WEATHER AND CLIMATE: WHAT'S THE DIFFERENCE?

DESCRIPTION

This lesson plan enables students to learn the differences between weather and climate. Students collect local weather data for a defined period of time, and then compare these data with longer-term climate data for their community.

BACKGROUND

Weather is a specific event or condition that happens over a period of hours or days. For example, a thunderstorm, a snowstorm, and today's temperature all describe the weather. Weather is highly variable day to day, and from one year to the next. For example, Minneapolis might have a warm winter one year and a much colder winter the next. This kind of change is normal. But when the average pattern over many years changes, it could be a sign of climate change.

Climate refers to the average weather conditions in a place over many years (usually at least 30 years, to account for the range of natural variations from one year to the next). For example, the climate in Minneapolis is cold and snowy in the winter, while Miami's climate is hot and humid.

The climate in one area, like the Midwest or Hawaii, is called a regional climate. The average climate around the world is called global climate. When scientists talk about global climate change, they're talking a pattern of changes happening around the world over many years. One of the most important trends that scientists look at is the average temperature of the Earth, which has been increasing for many years.

Rising global temperatures are leading to other changes around the world, such as stronger hurricanes, melting glaciers, and the loss of wildlife habitats. That's because the Earth's air, water, and land are all related to one another and to the climate. By examining trends in weather and temperature data, along with the changes occurring in all of these systems, scientists can get a good understanding of today's climate change.

MATERIALS

- Thermometer for recording temperature outdoors
- A copy of the "Daily Weather Data" worksheet for each day of data collection
- A copy of the "Instructions for Getting Climate Data (Daily Average Temperature)" for each student or group of students (optional: the educator can look up these data ahead of time and fill in the table before the class to save time)

TIME:

Introduction: 30 minutes
Data collection: 10 minutes per day (for one or more weeks)
Part 1 graphing/analysis: 45 minutes
Part 2 graphing/analysis: 45 minutes
Part 3 discussion: 15 minutes

LEARNING OBJECTIVES:

Students will:

- Learn to collect and graph local weather data
- Learn to access and understand longer-term local climate data
- Understand the general distinctions between weather and climate
- Understand that daily weather measurements are highly variable compared with longer-term climate data

NATIONAL SCIENCE STANDARDS:

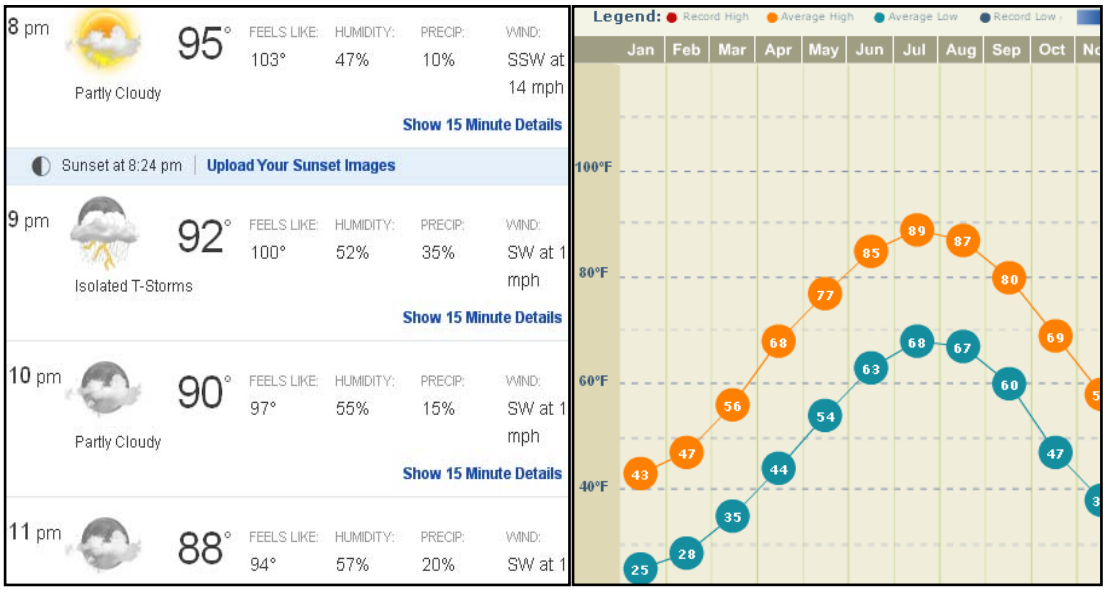
- Content Standard A: Science as inquiry
- Content Standard D: Earth and space science

ADAPTED FROM:

National Center for Atmospheric Research (NCAR)/University Corporation for Atmospheric Research (UCAR): http://eo.ucar.edu/educators/ClimateDiscovery/LIA_lesson1_9.28.05.pdf.

- A copy of the "Instructions for Taking Weather Observations" for each student group, plus one additional copy to post in the classroom
- A copy of "Weather vs. Climate Summary" for each student or group
- A copy of the "Temperatures in the Contiguous 48 States, 1901 to 2011" graph
- Graph paper for each student
- Pencils
- Colored pencils
- Computer and Internet access

Weather vs. Climate



It is normal for the weather to change on a daily or even hourly basis. But when the average pattern over many years changes, it is a sign of climate change. Image source: http://www.weather.com.

VOCABULARY

Climate:
The average weather conditions in a particular location or region at a particular time of the year. Climate is usually measured over a period of 30 years or more.

Climate change:
A significant change in the Earth's climate. The Earth is currently getting warmer because people are adding heat-trapping greenhouse gases to the atmosphere. The term "global warming" refers to warmer temperatures, while "climate change" refers to the broader set of changes that go along with warmer temperatures, including changes in weather patterns, the oceans, ice and snow, and ecosystems around the world.

Global warming:
An increase in temperature near the surface of the Earth. Global warming has occurred in the distant past as the result of natural causes. However, the term is most often used to refer to recent and ongoing warming caused by people's activities. Global warming leads to a bigger set of changes referred to as global climate change.

Weather:
The condition of the atmosphere at a particular place and time. Some familiar characteristics of the weather include wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. Weather can change from hour to hour, day to day, and season to season.

INSTRUCTIONS

Advance Preparations

1. Familiarize yourself with the procedure for using your thermometer to collect atmospheric temperature data by referring to the steps in "Procedure for Measuring Daily Temperature."

2. Determine how long you want students to collect weather data (for example, a week, a month, or several months) for Part 1 of this lesson. Depending on your location, one week to two weeks of data collection might be enough to illustrate weather variation.

3. For Part 2 of the lesson, familiarize yourself with the longer-term climate data at http://www.weather.com and prepare the worksheets by following the steps in "Instructions for Getting Climate Data (Daily Average Temperature)."

Part 1: Collecting Temperature Data

1. Explain to students that they will collect temperature data to see how the temperature varies from day to day.

2. Ask students to brainstorm what other aspects or characteristics of the weather might influence temperature). *[Answer: wind, precipitation, cloudiness.]* Tell students that they will collect data about these factors too.

3. Hand out a copy of the "Daily Weather Data" worksheet to each student. Have students break into pairs. Tell students that each day a different pair of students will take weather measurements and record these measurements in this worksheet.

4. Introduce students to the procedure for taking the thermometer out of doors. Pass out the "Procedure for Measuring Daily Temperature" handout to each pair of students and guide them through the steps of using the thermometer. Post the procedure in a prominent classroom location for future reference.

5. Tell students that because different people will be collecting data, it is important to collect the data the same way each time to be consistent. Explain that every observation should be made at a consistent time of the day and the same location.

    - Ask students what time of day they would expect the temperature to be the highest, and what time they would expect to observe the lowest temperature.
      [Answer: The warmest part of the day is usually in the afternoon. Although the sun is at its highest in the sky at noon, it takes time for land and water to heat up, which is why the hottest part of the day typically occurs later in the afternoon. The temperature generally falls as the sun goes down in the evening and at night, and gradually increases again as the sun rises in the morning.]

    - As a group, determine a time and location to take measurements every day.

6. As a class, record data for three days on the "Daily Weather Data" worksheet to acclimate students to the observation methods. Once students appear comfortable with the data collection process, have the student pairs collect and share their data daily with the class.

Part 2: Comparing Student Data With Climate Data

1. Once the students have collected data for the allocated time period, set aside a class period for the second part of this lesson. Before the class, transfer the time and temperature data from all the "Daily Weather Data" worksheets to the "Weather Data" section of the "Weather vs. Climate Summary" worksheet.

2. In class, tell students that they will be graphing their weather measurements and comparing the data they have collected with longer-term climate data for your community.

3. Pass out the "Weather vs. Climate Summary" worksheet to each student. Explain that the time and temperature data in the "Weather Data" section is a summary of all the temperature measurements taken by the class. Information in the "Climate Data" section is a longer-term temperature data of their community for the same time of the year, which they will now get from Weather.com.

4. In small groups or as a class, have students obtain daily average temperature data from Weather.com by following the steps in "Instructions for Getting Climate Data (Daily Average Temperature)." Ask them to record these data in the "Climate Data" section of the "Weather vs. Climate Summary" worksheet. Explain that the daily temperature values shown in the Weather.com charts are calculated based on many years of data and that they present an average temperature over these years, either by day or by month. *Alternatively, to save time, you can collect these data ahead of time, pass out the completed "Weather vs. Climate Summary" worksheet, and just have the students proceed with the graphing project.*

5. Have students compare the "climate data" from Weather.com with their own "weather data" for the same time of year. Ask them whether they would expect their measurements to be closer to the daily high, the daily low, or the daily average. The best answer will depend on the time of day they recorded their data. For example, if students measured temperature in the late afternoon, these values might be closest to the daily high. Conversely, if students measured temperature during the morning, their temperatures might be more representative of the daily mean temperature.

6. Hand out graph paper and pencils to each student. Have students plot their graphs. Begin by having the students label their graphs (Y/vertical axis = temperature, X/horizontal axis = date), and help them choose an appropriate range of values for their temperature axis based on their measurements. Have them plot the temperature values from the "Weather Data" section in one color and connect the data points with that same color of pencil. Have them plot the average daily high, low, and mean temperatures from the "Climate Data" section on the graph in three other colors.

7. Once students have plotted their graphs, ask the students if their data are "typical" or representative of the weather for the period of time they have been monitoring. The goal is for students to begin to understand that daily variations in weather are normal.

8. Discuss the differences between weather and climate:

   - Which vary more widely: the daily temperature values or the long-term average temperature values? Why?
     [Answer: Daily temperature values are more variable as they represent the weather observed on each day of the month. Average temperature values are calculated by averaging daily temperature values over many years, and thus these values are less variable.]

   - Are the temperatures that the class measured warmer, cooler, or about the same as the long-term average?
     [Answer: This answer depends on the data recorded in the class.]

   - If a scientist reported that your state was warmer last month than the same month a year ago, would you consider this to be evidence for climate change? Why or why not?
     [Answer: No. The weather in a particular place naturally varies from year to year, and some years are hotter than others. Evidence of climate change is based on data collected and observed over at least a few decades.]

- Imagine that almost every summer for the past decade has been hotter than usual. Could this be a sign of climate change? Yes or no?
  [Answer: Yes. Climate change occurs over many years, so a pattern of many hotter summers could be a sign of climate change. This is especially true if the same pattern is happening in many places around the world.]

Part 3: Understanding National Temperature Trends

1. Hand out a copy of "Temperatures in the Contiguous 48 States, 1901 to 2011." Tell students that this long-term temperature graph was created using average temperature values from 1901 to 2011 collected from thousands of weather stations across the United States, as well as from satellite data. Scientists use long-term temperature data (along with other climate indicators such as rainfall, snow, storms, etc.) to understand climate patterns at regional and global levels.

2. Discuss what is meant by "temperature anomaly" and "baseline."
   [Answer: A temperature anomaly measures how the actual temperature differs from a reference value such as the long-term average, which is often called a baseline. A positive anomaly (in this case, the red bars) indicates that the observed temperature was warmer than the long-term average, while a negative anomaly (in this case, the blue bars) indicates that the observed temperature was cooler than the long-term average.]

3. Ask students to observe the patterns of the red and blue temperature bars, and answer the following questions:

   - Which decades were the coolest?
     [Answer: 1900–1930.]

   - Which decades were the warmest?
     [Answer: 1930–1940 and the late 1990s to present.]

4. Tell students that seven of the top 10 warmest years ever recorded in the United States have occurred since 1990. Explain that between 1901 and 2011, some years were warmer than average and some years were cooler, but that over the span of 100 years, we can see a distinct trend toward warmer temperatures in the past few decades. Ask students, based on their knowledge of weather and climate, if this trend could be a sign of climate change.
   [Answer: Yes. Climate change occurs over many years, so a pattern of many hot years in a row could be a sign of climate change.]

EXTENSION

Meteorologists collect weather data using many different techniques, including on-the-ground measuring instruments at weather stations, weather balloons, and satellites. Since 1995, the GLOBE Student Climate Research Campaign (GSCRC) has enabled students to share their weather measurements with other students and scientists all over the world. This activity helps students become familiar with the GSCRC and encourages students to develop and participate in their own investigations by exploring research questions about their local or regional climate.

Instructions

1. Introduce the students to the GSCRC. Tell them how the program has enabled millions of students to collect and share their weather and climate data with other students and scientists around the world.

2. Show the class a video about the program that is available in the *Welcome to GLOBE* panel on the right side of the website http://www.globe.gov/home.

3. As a homework assignment, ask each student to explore the GSCRC website and find out what types of projects students are doing in your community, in neighboring communities, or in your state. A good place to start is the GLOBE Program's *Community Map* on the *Community* page (http://www.globe.gov/community/map). Ask students to answer the following questions:

    - What is the project topic?
    - Where is the project located?
    - What types of data do the students collect and measure?
    - What methods and resources do the students use?
    - Have students used existing data provided by another school on the GSCRC website? How?
    - Have students collaborated with other schools or scientists in the GSCRC network? How?

4. Have students share their findings with the class.

WEATHER AND CLIMATE: WHAT'S THE DIFFERENCE?

PROCEDURE FOR MEASURING DAILY TEMPERATURE

NAME: _____ **DATE:** _____

Instructions:

1. Go outside and find a place away from the school building, preferably in the shade.
2. Wait two to three minutes to allow the thermometer to adjust to the outside temperature.
3. While standing, hold the thermometer at eye level.
4. Take a reading.
5. To confirm your observation, take two more readings after an interval of one to two minutes.
6. Record your final reading in the "Daily Weather Data" worksheet.

Things to remember:

1. Take the reading in a shaded area, away from direct sunlight.
2. Make sure the thermometer is not on the ground.
3. Make sure your fingers are not touching the bulb of the thermometer.
4. If it is raining or snowing, be sure to take a reading under an umbrella!

WEATHER AND CLIMATE: WHAT'S THE DIFFERENCE?

INSTRUCTIONS FOR GETTING CLIMATE DATA (DAILY AVERAGE TEMPERATURE)

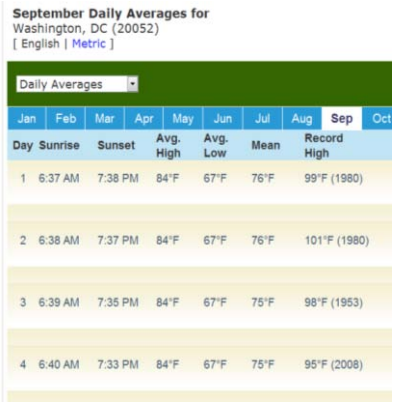
For the educator:

1. In the "Weather Summary Table," write down the dates and times when the students' weather measurements were taken.
2. Write the temperature that the students recorded on each date.

For the class:

1. The rest of the table is filled out by getting data from http://www.weather.com. It can be filled out by the students during class, or by the educator before the class.
2. On the main page, type your city name or ZIP code to get local weather. Then select "Monthly."
3. At the bottom of the calendar, select "Averages" and then choose "Daily Averages" from the drop-down menu at the top. Select the month in which you are doing the activity.
4. Write down the "average high," "average low," and "mean temperature" values from Weather.com for each day that students recorded weather data. Use the "Weather vs. Climate Summary" handout to record these values.

Getting Climate Data



September Daily Averages for
Washington, DC (20052)
[English | Metric]

Daily Averages

Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct

Day	Sunrise	Sunset	Avg. High	Avg. Low	Mean	Record High
1	6:37 AM	7:38 PM	84°F	67°F	76°F	99°F (1980)
2	6:38 AM	7:37 PM	84°F	67°F	76°F	101°F (1980)
3	6:39 AM	7:35 PM	84°F	67°F	75°F	98°F (1953)
4	6:40 AM	7:33 PM	84°F	67°F	75°F	95°F (2008)

Long-term temperature data for Washington, DC, show "daily averages" for the month of September.

Image source: Weather.com, September 2012

Weather vs. Climate Summary—Sample

Temperature unit: __X__ °F or _____ °C

	Weather data (recorded by class)		Climate data (daily averages from Weather.com)		
Date	**Time**	**Temperature**	**Average high temperature**	**Average low temperature**	**Mean temperature**
September 8	1:00 pm	70 °F	83 °F	63 °F	73 °F
September 9	1:15 pm	69 °F	82 °F	62 °F	72 °F

WEATHER AND CLIMATE: WHAT'S THE DIFFERENCE?

WEATHER VS. CLIMATE SUMMARY

Temperature unit: _____°F or _____°C

	Weather data (recorded by class)		Climate data (daily averages from Weather.com)		
Date	Time	Temperature	Average high temperature	Average low temperature	Mean temperature
Week 1					
Week 2					
Week 3					
Week 4					

Daily Weather Data

Name: _____ **Date:** _____

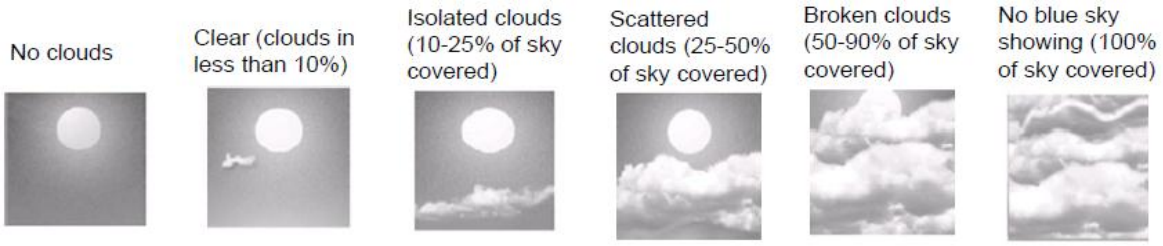
Time: _____

The temperature is: | °C | | °F |

Unit conversion:

°F = °C × (9/5) + 32
°C = (°F - 32) × (5/9)

Cloudiness *(Circle one)*



Precipitation *(Check one)*

____ Heavy rain
____ Light rain
____ Light snow falling
____ Heavy snow falling
____ Hail
____ Other _____

Wind *(Check one)*

____ Completely calm
____ Light breeze (wind felt on face, leaves rustle)
____ Moderate breeze (flags flap a little, small branches and leaves move)
____ Strong breeze (wind whistles, umbrellas turn inside out, bushes sway)
____ Gale (it's difficult to walk in the wind, tree twigs breaking)

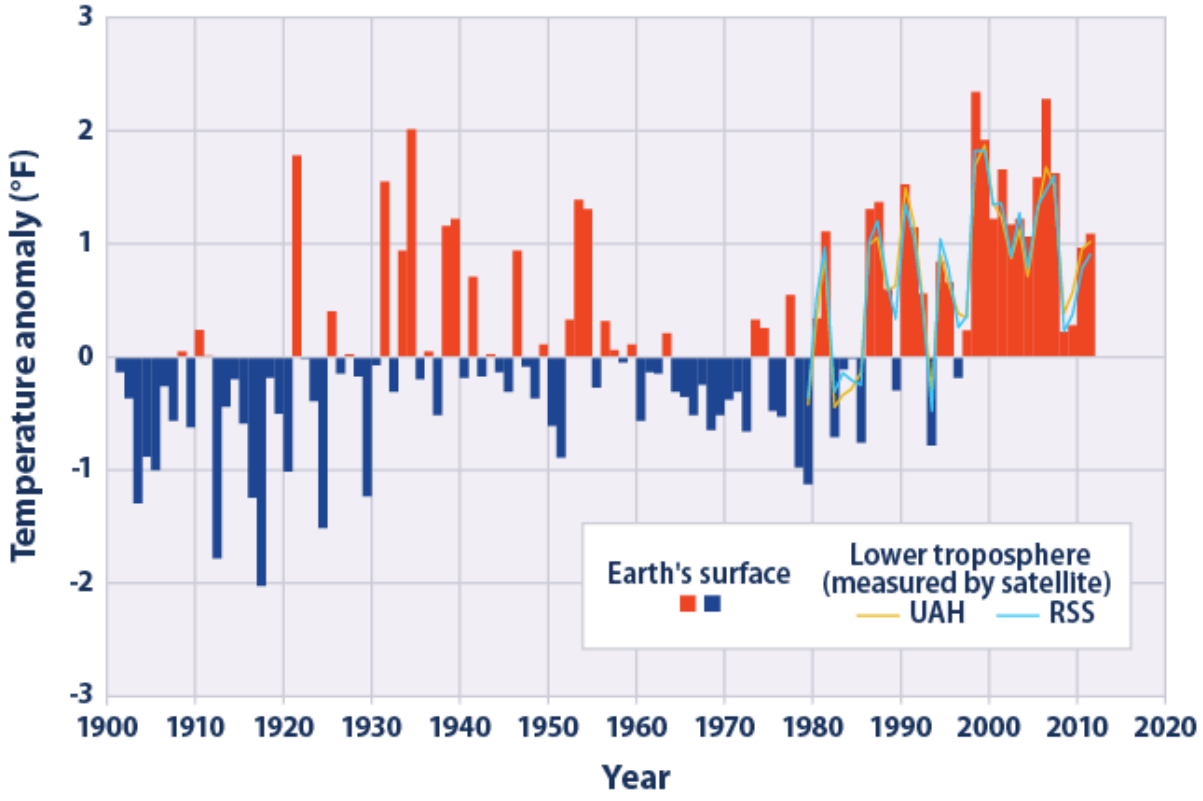
EPA United States Environmental Protection Agency

WEATHER AND CLIMATE: WHAT'S THE DIFFERENCE?

NAME: _____ TITLE: _____ DATE: _____

WEATHER AND CLIMATE: WHAT'S THE DIFFERENCE?

Temperatures in the Contiguous 48 States, 1901 to 2011



Climate is the average of daily weather data such as temperature and precipitation collected over a long period of time. This figure shows how average temperatures in the contiguous 48 states have changed since 1901. Surface data come from land-based weather stations, while satellite measurements cover the lower troposphere, which is the lowest level of the Earth's atmosphere. "UAH" (yellow line) and "RSS" (blue line) represent two different methods of analyzing the original satellite measurements. This graph uses the 1901 to 2000 average as a baseline for depicting change. Choosing a different baseline period would not change the shape of the trend.

Data source: U.S. EPA, *Climate Change Indicators in the United States.* http://www.epa.gov/climatechange/science/indicators/.