

## ED 5641 - Global Change Teaching Unit (August 2006)

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### Unit Overview

This five-day unit will add new information and hands-on activities to my current environmental science unit on *Air, Atmosphere & Climate* in order to emphasize global warming. Students will learn in greater detail about the factors that scientists believe contribute to global warming; carbon dioxide, methane gas, and other pollutants. Students will learn how their actions contribute to these factors and how to reduce their use of energy in order to reduce the carbon dioxide emissions which they are responsible for. Students will also learn about other interactions that affect the level of carbon dioxide in our air, like carbon sinks. Students will be introduced to the Michigan Technological University's Aspen FACE Research and the information that has been gathered through this project. Students will also learn how to find information from the U.S. Environmental Protection Agency website and how to find information about Ozone from the Airnow website.

### References & Sources Consulted

U.S. Environmental Protection Agency's Climate Change, Wildlife, and Wildlands: A Toolkit for Teachers and Interpreters. I will use the 11 minute video, the Power Point presentation, and Climate Change & BIRDS pamphlet. (There is an 800 phone number on the CD for ordering pamphlets).

U.S. Environmental Protection Agency Global Warming website: [www.epa.gov/globalwarming/](http://www.epa.gov/globalwarming/)

U.S. Environmental Protection Agency Global Warming Wheel Card Classroom Activity Kit

Power Point Presentation from Global Change class CD: Introduction to Elevated CO<sub>2</sub> and Ozone  
Bill Holmes, School of Natural Resources & Environment, Univ. of Michigan

Michigan Technological University. Aspen FACE Research Site: <http://aspenface.mtu.edu/>

U.S. Environmental Protection Agency Ozone website: [www.epa.gov/airnow/](http://www.epa.gov/airnow/)

### Teaching & Learning Objectives

*Students will be able to:*

1. Formulate questions that can be investigated using: testing, measuring, data gathering, observing, and acquiring verifiable information. Investigate and evaluate background information when forming their questions.
2. Find, collect, organize, and interpret information that they gather from scientific journals, books, other resources and computer reference materials.
3. Recognize the human origins of scientific knowledge, the particular rules and values of scientific communities, and the strengths and limitations of scientific and technological knowledge.
4. Identify the components of the natural world surrounding them and assess how they interact with the natural world, not just the man-made world.
5. Recognize weaknesses in arguments that are presented as scientific.
6. Describe how changes within the environment select for survival and reproduction of certain individuals.
7. Predict how specific changes within the environment may increase/decrease a population's size and analyze how specific human activities may affect population sizes.
8. Show how external events, natural or man-made, can cause an ecosystem to change in many ways.

9. Give examples of how their daily activities can both positively and negatively affect air quality; and identify how their decisions impact air quality.

### **Michigan Content Benchmarks Addressed**

#### I. Construct new scientific and personal knowledge.

1. H.S. 1: Ask questions that can be investigated empirically.
1. H.S. 4: Gather and synthesize information from books and other sources of information.

#### II. Reflect on the nature, adequacy, and connections across scientific knowledge

1. H.S. 1: Justify plans or explanations on a theoretical or empirical basis.
1. H.S. 2: Describe some general limitations of scientific knowledge.
1. H.S. 6: Develop an awareness of and sensitivity to the natural world.

#### III. Use scientific knowledge from the life sciences in real-world contexts

4. H.S. 2: Explain how a new species or variety may originate through the evolutionary process of natural selection.
5. H.S. 3: Describe general factors regulating population size in ecosystems.
5. H.S. 4: Describe responses of an ecosystem to events that cause it to change.

#### V. Use scientific knowledge from the Earth and space sciences in real-world contexts

3. H.S. 4: Explain the impact of human activities on the atmosphere and explain ways that individuals and society can reduce pollution.

### **Classroom or Field Activities**

#### Day 1:

Students will be introduced to Climate Change through the Climate Change, Wildlife, and Wildlands Video. Students will observe the Climate Change, Wildlife, and Wildlands Power Point presentation narrated by the teacher, filling out the student worksheet (Climate Change, Wildlife & Wildlands Guided Note Worksheet for Power Point Presentation) of important points.

#### Day 2:

Students will work in the computer lab. They will investigate the EPA Global Warming website, using their student worksheet, What Does the EPA Say About Global Warming?. Send home the student introduction sheets on the Greenhouse Effect and Carbon Dioxide to read before Day 3.

#### Day 3:

Students will be given a short review of Global Warming and Carbon Dioxide. In groups of three, students will use the Global Warming Wheel Card provided for Activity #1 and #2 (from the EPA Global Warming Wheel Card Classroom Activity Kit). Students will take home the homework activity #3 (from the previously mentioned Kit) to gather the needed information. Students will complete the homework activity #3 in class the next day.

#### Day 4:

Students will return to their groups to complete their homework assignment, homework activity #3. Students will then observe the power point presentation on the FACE site with some introduction from the website. Students will complete their worksheet, The Aspen FACE Experiment Note taking guide for Power Point Presentation, during the power point presentation. Students will finish the period discussing The Climate Change and Birds EPA pamphlet (this can be printed from the CD if you don't order them) in groups of four.

#### Day 5:

Students will work in the computer lab with the [www.epa.gov/airnow/](http://www.epa.gov/airnow/) website with their worksheet guide, Ozone Group Work.

## **Teacher Prep for 5-Day Unit:**

Day 1: Play video as an introduction to climate change.

From the CD, print out the script to the power point, read script during power point presentation.  
Pass out worksheet before beginning the presentation.

Day 2: Sign up for computer lab. Hand out “What does the EPA say about Global Warming?” worksheet in lab. Circulate to observe and give help.

Day 3: EPA Global Warming Wheel Card Classroom Activity Kit

This is a great little kit – and can be used directly with very little “tweaking”.  
Teacher directions.

Print out on a color copier Wheel Card sheets from:

[www.epa.gov/globalwarming/publications/outreach/wildlife.html](http://www.epa.gov/globalwarming/publications/outreach/wildlife.html).

Review the Teacher Introduction sheet – for your own knowledge.

Copy the Student Introduction sheets for students to take home and read before Day 3.

Copy the Student Activity sheets for #1 and #2 and the homework #1 sheet.

Instruct students that they do not have to make the wheel cards, they will simply use them to complete the activity worksheets. They will work in groups of 3.

They will take home the homework sheet to collect the appropriate information (with parental initials to prove parental involvement) and return to class on Day 4 to use the Wheel Cards in groups to finish their homework. (Circulate among the groups to check that information was collected at home and initialed)

Day 4: Intro this with the Research Questions from website: <http://aspenface.mtu.edu>

Use FACE Power Point presentation from class CD. (Once I see the class CD, I might revise the student worksheet.)

Pass out “Climate Change and BIRDS” (you may order these from the EPA or  
Print them from the Climate Change, Wildlife and Wildlands CD).

Have students discuss in groups of four their reactions to the pamphlet. You might want to prompt students by asking them “What can you do?”.

Day 5: Sign up for computer lab. Hand out “Ozone group work” worksheet in lab.

Circulate to observe and help. This activity was developed in class by our group.

## Globe Project Design

### Scientific Method Student Activity: Lesson Plan

1. **Essential Question:** *How does Lake Michigan affect ozone formation?*
2. **Hypothesis:** Student generated as a statement. Key concepts should include Lake Michigan, VOCs, NO<sub>x</sub>, sunlight and wind direction leading to increased ozone formation.
3. **Explains the study design to test the hypothesis:**
  - Prior knowledge base from Pollution Lecture the day before.
  - Students gather background information on ozone.
  - Students record and analyze data from June, July and August 2003, 2004 and 2005.
  - Students draw conclusions about ozone formation over Lake Michigan.
  - Students will predict past and future weather patterns and ozone related formation over Michigan.

#### 4. **Body of Existing Knowledge**

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[www.epa.gov/airnow/](http://www.epa.gov/airnow/)

[www.deq.state.mi.us/aqi](http://www.deq.state.mi.us/aqi)

[www.scorecard.org](http://www.scorecard.org)

[www.scilinks.org](http://www.scilinks.org)

[www.crh.noaa.gov/dtx/images/DTW\\_JUN2003.png](http://www.crh.noaa.gov/dtx/images/DTW_JUN2003.png)

#### 5. **Data collection: Ozone Formation.**

- Students collect ozone formation data from above listed web pages.
- Relevant scale provided by [www.airnow.com](http://www.airnow.com).
- Long term data provided by [www.airnow.com](http://www.airnow.com).
- Other data information provided by above web sights.

#### 6. **Data analysis and conclusions: Ozone Formation**

- Students graph temperature and peak ozone levels for June, 2003.
- Students will use ozone data from [www.airnow.com](http://www.airnow.com) and graph generated from data to draw conclusions regarding ozone formation over Lake Michigan.
- Students should draw relevant conclusions regarding pollution, air currents, heat/sunlight and ozone formation over Lake Michigan.

#### 7. **Organization:**

- Day 1: Lecture topic Pollution and movie clip.
- Day 2: Computer Lab activity with [www.airnow.com](http://www.airnow.com) database and web sights from Day 1 lecture. Homework assignment: Graphing exercise.

### **Overall Unit Assessment**

I collect notebooks at the end of each unit, any assignments that are not collected and graded during the unit are checked at this time. Of the work assigned in the above five days, I would only collect the Day 2 computer worksheets and the Day 5 computer worksheets to grade individually. The other worksheets would be graded as a part of the notebook grade. I would also add a short essay section to their unit test to cover these addition activities.

### **Revised Overall Unit Assessment**

I collect notebooks at the end of each unit; any assignments that are not collected and graded during the unit are checked at this time. Of the work assigned in the above five day plan, I would only collect the:

Day 2 computer worksheets	20 pts
Day 3 EPA Global Warming Worksheets (Act. #1, #2, & the Homework #3 – 10 pts ea.)	30 pts
Day 5 Ozone Group Work worksheets	20 pts

The other worksheets would be graded as a part of the unit notebook grade (50 pts).

I would also add a short essay section to their unit test to cover these additional activities.

### **Essay Test Questions (5 pts each – making up 25% of the test score)**

1. What is global warming? Explain whether we should be concerned and support your answer. What can be done about it? (this is too much like #3 – so delete this part of the question)
2. How might global warming affect Michigan?
3. How can you lessen your impact on global warming?
4. What is unique about the FACE experiment? Give one of their findings.
5. What is the difference between good ozone and bad ozone? How can we create less bad ozone?

### **Essay Questions - CORRECT RESPONSES** (these come from the worksheet answers)

1. Global warming is an increase in the earth's average temperature. (2pts) We should be concerned about it because even though we don't know exactly what will happen, scientists have a pretty good idea of what's to come: sea level will continue to rise, human health problems will increase, habitat changes will likely cause extinctions, changing weather patterns could affect agriculture and other natural habitat. (any three results for 1 pt each)
2. It has already increased the average temperature by one degree Fahrenheit in Ann Arbor, Michigan. It has also been projected that by 2100, temperatures in Michigan could increase by about 4° F in all seasons. Precipitation is projected to increase by 5-15% in winter, spring, and fall, and by around 20% (with a range of 10-40%) in summer. (5 points for a complete answer, 4 points for answers with close numbers, 3-1 points for incomplete answers.)
3. Anyone and everyone can help by any or all of the following; recycle, walk more, plant trees, be informed, conserve energy, try alternative energy sources, and encourage others to do like wise. (1 pt for any five ways to help).
4. It has an open-air control of atmosphere conditions, it is on a fairly large scale, it is long term, it has received major investments, and it is able to be used my large terms of researchers. Students may list any of the research findings from their note worksheet. (3 pts for unique aspects, 2 pts for a finding).
5. Good ozone is located in the upper atmosphere and blocks harmful UV rays. (2pts) Bad ozone is located in our lower atmosphere, ground level, and is created when man made pollutants react chemically in the presence of sunlight. (2 pts) We create less bad ozone, but creating less pollution. (1pt)

**Climate Change, Wildlife & Wildlands**  
**Guided Note Taking Worksheet for Power Point Presentation on Day 1**

1. Climate vs. Weather – What is the difference?
2. How does \_\_\_\_\_ part of the cryosphere, affect the climate?
3. How does the biosphere affect the climate?
4. How do people affect the climate?
5. Do we need our “greenhouse effect”? \_\_\_\_\_ Why?
6. Give a natural source of carbon dioxide and an unnatural source of carbon dioxide.  
\_\_\_\_\_
7. What is a carbon sink and give an example.
8. Give a natural source of methane. \_\_\_\_\_
9. But, what accounts for 65% of methane? \_\_\_\_\_
10. What makes up the largest part of the 1996 Total U.S. Greenhouse Gas Emissions pie chart?  
\_\_\_\_\_ Where does this part come from? \_\_\_\_\_
11. What do we mean by “global warming”?
12. How much has our global temperature increased in the last century? \_\_\_\_\_
13. How many scientists are involved with the IPCC? \_\_\_\_\_
14. What did they conclude in their 1995 report?
15. Based on computer climate models, how much more will our global temperature increase in the next 100 years? \_\_\_\_\_
16. What kinds of instruments and/or what ways do we use to measure the Earth’s temperature?

17. Could global warming affect El Nino or La Nina events? \_\_\_\_\_

18. Could we see more extreme weather events due to global warming? \_\_\_\_\_

19. What human activities contribute to greenhouse gases?

20. Should we really worry about this?? \_\_\_\_\_ Why?

21. What can **you** do about global warming?

## WHAT DOES THE EPA SAY ABOUT GLOBAL WARMING?

Use with [www.epa.gov/globalwarming/](http://www.epa.gov/globalwarming/) - Day 2

### Directions:

Go to: [www.epa.gov/globalwarming/](http://www.epa.gov/globalwarming/) . Click on “climate” and complete the following statements:

1. Most of the global warming over the past 50 years is attributable to \_\_\_\_\_ and \_\_\_\_\_.
2. Since the beginning of the industrial revolution, atmospheric concentrations of carbon dioxide have increased nearly \_\_\_\_\_%, methane concentrations have more than \_\_\_\_\_, and nitrous oxide concentrations have risen by about \_\_\_\_\_%.
3. Fossil fuels burned to run cars and trucks, heat homes and businesses, and power factories are responsible for about \_\_\_\_\_% of U.S. carbon dioxide emissions, \_\_\_\_\_% of methane emissions, \_\_\_\_\_% of nitrous oxide emissions.
4. The 20<sup>th</sup> century’s 10 warmest years all occurred in the last \_\_\_\_\_ years of the century.
5. Scientists expect that the average global surface temperature could rise \_\_\_\_\_ in the next 50 years, and \_\_\_\_\_ in the next century, with significant regional variation.

### In the right hand column click on “uncertainties”

6. Give a summary statement for each of the subtitles:
  - a. What’s known for certain?
  - b. What’s likely but not certain?
  - c. What are the big unknowns?
  - d. Living with Uncertainty

**Click “back” twice to get to the home page – then click on “educators” (gray box)**

Click on one of the choices and check out the information for just a couple of minutes.

**Click “back” to home page, click “US”, click on Michigan on the map, click on “Climate Change in Michigan”**

Read and answer the following questions or complete the following statements:

7. Over the past century, the average temperature in Ann Arbor, Michigan, has

\_\_\_\_\_.

8. Based on the projections given by the IPCC, Intergovernmental Panel on Climate Change, and the HadCM2 (climate model), it is projected that by 2100, temperatures in Michigan could increase by about \_\_\_\_\_ in all seasons. Precipitation is projected to increase by \_\_\_\_\_ in winter, spring, and fall, and by around \_\_\_\_\_ in summer.

9. Global climate change poses risks to \_\_\_\_\_ and to \_\_\_\_\_ and \_\_\_\_\_ ecosystems. Similar temperature changes have occurred in the past, but the previous changes took place over \_\_\_\_\_ or \_\_\_\_\_ instead of \_\_\_\_\_.

10. List five human health risks:

- i.
- ii.
- iii.
- iv.
- v.

11. How will forests be affected?

12. How will water resources be affected?

13. How will agriculture be affected?

14. How will our freshwater ecosystems be affected?

**The Aspen FACE Experiment**  
Note-taking Guide for Power Point Presentation – Day 4

**Some of the questions that The Aspen FACE Experiment has been designed to address are:**

- ◆ Will more or less CO<sub>2</sub> be sequestered by forest trees as CO<sub>2</sub> levels rise?
- ◆ Will elevated CO<sub>2</sub> alleviate other stresses (e.g. ozone, drought, low fertility)?
- ◆ Will our forests become more or less productive over time under elevated CO<sub>2</sub>?
- ◆ How will elevated CO<sub>2</sub> affect insect and disease interactions with trees?
- ◆ How do CO<sub>2</sub> and the greenhouse gas ozone interact?

**1. What is unique about the FACE Experiments?**

- \_\_\_\_\_ control of atmosphere conditions
- Fairly \_\_\_\_\_ scale
- \_\_\_\_\_ than previous chamber experiments
- Major investment of research money
- \_\_\_\_\_ teams of researchers

**2. Describe the effects of increased CO<sub>2</sub> and Ozone on Trees**

Effects of elevated CO<sub>2</sub>:

Effects of elevated Ozone (O<sub>3</sub>):

## Research Findings I

Tree growth \_\_\_\_\_ under elevated CO<sub>2</sub> and \_\_\_\_\_ under O<sub>3</sub> in Aspen (not Birch)

O<sub>3</sub> \_\_\_\_\_ to protective coating of leaves \_\_\_\_\_ resistance to insects.

CO<sub>2</sub> \_\_\_\_\_ the damaging effects of O<sub>3</sub>, but O<sub>3</sub> counteracts \_\_\_\_\_  
by CO<sub>2</sub>

## Research Findings II

O<sub>3</sub> \_\_\_\_\_ most CO<sub>2</sub> induced enhancements in ecosystem processes.

Elevated CO<sub>2</sub> \_\_\_\_\_ normal autumn leaf senescence, predisposing some trees to

\_\_\_\_\_

Aspen and Birch insects and diseases \_\_\_\_\_ under elevated CO<sub>2</sub> and O<sub>3</sub>

## Ozone Group Work

**Question.** *Do you think Western Michigan has an ozone problem?*

**Your Group's Hypothesis:**

### Instructions

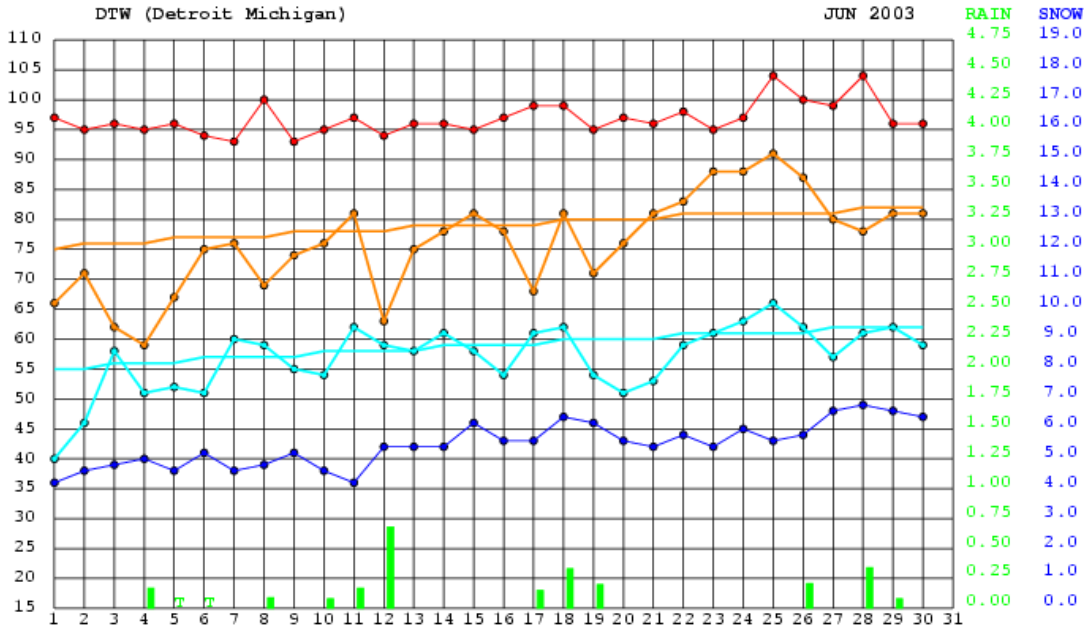
1. Go to [www.epa.gov/airnow/](http://www.epa.gov/airnow/)
2. In the far right corner choose Ozone found under Air Quality Basics.
3. Read about good and bad ozone.
4. Answer these questions.
  - a. Where is the good ozone located and what is its function?
  
  - b. What depletes the good ozone?
  
  - c. Where is the bad ozone located and what creates it?
  
  - d. List three health problems associated with bad ozone? (hint you may need to go to *Ozone and your health* found lower on that page then choose *How can ground-level ozone affect your health*)
    - i.
  
    - ii.
  
    - iii.
5. Scroll down to the Air Quality Index color chart. Write down a one-word descriptor of each color code (I've given the one for green 😊)  
Green= good  
Yellow=  
Orange=  
Red=  
Purple=
6. After answering this question go back to Air Now [www.epa.gov/airnow/](http://www.epa.gov/airnow/) home page. In the far left corner choose *Ozone*, and then choose *Ozone Now* found under *National overview*.  
Answer the following question.  
What is the current ozone reading for our area? \_\_\_\_\_ (Use color code on right side)

## Data Collection

7. Choose *Map Archives* found on the lower right.
8. Click on map of Michigan, chose Month *June* Year *2003* and region *Midwest* click *ozone* box (the days of the month may take a moment to load)
9. Click on the 23<sup>rd</sup>. The top map will indicate the time of day and the progression of ozone forming in the Midwest.
  - a. Where are the worst areas?
  - b. Are we one of them?
  - c. What time of day seems to be the worst?
  - d. If the major pollutants were formed in Gary and Chicago, infer which way the wind was blowing.
  - e. List three factors that you believe influence bad ozone formation?
    - i.
    - ii.
    - iii.
10. Click *back*, you should now be looking at the month of June again. Note bad ozone trends during this month; list the peak ozone level for each day.
11. Create line graph of the peak ozone level and daily high temperatures (temperature data supplied on next page) for the month of June, 2003.
12. Respond to the following questions.
  - a. What is the formula or equation for ozone formation?
  - b. Why do you think the ozone levels increase over Lake Michigan?
  - c. Review ozone data for July & August 2003, 2004 and 2005. Speculate on the weather conditions in the summer of 2004 and 2005

2004:

2005:



TEMPERATURE AND PRECIPITATION DATA

Average High.....76.2	Monthly Normal.....79.0	Average Low.....57.0	Monthly Normal.....58.9
Average for Month...66.6	Monthly Normal.....69.0	Monthly HDD.....48	Monthly Normal HDD..41
Monthly CDD.....104	Monthly Normal CDD..145		
Monthly Precip.....2.50	Monthly Normal.....3.55	Yearly Norm Precip..15.96	
Monthly Snow.....0.0	Monthly Norm Snow...0	Yearly Norm Snow....	

GRAPH KEY	Record High Temp	Mean High Temp	Mean Low Temp
	Daily High Temp	Daily Low Temp	Record Low Temp