Paleoclimate of the Hudson Valley

Time: 1-2 class periods
National Benchmarks: Benchmarks 5A: Diversity of Life; 5D Interdependence of Life; 5E: Flow of Matter and Energy; 9B:Symbolic Relationships; 9D:Uncertainty; 12B:Computation and Estimation; 12D:Communication Skills; 12E:Critical-Response Skills.
National Science Content Standards: *Science as Inquiry: A*; *Life Science: C*: Biological Evolution; The Interdependence of Organisms; Matter, Energy, and Organization in Living Systems; *Science and Technology: E:* Abilities of Technological Design; Understandings about Science and Technology; *Science in Personal and Social Perspectives: F:* Population Growth; Natural Resources: Environmental Quality; Natural and Human-induced Hazards; Science and Technology in Local, National, and Global Challenges
New York State Standards: 1, 2, 3, 4, 5, 6, 7

Objective: Students will know how the climate of the Hudson Valley has changed since the last glaciation and be able to explain these changes.

Lesson Outline:

1. Students brainstorm about ecosystems in the past
2. Using prepared soil 'samples' with fossilized 'pollen', students determine the climate history of the region
3. As a class, students reconstruct the history of the last 16,000 years

Materials: 8 bags of soil with 14 types of confetti (or other materials) organized in the manner described below, student worksheets, tweezers, paper plates, sample sediment 'core' with visibly different soil layers: can be made out of different kinds of soil in a tennis ball container, graduated cylinder, soda bottle, etc. These layers can represent the exact layers from the activity, or it can be used only as a visual to get students thinking about the concept of soil layers.
Preparation: Before class, prepare eight bags of soils with the below mentioned types of confetti. The ratios are approximate. Feel free to use whatever colors of confetti you have on hand, pieces of paper (hole-punch construction paper or laminated colored paper) or other materials to represent the pollen. You can use visibly different soil types for each 'layer' with pollen, but this is not necessary. You can also just tell the students that the soil layers might look alike now, but they look different when scientists collect them.

Once you have prepared the zip-loc bags with the soil and confetti, disperse the bags to your groups of students. If you can't make eight groups, it would be advisable to give one group two layers (probably the simpler layers, ie 2, 3, or 4). Once students have identified the 'pollen' based on the charts they have, they will be able to reconstruct the paleoclimate of the Hudson Valley. You can keep the zip-loc bags for future use.

Color and Shape	Plant Species	Climate Characteristics

Pink Hearts	Oak	Found in warm, temperate sites with dry, warm summers
Red Hearts	Spruce	Found in cold, sub-alpine sites
Silver Circles	Fir	Prefers cold, somewhat moist soils.
Clear stars	White pine	Temperate, cool climate
Silver stars	Chestnut	Prefers moist and cooler temperatures
Blue stars	Hickory	Warm and dry, well-drained soils
Black stars	Paper Birch	Enjoys cold, sub-alpine conditions
Gold hearts	Hemlock	Requires moist soil, temperate conditions
Turquoise circles	Ragweed	Native, Indicator of disturbance
Red stars	Common reed	Invasive grass, hybrid of native & alien
Purple stars	Sedge	Wetland or tundra indicator
Gold circle	Dwarf birch	Grows in cold climates, often at high altitudes
Dark pink circle	Sorrel	Disturbance indicator
Blue circles	Creeping evergreen shrub	Very cold climate, rocky soils, often found at high altitudes

Layer	Soil type	Time period	Species found in soil core	Confetti set-up
1	sandy	100-400 years ago	Ragweed, common reed, few oak (due to deforestation), sorrel	10-turquoise circles 10-dark pink circles 10-red stars 5-pink hearts
2		400-3000 years ago	Oak and chestnut	10-pink hearts 10-silver stars
3	well drained loam or clay	3,000-5,000 years ago	Oak and hickory	10-pink hearts 10-blue stars
4	shallow loam or silt loam over bedrock	5,000-7,500 years ago	Oak and hemlock	10-pink hearts 10-gold hearts
5	Lake or peat	7,500-11,500 years ago	White pine and oak	10-clear stars 10-pink hearts
6	Lake or peat	11,500-12,700	Spruce, fir, paper birch	10-red hearts 10-silver circles 10-black stars

7	sandy soils, well-drained	12,700-15,000 years ago	Spruce, some fir, oak, white pine	10-red hearts 10-clear stars 5-silver circles 10-pink hearts
8	rocky soils with some peat.	15,000-16,000 years ago	Creeping evergreen shrub, dwarf birch, sedge	10-blue circles 10-gold circles 10-purple stars

Engage: Show students the sediment core and ask: What do you think we can discover about the history of a place using the sediment layers. Ask: How far into the past can we go? Students will probably think about fossils or the Grand Canyon. Explain that when we collect a sediment core, we are getting a slice of the soil's layers. There are many differences between layers, including the tiny, fossilized pollen grains found within them. Ask: how can scientists tell what kind of pollen is in a sediment core? Explain that they will become 'scientists' to discover the paleoclimate of the Hudson Valley. Another option is to bring in a flower with pollen. They could observe the pollen under a microscope. Remind students of the difference between pollen and spores.
Explore: Distribute the materials to each group of students: one layer (bag with 'pollen'), tweezers, and a paper plate. Students should sift through their sediment layers and separate out each of the different pollen types. Allow enough time to discover what layer they have and what type of climate may have existed during this period, using the information on their student guide. Once all groups have completed their work, they should compare their results using the chart on their worksheet and complete the class graph. A rough graph of the general temperature changes can be created on the board (put 'temp' on the y-axis as warm, cool, and cold and time on the x-axis). This should allow a discussion of the history of climate change in the Valley. Then, show students the two attached graphs of climate change over the last 14,000 years and the last 400 years. Students should now be able to answer all of the questions on their data sheets.
Explain: Scientists are interested in studying the history of climate change in order to understand patterns of change over time. Since each type of pollen has a distinct shape, scientists can find out what plant produced the pollen. By discovering what types of plants lived during each time period, scientists can infer what the climate was like during that time, and even how many of each type of plant lived during that period. They can also draw conclusions about how long it took for different changes to take place. For instance, how long did it take from the last ice age until the appearance of marsh plants? The speed that plant communities migrate into an area can help scientists understand how plants are currently migrating around the world, and what might happen when the temperatures increase in the future. Scientists from Lamont-Doherty have collected pollen samples throughout the Hudson River area, and are continuing to collect samples to create a more complete picture. "Background Reading About Dr. Peteet" available below under "Lesson Resources" contains more information about this effort.

When discussing the pattern of climate change over the last 16,000 years, it might be helpful to give students background on climate change. There are a number of things

that can alter the global temperature: changes in the sun's activity, distance of the sun's orbit from earth, volcanic eruptions, greenhouse gas emissions (including aerosols, which can provide a cooling effect). However, we know from data that the sun (solar radiation) has been relatively constant in the 20th century, and that greenhouse gases are higher now than at anytime during the last 600,000 years.

Extend: Students can investigate other regions of the world to determine the paleoclimate data. Information can be found at: Climates of the Past (http://bit.ly/11a4PsU). Students could also be led on a guided walk and discuss what a current 'layer' would look like.

Evaluate: Students should be able to complete the activity and answer the questions appropriately. Students could also draw or write a story about one layer using what they know from the chart and more research (including information about the animals that have lived in the area).

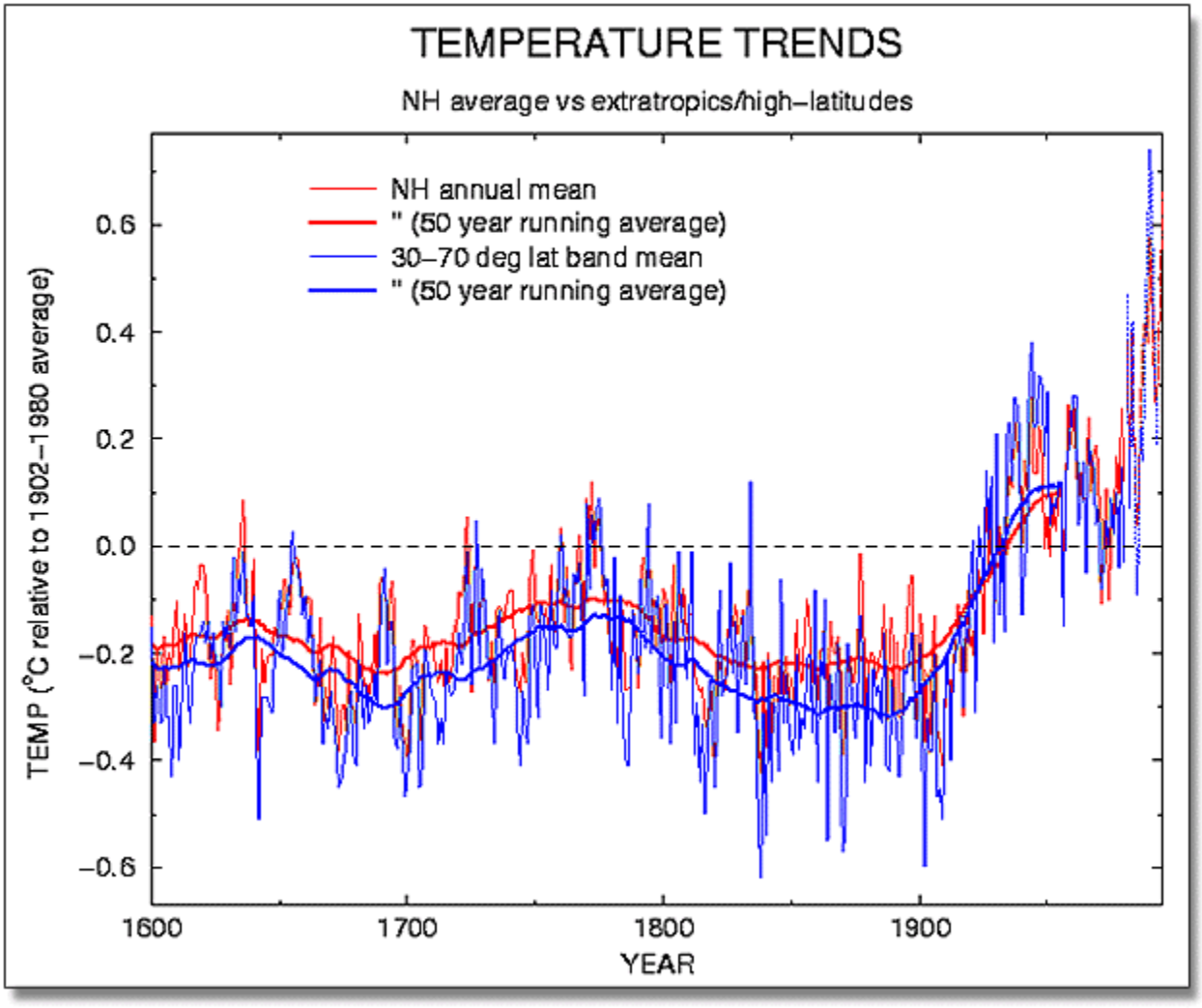
Comments:

Credit:

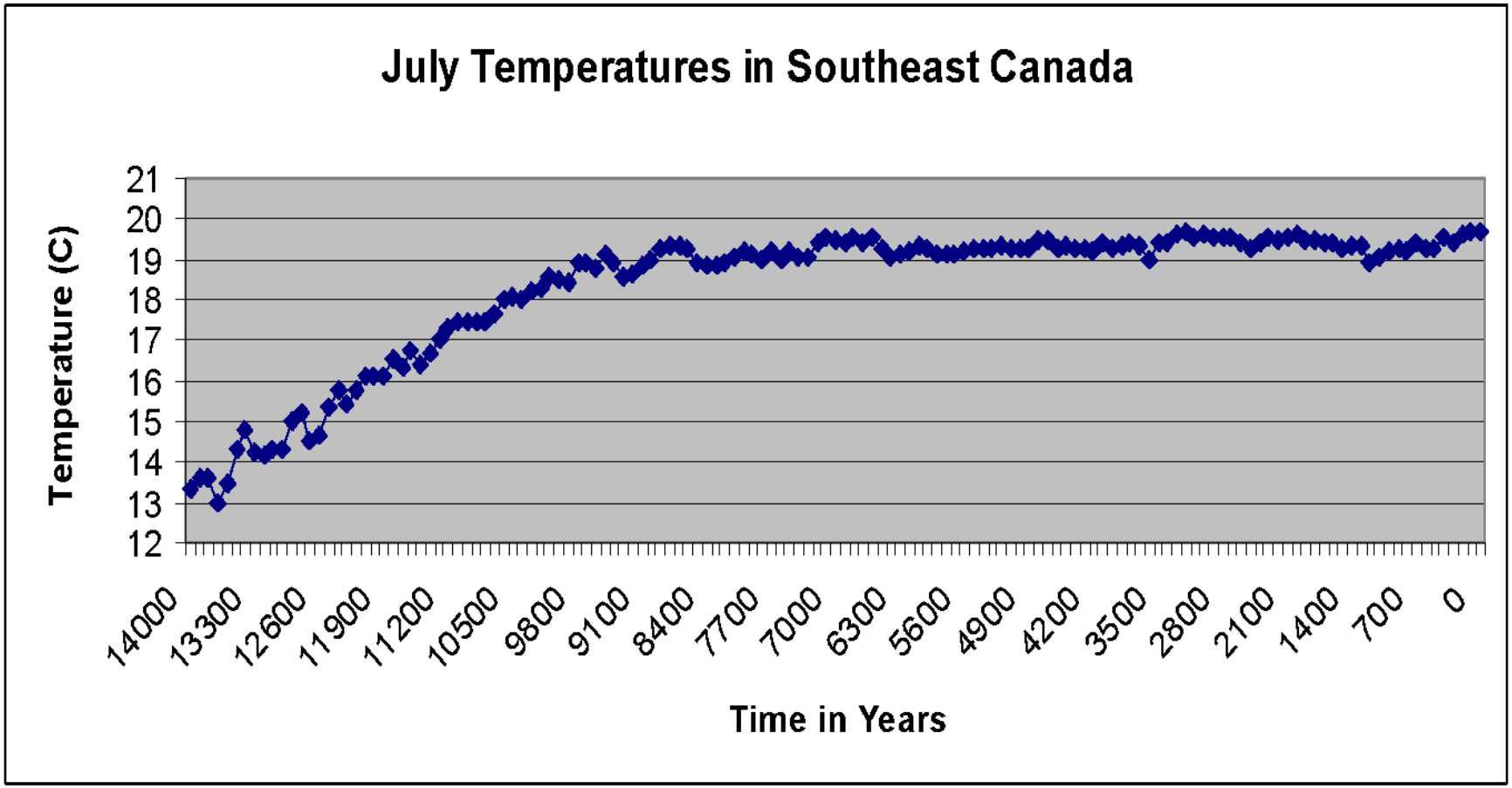
Lesson modified from University Corporation for Atmospheric Research lesson plan, www.windows.ucar.edu using data from Lamont-Doherty Earth Observatory, for the Changing Hudson Project, Institute of Ecosystem Studies, 2007. Last edit: January 2013.

Lesson Resources:

File name	Title as listed on website	Document title
Paleoclimate_reading_Dr_Peteet	Background reading about Dr. Peteet	Mud Records New York History
Paleoclimate_reading	Lesson reading	Paleoclimate of the Hudson River Valley
Paleoclimate_worksheet	Lesson worksheet	Paleoclimate of the Hudson River Valley
Paleoclimate_graphs_alone	Supplemental temperature change graphs	none



Source: National Climate Data Center (NOAA), [NH Temperature Trends](http://1.usa.gov/Yf1nIY) (http://1.usa.gov/Yf1nIY)



Source: Viau, A.E., et al. 2006. North American 14,000 Year Pollen-based July Temperature Reconstructions, IGBP PAGES/World Data Center for Paleoclimatology