Lisa Thoss

Stevenson High School, Lincolnshire, IL
AP Environmental Science

Textbook: Environment: The Science Behind the Stories (AP Edition)
By Jay Withgott & Scott Brennan

Course Unit Outlines where we focus on climate change:
Unit 6: Weather, Climate, Biomes, and Biodiversity

Topics covered:
i. El Nino Southern Oscillation
ii. Biomes
iii. Weather
iv. Biodiversity Index
v. Global Wind and Weather Patterns
vi. Seasons
vii. Factors Affecting Climate
viii. Preservation of Biodiversity
ix. Endangered Species
x. Extinction
xi. Legislation and Treaties

Objective:

Define climate, weather and biodiversity as afunction of population dynamics, evolution, and human impact.

Targets

1. Demonstrate how various forces lead to the global prevailing windpatterns.

2. Describe the major factors that determine the temperature,precipitation, and air pressure in a location and the impact each factor has ondetermining local climate.

3. Describe the major characteristics of the world's terrestrial andaquatic biomes.

4. Explain the various factors that lead to the El Nino-SouthernOscillation (ENSO).

Unit 11: Global warming, air pollution, and ozone depletion
Topics covered
i. Structure of the atmosphere

ii. Greenhouse effect
iii. Climate change
iv. Primary and secondary pollutants
v. Sources and effects of air pollution
vi. Acid deposition
vii. Photochemical smog
viii. Temperature inversions
ix. Indoor air pollution
x. Noise pollution
xi. Stratospheric Ozone chemistry
xii. Legislation and Treaties

Objective: Identify sources andcosts associated with and solutions for air pollution. Provide evidence forglobal warming and ozone loss and solutions for each.

Targets:

1. Describeand identify the location of the layers of the atmosphere.

2. Describethe forcings that influence the Earth's natural climate.

3. Identifygreenhouse gases (CO_2, CH_4, H_2O, CFC, N_2O,O_3) and describe their impact on global climate.

4. Describepositive and negative feedbacks that could influence climate change.

5. Describephysical and political consequences from anthropogenic climate change.

6. Describepersonal and political solutions to reducing the impact of anthropogenicclimate change.

7. Describethe criteria air pollutants (CO, NOx, O_3, Pb, Particulates, SO_2)and their impact on air quality.

8. Describethe role and formation of secondary pollutants (VOCs, PAN, O_3, H_2SO_4,HNO_3).

9. Describethe impacts of indoor and outdoor air pollutants on human health and the lawsthat regulate air quality.

10. Describe a thermal inversion and its influence onair quality.

11. List and describe the major indoor air pollutants(VOC, radon, cigarette smoke,asbestos, and formaldehyde).

12. Describe the natural formation and degradation of stratospheric ozone and the

influenceof CFCs.

13. Describethe identification of and the political solutions to ozone degradation.

12. Describethe natural formation and degradation of stratospheric ozone and the influenceof CFCs.

13. Describethe identification of and the political solutions to ozone degradation.

LABS:
CO2 and Heat Absorption
Cars, CO2 and You
Personal Carbon Footprint
Alternative Energies Study

Attached below is our newest lab written in correlation with Northwestern University's Office of STEM Education Partnerships
For more information visit:
http://www.osep.northwestern.edu/climate-change-activities

When will the Poles Disappear?

Lesson Plan Developed by:

Don Carmichael, John Deppong, Lisa Thoss, Dave Wilms, Stevenson High School, Lincolnshire, Illinois
Mary Ellen Johnson,

Based on Presentation

Yarrow Axford. June, 2011. Northwestern University, Climate Change Curriculum Professional Development. Evanston, IL.

Purpose

Due to the increase in atmospheric temperature that has occurred over the last half century there is less and less sea ice at the end of the arctic summer. You will be using a linear regression to predict what year the arctic might disappear.

Overview

In this activity the data that will be used has been collected by scientists from the National Snow and Ice Data Center in Colorado that has been tracking the sea ice extent since 1978. When using the regression model for prediction it is important to consider the assumptions that are made and the reliability of the data collected. The assumptions include considerations like whether or not the rate of sea ice melt, solar output, the rate of atmospheric warming are all constant.

Student Outcomes

Students will be able to:
- Plot and interpret a linear regression of annual sea ice extent.
- Compare 2 sets of data to determine the projected years that the sea ice extent will disappear.
-

Illinois State Science Standards

11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.
11.A.4d Apply statistical methods to the data to reach and support conclusions.

Climate Literacy Essential Principles:
5. Our understanding of the climate system is improved through observations theoretical studies, and modeling. (C, E)

Time

One class period plus additional homework before and after.

Level

Grades 11-12, Environmental Science & Statistics

Materials and Tools

- A computer with graphing software such as Excel or a graphing Calculator
- A copy of the data

Preparation

Ask students if they are able to do linear regression models on a graphing calculator OR reserve computers to use Excel. There is an online movie that is a great visual of the Sea Ice found at : http://nsidc.org/data/google_earth/images/seaice_2008_climatology_lr.mov

Prerequisites

Students should have some knowledge of graphing a linear regression in their graphing calculator or on Excel.

Background

The data scientists collect is used to make conclusions about what is being studied. The data collected is based on an experiment that has been designed to test a hypothesis. Sometimes the data seems very disorganized which makes it difficult to make a conclusion. It these cases, scientists often use math tools to help make the data more understandable. One of these tools is called a Linear Regression Model. In this activity we will use linear regression to examine arctic sea ice using data scientists have collected.

When there are two variables, x and y, that change with respect to each other, scientists look to se if there is a relationship between them. They look to see how one variable changes with respect to the other. A simple example of how one variable changes compared to another is how the cost of a pizza changes with its diameter. A more complex example is how ocean surface temperature affects hurricane strength. A regression can be used to predict if the two variables change at a known rate. Given the diameter of a pizza, one could predict the cost of a pizza or given a ocean surface temperature predict the intensity of hurricanes.

During each winter in the northern hemisphere the north pole is entirely in the dark, receiving no sunlight due to the tilt of the earth. From October through March it is so cold that the ocean water freezes and the polar ice cap grows. During the summer the arctic is bathed in 24 hours of daylight and the sea ice melts. In the recent past the amount of sea ice that melts exceeds the amount of sea ice that grows. Due to the increase in atmospheric temperature that has occurred over the last half century there is less and less sea ice at the end of the arctic summer.

When using the regression model for prediction it is important to consider the assumptions that are made and the reliability of the data collected. The data you will be using has been collected by scientists from the National Snow and Ice Data Center in Colorado. They have been tracking sea ice extent since 1978. The assumptions include considerations like whether or not the rate of sea ice melt, solar output, the rate of atmospheric warming are all constant.

Teaching Notes

Students can create graphs in Excel by doing the following steps:

1. Type all Years in Column A & Extent Area in Column B.
2. Select all data in both columns and click Charts> X Y (Scatter)
3. To see data points alone click on “Marked Scatter”
4. For the chart to be viewed alone on the top of your screen go to Chart, select “Move Chart…” and select new sheet.
5. For a best fit line go to Chart, select “Add Trendline…”
6. Double click on the line, in the left toolbar click “options” within the Forecast box you can continue the line forward or backward beyond the data points until it crosses the year axis.

Additional Information

http://nsidc.org/data/seaice_index/

Assessment

Completed graph and prediction date are indicators of understanding.
Complete student questions should be checked for understanding.

Name:_____ **Period:**_____
Date:_____

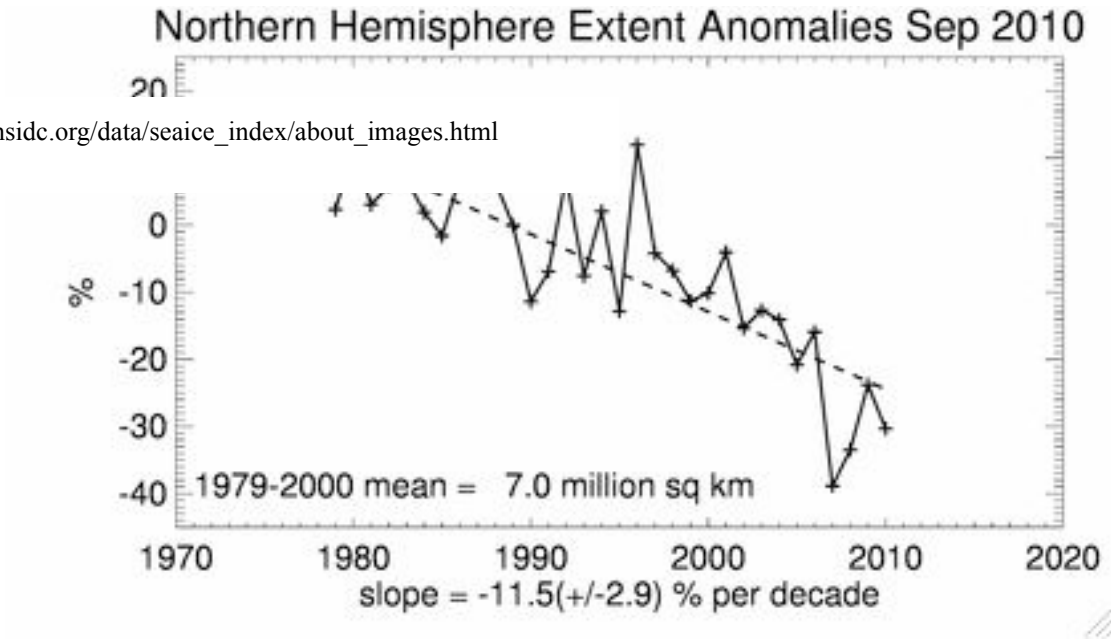
When will the Poles Disappear?

The data scientists collect is used to make conclusions about what is being studied. The data collected is based on an experiment that has been designed to test a hypothesis. Sometimes the data seems very disorganized which makes it difficult to make a conclusion. It these cases, scientists often use math tools to help make the data more understandable. One of these tools is called a Linear Regression Model. In this activity we will use linear regression to examine arctic sea ice using data scientists have collected.

When there are two variables, x and y, that change with respect to each other, scientists look to se if there is a relationship between them. They look to see how one variable changes with respect to the other. A simple example of how one variable changes compared to another is how the cost of a pizza changes with its diameter. A more complex example is how ocean surface temperature affects hurricane strength. A regression can be used to predict if the two variables change at a known rate. Given the diameter of a pizza, one could predict the cost of a pizza or given a ocean surface temperature predict the intensity of hurricanes.

During each winter in the northern hemisphere the north pole is entirely in the dark, receiving no sunlight due to the tilt of the earth. From October through March it is so cold that the ocean water freezes and the polar ice cap grows. During the summer the arctic is bathed in 24 hours of daylight and the sea ice melts. Each September the sea ice is at it's minimum extent because it has been melting all summer. In the recent past the amount of sea ice that melts exceeds the amount of sea ice that grows each year. Due to the increase in atmospheric temperature that has occurred over the last half century there is less and less sea ice at the end of the arctic summer.

When using the regression model for prediction it is important to consider the assumptions that are made and the reliability of the data collected. The data you will be using has been collected by scientists from the National Snow and Ice Data Center in Colorado. They have been tracking sea ice extent since 1978. The assumptions include considerations like whether or not the rate of sea ice melt, solar output, the rate of atmospheric warming are all constant.



http://nsidc.org/data/seaice_index/about_images.html

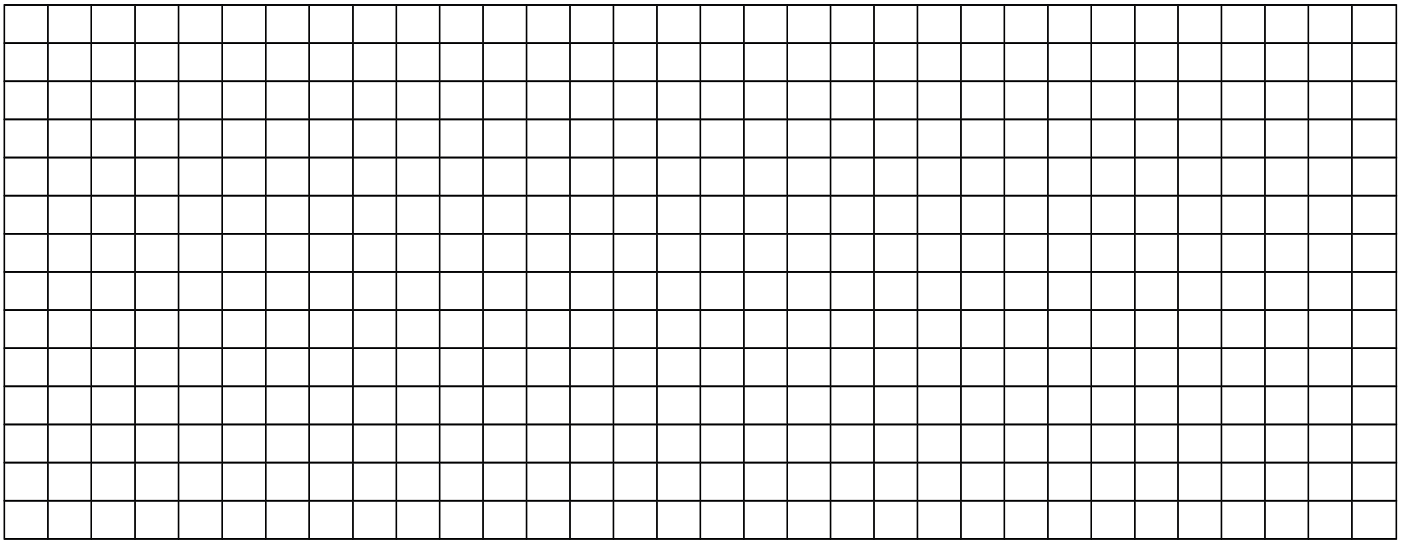
Data Analysis

1. Create a graph and plot the values in the data chart below with the year on the independent axis and percent sea ice coverage on the dependent axis.

Sea Ice Minimum Extent (September of each year) from 1979 through 2010

Year	Sea Ice Minimum Extent (%)
1979	7.20
1980	7.85
1981	7.25
1982	7.45
1983	7.52
1984	7.17
1985	6.93
1986	7.54
1987	7.48
1988	7.49
1989	7.04
1990	6.24
1991	6.55
1992	7.55
1993	6.50
1994	7.18

Year	Sea Ice Minimum Extent (%)
1995	6.13
1996	7.88
1997	6.74
1998	7.56
1999	6.24
2000	6.32
2001	6.75
2002	5.96
2003	6.15
2004	6.05
2005	5.57
2006	5.92
2007	4.30
2008	4.68
2009	5.36
2010	4.90



2. Using a ruler Draw a line the you think best approximates the data. This line is called a line of best fit and is a visual description of linear regression.

3. Using a computer find the linear regression by following these steps using Excel:
    1. Type all Years in Column A & Extent Area in Column B.
    2. Select all data in both columns and click Charts> X Y (Scatter)
    3. To see data points alone click on "Marked Scatter"
    4. For the chart to be viewed alone on the top of your screen go to Chart, select "Move Chart…" and select new sheet.
    5. For a best fit line go to Chart, select "Add Trendline…"
    6. Double click on the line, in the left toolbar click "options" within the Forecast box you can continue the line forward or backward beyond the data points until it crosses the year axis.

4. Find the year on the X axis where the linear regression line crosses the axis. This point is the prediction for when the sea ice in the arctic will completely disappear at the end of the summer.

Conclusions:

1. In what year will do you predict the sea ice will melt entirely during the arctic summer?

2. What causes the ice to melt?

3. Latent heat is the energy necessary to cause something to change state, like form a solid to a liquid. As the heat energy is added to the melting substance no change in temperature occurs. This is

because all of the energy is going into breaking the bonds holding the solid together. Once all of the substance has melted any additional energy will cause the temperature of the liquid to rise. What will happen to the temperature of the water in the arctic once the sea ice melts?

4. The pole help to moderate the temperature of the planet by absorbing energy without causing a change in temperature. What will happen to the temperature of the arctic ones the ice melts?

5. **If the current amount of CO_2 in the atmosphere stays constant and the period of warming we are currently in continues what will happen to the temperature in the poles?**