Teacher Guide: Observing Weather (Customary)

Learning Objectives

Students will …

- Make measurements of weather conditions using a thermometer, anemometer, rain gauge, and hygrometer.
- Observe and record a variety of weather phenomena, including rain, snow, fog, thunderstorms, and aurora borealis.
- Use graphs and tables to compare weather conditions during the winter and summer and in different locations, including:
  - Comparing weather on the Pacific coast to weather in the Great Plains.
  - Comparing weather near the Arctic Circle to weather in the tropics.

Vocabulary

anemometer, atmosphere, aurora borealis, cumulonimbus cloud, equator, evaporate, fog, humidity, hygrometer, latitude, precipitation, rain gauge, thermometer, temperature, thunderstorm, weather, weather station

Lesson Overview

The *Observing Weather (Customary)* Gizmo allows students to observe and measure typical weather conditions in a variety of locations. For each location, students can observe weather on January 1 and July 1. Students use a thermometer, anemometer, rain gauge, hygrometer, and their own observations to record and describe the weather.

Note: In this version of the Gizmo, U.S. customary units are used. For metric units, try the Observing Weather (Metric) *Gizmo.*

The Student Exploration sheet contains three activities:

- Activity A – Students learn how to read and record weather data from each instrument.
- Activity B – Students compare weather phenomena in San Francisco and Kansas City.
- Activity C – Students compare weather phenomena in Yellowknife, Canada and Miami.

Suggested Lesson Sequence

1. **Pre-Gizmo activities** (15 – 30 minutes)
   Begin with a general class discussion on what weather is. Ask students to describe the different elements that make up weather (temperature, cloudiness, etc.) and how they are measured. Ask students how the weather in their area changes throughout the year.

   Next, look up the local weather forecast in a newspaper or online (or watch a weather report on the news). Take the class outside with thermometers or other simple instruments and compare the forecasted weather to the actual weather that is occurring.

2. **Prior to using the Gizmo** (10 – 15 minutes)
Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class, but do not provide correct answers at this point. Afterwards, if possible, use a projector to introduce the Gizmo and demonstrate its basic operations. Demonstrate how to take a screenshot and paste the image into a blank document.

3. **Gizmo activities** (15 – 20 minutes per activity)
Assign students to computers. Students can work individually or in small groups. Ask students to work through the activities in the Student Exploration using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.

4. **Discussion questions** (15 – 30 minutes)
As students are working or just after they are done, discuss the following questions:

   - How many degrees does each line in the thermometer represent? [2 °F] How many inches does each line on the rain gauge represent? [0.1 inches] How much does each short line on the hygrometer represent? [2%]
   - Why does Kansas City have a much bigger temperature difference between winter and summer than San Francisco? [San Francisco is located next to the cool Pacific Ocean, which doesn't change much in temperature throughout the year. The ocean keeps things from getting too hot in the summer and from getting too cold in the winter.]
   - In which location would you expect the smallest temperature difference between January 1 and July 1? Why? [Manaus because it is on the equator. The hours of daylight, altitude of the sun, and typical temperatures are similar in January and July near the equator.]
   - In which location is it summer in January and winter in July? [In Sydney there are more daylight hours on January 1 than on July 1, and the weather is warmer.]

5. **Follow-up activity: Home-made weather station** (varies)
Divide students into groups and challenge them to build their own weather station. Students can be given thermometers but otherwise must use scrap materials and their own ingenuity to measure wind speed and direction, precipitation, and humidity. (You can add a barometer to the assignment as well, although air pressure is not covered in the *Observing Weather* Gizmo.) Some resources for building hand-made weather instruments can be found in the **Selected Web Resources** at the end of this document.

   After students have built their weather stations, set them up outside. If possible, go out at the same time each day and take measurements. Compare the values from the different weather stations and compare these values with local weather reports.

Scientific Background

Weather is defined as the state of the atmosphere at a given time and place. Most weather occurs in the lowest layer of the atmosphere, called the *troposphere*, from Earth's surface to a height of 3.7 to 6.2 miles. Weather is described by the temperature, humidity, barometric pressure, wind speed and direction, cloud cover, and precipitation. Weather, which is a description of conditions at a given time, should be distinguished from climate, which is the

average weather for a given location. Most climate data is obtained by averaging weather data over a period of 30 years.

Most weather data is obtained from weather stations, or structures that contain a variety of instruments including a thermometer (temperature), an anemometer (wind speed and direction), a rain gauge (precipitation), a hygrometer (humidity), a barometer (air pressure), and a pyranometer, which measures the intensity of solar radiation. Weather data is also obtained from satellite imagery of clouds and from Doppler radar, which tracks precipitation. By combining the data from many weather stations, meteorologists can identify and track major weather systems and forecast future weather.

Variations in weather occur from the interaction of large-scale atmospheric circulation patterns with local conditions. A basic cause of weather is a difference in temperature between two locations. Air over the warmer location will tend to expand and rise, creating a region of lower pressure. This will cause air to flow from cooler, higher-pressure regions to the area of low pressure. As winds blow from one location to another, they are bent by Earth's rotation, a phenomenon called the Coriolis effect.

On a global scale, the factors that cause temperature differences and influence weather patterns include the following:

- Areas near the equator experience more direct sunlight than areas near the poles, which causes tropical regions to be hotter than the poles. Latitudinal temperature differences cause global patterns of air circulation, including the jet stream.
- Areas of higher elevation tend to be cooler than low-elevation areas. As air passes over a mountain range, it rises and cools, causing cloud formation and precipitation. On the far side of the mountain range air descends and warms, causing clouds to dissipate. This "rain shadow" effect can make one side of a mountain range wetter than the other.
- Land heats up and cools down more quickly than oceans. In coastal areas, land tends to be warmer than the ocean during the day and cooler than the ocean at night, leading to an ocean breeze during the day and a land breeze at night. On a larger scale, inland areas tend to be warmer than coastal areas in the summer and colder in the winter.
- Ocean currents and ocean temperature also influence weather and climate. Some coastal areas, such as the east coast of the U.S., are warmed by the presence of the warm Gulf Stream current, which flows north from the tropics. The west coast of the U.S. is cooled by the California current, which flows southward from the northern Pacific.

Selected Web Resources
Weather introduction: https://www.nationalgeographic.org/encyclopedia/weather/
NWS weather school: http://www.srh.noaa.gov/jetstream/
Weather activities: http://www.sciencekids.co.nz/weather.html, http://www.weatherwizkids.com/
Weather and climate: http://video.nationalgeographic.com/video/climate-weather-sci, https://www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html
Homemade weather station: https://www.sercc.com/education_files/anemometer.pdf, http://easyscienceforkids.com/make-your-own-barometer/, https://hubpages.com/education/How-to-Make-your-own-Hygrometer
Weather Maps Gizmo: http://www.explorelearning.com/gizmo/id?618
Relative Humidity Gizmo: http://www.explorelearning.com/gizmo/id?425
Coastal Winds and Clouds Gizmo: http://www.explorelearning.com/gizmo/id?627