Investigating Climate Change Issues With Web-Based Geospatial Inquiry Activities

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Overview

The unit begins with an investigation using Google Earth to explore global temperature changes during a recent 50 - 58 year period. Students explore, analyze, and interpret climate patterns of 13 different cities, and analyze differences between weather and climate patterns. Next, students are introduced to the four main Earth spheres (atmosphere, lithosphere, hydrosphere, and biosphere) and explore the structure and composition of the atmosphere with an emphasis on greenhouse gases and the role that ozone plays in the troposphere and stratosphere.

Students explore and investigate concepts pertaining to Earth system energy balance including albedo, and surface and atmospheric absorption and reflection. In the next learning activity, students use Google Earth to determine how latitude, elevation, proximity to bodies of water, and mountain ranges affect a location's climate.

Next, student learning activities focus on the carbon cycle and the importance of greenhouse gases in our atmosphere. Students also learn about paleoclimatology and complete a paleoclimate reconstruction lab in which they reconstruct past climates using lake varves as a proxy to interpret long-term climate patterns and understand annual sediment deposition and how it relates to weather and climate patterns. Students then use a Web-based geologic timeline to examine temperature, CO_2 concentration, and ice cover data to investigate how climate has changed during the last 715 million years.

Students use a Web-based carbon calculator to determine their carbon footprint and examine their personal and household habits and choices in relation to their carbon footprint. Next, students use Google Earth to investigate geographical areas and populations affected by recent changes in climate patterns.

In the culminating investigation, students use Google Earth to explore evidence of climate change during 1980 – 2010 including changes in Arctic Sea ice extent and changes in the distribution of coral reefs in the Caribbean Sea. They then use Google Earth to explore future world scenarios by examining the effects of a 2-meter rise in sea level on the existing landscape. Students then explore strategies at personal and societal levels to help reduce atmospheric carbon emissions levels.

Educative Curriculum Materials

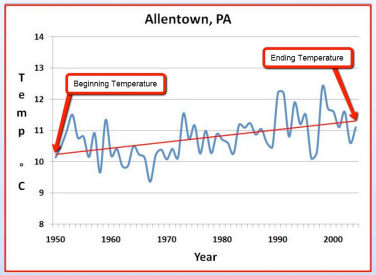
1. Support and promote teacher science and environmental learning in addition to student learning.
2. Pedagogical design capacity – adapt curriculum for productive instructional ends.
3. Geospatial pedagogical content knowledge.
4. Spatial thinking and spatial analysis

An easy to use interface for teachers and students

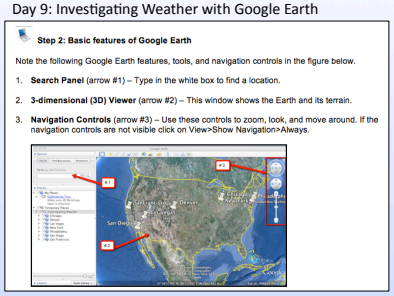
During Spring 2011, we conducted a pilot test of the first version of the Climate Change curriculum with one teacher and five intact classes of students, representing three different ability level tracks. The sample consisted of 122 students. We used a pre-post study design to measure students' climate change knowledge and spatial reasoning skills using a comprehensive 28-item Climate Change Knowledge Assessment that aligns to benchmark climate literacy goals for 8th-grade students. This curriculum will be utilized in all 8th grade classrooms in the Bethlehem Area School District in 2012.

Funding Provided by the Toyota USA Foundation and NASA

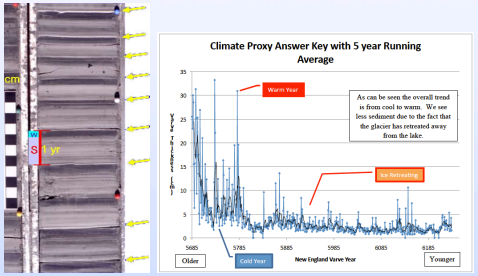
Day 1: 50 Year Global Climate Records



Day 9: Investigating Weather with Google Earth

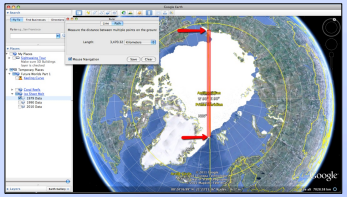


Day 14: Using Lake Varves as a Climate Proxy



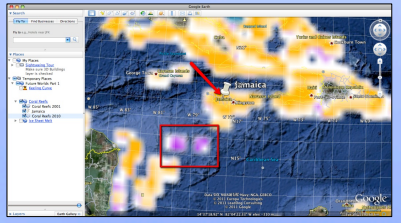
In this lab investigation, students reconstruct past climates using lake varves as a proxy. They explore the use of lake varves as a climate proxy to interpret long-term climate patterns and understand annual sediment deposition and how it relates to weather and climate patterns.

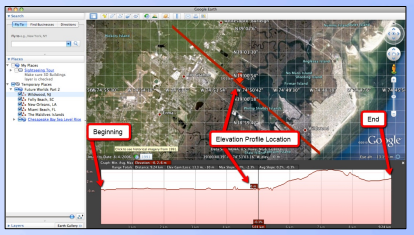
Day 17 and 18: Future Worlds with GE



This is a two day activity in which students look at changes in CO_2 concentration, coral reef habitat, and sea ice extent during the last 30 years. Students being to understand that there has been some rapid changes in the environment in recent history. During the second day of the activity, students are presented with the IPCC's worst case scenario of a 2 meter rise in sea level. Students use Google Earth to navigate through low lying locations that could be affected by sea level rise. They then observe 1 meter and 2 meter rise sea level rise scenarios in the Chesapeake Bay watershed.

Students use the Keeling Curve measured in Hawaii to see how CO_2 concentrations have changed from 1960-2010. Students then determine the area of the Arctic Ice Sheet in 1979, 1990, and 2010 to see how sea ice extent has changed over the last 30 years.

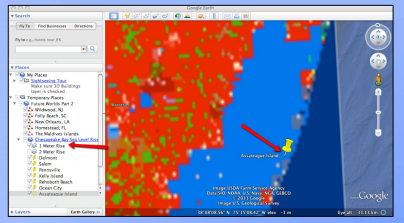




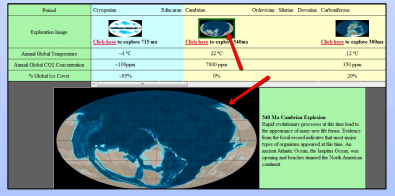
Students explore sea level rise at Wildwood, NJ using the Google Earth Elevation Profile tool. Assuming a 2 meter rise in sea level, 5.71 km of residential land and marsh would be underwater.

Students also use GE to explore a 1 and 2 meter rise in sea level in the Chesapeake Bay region.

The carbon calculator below allows students to determine their annual carbon footprint and compare their activities to the the United States and global average.



Day 15: Interactive Geologic Timeline



Results

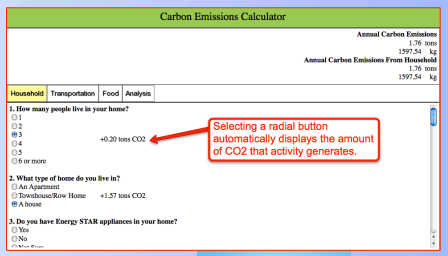
Question/ Criteria	Exemplary (4)	Proficient (3)	Adequate (2)	Needs Improvement (1)	Insufficient Response (0)
Question #3 What would it actually take for humanity to lower the levels of carbon dioxide in the atmosphere?	All ideas or activities are identified with **clear, specific, and realistic examples.** Student examples: ☐ Chose a specific renewable/ sustainable energy sources such as solar or geothermal instead of burning fossil fuels ☐ Plant more trees ☐ Preserve forests	At least half of the listed ideas or activities are depicted with **general, realistic examples** but lack specific detail. AND No student responses are in the **Needs Improvement** category. Student examples: ☐ Stop burning fossil fuels ☐ Switch to a renewable resource ☐ Stop factories from polluting ☐ Use clean energy ☐ Use fewer appliances	Most ideas or activities are **vague or unrealistic but accurate.** Student examples: ☐ Use energy wisely ☐ Find more efficient ways of doing things ☐ Start recycling ☐ Reduce power usage ☐ Turn lights off ☐ Stop pollution	Most ideas or activities are **ambiguous and include misunderstandings.** Student examples: ☐ Do environmentally friendly things every day/ be green ☐ Burn my own trash ☐ Emission of CO2 needs to stop	Student did not address components of question.

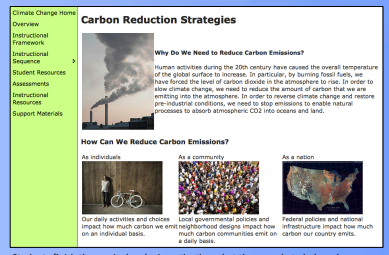
Overall Climate Change achievement and achievement by ability track for pre/post test. N=109

	Pretest Mean (SD)	Posttest Mean (SD)	t-Value	Effect Size
Overall (N=107)	8.91 (3.00)	12.17 (3.40)	10.676*	1.21
Low track (N=34)	7.44 (2.38)	10.32 (2.87)	3.55*	1.20
Middle track (N=44)	8.75 (2.65)	12.00 (2.90)	7.05*	1.23
Upper track (N=29)	10.86 (3.17)	14.59 (3.32)	7.031*	1.17

**p<.001.*

Day 16: Carbon Emission Calculator





Students finish the curriculum by investigating what they can do to help reduce carbon emissions in their lives.

Bi-weekly survey response summary to educative curriculum materials.
N = 70 responses from 15 teachers. Scale: 1 (Strongly Disagree) to 5 (Strongly Agree)

Item Please rate your interactions with the curriculum.	Strongly Disagree % (n)	Disagree % (n)	No Opinion % (n)	Agree % (n)	Strongly Agree % (n)	Mean
The curriculum and support materials provided me with appropriate content knowledge.	0.0% (0)	4.3% (3)	5.4% (4)	62.9% (44)	27.1% (19)	4.13
The curriculum and support materials provided appropriate teaching ideas to help me use the instructional materials.	0.0% (0)	7.1% (5)	15.7% (11)	48.6% (34)	28.6% (20)	3.99

Please rate your interactions with the curriculum.	Strongly Disagree % (n)	Disagree % (n)	No Opinion % (n)	Agree % (n)	Strongly Agree % (n)	N/A	Mean
The curriculum and support materials helped me use geospatial-learning tools with my students.	0.0% (0)	1.4% (1)	5.7% (4)	60.0% (42)	25.7% (18)	7.1% (5)	4.18

Peer Review Dissemination

- National Science Digital Library's Digital Library for Earth System Science
- National Science Teachers Association's (NSTA) SciLinks
- Pennsylvania Department of Education
- Pennsylvania Center for Environmental Education
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