclone precipitation pattern.

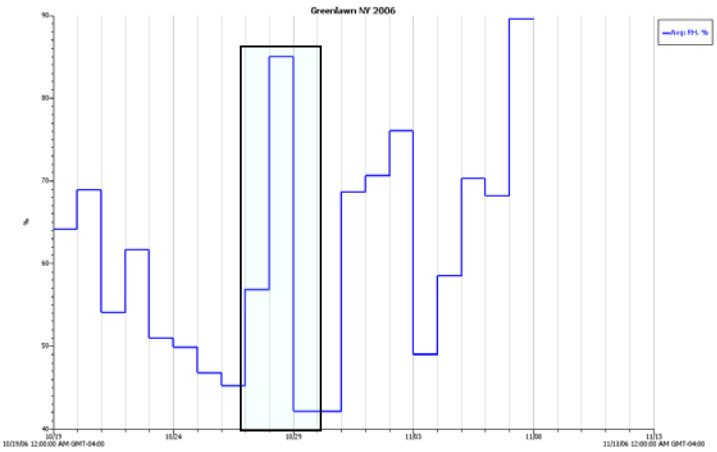


Figure 3
Hobo Temperature Graph

Temperature rises during the storm and drops following the storm, consistent with the passage of a warm front followed by a cold front.

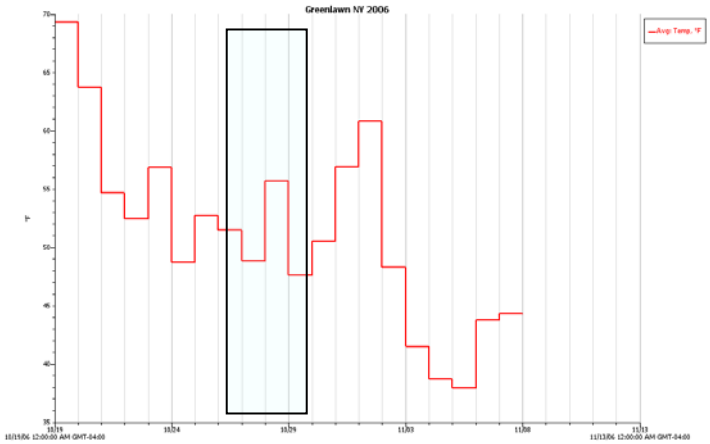


Figure 4
Hobo Barometric Pressure

Pressure drops drastically as the storm passes through and then climbs, consistent with the passage of a low pressure system followed by a high pressure system.

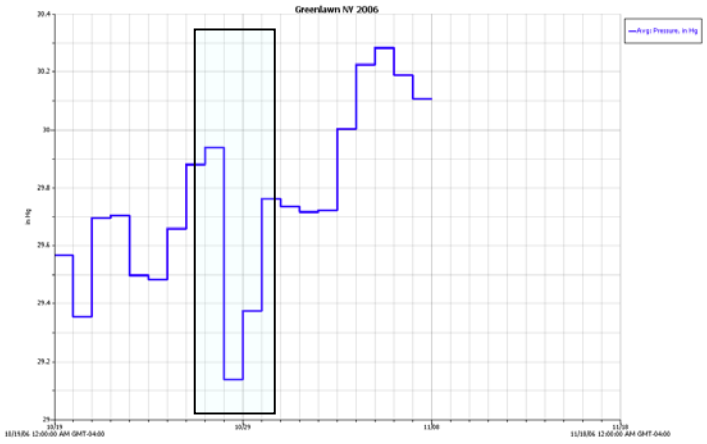
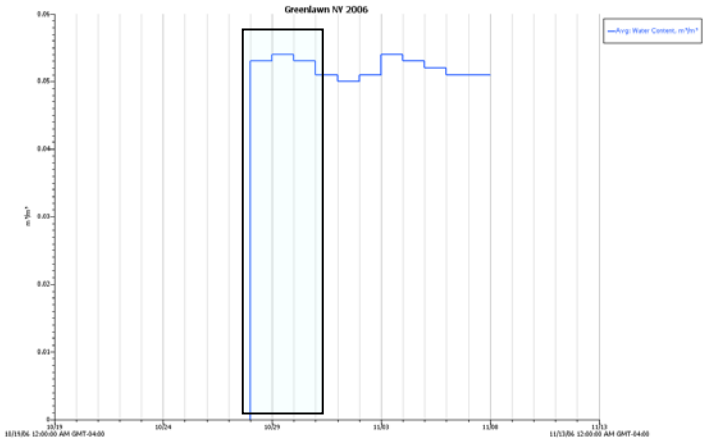
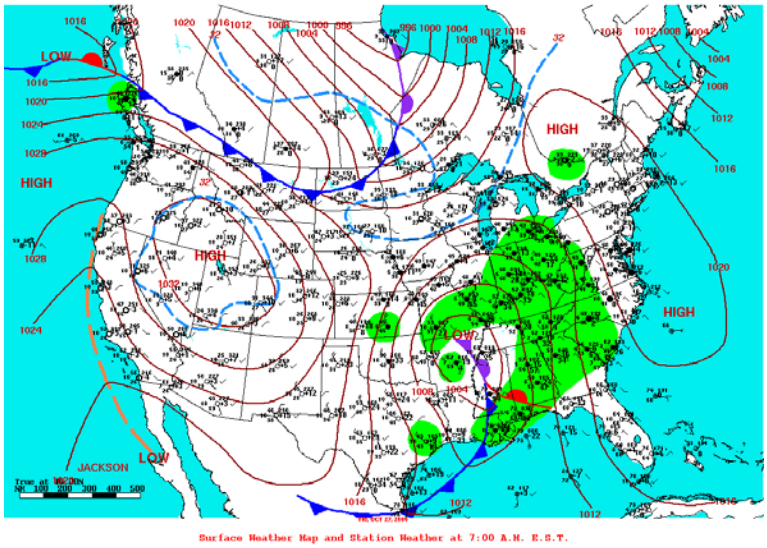


Figure 5
Hobo Soil Moisture



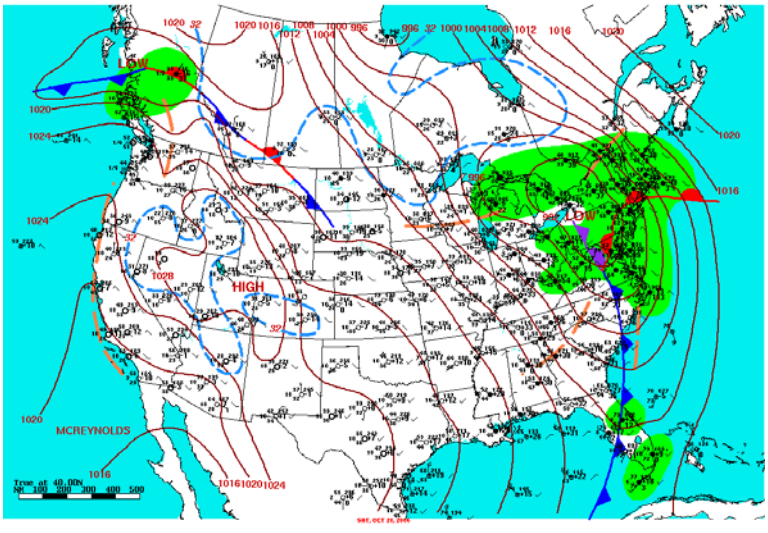
Soil moisture concentration peaks on October 29th, one day after the peak in precipitation. The lag is due to the rate at which the rain water takes to infiltrate down to the soil moisture sensor. Soil moisture is not a weather parameter; however, it can be used to extend the lesson to the hydrologic cycle and the role of the Pine Barrens as a recharge basin for Long Island's freshwater aquifers.

Figure 6



NOAA synoptic map for October 27th showing the location of high and low pressure systems, wind speeds and patterns, temperature, relative humidity, precipitation, barometric pressure and location of fronts.

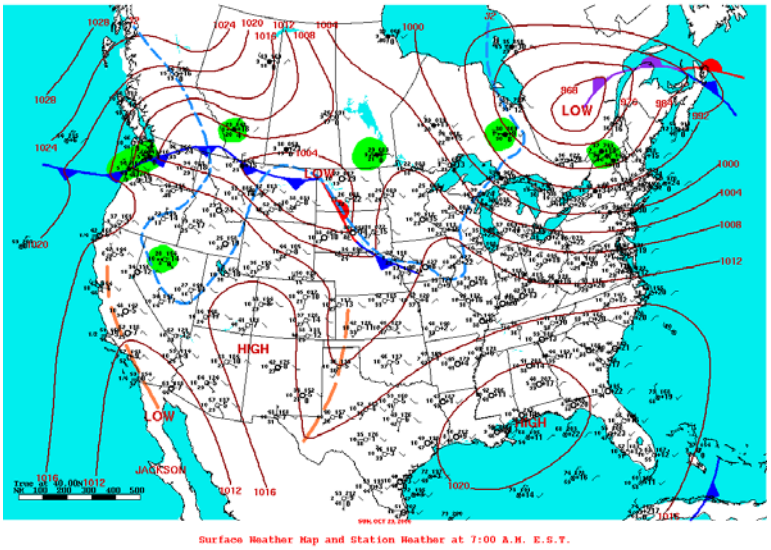
Figure 7



NOAA synoptic map for October 28th. Map shows that temperature has risen, pressure and relative humidity have dropped and precipitation is present. These conditions are consistent with the Hobo data and represent the conditions necessary for cyclone formation.

Figure 8

NOAA synoptic map for October 29th, one day after the storm. Temperature has dropped, precipitation is gone, relative humidity and barometric pressure have risen. These conditions are consistent the Hobo data and represent expected conditions following a cyclone.



Using the information students have learned in class about weather variables necessary for the formation of cyclones allows students to make predictions about those variables. Students can use both Hobo data and historic weather data to test the validity of their hypotheses. In the example above, each of the students predictions are supported by the data obtained from both the Hobo and from the NOAA daily synoptic maps.

Conclusion

The Hobo data logger provides Long Island students with an opportunity to conduct scientific investigations using actual data collected in an environmentally sensitive ecosystem in their own area. It introduces students to remote sensing technology and technical software while strengthening their connection to the environment. In the future, the PINES project may expand to include several Hobo weather stations which will increase the opportunities for investigation to include comparisons of weather characteristics within the Pine Barrens themselves. Students will then have a truly rare opportunity to make real discoveries about the ecological sustainability of an unusual and endangered ecosystem.

Internet Links

NOAA Daily Weather Maps
http://www.hpc.ncep.noaa.gov/dailywxmap/index_20061029.html

Brookhaven National Laboratory's Weather Page
http://wx1.bnl.gov/weather/WxMaps.jsp

Appendix A

New York State Earth Science Standards Correlation

Standard	Key Idea	Performance Indicator	Lab Correlation
Standard 1 Analysis, Inquiry, and Design Scientific Inquiry	Key Idea 2 Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.	NA	Students will engage in an inquiry investigation where they will develop hypotheses, collect, graph and analyze data, and draw conclusions.
Standard 2 Information Systems	Key Idea 1 Information technology is used to retrieve, process, and communicate information as a tool to enhance learning.	NA	Students will use remote sensing data loggers and software and internet weather sources to collect data.
Standard 6 Interconnectedness: Common Themes Patterns of change Standard 4 Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.	Key Idea 5 Identifying patterns of change is necessary for making predictions about future behavior and conditions. Key Idea 2 Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.	NA 2.1c Weather patterns become evident when weather variables are observed, measured, and recorded. These variables include air temperature, air pressure, moisture (relative humidity and dewpoint), precipitation (rain, snow, hail, sleet, etc.), wind speed and direction, and cloud cover.	Students will use their knowledge of the weather patterns that characterize cyclones to predict the behavior of weather variables. Students will collect data on weather variables and identify weather patterns that are characteristic of cyclones.
Standard 4 Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.	Key Idea 2 Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.	2.1d Weather variables are measured using instruments such as thermometers, barometers, psychrometers, precipitation gauges, anemometers, and wind vanes	Students will become familiar with sensors, gauges and datalogger instruments using the Hobo weather station.

Standard	Key Idea	Performance Indicator	Lab Correlation
Standard 4 Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.	Key Idea 2 Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.	2.1g Weather variables can be represented in a variety of formats including radar and satellite images, weather maps (including station models, isobars, and fronts), atmospheric cross-sections, and computer models.	Students will construct data graphs supplemented by synoptic maps, satellite and radar weather tools assist them in drawing conclusions about their data.