

Air Quality & Climate Change

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Unit Overview

The theme of this unit is *Air Quality: Human Impacts and Ecological Implications*. The students will explore a variety of air quality issues that are created by mans actives and how they impact the biosphere. My current unity consists of how pollution is formed. I intend to expand this unit so that it can be used in my biology and ecology classes for the benchmark on mans activities and air quality, chemistry for qualitative analysis.

Sources Consulted

Gore, Al. *An Inconvenient Truth*. Emmaus, PA. Rodale Publishing. (2006)

Michigan Environmental Education Curriculum Support. *Air Quality*. Michigan Department of Environmental Quality pg 192, 213, 214 (1998)

The Day after Tomorrow. Dir./Co writer Roland Emmerich and Producer Mark Gordon Perf. Dennis Quad, Jake Gyllehaal, Ian Holm, Emmy Rossum, Sella Ward. 20th Century Fox, 2004

Alley, Richard B. “Climate Change” *Scientific American*. Nov. 2004: 62-69.

Excerpts from Power Points :

Holmes, Bill. “Introduction to Elevated CO₂ and Ozone”. Global Change Teacher Institute. MTU. 20, July. 2006

Burton, Andrew “Effects of Temperature and Moisture.” Global Change Teacher Institute. MTU. 20, July. 2006

Burton, Andrew “ Acid Rain, Nitrogen Deposition and Nitrogen Saturation.” Global Change Teacher Institute. MTU. 18, July. 2006

Bradley, Dr. Kate. “An Introduction to Global Change.” Global Change Teacher Institute. MTU. 18, July. 2006

The following web pages provide information for student research:

<www.epa.gov/airnow/> U.S. Government Web site. Used for computer lab activity. See Handout

<www.deq.state.mi.us/aqi/> Michigan Air Quality Conditions web page to access Michigan’s air quality

<www.crh.noaa.gov/dtx/images/DTW_JUN2003.png> Graph of June 2003 Detroit weather conditions used in conjunction with Air Now handout.

Michigan Curriculum Framework & Benchmarks

The benchmarks addressed in this unit are:

- SCI.1.1.HS.1-5 Construct new scientific and personal knowledge
- SCI.II.1.HS1-7 Nature, adequacy and connections across scientific knowledge.
- SCI.III.5.HS.1-6 Ecological relationships between species and environments.
- SCI.V.2.HS.2 Human activities and impacts on Air, soil and water quality
- SCI.V.3.HS.4 Explain the impact of human activities on the atmosphere and explain ways that individuals and society can reduce pollution.

Teaching and Learning Objectives

At the completion of this unit, the learner will be able to:

1. Explain how the combustion of fossil fuels leads to the formation of air pollutants SO_x, NO_x, CO₂ and O₃.
2. Describe the Jet Stream and seasonal wind patterns in the Midwest to the formation of Acid Rain and Ozone in Western Michigan.
3. Design and experiment to test the effects of Acid Rain and Ozone on local flora and fauna.
4. Draw conclusions and hypothesize long-term impacts of Acid Rain and Ozone formation on ecological relationships
5. Investigate alternative methods of energy production as a means of address global climate change, and describe their potential impacts and economic feasibility.

Assessments

1. Answers all Section Reviews in Lecture Note Pack with complete sentences, thoughts, and accuracy. (20pts)
2. Field work and computer labs (30pts)
3. Written Assessment (50pts)

Globe Project: Acid Rain

Day 1.

- Lecture on Acid Rain formation (30 min) followed by student construction of collection devices (30min).
- Students will be divided into 6 groups of four. Each group will construct three collection devices and label: *open area*, *pine canopy* and *hardwood canopy*.

Day 2.

- Students will generate a question and hypothesis regarding the influence of canopy on the pH of rainfall. (20minutes)
- Students will place collection devices in designated location per label. (40min)

Day 3.

- Students will test pH of their three samples and record on the class data table projected on white board.
- Students will create a class data table.
- Students will calculate the average pH of each location (open, pine & hardwood).
- Students will create a bar graph illustrating the average of each location.
- Students will write a conclusion paragraph (minimum 10 sentences) including refuting or supporting their original hypothesis, discuss possible sources of error and suggest possible improvements on experimental design.
- Students will predict the impacts of acid rain on soil minerals and the biotic community.
- Students will predict the impacts of acid rain on water quality and the biotic community

Globe Project: Ozone/Global Warming

Day 4

Lecture: *Ozone Formation*. Review wind patterns (20 minutes). Students create a homemade Ozone detector; write an essential question about local ozone levels and a hypothesis (40min)

Day 5

Air Now computer lab activity. Instructions on handout

Day 6

Milkweed monitoring: Divide students into 6 groups. Each group monitors a designated location in the school field. Students count the # of milkweed plants and note the # of plants with ozone damage and the location of the damage on the plant.

Day 7

Excerpts from Power Points Global Change Teacher Institute

Day 8

Movie “Day After Tomorrow” followed by guided readings from Scientific American and worksheet

Day 9

Learning assessment.

Names _____

Date _____

Ozone Group Work – Student Page

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

Your Hypothesis:

Procedure for background information:

1. Go to 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. What are some (at least three) of the 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*)

1

2

3

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=

After answering this question go back air now home page (found on top)

5. In the far left corner choose *Ozone*, then chose *Ozone Now* found under *National overview*
What is the current ozone reading for our area? _____ (Use color code on right side)

Data Collection

6. Choose *Map Archives* found on the lower right
7. 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)
8. Click on the 23rd. 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 I told you that the major pollutants were formed in Gary and Chicago, infer which way the wind was blowing.
 - e. List three factors that you believe to influence bad ozone formation?
 - 1.
 - 2.
 - 3.
9. Click *back*, you should now be looking at the month of June again. Note bad ozone trends during this month.
10. Create line graph of the peak ozone level and daily high temperatures (data supplied) for the month of June 2003.

Conclusion:

What is the formula for ozone formation?

Why do you think the ozone levels increase over Lake Michigan?

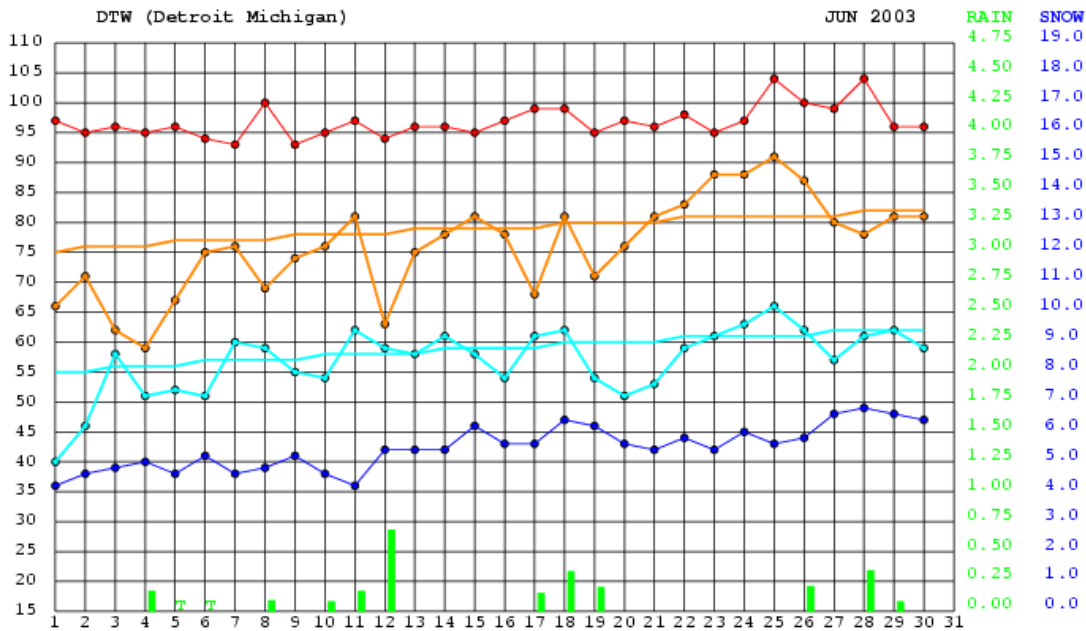
Review your original hypothesis. What changes would you make in your statement?

Review 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

Above is data obtained from June 2003. Note the rainfall (bar graph) on the lower part of the graph.

- Predict the amount of cloud cover days 1 through 20.
- Predict the amount of cloud cover days 20 through 25.
- How do you think cloud cover impacts ozone formation?
- Predict the relative ozone activity for the record highs recorded. Do you think they all occurred in the same month?
- If global temperatures do rise by 5 degrees how would that impact our ozone formation? What would be two factors that could keep the ozone levels lower?
- Create a graph of daily temperatures and ozone levels for the month of June 2003. Please be sure to include a Title, key, X and Y axis with labels and units ☺

Acid Rain Evaluation – Student Page

The normal pH of rainfall is approximately _____

Question: How does air quality affect the pH of rain?

Hypothesis: Student generated

Question: Does the canopy of various tree species affect the pH of rainfall?

Hypothesis: Student generated

Procedure:

Construct the collection device. Insert a large plastic funnel into the one holed stopper; insert the stopper into the mouth of the collection jug so that it is secure. Label the collect jug with your group # and name and OPEN, repeat this procedure for the PINE and Deciduous locations

Class Data Table

Locations

Groups	OPEN pH	Pine Canopy pH	Deciduous Canopy pH
#1			
#2			
#3			
#4			
#5			
#6			
Class Average			

Create a bar graph illustrating normal rain pH, our Open, Pine and Deciduous rain pH.

Questions. (May be answered on the back of this handout)

1. How did the open pH compare with the predicted pH of rainfall?
2. What factors might affect the pH of rainfall in West Michigan?
3. Explain why you think the pH of the Adirondacks; a pristine forest area in northern NY has pH rainfalls below 5.
4. Predict the rise or fall of pH in Western Michigan in the winter and summer based on your knowledge of seasonal wind patterns.
5. Predict the implications of acid rain on soil nutrient availability and biotic sustainability.
6. Predict the implications of acid rain on water quality and the impact on biotic organisms.
7. Review and rewrite your hypothesis to reflect your understanding of the data collected.

Milkweed Monitoring of Ozone Damage – Student Page

Question: What effect does ozone have on milkweed plants?

Hypothesis: Student generated

Procedure

1. Divide into 6 groups.
2. With a measuring tape mark off 50ft along the west parking lot along Seminole Road. This is your plot length; the depth is from Seminole Rd edge to the parking lot asphalt.
3. Each group counts the number of milkweed plants noted, the number of plants with ozone damage and description of the damage. Refer to your handout with the picture of ozone-damaged milkweed.

Data Table

Groups	Total # of Milkweed plants noted	Total # of plants with Ozone damage	General location and description of noted ozone damage
#1			
#2			
#3			
#4			
#5			
#6			

Based on the class data do the milkweed plants in front of the west lot show significant ozone damage? (What do you think is *significant*?)

Discuss how ozone causes damage to living things.

What can you do to protect yourself from ozone damage?

What can **you** do to prevent further ozone formation?

Lecture Note Packet: AIR & Climate

Teacher Lecture Notes

Student Lecture Notes

What Causes Air Pollution?

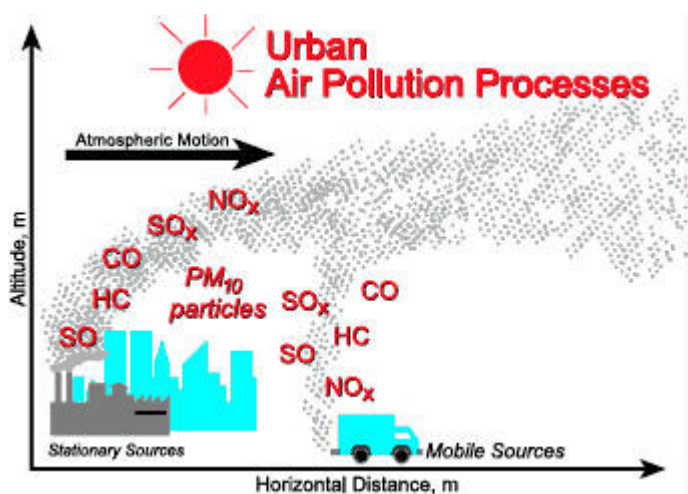
www.epa.gov/airnow/

www.deq.state.mi.us/aqi

www.scorecard.org

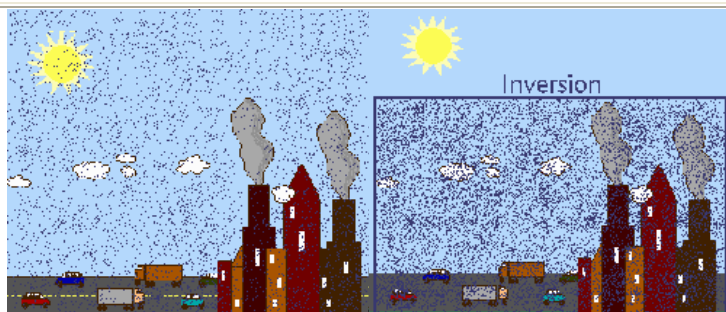
Clean air: 76% nitrogen, 21% oxygen, 1% argon, carbon dioxide and water vapor.

Pollution. Most from human activities, some from nature. *Primary* pollutant put directly into the air (CO_2 , NO_n , SO_n), *secondary* pollutants formed from primary pollutants reacting with other substances in the air (Acid rain, O_3). Most air pollution in urban areas comes from cars and industry. 1273 England first "Clean Air Act"



Clean Air Act-1970 gives EPA regulatory of auto emissions. No lead gas caused 78% drop in lead air pollution 1988-95. Catalytic converters decrease sulfur compounds. Industry burn fossil fuels releasing carbon dioxide, sulfur dioxide and nitrogen oxides, VOC's (solvents). Scrubbers and electrostatic precipitators.

Thermal Inversions- normally warm air rises removing pollutants to some other sight where they can fall back to earth in the form of wet or dry precipitation. In an inversion the air is warmer up above so the pollutants are trapped close to the ground. Usually associated with little or no breeze and valleys (LA). Smog is created when NO_n and hydrocarbons react with sunlight. www.scilinks.org Key word HE155



Global Warming

Blanket of pollutants such as CO_2 and CH_4 that blanket the earth trapping the radiant heat from earth's surface. As these gases build in our atmosphere our yearly average temperatures slowly raise. Glaciers melt and sea levels rise, bacteria and fungus proliferate. Many organisms have specific habitats they require. What will happen to plants whose evolutionary process have allowed them to thrive in a particular habitat if the climate changes?

Lets review the carbon and nitrogen cycles for plants. Wouldn't additional carbon dioxide be good for them?

Section Review

1. Sulfur trioxide is formed when oxygen and sulfur dioxide in the air combine. Is SO_3 a primary or secondary pollutant? Explain
2. How has the Clean Air Act reduced car and industry pollution?
3. What are two factors contributing to pollution in LA?
4. Why was air pollution a problem in London 100yrs ago? (Before auto's)
5. Discuss the pros and cons from a plants point of view on excessive carbon dioxide.
6. Explore the best way to reduce auto pollution.

Effects on Human Health

- Chronic Bronchitis and asthma
- Emphysema and Lung cancer
- Sick-building Syndrome
- Radon gas
- Asbestos

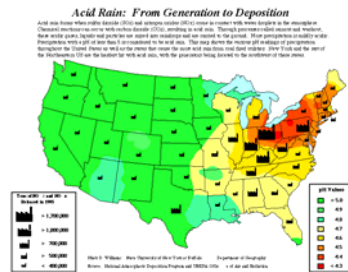
Section Review

1. Why is it difficult to establish a direct link between air pollution and health problems?
2. Why might asbestos be more likely to cause lung cancers in smokers than non-smokers?

- If you keep your windows open in the summer are you more or less likely to get Sick-building syndrome? Explain.

Acid Precipitation

Acid rain- from fossil fuel burning SO_n and NO_n with moisture produce sulfuric acid and nitric acid rain. This causes the leaching of minerals such as aluminum from soil, which clogs fish gills and they suffocate. In some areas the water has become so acidic it interferes with reproduction. Worse in spring-acid shock. Forests-acid depleted need minerals from soil and also burns foliage of plants. *Helsinki Declaration* (1985 UN) cut SO_n emissions by 30%/10yrs. *Sofia Protocol* (1989UN) NO_n reduction. European Union 1994 cut Sulfur in diesel 30%, 96 another 80%



- http://go.owu.edu/%7...222_lo/geog_222_lo09.html
- <http://www.epa.gov/airtrends/acidrain.html>
- <http://www.nct.org/a...rs%20or%20acid%20rain.htm>
- <http://www.eces.org/gallery/000465.php>

Michigan is fortunate in that our early geologic history included being an ancient sea, which gives us a limestone base. Limestone mineral is made of calcium carbonate, the same buffer used to neutralize stomach acid. This keeps our lakes from turning acid like the Adirondack Mountains of New York.

Section Review

- What human activities contribute to acid rain?
- Why is international cooperation necessary to reduce acid rain?
- Why is lime sprayed on lakes in NY Adirondack Mts.?
- What currently protects Michigan waters from the effects of acid rain?

Atmosphere and Climate

Teacher Lecture Notes

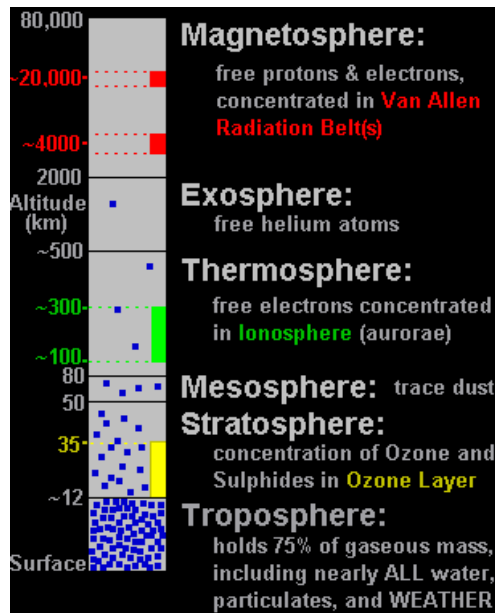
Student Lecture Notes

The Atmosphere

www.deq.state.mi.us/aqi
www.scorecard.org www.epa.gov/airnow/

Atmosphere-thin layer of gases surrounding earth. Composition: N₂, O₂, H₂O vapor, Ar, CO₂, He, etc.

Atmosphere Layers – www.uwsp.edu/~hevwod/GEOG101/airstruc/



4 byo- photosynthetic bacteria - oxygen. Balance of photosynthesis and respiration (CO₂~ 0.03% temp to support life). Let's write the formulas for photosynthesis (plants only) and cellular respiration (plants and animals)

Our atmosphere fluctuates in the amount of CO₂ present dependent on the season. Can you guess why?

Lets draw a graph that shows the seasonal fluctuation.

Now consider in your graph that the CO₂ levels have continued to raise globally even with photosynthesis occurring. Will plants manage to convert enough CO₂ to keep earth from getting a temperature? There is another CO₂ "sink", the ocean.....how much can it hold? How about the carbon reserve in soils...how much can they hold?

Ice core data tells us that earths CO₂ levels have fluctuated in the past. However we are rapidly reaching the highest levels ever at a rate faster

that recorded in cores. What will the future hold? Contrary to anything you have heard, scientist DO AGREE that global warming is real, from man, and happening at an unprecedented rate. What they don't agree on is what will happen. There are many models for predicting weather patterns globally. You will most likely be here to witness them! The fact that several glaciers in Alaska have retreated more than 8 miles over the last few years should be of concern to us!

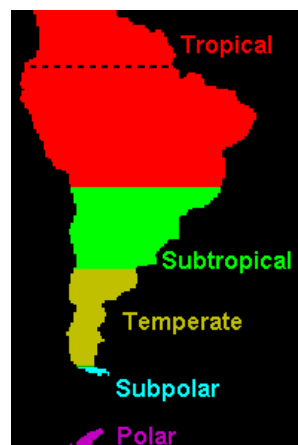
Section Review

1. Name two characteristics of the atmosphere that make life possible on earth
2. What caused the amount of oxygen to increase in the atmosphere?
3. In which atmosphere layer do we live?
4. What do YOU predict will happen to the earth as we warm? Your prediction should be based on research regarding several climate models (not just "*The Day After Tomorrow*")

Climate

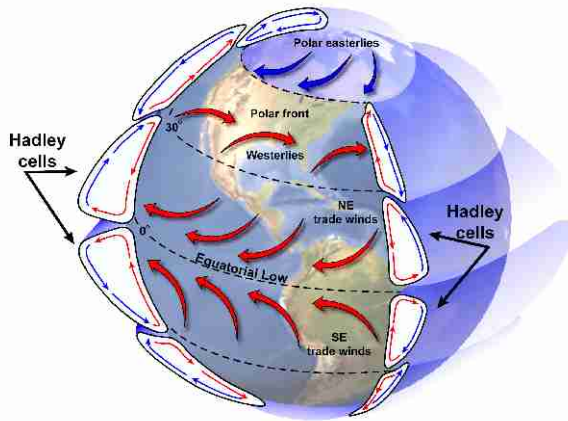
Climate- average weather for long period of time. Temp and precipitation determine the type of organisms can live there.

Climate is determined by a variety of factors. The most important is **latitude**.



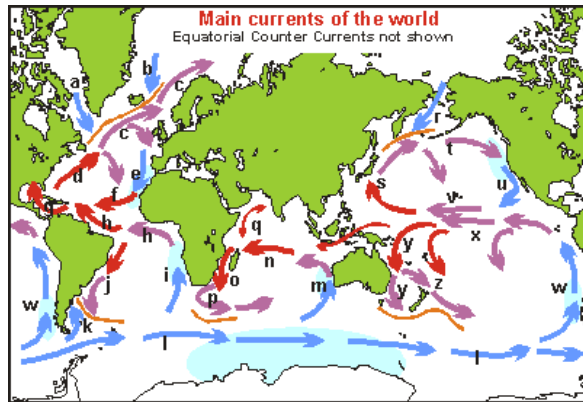
Atmospheric Circulation Patterns also influence climate.

www.atmosphere.mpg.de/enid/ox.html



Find Michigan, what global current affects us? Lets draw a map together indicating the current that brings us cold and warm winds. Hint...you've heard about it on the news!

And last, but not least **Ocean Currents** affect our climate.
www.poemsinc.org/oceano/currents.htm



The North Atlantic current acts like a conveyer belt. Warm water moves on the surface northward warming us while cold water travels deep under the ocean back toward the equator. As glaciers melt the ocean water is becoming less salty (freshening). Since monitoring began about 40 years ago the current has slowed by 30%. What will it mean to the northern regions (us) if it continues to slow? Hint: What has “run” over Michigan 4 times in the past shaping our topography and creating the Great Lakes?

Seasonal Changes: Earths tilt of ~ 23degrees and orbit. When the northern hemisphere points toward the sun we have summer:)

Weather - what's happening in the atmosphere at a particular place and time. Short term.

www.discoveryschool.com

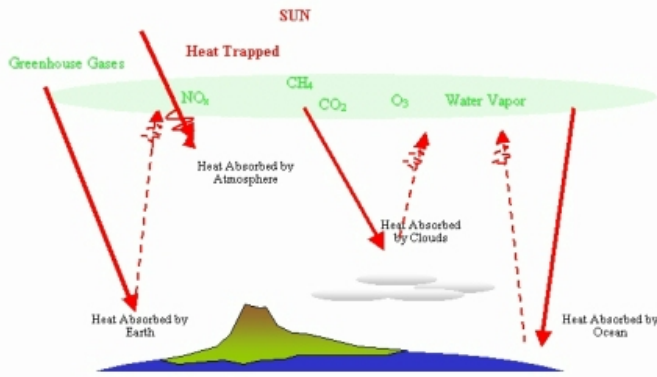
Click "**Lesson plans**" then "**grades 9-12**". Build your own weather station. There are lotsa cool ideas for projects in this web sight!

Section Review

1. Explain why the equator receives more sun light than the poles
2. Explain the difference between Ireland's and Moscow's temperatures, event though they're at nearly the same latitude.

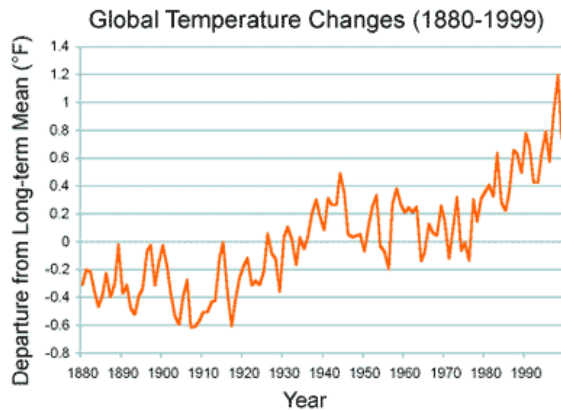
Green House Earth

Outer space is icy cold; Earths atmosphere acts like a Green House. Not all gas traps heat radiated of Earth, the main heat holders are carbon dioxide, methane and CFCs.



resources.emb.gov.hk/.../e_m2_1_3.htm

These gases come from cellular respiration, decomposition and the burning of fossil fuels. Kyoto Act.



Source: National Climatic Data Center, 2000. Climate of 1999 - Annual Review
Online at <http://www.ncdc.noaa.gov/ol/climate/research/1999/ann/ann99.html>

www.pca.state.mn.us/hot/globalwarming.html

As the earth heats, climate changes, ocean currents change, atmospheric currents change.....Leading to habitat changes.

Adaptations allow organisms to survive and reproduce, but they take millions of years to be successful. Man has the ability to manipulate his environment to suit his needs. Can all life do this?

Section Review

1. What are the two main causes of increased carbon dioxide in the atmosphere?
2. What evidence do scientists have that global warming is occurring?

The Ozone Shield

There are two layers of ozone. One is good, the other is bad!

library.thinkquest.org/11353/ozone.htm

Good Ozone: Found in the stratosphere, protects from UV radiation. When UV radiation penetrates earth's atmosphere plant and animal DNA is affected! CFCs thin the ☺ ozone Montreal Protocol.

Bad Ozone: found in the troposphere from NO_x reacting with VOCs and heat/sunlight. We will do the computer lab activity from the AIRNOW web sight so you can gather more information about ☹ ozone

Section Review

1. What are the two types of ozone? Where are they located and what do they do?
2. What are the main sources of CFC's? How can YOU prevent depletion of the ☺ ozone?
3. What are the main sources of ☹ ozone and what can YOU do to prevent it? Be able to list at least three things!

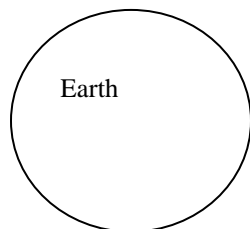
Air & Climate Assessment

Score _____/43 points

Name _____ Hour _____ Date _____

Please answer all questions in complete sentence and thought☺. There are points for that!

1. On the below picture of the earth indicate the relative locations of the good and bad ozone. (2pts)



2. Discuss the benefit of the good ozone. (2pt)
3. How is the good ozone depleted? (2pts)
4. Discuss at least two ways you can prevent the depletion of the good ozone (3pts)
5. Write the equation for the formation of bad ozone. (fill in the blanks)(4pts)
$$\text{_____} + \text{_____} + \text{_____} \rightarrow \text{_____}$$
6. What are two sources of the reactants (not sunlight-dah!) in the above formula? (3pts)
7. Discuss two human health affects related to bad ozone? (3pts)
8. Discuss two plant health affects related to bad ozone? (3pts)

