Lesson 1

Investigating the Differences Between Climate and Weather

Hudson River Estuary
Sea Grant New York
New York State Water Resources Institute
Cornell University

Investigating the Differences between Climate and Weather

NYS Intermediate Level Science

Standard 1: Analysis, Inquiry and Design/Scientific Inquiry

- S1.2c Differentiate among observations, inferences, predictions, and explanations.
- S2.1d Use appropriate tools and conventional techniques to solve problems about the natural world, including: measuring, observing, describing, classifying, sequencing.
- S2.3b Conduct a scientific investigation.
- S2.3c Collect quantitative and qualitative data.
- S3.1a Organize results, using appropriate graphs, charts, and data tables.
- S3.2d Formulate and defend explanations and conclusions as they relate to scientific phenomena.
- S3.2h Use and interpret graphs and data tables.

Standard 6: Interconnectedness

- 5.2 Observe patterns of change in trends or cycles and make predictions on what might happen in the future.

Standard 4: The Physical Setting

- 2.2i Weather describes the conditions of the atmosphere at a given location for a short period of time.
- 2.2j Climate is the characteristic weather that prevails from season to season and year to year.
- 2.2q Hazardous weather conditions include thunderstorms, tornadoes, hurricanes, ice storms, and blizzards. Humans can prepare for and respond to these conditions if given sufficient warning.
- 2.2r Substances enter the atmosphere naturally and from human activity. Some of these are carbon dioxide, methane, and water vapor. These substances can affect weather, climate, and living things.

Next Generation Science Standards

Science and Engineering Practices:

2. Developing and using models
4. Analyzing and interpreting data
6. Constructing explanations
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Grade 6

- ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

Grade 7

- LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Common Core State Standards

ELA in the Content Areas - Grades 6-8

CCSS.ELA-Literacy.RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Common Core State Standards - Mathematics

Standards for Mathematical Practice

CCSS.Math.Practice.MP2

Reason abstractly and quantitatively.

CCSS.Math.Practice.MP4

Model with mathematics.

Grade 6

CCSS.Math.Content.6.NS.C.8

Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.

Investigating the Differences Between Climate and Weather

Adapted from the Climate Discovery Teacher's Guide, National Center for Atmospheric Research: http://eo.ucar.edu/educators/ClimateDiscovery/LIA_lesson1_9.28.05.pdf

Introduction

Interpreting local weather data and understanding the relationship between weather and climate are important first steps to understanding larger-scale global climate changes. In this activity, students will collect weather data over several days or weeks, graph temperature data, and compare the temperature data collected with averaged climate data where they live.

Background Information

When atmospheric scientists describe the "weather" at a particular time and place or the "climate" of a particular region, they describe the same characteristics: air temperature, type and amount of cloudiness, type and amount of precipitation, air pressure, and wind speed and direction. Why are the same characteristics used to describe both weather and climate? And why do we eagerly listen to the local weather forecaster but pay far less attention to predictions from the state climatologist?

Weather is the set of current atmospheric conditions, including temperature, rainfall, wind, and humidity at any given place. Weather is what is happening right now or likely to happen tomorrow or in the very near future.

Climate is sometimes referred to as "average" weather for a given area. The National Weather Service uses values such as temperature highs and lows and precipitation measures for the past thirty years to compile "average" weather for any given area. However, some atmospheric scientists consider "average" weather to be an inadequate definition. To more accurately portray the climatic character of an area, variations, patterns, and extremes must also be included. Thus, climate is the sum of all statistical weather information that helps describe a place or region.

In the winter, we expect it to often be rainy in Portland, Oregon, sunny and mild in Phoenix, Arizona, and very cold and snowy in Buffalo, New York. But it would not be particularly startling to hear of an occasional January day with mild temperatures in Buffalo, rain in Phoenix, or snow in Portland. Meteorologists often point out that "Climate is what you expect and weather is what you get." Or, as one middle school student put it, "Climate helps you decide what clothes to buy, weather helps you decide what clothes to wear." Scientists rely on large amounts of data over long timeframes to establish if the current weather patterns are usual. As weather measurements have been made for only 100-200 years, scientists look to records preserved in ice cores, tree rings, and sediment layers to identify how climate has varied in the past. Worldwide averages are used to describe global climate. Global climate is not easy to change. Regional averages may vary a bit, without causing a change in global climate. For instance, if the climate of Tunisia becomes warmer, and the climate of Mexico becomes cooler, the global average may not change. However, if regions warm more and are not balanced by other areas that cool, then global climate warms, as is the case over the past century. To investigate how climate may be changing due to human influences, scientists use weather data from as far back as the historical record goes (100-200 years). Detailed daily weather data are collected at surface weather stations throughout the world.

Understanding and interpreting local weather data and understanding the relationship between weather and climate are important first steps to understanding larger-scale global climate changes.

Objectives

Students will be able to

- Collect and analyze local weather data and compare their findings to climate data.
- Compare and contrast weather and climate.
- Explain that daily weather measurements are highly variable compared to long-term climate data.
- Give examples of climate changes being observed in the Hudson Valley.

Materials Required

- Thermometers
- Student data sheets
- Graph paper

Advanced Preparation

- Print and copy the Weather Data Student Page from Investigating the Difference Between Climate and Weather: http://eo.ucar.edu/educators/ClimateDiscovery/LIA.htm
- Print and copy the Climate Change in the Hudson Valley Fact Sheet: http://www.dec.ny.gov/docs/remediation_hudson_pdf/hreccfs.pdf (end of this section)
- Find climate data for your city, or use the sample data from Newburgh, NY below. Climate data may be obtained from regional climatologists or local news stations. Alternatively, go to www.weather.com or www.wunderground.com and search for your city name to get local weather and monthly averages. Show the graph of monthly averages to the class when introducing Part 2 of this lesson.
- Choose Daily Averages and select the month in which you are doing the activity. Use the mean temperature values when plotting climate data in the Explain part of the lesson.

Engage

Discuss with students:

- When you think about weather, what do you think about?
- If we wanted to compare weather from day to day scientifically, how could we do that?
- Do you think our weather is consistent from day to day, or very variable?
- In which months do you think the weather is most consistent? Most variable?

Explore

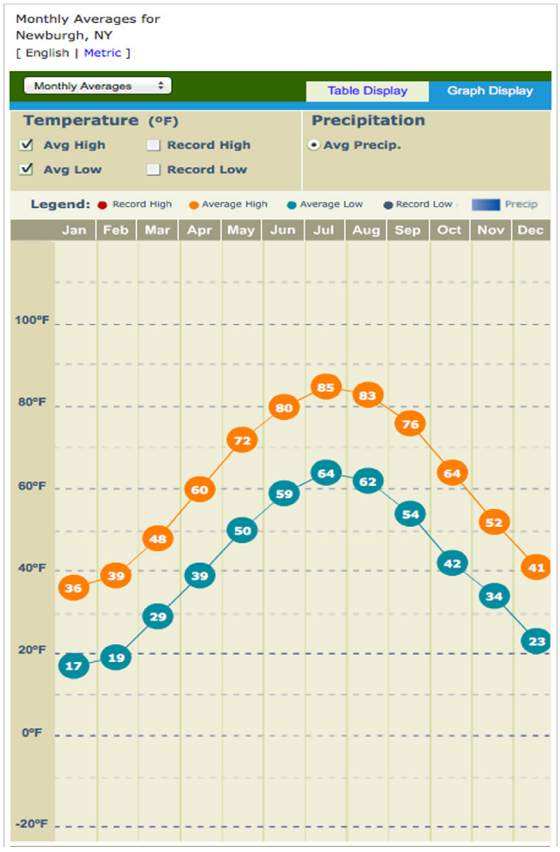
1. Explain to students that they will be collecting daily weather data, including temperature, cloud cover, and wind. Ask:
   a. What factors might affect temperature? b. How?
2. Review with students how to use the thermometer.
3. Explain that each day a different pair of students will take the temperature measurement, and that because different people will be collecting data, it is important to use consistent procedures. As a group, determine the procedure that students will follow each day to take measurements.

(Observations should include the time of day and location. Care should be taken to ensure that body or building heat doesn't influence temperature measurements. Other considerations might include distance off the ground, number of measurements, length of time outside before measuring, etc.)

4. Post these methods in a prominent classroom location.
5. Model how to use the Weather Data Student Page. Explain that each day, a team will use the student page to record their findings. Be sure students understand how they will qualitatively assess the cloud cover and wind.
6. Create a classroom data table in which student pairs will record the daily temperatures.

Explain

- After one month, direct students to create a line graph of the daily temperatures from the classroom data table.
- Ask students to make at least two observations based on their graph, and identify any patterns they see in the data. Discuss these observations as a class.
- Ask the students if they think that their data is "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.
- Explain that the term weather describes short-term changes in a local area, whereas climate refers to long term patterns and wider regions. Ask students whether they collected weather or climate data.
- Show students the graph of average daily temperature over a year for Newburgh, NY, or for your city. (See Advanced Preparation section above for help finding a graph.)
- www.weather.com/weather/wxclimatology/monthly/graph/USNY1003



- Ask students what general patterns they see about climate from the graph. Ask how this graph might help someone who is visiting the region to plan what sort of clothes to bring with them. For instance, if they are visiting in July, what should they bring? Would it help them to plan for tomorrow specifically?
- Next, show students the average temperature data for the same time period that they observed. To access the data for Newburgh, NY, go to: www.weather.com/weather/wxclimatology/daily/USNY1003 To use the data from your city, follow the instructions in Advanced Preparation. Ask students to focus on the mean temperatures for the time period.
- Compare the data from the climate graph to student weather data for the same time of year. To do this, students should plot climate temperature data points on their graphs with a different color and connect points with a line.
- Discuss the differences between weather and climate:
  - Which is more variable: the daily temperature values or the average temperature values? Why?
  - Is the temperature data that the class collected warmer, cooler, or about the same as the average?
  - If you were asked to predict the temperature for tomorrow, which data would you find the most useful: the previous day's temperature, or the average temperature for that day?

Elaborate

- Bridge the discussion of weather and climate into a discussion of climate change. Explain to students that scientists have been closely studying temperature and other data, and that over the past 150 years or so, our global climate has been warming. Note that scientists are collecting data from all over the world.
- Discuss:
  - 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?
  - Distribute copies of the Climate Change in the Hudson Valley Fact Sheet: www.dec.ny.gov/docs/remediation_hudson_pdf/hreccfs.pdf *(The NYSDEC is updating this sheet to include even more information, so please check for the latest version.)*

  Read the first page as a class. Then discuss:
  - How is New York State's climate changing?
  - How are these changes affecting living things?
  - What are scientists predicting for the future?

Evaluate

In a paragraph or Venn diagram, have students compare and contrast weather and climate.

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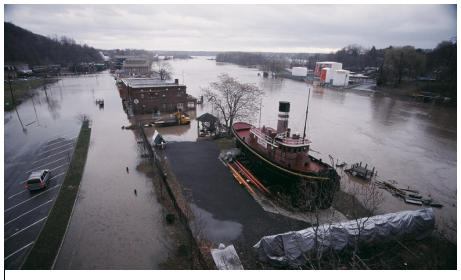
Hudson River Estuary Program

Climate Change in the Hudson Valley

The climate of the Hudson Valley is changing. Climate scientists have documented actual and expected changes in our regional climate and how these changes will affect natural and human communities in our region.



Climate change is increasing the risk of flooding in shoreline communities (C. Bowser)

Why is the climate changing?

As the sun warms the Earth, the Earth radiates heat. Certain gases, called greenhouse gases (GHGs), trap some of this heat in the lower atmosphere. Some human activities, like burning fossil fuels, release GHGs into the atmosphere and intensify the greenhouse effect, warming the earth. This warming, called global warming, is affecting long-term weather patterns, or climates, around the world and in the Hudson Valley.

How much has the climate changed in our region?

- New York State's average temperature has gone up nearly 2ºF in 30 years.
- Winter average temperatures have warmed even faster, 5ºF in 30 years.
- Bloom dates of many plant species are 4-8 days earlier on average than they were in the early 1970s.
- Average rainfall is increasing, and days with snow cover are decreasing.
- Sea level in New York Harbor is 15 inches higher today than it was in 1850.

What kinds of changes can we expect in the future in the Hudson Valley?

- Shorter, warmer winters and longer, hotter summers will affect local farmers and winter recreation, and may increase diseases carried by insect populations as they shift northward.
- Rising sea levels and strong storms will cause localized floods and threaten shoreline infrastructure and development.
- Rising summer air temperatures will increase pollution-related asthma and heat exhaustion, especially in urban areas.
- Invasive species and nuisance plants will thrive under elevated atmospheric CO_2 levels.

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How can we respond to climate change?

The severity of climate change we see will depend on energy choices we make today and over the next decade. The Hudson River Estuary Program is working with NYSDEC's Climate Change Office and regional partners to help communities understand the sources and projected impacts of climate change and to coordinate regional responses.

Wetlands help absorb floodwaters (C.Bowser)

How can local governments reduce greenhouse gas emissions?

- Organize a global warming task force and complete a greenhouse gas emissions inventory. For more information: ICLEI Local Governments for Sustainability (http://www.iclei-usa.org/programs/climate) and The Climate Registry (www.theclimateregistry.org/)
- Reduce greenhouse gas emissions and save money by improving the energy efficiency of municipal buildings and operations
- Install solar, wind or other renewable energy technologies in power facilities
- Add hybrid and more fuel-efficient vehicles to government fleet
- Reduce solid waste through recycling programs

How can local governments adapt to a changing climate?

- Identify potential impacts (e.g., increased risk of flooding)
- Develop emergency management teams and improve emergency communication
- Keep development out of flood-prone areas
- Manage stormwater to reduce flooding and find alternatives to paved surfaces
- Conserve wetlands and forests that absorb floodwaters and recharge groundwater

What can I do to help?

- Reduce greenhouse gas emissions and save money by improving energy efficiency
- Walk, bike or carpool to work or on errands
- Buy Energy Star appliances
- Support green power. Check your utility's website for more information
- Get involved in your local government! Organize a community presentation or event on climate change

How can I learn more about climate change in the Hudson Valley?

Visit the Hudson River Estuary Program web site at: http://www.dec.ny.gov/lands/39786.html

Or contact:
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845-256-3017

www.dec.ny.gov

Hudson River Estuary Climate Change Lesson Project

www.nyseagrant.org
http://www.dec.ny.gov/lands/

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