Climate Change Curriculum

Subject Areas: Science & Social Science
Grade Level: Elementary - Grade 4

Summary

The students will learn about climate change through interactive activities that emphasize questions, discussions, group work, problem solving and research at home. The lesson plan contains five activities, each of which could take 30 minutes to one hour. Most of the activities have homework that the students can do to prepare for the lesson. The activities build on each other and are best done in consecutive order, however all activities can be done exclusively. The lessons are geared towards middle school students that live in Southeastern Arizona, specifically within the Santa Cruz Watershed. The lessons are also meant to increase the awareness of the regional nature of these issues, and therefore the lessons include activities about the U.S.-Mexico border area.

Goal

To explore the concept of climate change and climate variability and examine the social and environmental consequences of climate change.

Objectives

Students will:

- Learn new vocabulary related to climate change
- Distinguish between local climate and weather
- Explore the meaning of average climate data by calculating average temperatures
- Learn about global warming as one example of climate change
- Role play as climatologists to predict future weather patterns
- Think critically about climate adaptations of plants, animals and humans

Arizona Standards Met For Science, Grade 4

Stand 3: Science in Personal and Social Perspectives
Concept 1: Changes in Environment
PO1 – Describe how natural events and human activities have positive and negative impacts on environment (e.g., fire, floods, pollution, dams)
PO2 – Evaluate the consequences of environmental occurrences that happen either rapidly (e.g., fire, flood, tornado) or over a long period of time (e.g., drought, melting ice caps, the greenhouse effect, erosion)
Strand 6: Earth and Space Science
Concept 2: Earth's Processes and Systems
PO6 – Analyze evidence that indicates life and environmental conditions have changed (e.g., tree rings, fish fossils in desert regions, ice cores)
Concept 3: Changes in the Earth and Sky
PO3 – Differentiate between weather and climate as they relate in the southwestern United States
PO6 – Compare weather conditions in various locations (e.g., regions of Arizona, various U.S. cities, coastal vs. interior geographical regions)

Important Vocabulary
(All these terms are defined within the text of the curriculum)

- Climate
- Weather
- Climatic variability
- Paleoclimatology
- Dendrochronology
- Climate change
- Global warming
- Greenhouse gases
- Adaptation

Additional Sources of Information

For teachers

- CLIMAS http://www.ispe.arizona.edu/climas/
- EcoHealth http://ecohealth101.org/
- Global Warming and Climate Change Resources http://www.istl.org/01-fall/internet.html
- U.S. Global Change Research Information Office http://www.gcrio.org/edu/
- University Corporation for Atmospheric Research (UCAR), Introduction to Climate http://www.ucar.edu/learn/1_2_1.htm

For students

- UCAR – Kids Crossing http://www.eo.ucar.edu/kids/green/index.htm
- EPA Global Warming http://www.epa.gov/globalwarming/kids/gw.html

Related Curriculum

- Project WET http://ag.arizona.edu/AZWATER/wet/
- The Santa Cruz River, Its People and Environment (SCRIPE) http://www.sccedu.org/scripe/

Activity 1: What is the Local Climate?

Estimated Time	30 minutes
Homework	Ask the students to research the difference between weather and climate
Materials Needed	Map of Arizona that includes border area

1. Ask the students to describe the climate of Arizona. First ask them what are the seasons in Tucson (or your local area). Write on the board each season (summer, monsoon, fall, winter,

and spring) and then ask the students to describe what the weather is like for each season and write the descriptive words on the board.

2. Then ask the students if the climate is ever different than what they have written for each season. Ask the students to give examples.

3. Ask the students what the difference is between weather and climate. You can explain the difference as follows: **Weather** describes the current conditions of temperature, rain, wind, etc. You determine the weather by looking outside or listening to the news. **Climate** describes the conditions of temperature, rain, wind, etc. over a long period of time in a given area. The climate includes average conditions, regular weather patterns, and infrequent events such as hurricanes or floods.

4. Have a map of Arizona that includes the border area. Point to different places in Arizona and ask the students if the climate is similar or different in these areas than in Tucson. Try pointing to Flagstaff, the Grand Canyon, Phoenix, Nogales, Arizona, and Nogales, Sonora. Ask if the climate is similar across the U.S.-Mexico border. Have the students describe how the climate is similar or different in each place.

Activity 2: What Is Average Climate?

Estimated Time	One hour
Homework	Have the students find the weather report from the previous day. Have them find out the high and low temperature recorded for that day. In addition they should find out what the average high and low temperatures are for that day. They can watch the news, look in the newspaper, or look on the Internet.
Materials Provided	Tucson Climate Data worksheet (p. 9-10)
Materials Needed	calculators

1. To start, discuss the following questions with the students:
   - How do we know what the weather is supposed to be like in the winter, spring, summer, and fall?
   - Is there a pattern to weather in Arizona? How do we know the pattern?
   - What does average temperature mean?

2. Put the students in pairs to figure out how average temperatures are determined. Have them calculate the average high and average low temperature for the 4 different groupings of years given below. Give them a copy of the handout *Tucson Climate Data* (p. 9-10) or write the information on the board from the worksheet. *The data given in the Tucson Climate Data Worksheet is from the National Climate Data Center (http://cdo.ncdc.noaa.gov/CDO/cdo). The data on the worksheet goes up to 2004, so if you would like to supplement with current data, you can find data on the website.

- What is the average high temperature on February 1st in Tucson for the following time periods?
  - 2003-2004 (answer: 69)
  - 2000-2004 (answer: 65.6)
  - 1995-2004 (answer: 66.9)
  - 1975-2004 (answer: 65.6)

- What is the average low temperature on February 1st in Tucson for the following time periods?
  - 2003-2004 (answer: 45.5)
  - 2000-2004 (answer: 39.6)
  - 1995-2004 (answer: 42.1)
  - 1975-2004 (answer: 43.4)

2. Have the groups discuss and write down answers to the following questions (Questions included on handout, or write on the board)
   1) Did the average change with each group of years?
   2) From the high temperatures given over the 30-year period, what are the highest and lowest temperatures? What is the difference between the highest and lowest temperatures? **Answer – (84 & 44) (40).**
   3) From the low temperatures given over the 30-year period, what is the difference between the highest and lowest temperature? **Answer – (56 & 28) (28)**
   4) Which group of years do you think would be the best to use for an average?
   5) Would the average temperature be different in other cities in Arizona such as Phoenix, Flagstaff, or Nogales? Could we use the same average climate data in these cities as Tucson? Why or why not?
   6) Is 30 years enough data to find an average? Would it be better to use temperatures from the last 100 years? Why?

5. Now explain the concept of **climate variability**. Show how this activity illustrates variability within a climate. Within the climate there is a range of possibilities in temperatures, precipitation, wind, humidity, etc. Point out how the high temperatures and low temperatures were different almost every year, and there was a wide range of temperatures.

Extension Activity

1. Explain that weather has only been recorded for about the last 130 years. This is called instrumented data. To determine climate before the time of instrumented data, climate is determined by other methods referred to as **paleoclimatology**. Paleoclimatology is the study of past climates, before recorded climate data.

2. Ask the students to brainstorm how you might figure out climate data before instrumental recordings. After brainstorming, explain the concepts of tree ring data and ice cores. Show them pictures of tree rings and ice cores. The study of past climate through studying tree rings is called **dendrochronology**. There is a lot of dendrochronology work done on the

University of Arizona Tree Ring Lab. Their website is: http://www.ltrr.arizona.edu/. They provide information and activities for students and educators on their website.

Activity 3: What is Climate Change and Global Warming?

*This activity would follow Activity 1 and 2.

Estimated Time	One hour
Homework	Have the students research global warming and the greenhouse effect. Have them bring in two examples of ways greenhouse gases are produced.
Materials Provided	Climate Change & Global Warming worksheet (p. 11-12)

1. Now that the students understand their local climate and the concept of average climate data, have the students explore the concept of changing climate. By now, the students should have a basic understanding of the local climate and the variability of weather in any given climate.

2. Write **climate change** and **global warming** on the board. Ask the students to describe what these terms mean. After some discussion, give the following definitions of climate change and global warming. **Climate change** is when long-term patterns of weather shift. A long-term decrease in temperature, a long-term increase in temperature, or a change in precipitation patterns are all examples of climate change. **Global warming** is one type of climate change characterized by a general warming in the Earth's average temperatures. Scientists agree that the Earth is currently in a state of global warming. Some of the debate about global warming is related to the cause of warming and to what degree humans are causing global warming. One cause of global warming is the increase in **greenhouse gases**. Greenhouse gases, such as carbon dioxide and water vapor, are found in the atmosphere and keep heat waves from escaping the earth. Greenhouse gases exist naturally, however human activities are increasing the amount of greenhouse gases in the atmosphere. The burning of fossil fuels is the largest source of greenhouse gases.

3. Now give the students the handout *Climate Change and Global Warming* (p. 11-12). Have the students read over the handout silently in class.

4. Ask the students the following questions to generate discussion:
   - Is climate change natural, human-caused, or both?
   - Is global warming natural, human-caused, or both?
   - How do humans influence or affect the climate?

5. Talk about greenhouse gases in more detail and about the largest sources of greenhouse gases from humans. Go over the chart for the sources of greenhouse gases that is on the handout.

6. Now read the following case scenario about greenhouse gases to the class.

Crossing the Border…

The towns of Nogales, Arizona and Nogales, Sonora sit on the border between the U.S. and Mexico. There are two main highways that cross the border. At these border crossings, there are a number of security checks. There are security checks for all people, vehicles, and trucks crossing the border. If you have ever crossed the border, you might know that it can take up to 2 hours to cross the border from Mexico into the U.S. There is always a long line of cars sitting at the border with the engines running, just waiting to cross. This is a large source of the carbon dioxide, which is a greenhouse gas! The pollution from cars is very bad for the air quality in the cities on both sides of the border.

5. Now have the students get into small groups to discuss possible solutions to reduce the amount of carbon dioxide emitted at the border. Have them write up three ways to reduce traffic and air pollution at the border crossing. If there's time, have them share one of their solutions with the class.

Activity 4: Predicting Climate Change

Estimated Time	45 minutes
Homework	Have the students research past climates, like the Ice Age, to understand how climates can change over time. Have the students research what factors lead to changes in climate.

1. Explain to the students what climatologists are and how they make predictions for future climates. Climatologists are scientists who study patterns of weather. They often use computer generated models to predict what future climates will be like. Right now, climatologists are working to predict the climate changes due to global warming. Predicting future climates with computer models is very complex and difficult, and the results are debatable. To see some examples of climate predictions, you can look at the Hadley Center online at: http://www.metoffice.com/research/hadleycentre/models/modeldata.html.

2. Students will role-play as climatologists, and make climate change predictions for the future. They will make predictions for their local climate in SE Arizona. Have them break up into small groups and write up their climate predictions. Have them predict temperature, precipitation, and other climatic events like floods, fires, tornadoes, and hurricanes for the following time periods:

   - Predict climate for 25 years from now
   - Predict climate for 50 years from now
   - Predict climate for 100 years from now

- Predict the climate for 500 years from now

It might be helpful to have some of the SE Arizona climate norms written on the board such as average temperature, average precipitation, rainfall patterns, or other weather patterns.

3. After the groups have written up their predictions, have them share one or two predictions with the class.

Activity 5: Adaptations to Changing Climate

Estimated Time	At least one hour
Homework	Have the students write a one page response to the following question: How does climate affect the lives of humans? Pick one example of a change in climate and how it would affect your family.
Materials Provided	Water Connections Worksheet (p. 13)

1. Start this activity with a discussion of how climate affects plants, animals, and people. Explain that the climate will largely determine what type of plants and animals live in a certain area. Ask the students what type of plants live in a desert environment. Explain that climate will often influence what type of livelihoods people will have in the area. For example, the warm weather and many sunny days in the Southwest are ideal for agriculture. However, the farmers are limited by the amount of water - they have to rely heavily on irrigation from river water and ground water.

2. Illustrate how the plants, animals, people, and industry in SE Arizona all rely on water. Hand out the *Water Connections* worksheet (p.13). Explain that the Santa Cruz River is found in SE Arizona, and is a major source of water in this area.

3. Have students discuss the relationships of the plants, animals, people, and industry within the Santa Cruz River Environment. The following questions can guide their discussion:

   - How do the wildlife and plants depend on the Santa Cruz River?
   - How do the ranchers and farmers depend on the Santa Cruz River?
   - How does industry depend on the Santa Cruz River?
   - How do each of these groups depend on the climate?
   - Does changes in the climate affect the Santa Cruz River?
   - What is the relationship between the plants, animals, and people? Do they depend on each other? Are they competing with each other for water?

5. Read the following scenario of climate change and then summarize the climate changes on the board [3 degrees warmer, less winter rain - 9 in/year, less water in Santa Cruz River].

Imagine that over the next 50 years the average temperature increases by 3 degrees Fahrenheit in Southeastern Arizona. Along with the change in temperature, the precipitation changes.

There is less rain in the winter, although the summer rain stays about the same. Overall the yearly average rainfall is 9 inches instead of 14.3 inches. As these hot, dry conditions continue, there is less water going into the Santa Cruz River. These conditions are no longer favorable to some of the plant and animal communities in the surrounding area. What will happen?

4. Have the students break up into small groups and discuss the following questions:
   - Who will be affected first – the plants, animals, or people?
   - What will happen to the plants and animals if there is less water?
   - What can the plants and animals do to survive a change in climate? Can they move to a better climate?
   - What will happen to the farmers and ranchers? Will they be affected by the changes in climate? How? Would they move away?
   - What will happen to the industries? How will industry respond to a shortage of water?
   - Who will the climate change affect more – the plants, animals, or people in each habitat?

5. Discuss the concept of adaptation with the students. **Adaptation** is when a person, animal, or plant changes in some way in response to the climatic conditions. Give some examples of adaptations that could occur in SE Arizona.

6. As a final wrap up question, have each student write a short paragraphs on their opinion of the following question: Do you think it is easier for humans to adapt to climate change or for plants and animals to adapt to climate change? Why?

Tucson Climate Data Worksheet
(University of Arizona Weather Station)

Month/Day/Year	Precip (HI)	Max Temp (F)	Min Temp (F)
2/1/1975	0	63	40
2/1/1976	0	78	42
2/1/1977	0	70	39
2/1/1978	30	67	51
2/1/1979	1	61	42
2/1/1980	0	74	53
2/1/1981	0	58	36
2/1/1982	0	58	38
2/1/1983	0	58	39
2/1/1984	0	73	50
2/1/1985	0	44	28
2/1/1986	28	64	55
2/1/1987	0	68	42
2/1/1988	0	62	47
2/1/1989	0	70	54
2/1/1990	0	54	41
2/1/1991	0	77	51
2/1/1992	0	74	56
2/1/1993	0	65	43
2/1/1994	0	60	33
2/1/1995	0	77	44
2/1/1996	15	63	52
2/1/1997	0	73	45
2/1/1998	0	64	43
2/1/1999	0	64	39
2/1/2000	0	65	41
2/1/2001	0	61	35
2/1/2002	0	64	31
2/1/2003	0	84	49
2/1/2004	0	54	42

Data from the National Climate Data Center (http://cdo.ncdc.noaa.gov/CDO/cdo)

Activity Questions

1) Did the average change with each group of years?

2) From the high temperatures given over the 30-year period, what are the highest and lowest temperatures? What is the difference between the highest and lowest temperatures?

3) From the low temperatures given over the 30-year period, what is the difference between the highest and lowest temperature?

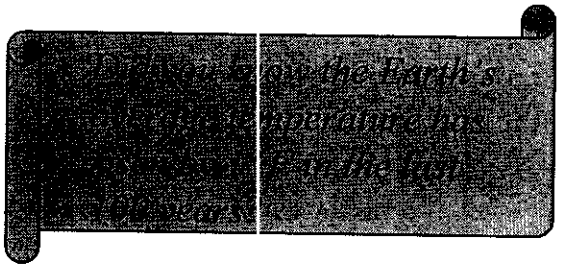
4) Which group of years do you think would be the best to use for an average? Why?

5) Would the average temperature be different in other cities in Arizona such as Phoenix, Flagstaff, or Nogales? Could we use the same average climate data in these cities as Tucson? Why or why not?

6) Is 30 years enough data to find an average? Would it be better to use temperatures from the last 100 years? Why?

Climate Change and Global Warming

Climate change is an important issue that concerns people all around the world!



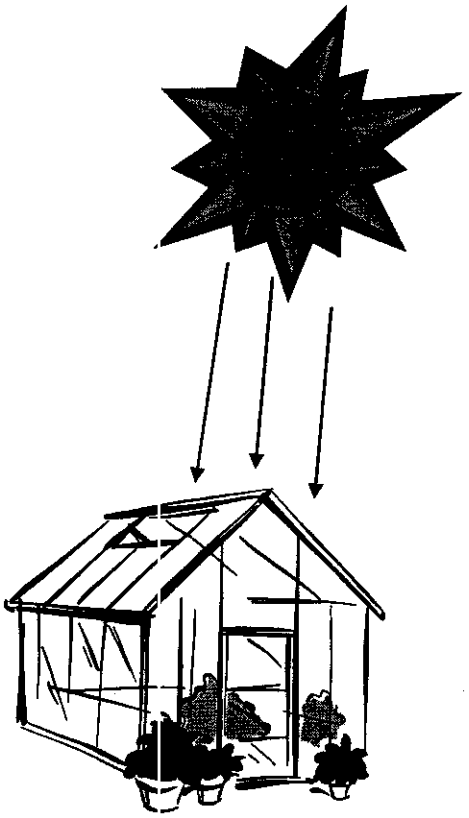
Definitions

Climate Change:
Shifts in long-term patterns of weather.

Global Warming:
One type of climate change characterized by a general warming trend in the Earth's average temperatures.

Greenhouse Gases:
Gases in the atmosphere that reflect heat waves back to the Earth. Some greenhouse gases are carbon dioxide, methane, nitrous oxide, and water vapor.

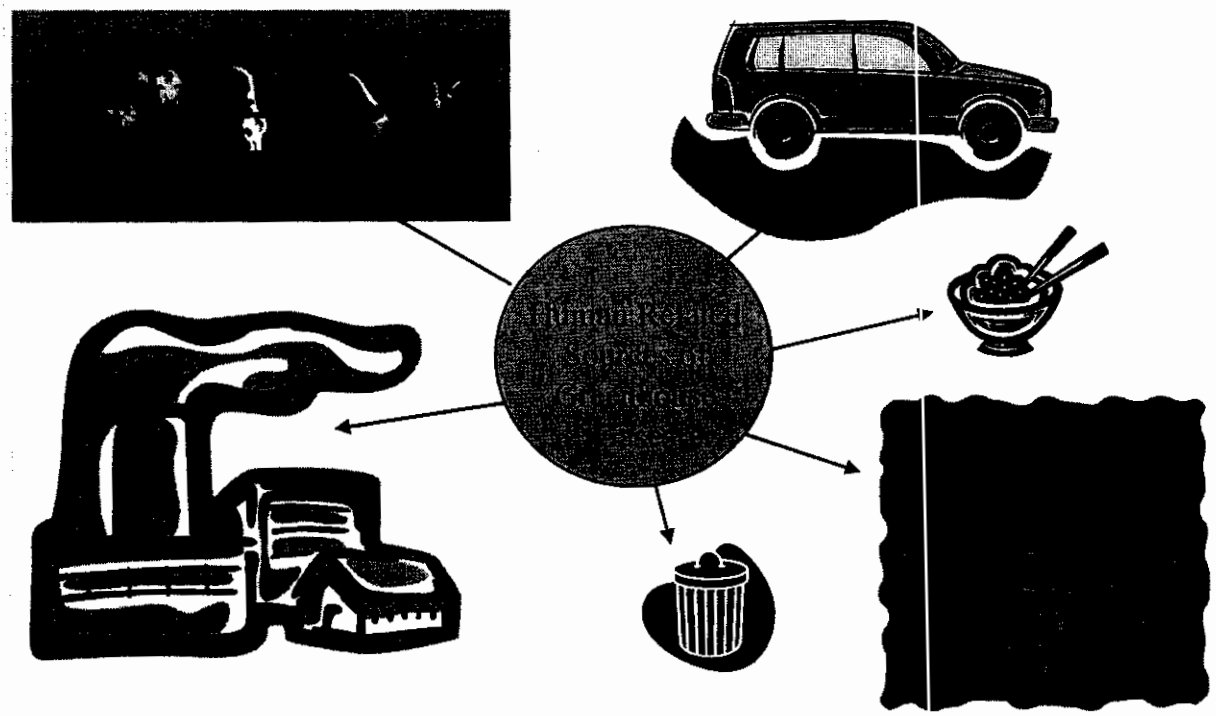
Greenhouse Effect:
A natural process that traps heat on the Earth's surface. Heat waves from the sun enter the Earth's atmosphere and are either absorbed by the Earth's surface or reflected back to the atmosphere. Greenhouse gases in the atmosphere prevent reflected heat waves from leaving the atmosphere and therefore keep the Earth warm. Think about how the sun heats a greenhouse - it's the same thing! The glass on the greenhouse allows the sun's rays to enter the building but prevents reflected rays from leaving.



Question and Answer

How do humans add to global warming?

Humans add to global warming through the production of greenhouse gases such as carbon dioxide. Carbon dioxide is the largest human source of greenhouse gases. Carbon dioxide comes from the burning of fossil fuels (to fuel cars, heat homes, and power factories) and deforestation. Methane is the second largest source of greenhouse gases and comes from domesticated animals (such as cows), rice cultivation, and from human waste and garbage.



If the climate is always changing, why are people concerned about climate change and global warming?

There is concern about climate change because scientists are realizing that humans are contributing to climate change through the addition of greenhouse gases. Global warming will lead to many environmental changes that will impact human populations. Some changes that are already seen as a result of global warming are the melting of glaciers, rising sea levels, and changing plant communities. Scientists want to know more about what the future changes will be and how they can best adapt to those changes.