

Title: Global Warming or Temperature Trends

Brief Overview:

Students will be given temperatures from two cities. They will graph the data on a double line graph and create a box and whisker plot. After graphing the data and reading the literature provided, they will analyze the data and identify any visible trends.

Links to NCTM Standards:

- **Mathematics as Problem Solving**
Students will demonstrate their ability to problem solve by making conclusions based on the real world data that has been provided.
- **Mathematics as Communication**
Students will demonstrate their ability to communicate mathematically by writing a paragraph that includes appropriate terminology.
- **Mathematics as Reasoning**
Students will demonstrate their ability to reason mathematically by building an argument that justifies their conclusions.
- **Mathematical Connections**
Students will demonstrate their ability to graph data and interpret scientific literature to make conclusions about a real-world problem.
- **Computation and Estimation**
Students will demonstrate their ability to compute by finding averages of temperatures provided to them.
- **Statistics**
Students will demonstrate their ability to organize and display data relating to the real world.

Grade/Level:

Grades 7-8

Duration/Length:

The unit is arranged to be performed over three 50-minute class periods.

Prerequisite Knowledge:

Students should have working knowledge of the following:

- Basic components of a line graph
- Basic components of a box and whisker plot
- How to write a paragraph using correct grammar and mathematical justifications

Objectives:

Students will:

- work in cooperative groups.
- create a double line graph.
- create a box and whisker plot.
- write a paragraph that analyzes the data.

Materials/Resources/Printed Materials:

- Paper and pencil
- Graphing calculator
- Graph paper
- Resource book
- Dictionary
- Highlighters

Development/Procedures:

The main idea behind the lesson is to gain a better understanding of global warming. Following a motivational discussion of current weather patterns and sharing one or more recent articles pertaining to possible changes in our climate, students will be given literature and data that show temperature trends around the world. The students will also be given data in a chart form. The data will represent average yearly temperatures over a 35-year period for two cities in the U.S. Students will create a double line graph and two box and whisker plots. Finally, they will write a letter to the editor of the newspaper defending the opinion they have formed after analyzing the data.

Performance Assessment:

The evaluation for this learning unit will be based on three activities(#3,#7,#8). Each of the activities has its own scoring tool. The scoring tools follow the worksheets.

Extension/Follow Up:

Students can use a graphing calculator to create a box and whisker plot. Students can also use a graphing calculator to create a scatter gram. Other related data can be presented and analyzed or graphed, such as the relationship between temperature and greenhouse gases.

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Global Warming

Resource Book

The Cold Facts on Global Warming

[Taken from an article by Sallie Baliunas, Ph. D]

Mankind has been bombarded with wailing that a disaster is around the bend. A TV special about global warming features images of parched, cracking farmlands, crying babies, and dehydrated adults. Everywhere we turn we hear the refrain: "The earth is becoming a hothouse because we keep burning fossil fuels."

Scientists like to examine the facts. Regarding global warming, the scientific facts suggest that we are overreacting, that the doomsday prophets are blind to the numbers. For instance, carbon dioxide (CO₂) is one of the "greenhouse gases" villains often blamed for the recent warming trend. Burning coal and other fossil fuels release CO₂ into the atmosphere, and the global warming doomsday crowd blames CO₂ increases during the last 100 years for the 0.5 degree Celsius rise in average global temperature.

Greenhouse gases, naturally present in the atmosphere, act like an insulating blanket over the earth and help warm the planet. Without them, the earth would be a Siberian wasteland with an average temperature of minus 18 degrees. Adding CO₂ to the atmosphere by burning coal should boost the natural greenhouse effect and make the earth slightly warmer. The great climate change debate becomes a cauldron of hyperbole and hot rhetoric when scientists predict how much warmer the earth might become.

These predictions are based on elaborate mathematical models carried out on large computers, and the numbers can wildly vary, depending upon who does the calculations. For example, the U.N. Intergovernmental Panel on Climate Change (IPCC) sees disaster in its crystal ball: If greenhouse gases continue to accumulate in the atmosphere, in the next 50 years the earth's temperature will rise between 15 degrees and 45 degrees Celsius. This dire forecast has promoted serious talk about the need for limiting CO₂ emissions with higher taxes and stricter regulations.

Before we enact sweeping changes, we should stop and ponder: Are the computer forecasts accurate? Are they based on scientific facts? Do we endanger our earth by delaying CO₂ emission restrictions until the climate experts come up with definitive data? The current computer forecasts are dismally inaccurate. The earth's actual response to the buildup of greenhouse gases in recent years highlighted the failure of computers to make the right call.

Modern temperature records began in 1880; they show a warming of about 0.5 degrees Celsius up to the present. During the same period, greenhouse gases in the atmosphere increased largely because of a 50 percent increase in CO₂. The forecasts predict a warming of 0.5 degrees to 2 degrees Celsius for that kind of boost in carbon dioxide. The IPCC report says "the size of this [observed] warming is broadly consistent with predictions of climate models."

But the timing of the temperature rise doesn't jibe with the predictions. Nearly all the 0.5 degree Celsius temperature rise occurred before 1940, but most of the CO₂ entered the atmosphere after 1940. The computer seems confused. The temperature jump occurred before the greenhouse gases were pumped into the atmosphere. Even more compelling--from 1940 to 1970, CO₂ built up rapidly above the earth. According to the greenhouse scenario, the earth's temperature should have shot up; instead, the temperature actually fell.

Greenhouse gases cannot explain the rise in global temperature prior to 1940, and the computer cannot explain the temperature drop between 1940 and 1970. The climatic drama that played out on this planet during the past century completely contradicts the predictions of the greenhouse theorists.

U.S. temperature records also challenge the accuracy of the computer forecasts. These forecasts stress that the United States should have warmed by at least 2 degrees Celsius during the last 50 years--faster than the global temperature because land heats up more quickly than ocean. However, U.S. temperature records show no warming trend during that stretch.

Add the global temperature record for the last two decades to the list of global warming counter arguments. According to the greenhouse forecasts, the buildup of greenhouse gases should have sent the global thermometer shooting up far past the range of normal quirks in climate. The computer forecasts would have us believe that such a large buildup of greenhouse gases during that period should have upped the global temperatures by about one-third of a degree, and U.S. temperatures warm by about two-thirds of a degree. Instead, NASA satellite data show that the average temperature of the earth has changed by less than one-tenth of a degree during the last 15 years. Apparently, the computer forecasts are exaggerating actual warming by a factor of five.

Suppose I am wrong. Suppose we are turning up the earth's thermostat, despite my take on the current scientific evidence. We could still delay a crackdown on CO₂ emissions for, say, five years, while scientists crunch a slew of numbers about the size of the greenhouse warming. Even if the greenhouse effect is the looming monster that the computer says it is (and don't forget how it grossly exaggerates), a delay of five years would penalize the earth with a mere extra .1 degree Celsius temperature rise in the next 50 years. That kind of slight nudge in temperature would hardly cause a blink for the inhabitants on earth.

In the end, we should heed the old credo that many scientists caught up in the greenhouse gases debate have conveniently ignored: to err on the side of caution. We need more time and data before we rush to judgment on the fate of Planet Earth.

[Dr. Sallie Baliunas is a Robert Wesson Fellow at the Hoover Institution and chair of the Science Advisory Board of the George C. Marshall Institute.]

Global Warming

[Taken from: "Global Warming," by Al J. Laukaitis in the Lincoln Journal Star;
"Global or Hot Air?" by Carl Leif Bates in the Detroit News; and
"Debate Over Greenhouse Gas Emissions Heating Up," by Caroline Clay
in the Sunday Herald -Times.]

Ignoring global warming is like the crew of the Titanic disdaining those infamous iceberg warnings.

That's what many scientists want people to believe. At the Kyoto (Japan) Climate Summit last month, more than 2,000 government leaders, scientists, and policy makers warned that Planet Earth is headed for its own metaphorical iceberg: global warming. The believers predict that if the greenhouse gases aren't reined in, global warming will wreak havoc on this planet. Sea levels rising because the polar caps melt... coastal cities, islands, and parts of Florida going under the drink... huge regions of the world becoming warmer and drier, sending farmers to the poor house... critical wildlife habitats being destroyed, sending some plants and animals into extinction.

"Most atmospheric scientists say these changes are under way," said Peter DeBrine, a senior program officer with World Wildlife Fund. "I think what we are seeing now is a destabilization of the climate. The problem now is the timing of it all. Yes, we've been through ice ages and climatic changes, but the problem today is how fast it's happening."

Many scientists believe global warming is caused by an increase in greenhouse gases--carbon dioxide, methane, nitrous oxide, and water vapor--found naturally in the environment. Without these gases coating the atmosphere, Earth would be a Popsicle. But those same scientists emphasize that human activities--like burning fossil fuels in power plants and cars--are belching greenhouse gases and turning up the earth's temperature.

According to some scientists, a few danger signs have already appeared. For example, the National Oceanic and Atmospheric Administration recently reported that 1997 was the warmest in the 20th Century and that nine of the last 11 years have been the warmest on record. After looking at climate records stretching back to 1880, the Union of Concerned Scientists highlighted several alarming trends:

- * All the warmest years on record have occurred in the past 15 years.
- * The 1990s were warmer than the 1980s--the previous champion of warm weather--by almost 0.2 degrees Fahrenheit.
- * In vast areas of the United States, temperature increases of two degrees to four degrees Fahrenheit are the norm for the 20th Century.

* Since weather aficionados began keeping reliable records in 1880, the average global surface temperature has risen by .8 degrees Fahrenheit.

Many scientists have developed long frowns over this issue. In December 1995, scientists from 120 nations met to discuss global warming. They agreed that existing evidence "suggests a discernible human influence on global climate." Nations heavy on industry have been the biggest culprits of greenhouse gas pollution. The bulk of these gases comes from the fossil fuels: coal used to produce electricity and petroleum we squirt into our cars and trucks. For example, the United States contains only four percent of the world's population, yet it emits 23 percent of the global warming gases. Federal climate researchers agree that humans deserve some of the blame for heating up the planet. They warn that if nothing is done to curb the air pollution, the average surface temperature of the earth could increase by as much as 6.3 degrees Fahrenheit by the end of the 21st Century.

"I feel strongly that global warming is here, induced by man's burning of fossil fuel," stated Indiana University geological sciences professor Simon Brassell. "The question is: Where is that going to take us?"

Many nations have decided that greenhouse gases will take mankind to an outdoor global sauna. Last December at the Kyoto Climate Summit, the world at-large agreed to reduce greenhouse gas emissions over the next few years. The treaty calls for the U.S., for one, to lower greenhouse emissions by seven percent below the 1990 level by the year 2012.

Opponents of the global warming brigade will quickly point out that climate change, by itself, is nothing to lose sleep over. Michigan's landscape has been both a tropical forest and a mile-thick sheet of ice in its history. Overall, the earth is about 13 degrees warmer than it was at the end of the last ice age 20,000 years ago.

But it took over 10,000 years to bump up the temperature. What alarms many scientists is that lately the earth's mercury has been rising at a rapid clip. "The big deal is the rate of change," said James Teeri, director of the University of Michigan Biological station. "It's happening very rapidly now." The warming after that last ice age frosting nosed up just a tenth of a degree per century. But in the 20th Century alone, Teeri noted, the temperature has gone up one full degree. The global warming gang can roll out some heavy guns disguised as evidence. "It's adding up," commented Henry Hengeveld, Environment Canada's science advisor on climate change. "How much more evidence do we need before we accept that the problem is real?"

During the 20th Century, mankind invented a weapon--unleashed by the atom--that could wipe out the species if vengeance runs roughshod on the planet. Global warming might well be the slow-ticking time bomb that blows up in our faces somewhere down the long road of history.

Average Annual Temperatures(°F) for Anchorage, Alaska and Baltimore, Maryland from 1961 to 1995

YEAR	ANNUAL AVERAGE ANCHORAGE	ANNUAL AVERAGE BALTMORE
1961	33.7	54.5
1962	35.4	53.5
1963	36.5	53.3
1964	33.3	55.1
1965	35.7	54.4
1966	32.9	53.8
1967	35.9	53.5
1968	35.7	55.3
1969	37.7	55.5
1970	37.0	56.1
1971	32.3	56.0
1972	31.9	54.8
1973	32.7	55.7
1974	35.4	55.4
1975	33.7	56.6
1976	36.4	55.0
1977	39.0	56.3
1978	39.7	54.7
1979	38.8	55.2
1980	35.9	55.3
1981	38.8	54.6
1982	33.8	54.6
1983	37.0	55.3
1984	38.6	54.9
1985	35.8	56.1
1986	38.1	55.8
1987	38.2	55.8
1988	37.6	55.0
1989	35.8	54.5
1990	34.8	57.9
1991	36.8	57.7
1992	35.5	54.5
1993	39.0	55.2
1994	36.5	56.3
1995	37.4	57.0

Source: The Weather Almanac, 1992 and 1997

Is the Earth Warming? (Student Tasks)

Three 50-minute class periods

Materials: Student resource books
Graph paper
Straight edges
Crayons or markers
Highlighters
Dictionaries

Outcomes: Using the data from the temperature tables and articles, students will create a graphic display, will form an opinion, and justify conclusions.

1. Read "The Cold Facts on Global Warming" on pages 1 and 2 of the Resource Book. Using the text, create a definition of global warming and identify possible causes of the problem.

2. Based on the evidence presented in this article, on what side of the global warming debate is the author? Cite at least one quote from the article to support your answer.

3. In light of the author's opinion on delaying a "crackdown" on CO₂ emissions, and your own knowledge of global warming, do you believe measures should be enacted immediately to control emissions? Give reasons to support your answer.

4. Read "Global Warming" on pages 3 and 4 of the Resource Book. State the author's position on global warming. Cite at least three points the author uses to support his position.

5. Hypothesize why the U.S., containing only 4% of the Earth's population, emits 23% of the world's greenhouse gases.

6. Based upon the author's prediction that the average surface temperature of the Earth may climb 6.3 degrees Fahrenheit by the end of the 21st century, would global warming be a problem that is likely to affect you?

7. Using the annual average temperatures for Anchorage, Alaska and Baltimore, Maryland on pages 11 and 12 of the resource book, create a double line graph. Use the provided graph paper and remember to include all necessary components of a double line graph.

8. Within your group describe any trends that you observe.

9. Calculate the average of the annual average temperatures for each city.

Anchorage average temperature (1961-1995): _____

Baltimore average temperature (1961-1995): _____

10. How do these compare to the average global temperature of 1990 which was 59.81 degrees? Hypothesize about the possible causes of any difference you found.

11. In the space below create two box and whisker plots for the same data you used in number 3.

Use information from the resource packet to complete the FAN chart below.
F-Facts that are **for** the premise that global warming is a problem.
A-Facts that are **against** the premise that global warming is a problem.
N-Facts that are **neutral** concerning the existence of global warming.

F	A	N

Scoring Rubric for Line Graph

- 5 Student labeled axes correctly, included title, used even intervals, correct data recorded, key included.
- 4 Student did four of the following ; labeled axes correctly, included title, used even intervals,correct data recorded, key included.
- 3 Student did three of the following ; labeled axes correctly, included title, used even intervals,correct data recorded, key included.
- 2 Student did two of the following ; labeled axes correctly, included title, used even intervals,correct data recorded, key included.
- 1 Student did one of the following ; labeled axes correctly, included title, used even intervals,correct data recorded, key included.

Scoring Rubric for Written Response

- 4 Student has an appropriate topic sentence, used correct grammar, included sufficient justifications based on data and/or literature, used mathematical terminology where applicable.
- 3 Student has included three of the following; has an appropriate topic sentence, used correct grammar, included sufficient justifications based on data and/or literature, used mathematical terminology where applicable.
- 2 Student has included two of the following; has an appropriate topic sentence, used correct grammar, included sufficient justifications based on data and/or literature, used mathematical terminology where applicable.
- 1 Student has included one of the following; has an appropriate topic sentence, used correct grammar, included sufficient justifications based on data and/or literature, used mathematical terminology where applicable.

Scoring Rubric for Box- Whisker Plot

- 5 Students will create a graph that has a title, the correct median, quartiles, extremes, outliers(if any), an appropriate key, and a scale with even intervals.
- 4 Students will include four of the following components in their graph; a title, the correct median, quartiles, extremes, outliers (if any), an appropriate key, and a scale with even intervals.
- 3 Students will include three of the following components in their graph; a title, the correct median, quartiles, extremes, outliers(if any), an appropriate key, and a scale with even intervals.
- 2 Students will include two of the following components in their graph; a title, the correct median, quartiles, extremes, outliers(if any), an appropriate key, and a scale with even intervals.
- 1 Students will include one of the components as indicated above.

Is the Earth Warming? (Answer Key)

1. Read "The Cold Facts on Global Warming" on pages 1 and 2 of the Resource Book. Using the text, create a definition of global warming and identify possible causes of the problem.
(Possible answer) According to the "Cold Facts" article global warming is the gradual heating up of the Earth's surface. It implies that possible causes are the increased burning of fossil fuels and the buildup of greenhouse gases.
2. Based on the evidence presented in this article, on what side of the global warming debate is the author? Cite at least one quote from the article to support your answer.
The author feels that some people are overreacting to the possibility of global warming. He states "Apparently, the computer forecasts are exaggerating actual warming by a factor of five."
3. In light of the author's opinion on delaying a "crackdown" on CO₂ emissions, and your own knowledge of global warming, do you believe measures should be enacted immediately to control emissions? Give reasons to support your answer.
(Answers will vary)
4. Read "Global Warming" on pages 3 and 4 of the Resource Book. State the author's position on global warming. Cite at least three points the author uses to support his position.
The author of this article feels that global warming is a real concern. He uses phrases like "a slow-ticking time bomb," "an outdoor global sauna," and "the Earth's mercury rising at a rapid clip." (Sample response)
5. Hypothesize why the U.S., containing only 4% of the Earth's population, emits 23% of the world's greenhouse gases.
(Possible Answer) While the United States makes up only 4% of the Earth's population, it is possibly one of the most industrialized countries in the world and therefore creates more pollution than most other countries.
6. Based upon the author's prediction that the average surface temperature of the Earth may climb 6.3 degrees Fahrenheit by the end of the 21st century, would global warming be a problem that is likely to affect you?
(Possible answer) Although I do not expect to live that long, the lives of my possible future children may be affected and adverse effects may also affect me before my life is over.

7. Using the annual average temperatures for Anchorage, Alaska and Baltimore, Maryland on pages 11 and 12 of the resource book, create a double line graph. Use the provided graph paper and remember to include all necessary components of a double line graph.

(see attached)

8. Within your group describe any trends that you observe.

(Answers will vary)

9. Calculate the average of the annual average temperatures for each city.

Anchorage average temperature (1961-1995): 35.94°F

Baltimore average temperature (1961-1995): 55.15°F

10. How do these compare to the average global temperature of 1990 which was 59.81 degrees? Hypothesize about the possible causes of any difference you found.

(Possible response) While both average temperatures are lower than the global average of 59.81°F, Baltimore's average is much closer. This is probably due to the fact that Baltimore is geographically in a more temperate or average location than Anchorage, Alaska.

11. In the space below create two box and whisker plots for the same data you used in number 3.

(Check student's work)

12. By this time, you should have developed an opinion about the global warming controversy. Either you feel that global warming is a legitimate threat to the future of the planet or that certain groups have greatly exaggerated its potential impact. Imagine that you have been spurred to write a letter to the editor of the Baltimore Sun. In that letter, you will state your position about global warming and defend it with relevant evidence. Use the articles that you read, the graphs you interpreted and created, and your FAN chart as evidence to support your basic views.

In your letter, first establish your central position about global warming. Discuss your major points and provide evidence to defend those points. Then discuss whether or not our lawmakers should legislate more laws to help control global warming. If you contend that global warming is a problem, suggest possible legal solutions. If you believe that global warming is not a valid future concern, suggest what should be done about existing global warming laws and regulations.

Write your rough draft on loose leaf and use the space below for your final draft.

(Answers will vary.)

Annual Average Temperatures

