Global Challenges

An Introductory
Climate Change Curriculum

Presented by Earth Day Network and the District of Columbia Office of Bilingual Education

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An Introductory Climate Change Curriculum

Target Population: Middle School

Introduction

This curriculum is intended to give your students an introduction to the complex topic of climate change. As part of Earth Day Network's Climate Change Solutions Campaign, these lessons can be taught alone or in conjunction with other resources and information we offer, including our climate change fact sheet, Environmental Jeopardy, and the Bobbie Bigfoot Sustainability Lessons. In this curriculum, students will study global warming; compare characteristics of climate zones and describe how convection currents in the ocean affect climate; and investigate how human activities have modified the environment in different ways, each of which has helped accelerate the process of global warming. We use the terms "global warming" and "climate change" interchangeably throughout these lessons.

The activities in the curriculum guide require basic supplies necessary for teaching environmental science and are listed in the applicable lessons. Most supplies needed are readily available at local grocery stores. Posters, videos, and models should be used to provide visual support for students. The curriculum guide also calls for the use of a science notebook. This is a bound notebook where students record their science experiences. The science notebook can become a valuable record of student progress and learning. It also encourages the use of writing in a real world context as writing in a science notebook mirrors the type of writing that scientists do when performing investigations.

The curriculum guide outlines activities that are meant to be a base of instruction which should be built upon according to the needs of the students. The science activities included are designed to give the students hands-on interaction with the science content presented – there are many other activities which teachers may choose to use to help reinforce these concepts. We encourage teachers to explore questions brought up in the classroom by the students themselves and to encourage an atmosphere of inquiry in the classroom. Earth Day Network would like to acknowledge the work of the District of Columbia Office of Bilingual Education's Hands-On Science Program in helping to create these lessons. Please direct all questions and comments about the curriculum to Earth Day Network's Department of Education at education@earthday.net.

Lesson One **Is the Climate on Earth Changing?**

Objectives Researches climatic changes

Motivation Ask students, "What is the weather today?" Ask, "What is the weather usually like this time of year?" Explain that climate is the average weather of a region over a long period of time. Write on the blackboard, "Climate is what you expect. Weather is what you get." Discuss what the saying means. Ask students, do you think our climate is changing? What have you heard about this?

Presentation Give each team a graph of average world temperature for the last century (attached, p.6). Ask teams to write a sentence about climate change based on the graph. Have the teams share their conclusions. Ask students to explain why they think the climate is changing.

Tell students they will read about global warming and the "greenhouse effect." (Be sure students understand that the greenhouse effect is a natural phenomena that keeps the earth warm. What scientists believe is happening now is the greenhouse effect has been enhanced due to increased emissions of $C0_2$ and other gases). As students read they should try to find out why scientists think the temperature on the Earth is rising.

Read about global warming: "Global Warming: An Introduction" (attached), by the Environmental Protection Agency

Practice Ask teams to discuss why the temperature on the Earth is rising and to write the reasons in their science notebook. Have teams share their findings.

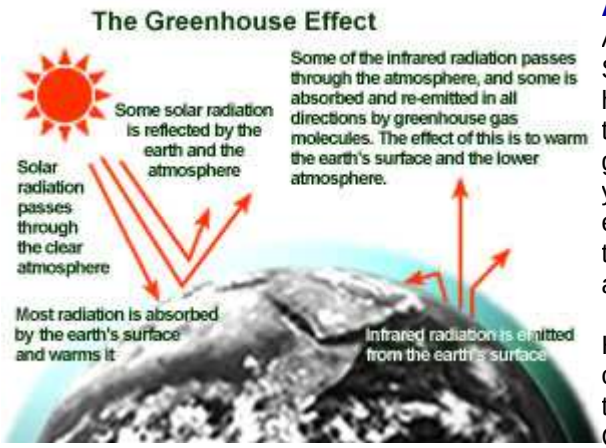
Instruct students to make a bar graph of the temperature in their city from 1963 to 2003. Have each team make a graph for a ten-year period – each person on the team will construct the same graph. Place groups in new teams of four with each team member contributing a graph from a different decade. Have the students tape their graphs together to make one graph of the forty year period.. Instruct students to work together to answer the questions about the weather in their city using the graph.

Closing Have each team discuss: What things can we do to slow down global warming? Each team member will write one response. Have teams stand up and share their answers. Instruct students not to repeat answers. A team can sit down when all of their answers have been shared.

Assessment Correct answers to questions about the graph

Source: Environmental Protection Agency

Global Warming



An Introduction

According to the National Academy of Sciences, the Earth's surface temperature has risen by about 1 degree Fahrenheit in the past century. The temperature has gone up the fastest during the past twenty years. There is new and stronger evidence that most of the warming over the last 50 years is because of human activities.

Humans have changed the chemical composition of the atmosphere through the buildup of greenhouse gases. Greenhouse gases are primarily carbon dioxide, methane, and nitrous oxide. The heat-trapping property of these gases is clear. But we are not sure exactly how earth's climate responds to them.

Changing Atmosphere

Energy from the sun heats the earth's surface. The earth radiates some of the sun's energy back into space. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the outgoing energy. They keep the sun's energy from radiating back into space. This is sometimes called the "greenhouse effect."

Without this natural "greenhouse effect," temperatures would be much lower than they are now. Life as we know it would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is 60℉. However, probl ems may arise when the amount of greenhouse gases increases.

Since the beginning of the industrial revolution, the amount of carbon dioxide in the atmosphere has increased nearly 30%. The amount of methane has more than doubled, and nitrous oxide has risen by about 15%. This has increased the heat-trapping capability of the earth's atmosphere.

Why are greenhouse gases increasing? Scientists believe that burning fossil fuels and other human activities are the main reason for the increase in carbon dioxide. Plant respiration and the decomposition of organic matter also release carbon dioxide into the atmosphere -- more than 10 times the CO_2 released by human activities! But in the past these releases were in balance, the carbon dioxide was absorbed by plants and the oceans.

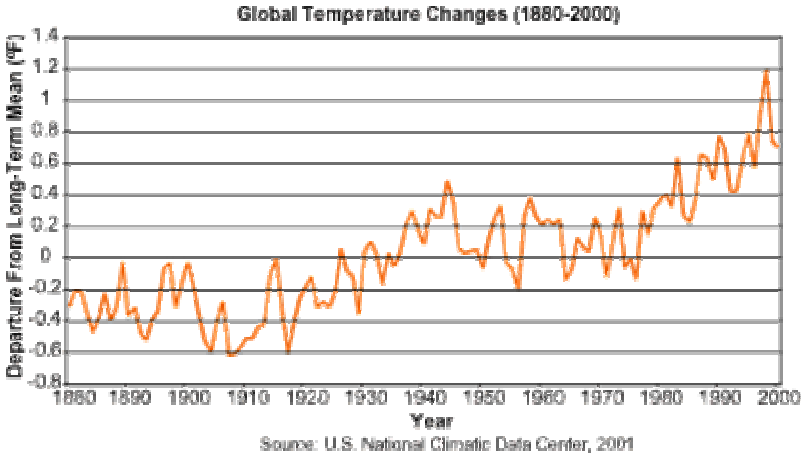
What has changed in the last few hundred years is the additional release of carbon dioxide by human activities. Fossil fuels burned to run cars and trucks, heat homes and businesses, and power factories are responsible for about 98% of U.S. carbon dioxide emissions, 24% of methane emissions, and 18% of nitrous oxide emissions. Increased agriculture, deforestation, landfills, industrial production, and mining also contribute a significant share of emissions. In 1997, the United States emitted about one-fifth of total global greenhouse gases.

Changing Climate

Global mean, or average, surface temperatures have increased 0.5-1.0°F since the late 19th century. The 20th century's 10 warmest years all occurred in the last 15 years of the century. Of these, 1998 was the warmest year on record.

Changes we have seen are:

- Less snow cover in the Northern Hemisphere
- Less floating ice in the Arctic Ocean
- Globally, the sea level is 4-8 inches higher than 100 years ago
- Worldwide precipitation over land has increased by about one percent
- There are more extreme rainfall events throughout much of the US



Increasing concentrations of greenhouse gases are likely to increase the rate of climate change. Scientists expect that the average global surface temperature could rise 1-4.5°F (0.6-2.5°C) in the next fifty years, and 2.2-10°F (1.4-5.8°C) in the next century, with significant regional variation. Evaporation will increase as the climate warms, which will increase average global precipitation. Soil moisture is likely to decline in many regions, and intense rainstorms are likely to become more frequent. Sea level is likely to rise two feet along most of the U.S. coast.

Calculations of climate change for specific areas are much less reliable than global ones, and it is unclear whether regional climate will become more variable.

Fill in the chart below for your city (instructions for finding the information are below the chart).

Average Temperature (C°) in January and February

Year	Temperature	Rank Based on the Time Period Selected (1963-2003)
2003		

2002		
2001		
2000		
1999		
1998		
1997		
1996		
1995		
1994		
1993		
1992		
1991		
1990		
1989		
1988		
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1976		
1975		
1974		
1973		
1972		
1971		
1970		
1969		
1968		
1967		
1966		

1965		
1964		
1963		

Visit NASA's Goddard Institute for Space Studies website: http://data.giss.nasa.gov/csci/stations/. Click on your city or the area on the map closest to your city (you can click anywhere and the closest weather stations will appear). Choose a climate monitoring station. At the bottom of the next page, click on the link that reads "Download the data as text". Fill in the above chart and answer the questions below.

1. Has the average winter temperature gone up or down since 1963? _____

2. What five years were the coldest?

3. What five years were the warmest?

4. Do you think the climate in your city is getting warmer, colder, or staying the same?

5. Why? To what might you attribute the change?

Average January and February Temperatures (C˚) from 1963 to 1972

Temperature C˚

	63	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**
Year										

1) Using the same data from the Goddard Institute for Space Studies, fill in the left-hand column of each graph with numbers that encompass the entire temperature range for your city from 1963 to 2002. There should be a difference of no more than one degree between each number. Graph the average temperature during the first decade. Round the temperatures for each year to the nearest whole number and add them together:

Year	**Temp**
1963	
1964	
1965	
1966	
1967	
1968	
1969	
1970	
1971	
1972	
TOTAL	

2) Divide the total by 10

3) The average temperature from 1963 to 1972 in

_____ was _____

Average January and February Temperatures (C˚) from 1973 to 1982

Temperature C˚

	73	**74**	**75**	**76**	**77**	**78**	**79**	**80**	**81**	**82**
Year										

1) Graph the average temperature during this decade. Round the temperatures for each year to the nearest whole number and add them together:

Year	**Temp**
1973	
1974	
1975	
1976	
1977	
1978	
1979	
1980	
1981	
1982	
TOTAL	

2) Divide the total by 10

3) The average temperature from 1973 to 1982 in _____ was _____

Average January and February Temperatures (C˚) from1983 to 1992

Temperature C˚

	83	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**
Year										

1) Graph the average temperature during this decade. Round the temperatures for each year to the nearest whole number and add them together:

Year	**Temp**
1983	
1984	
1985	
1986	
1987	
1988	
1989	
1990	
1991	
1992	
TOTAL	

2) Divide the total by 10

3) The average temperature from 1983 to 1992 in _____ was _____

Average January and February Temperatures (C˚) from 1993 to 2002

Temperature C˚

	93	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**
Year										

1) Graph the average temperature during this decade. Round the temperatures for each year to the nearest whole number and add them together:

Year	**Temp**
1993	
1994	
1995	
1996	
1997	
1998	
1999	
2000	
2001	
2002	
TOTAL	

2) Divide the total by 10

3) The average temperature from 1993 to 2002 in _____ was _____

Lesson Two **What are the Climate Zones?**

Objectives Describes characteristics of climate zones

Materials picture or video clip of polar environment, copies of world map for each student

Motivation Show pictures or a video clip of a polar environment. Ask students to describe what they see. Show students where to find the poles on a globe. Ask teams to brainstorm how they think global warming will affect the climate in these regions. Have each team share their ideas

Presentation Explain that there are three types of climate zones on the earth: Polar, Temperate, and Tropical. Show the students the Tropic of Cancer (at 23.5º N) and the Tropic of Capricorn (at 23.5º S). Explain that inside the two lines is the tropical zone, which is generally hot year-round. In the tropical zone, there are climate regions that are different. There is a tropical rain forest that is hot and wet. There is a tropical desert that is hot and dry. Show the students the Arctic Circle (66.5º N). Tell the students that north of this line is the polar zone—that is cold most of the year. There is also a polar zone at the south at the Antarctic Circle (66.5º S). Between the polar zone and the tropical zone is the temperate zone. In the temperate zone the winters are cool/cold and the summers are warm/hot. What zone is your city in?

Ask students to read about the climate zones. As students read, ask them to identify which zones they have lived in or visited.

Practice Color code a world map to show the climate zones and identify the lines of latitude that divide the zones.

Students will describe the climate of the three major climate zones in their science notebooks.

Closing Ask students to look at a map and determine the climate zones of the cities where they have lived. Have the students write about the climate of the cities in their science notebooks.

_____ is in the _____
city

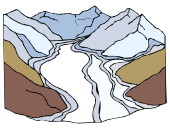
climate zone. The climate in _____is_____.
city

Assessment Description of climate zones. Proper identification of climate zones on map.

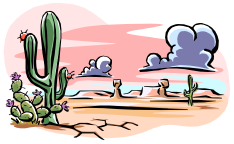
Climate Zones

Climate is the average weather of a place over a long period of time. There are three major climate zones in the world:

Zone	Climate
Polar Zone	cold and dry
Temperate Zone	warm summer, cold winter
Tropical Zone	hot summer, hot or warm winter





North Pole = 90 Nº

0º = equator

Where are the climate zones?

South Pole = 90º S

Lines of latitude are imaginary lines that go in an east-west direction around the earth. The **equator** is a line of latitude. The equator is the line halfway between the north and south poles. Latitude tells us how far north or south of the equator we are.

Lines of latitude are numbered beginning at the equator and ending at the poles. The latitude numbers begin with 0º at the equator and go up to 90º. All latitude numbers north of the equator are followed by the letter N for "north." All latitude numbers south of the equator are followed by the letter S for "south." 90º N is the North Pole. 90º S is the South Pole.

The **polar zone** is from the line of latitude 66.5º N to 90º N and from 66.5º S to 90º S. The line of latitude at 66.5º north is called the "arctic circle."

The **tropical zone** is from the equator 0º to 23.5º N and 23.5º S. The line of latitude at 23.5º N is called the Tropic of Cancer. The line of latitude at 23.5º S is called the Tropic of Capricorn. Between the Tropic of Cancer and the Tropic of Capricorn is the tropical zone.

The **temperate zone** is between the tropical zone and the polar zones.

Lesson Three **Ocean Currents and Climate**

Objectives Describes how currents in the ocean affect climate
Compares characteristics of climate zones

Materials For each group: two flasks with one-hole stopper, hot water, cold water, two thermometers, 9x 13 pan, two zip lock bags, ice, two bottles food coloring, two binder clips, globe

Motivation Have students group themselves by where they have lived or visited. Have the groups come to a consensus about the climate of that region. Have each group tell the class about the climate of their region. Have the students show the region on the map and show the closest ocean.

Presentation Explain that we are going to do an experiment to see how water temperature affects air temperature. Show the students the materials they will use and demonstrate how to set up the experiment. Have the students perform the experiments with their teams. Have teams share their results.

Practice Students perform an activity to discover how temperature affects ocean currents (attached).

Students find convection currents on a globe. Using the attached worksheet, students find the average temperature of cities at similar altitudes (sea level) and line of latitude but near different currents. Compare the average January and July temperatures. Determine how the currents affect the temperature.

Application Form groups based on birth cities/countries or places they have visited if there is not enough diversity. Ask students to find their birth city on the globe and look up information about their birth country in an encyclopedia or on the internet. Students must find out:

What climate zone is it in?
What is the latitude?
Which ocean current affects the city? Is it warm or cold?
What is the average summer temperature?
What is the average winter temperature?
What is the annual precipitation (rain and snow)?

Groups will share the information with the class. Students will compare the climates of the cities (see attached worksheet). As an exemplar, give an example from the polar zone.

Closing Students share which zone they would like to live in.

Assessment Comparison of average yearly temperatures of cities near major currents.
Comparison of climate zones

Problem: How does water temperature affect air temperature?

Hypothesis: **I think warm water will make the air temperature _____**

because _____.

I think cold water will make the air temperature _____

because _____.

Materials: 2 large flasks with one-hole stoppers, 2 thermometers, hot water, cold water

Procedure: 

1. Put a thermometer through the hole in the stopper of each flask.
2. Set the flasks next to each other and measure the temperature of the air inside each flask.
3. Wait until the temperature in both flasks is about equal. Record temperature.
4. Fill one flask half-full with hot water and one flask half-full with cold water.
5. Wait five minutes and take the temperature of air above the water in each flask.

Observations:

Time		Temperature
	Air in both flasks	
	Air in flask with cold water	
	Air in flask with hot water	

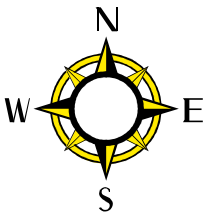
Conclusion:
How did the temperature of the water affect the temperature of the air?

_____

_____

_____

Currents and Climate



Ocean currents are large streams of water that move through the ocean. The sun warms the water at the equator. This warm water moves towards the poles where it is cold. The cold water from the poles moves towards the equator where it is hot. Currents follow the Earth's major wind patterns.

The currents from the equator warm the land they travel by. Both wind and land take heat from the warm ocean currents that come from the equator. Look at the map. Find the Gulf Stream. The Gulf Stream starts in the Caribbean. The Gulf Stream is a warm current. The Gulf Stream gives western Europe warm summers and mild winters.

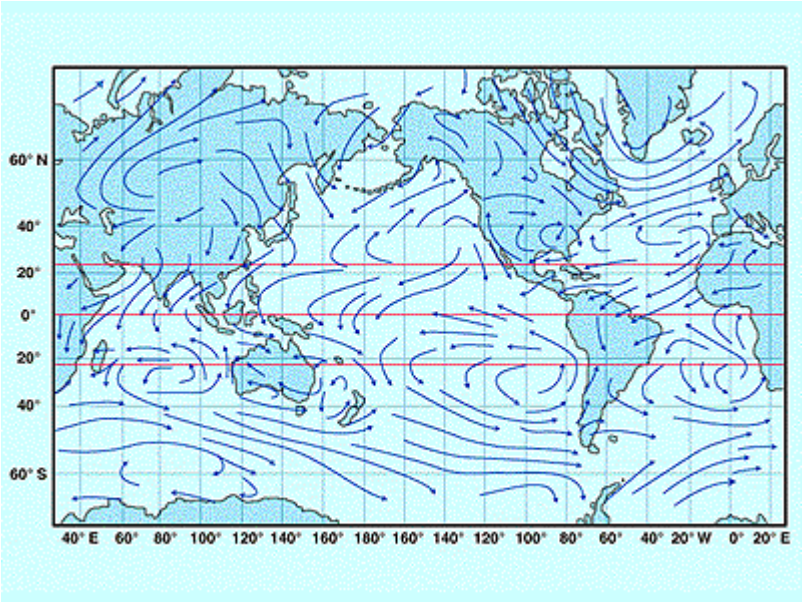


Figure 1a. Global wind patterns for a typical month of January. Note the similarities and differences between large-scale wind and current patterns (Fig. 1b).

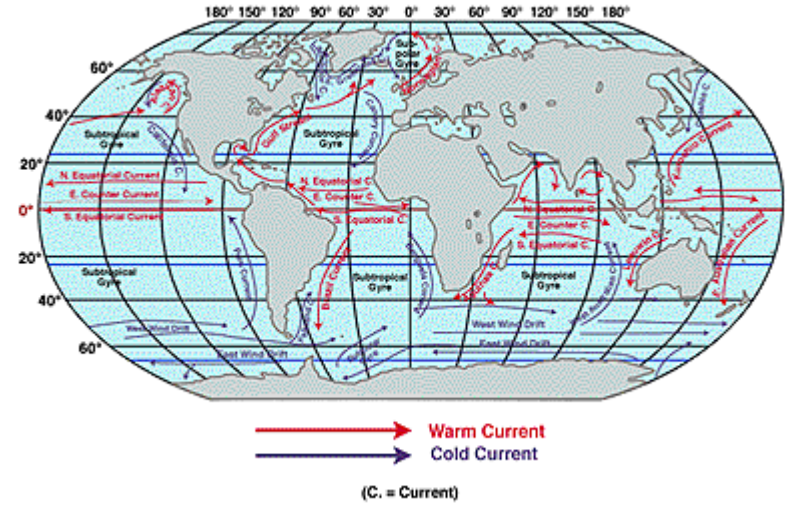
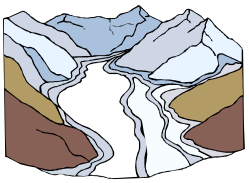


Figure 1b. Global wind-driven surface currents for a typical January. Warm currents are shown in red and cold currents are colored blue. Note the similarities and differences between large-scale ocean current and wind patterns (Fig. 1a).



How do hot and cold water move?

Materials: 1 rectangular pan, one zip lock bag full of ice, one zip lock bag full of hot water, two clips, two bottles of food coloring (different colors)

Procedure:

1. Fill the pan with room temperature water. Let the water settle for a few minutes.
2. Clip a bag full of ice at one end of the pan.
3. Clip a bag full of hot water at the other end of the pan.
4. Put two drops of food coloring in front of the bag of ice.
5. Put two drops of food coloring (a different color) in front of the bag of hot H_20.
6. Observe what happens to the hot and cold water.

Observations:

1.What happened to the food coloring near the bag of ice? _____

_____

2. What happened to the food coloring near the bag of hot water? _____

_____

Conclusion:

3. Based on your observations, what do you think happens to the cold water near the north and south poles?

_____

_____

4. Based on your observations, what do you think happens to the warm water near the equator?

_____

_____

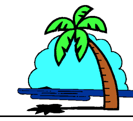
How Do Currents Affect Average Temperature?

1. Use a globe to fill out the chart.
   Use the lines of latitude and longitude to help you find the cities
   Find the ocean current that flows near these cities.
   Is the current warm or cold?

City	Latitude	**Longitude**	**Ocean Current**	**Warm or cold?**	**Average Jan. Temp. (F)**	**Average July Temp. (F)**
Portland, Maine, US	43ºN	70ºW			21.5	68.1º
Bordeaux, France	45ºN	0º			42.1º	68.7º
Nome, Alaska, US	64ºN	165ºW			7.2º	51.4º
Reykjvik, Iceland	64ºN	21ºW			31.5º	52.0º
Havana, Cuba	23ºN	82ºW			72º	82º
La Paz, Mexico	24ºN	110ºW			64.2º	84.4º

2. How does the current affect the climate of the cities?

Write the information about each city in the correct zone. Choose more cities.

Polar Zone 	**Temperate Zone** 	**Tropical Zone** 
City/Country: Ave. summer temp: Ave. winter temp: Ave. precipitation: Current: Latitude:	City/Country: Ave. summer temp: Ave. winter temp: Ave. precipitation: Current: Latitude:	City/Country: Ave. summer temp.: Ave. winter temp: Ave. precipitation: Current: Latitude:
City/Country: Ave. summer temp: Ave. winter temp: Ave. precipitation: Current: Latitude:	City/Country: Ave. summer temp: Ave. winter temp: Ave. precipitation: Current: Latitude:	City/Country: Ave. summer temp.: Ave. winter temp: Ave. precipitation: Current: Latitude:
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City/Country: Ave. summer temp: Ave. winter temp: Ave. precipitation: Current: Latitude:	City/Country: Ave. summer temp: Ave. winter temp: Ave. precipitation: Current: Latitude:	City/Country: Ave. summer temp.: Ave. winter temp: Ave. precipitation: Current: Latitude:

1. Which zone would you want to live in? ________________________________

2. Why? ____

____

3. How does that zone compare with the other zones? _______________________

____

4. What are two reasons the climate is different from the other zones?

a. ____

b. ____

Lesson Four **Researching Environmental Problems and Their Impact on Climate Change**

Objectives Researches the global warming consequences of selected environmental problems to conclude that climate change is a complex and widespread issue which requires overcoming many different and serious obstacles.

Infers that human activities are the major factor in climate change and offers suggestions for how to minimize human involvement, thereby slowing or even reversing global warming.

Language Objectives
Generates questions and linkages about issues, texts or topics of interest
Writes a working bibliography of 7-8 resources
Takes notes by paraphrasing main ideas and details from several sources
Identifies cause and effect relationship between and among ideas
Provides visual aids
Organizes an idea that clearly states a point of view
Arranges details, reasons, examples and anecdotes effectively and makes a strong statement
Supports arguments with detailed evidence, citing sources of information as appropriate

Motivation Bring in a picture of an area that has experienced environmental degradation which can be related to climate change (deforestation, melted glaciers, city sprawl, fossil fuel excavation, etc). Show the picture to the class. Write on the board: What do you think happened? Why do you think it happened? What could help fix this problem? Discuss the questions with the teams. Write answers on the board. Give a picture to each team and have each team answer the questions about their picture. Have each team share their answers.

Presentation Explain that each pair is going to study an environmental problem related to climate change. Show students pictures and books/articles explaining topics they can study such as those listed above. Try to suggest problems that you already have resources for the students to study.

Go over the project rubric and show an exemplar. Have the students give the exemplar a grade using the rubric.

Explain that students will need to choose a topic. Allow students to look at the resources you have and choose three topics they would like to study.

Place students in work pairs. Give the students a study guide and print resources to use to find the answers to the questions.

Environmental Problem Study Rubric

	Most information is correct	**Many details**	**Clear and neat**	**Sources listed**
4 =	**All** is correct	YES	YES	YES
3 =	YES	Maybe	Maybe	Maybe
2 =	NO	Maybe	Maybe	Maybe
1 =	NO	NO	Maybe	Maybe

Score	**Grade**
22-24	A
19-21	B
17-18	C
14-16	D
13 or less	F

Score

1. Describe problem _____
2. Describes cause of problem _____
3. Describes how humans affected problem _____
4. Describes how it relates to climate change _____
5. Describes possible solutions _____
6. Labeled map of region _____
7. Picture of organisms affected _____
8. Contains chart or graph _____
9. Describes the climate zone _____

Total _____

Grade _____

Teacher Comments:

Environmental Problem Research Guide

1. What environmental problem are you studying?

2. Where is this a problem?

3. In what climate zone is this environmental problem most common?

4. What makes this environmental problem a concern?

5. What caused this problem?

6. How did human activities contribute to the problem?

7. How does this problem relate to climate change?

8. What can humans do to help solve the problem?

9. What can you, specifically, do to help solve this problem?

9. Where did you find this information?