



**November 19, 2009**  
**4-H Educator Webinar**

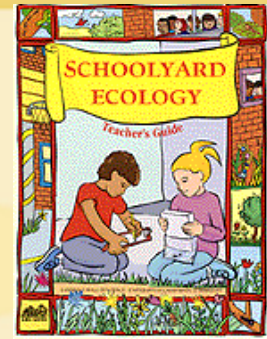
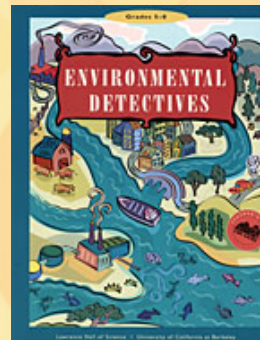
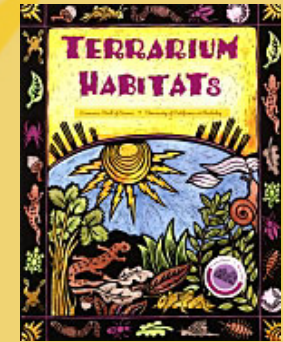
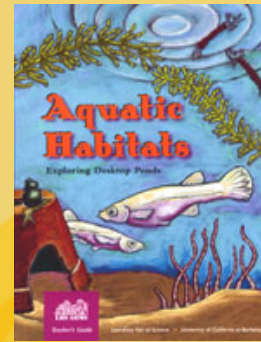
Ideas about Climate Change:  
Challenges and Opportunities

John Erickson, Lawrence Hall of Science.

# Projects I Draw Climate Change Curriculum Experience From:

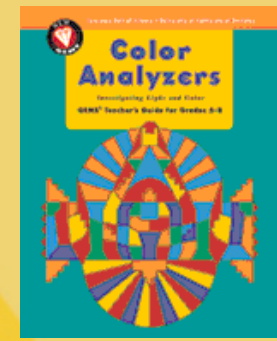
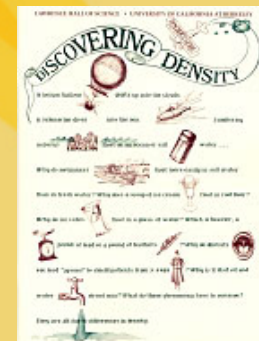
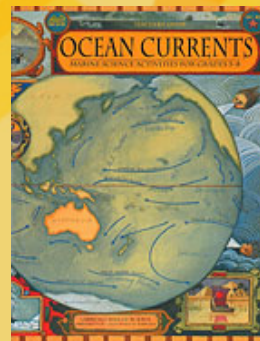
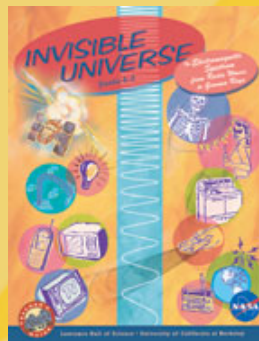
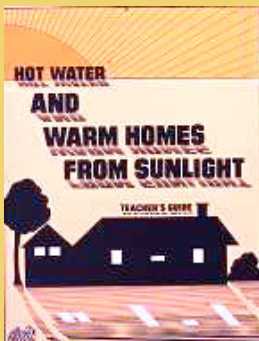
- GEMS Units
- Global Systems Science (GSS)
- Afterschool Kidz Science (ASKS)

# GEMS: Great Explorations in Math and Science



Environmental Issues

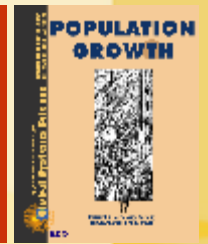
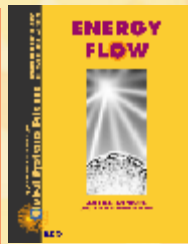
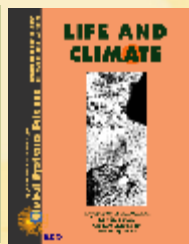
Studying Habitats



Basic Relevant Science Content



# Global Systems Science (and more)



Overview

Earth Systems

Global Problems

Causes and Solutions



Global Science by  
Christensen and Christensen



# Afterschool Kidz Science

- Green Science Series under development.
- Four units, four sessions each:
  - Alternative Energy
  - Waste
  - Water
  - Gardening

# Broad Content Categories:

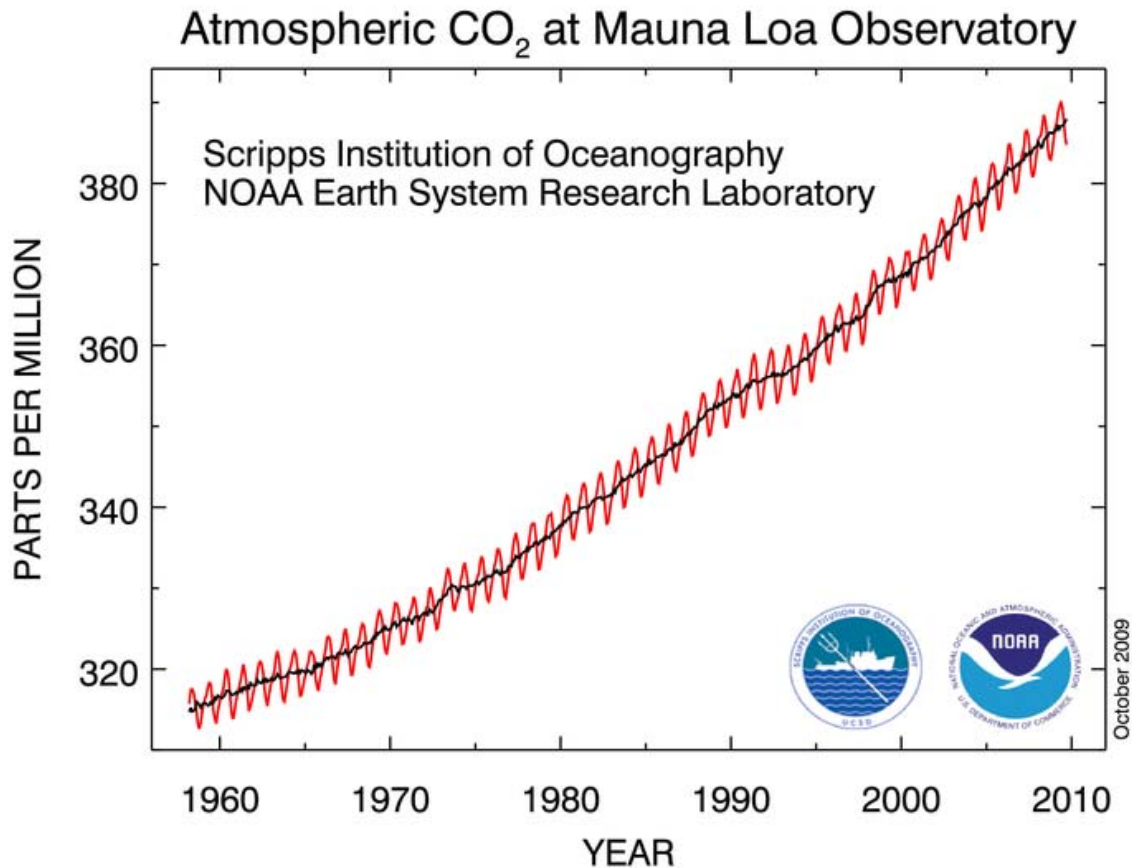
- The Carbon Cycle and Fossil Fuels
- Interaction of Light and Matter
- Change Over Different Time Scales
- Effects of Climate Change, Current and Future
- Monitoring Climate Change
- Solutions for Climate Change

# Broad Content Categories:

- The Carbon Cycle and Fossil Fuels
- Interaction of Light and Matter
- Change Over Different Time Scales
- Effects of Climate Change, Current and Future
- Monitoring Climate Change
- Solutions for Climate Change
- **Suggested strategy for this session: I'll go over some material in a content category, then we'll go over what experience we have at teaching this material and discuss briefly whether it is a good fit for afterschool programs. Then we move on to the next category.**

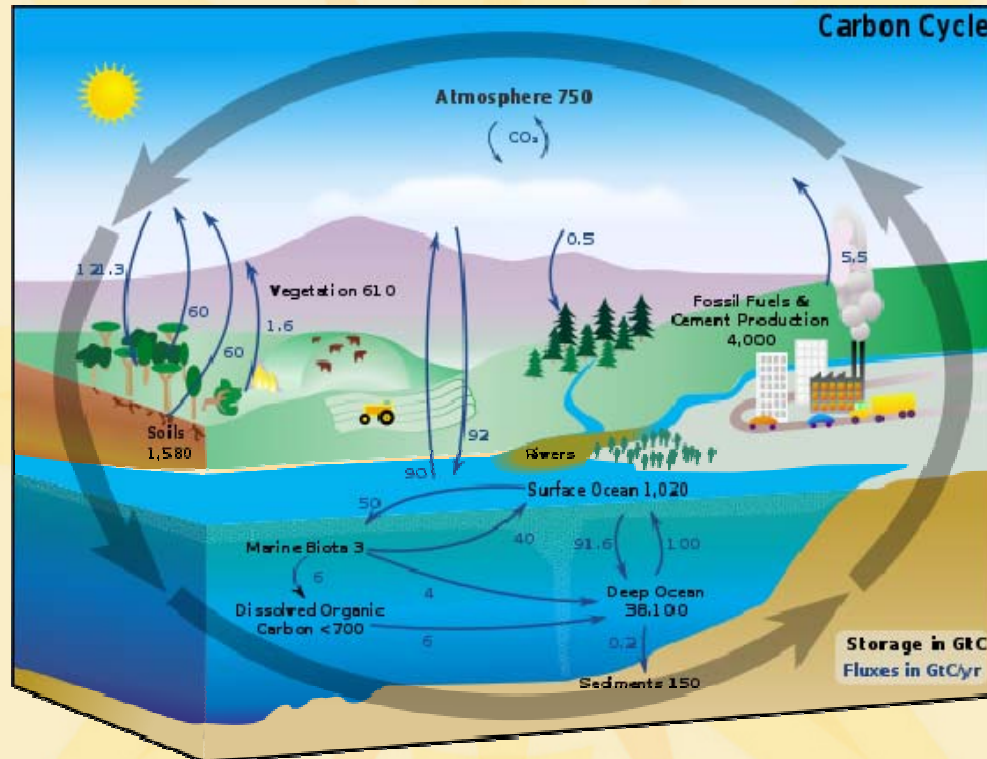
# Carbon Cycle and Fossil Fuel

- Something is changing in the atmosphere.





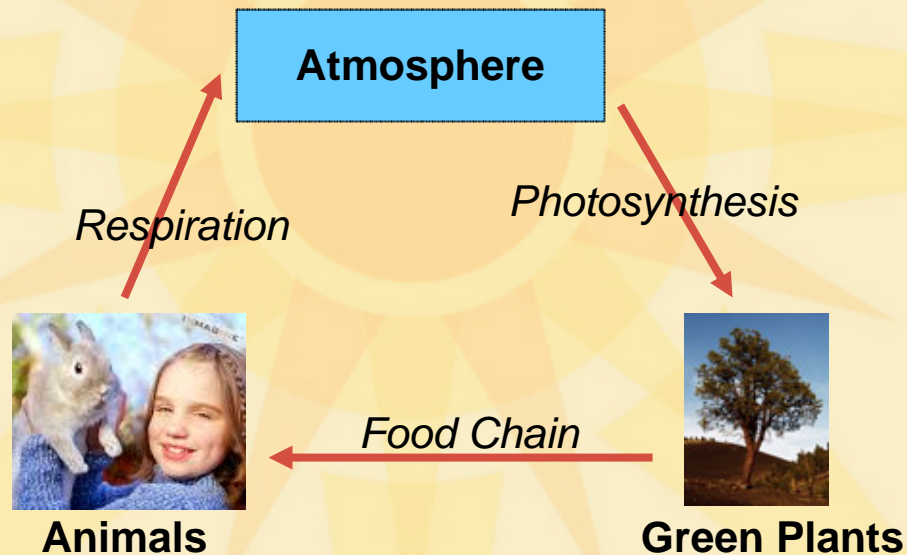
# Carbon Cycle and Fossil Fuel



- Aaak!
- There are places in the Earth System where there is **carbon** and there are ways that carbon moves from place to place.

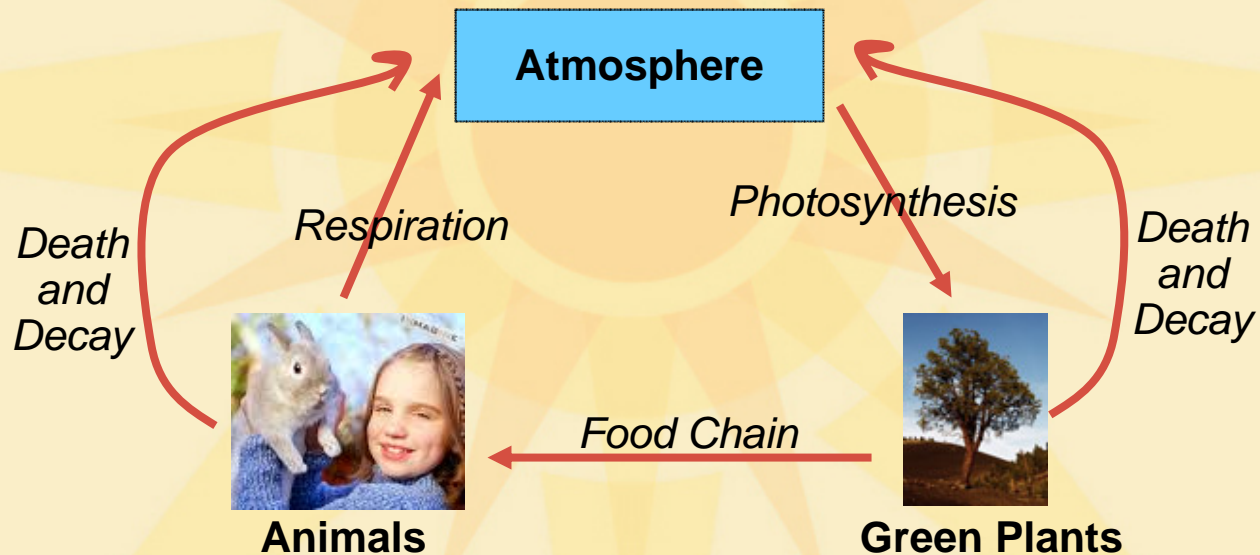
# Carbon Cycle and Fossil Fuel

- Our personal link to the carbon cycle:  
**Eating and Respiration**



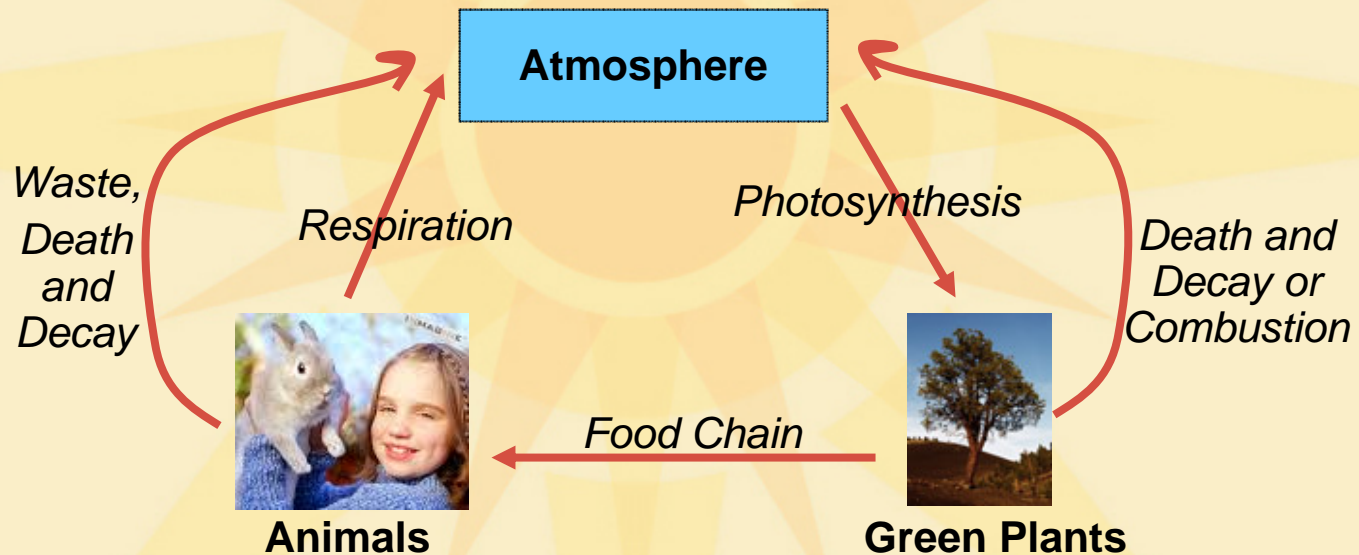
# Carbon Cycle and Fossil Fuel

- Another way living things participate:  
**Death and Decay**



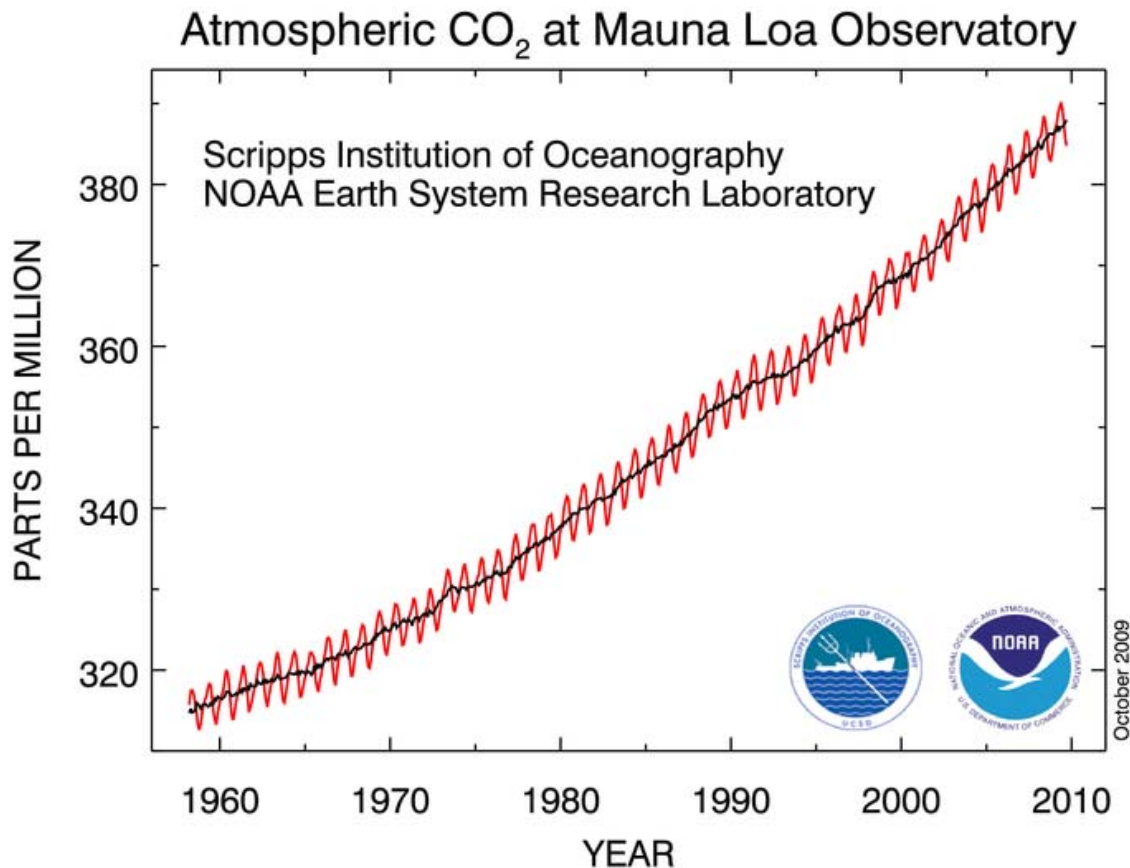
# Carbon Cycle and Fossil Fuel

- One more thing:  
**Combustion**



# Carbon Cycle and Fossil Fuel

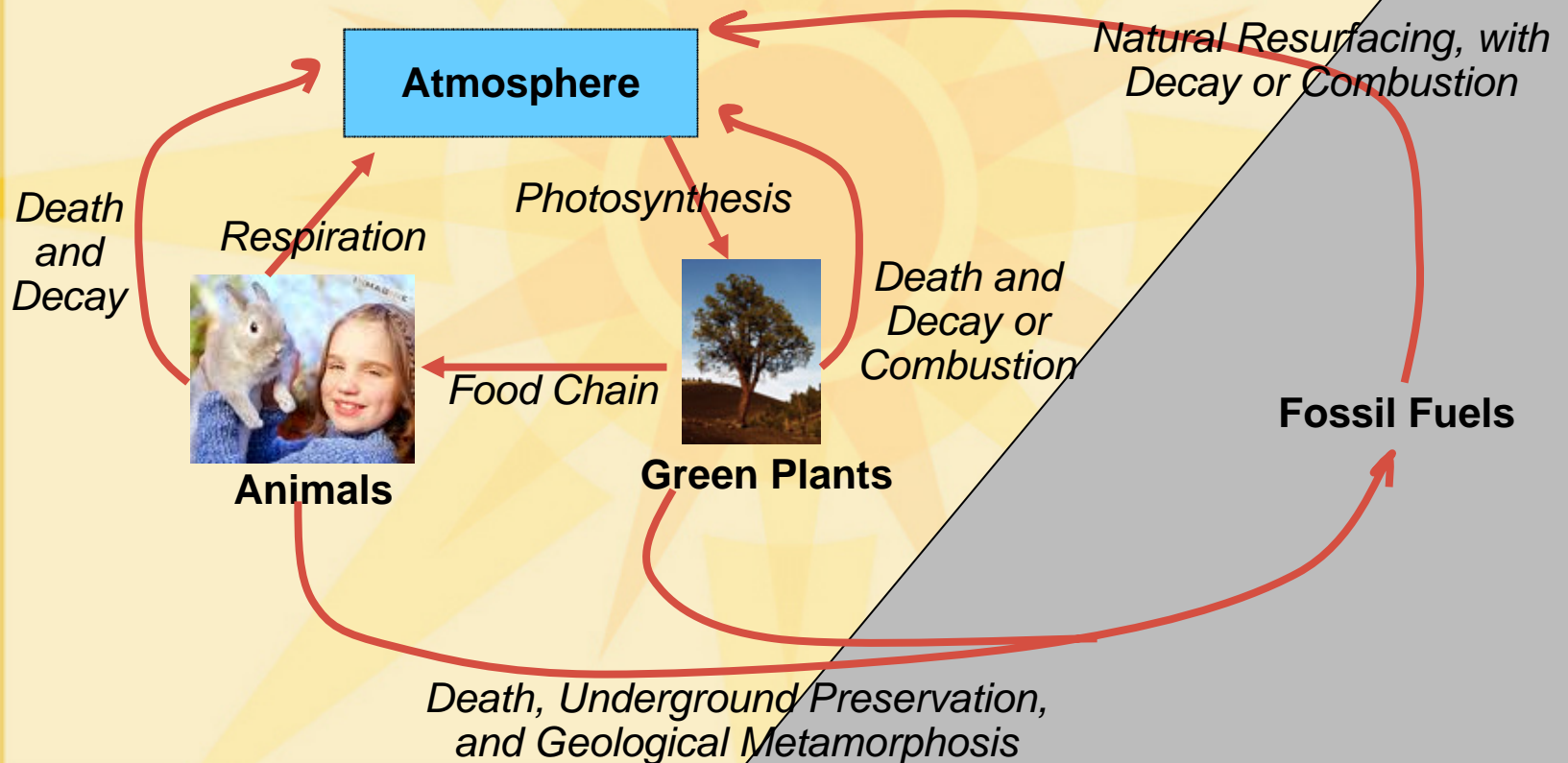
- What ideas can we come up with about this data now?





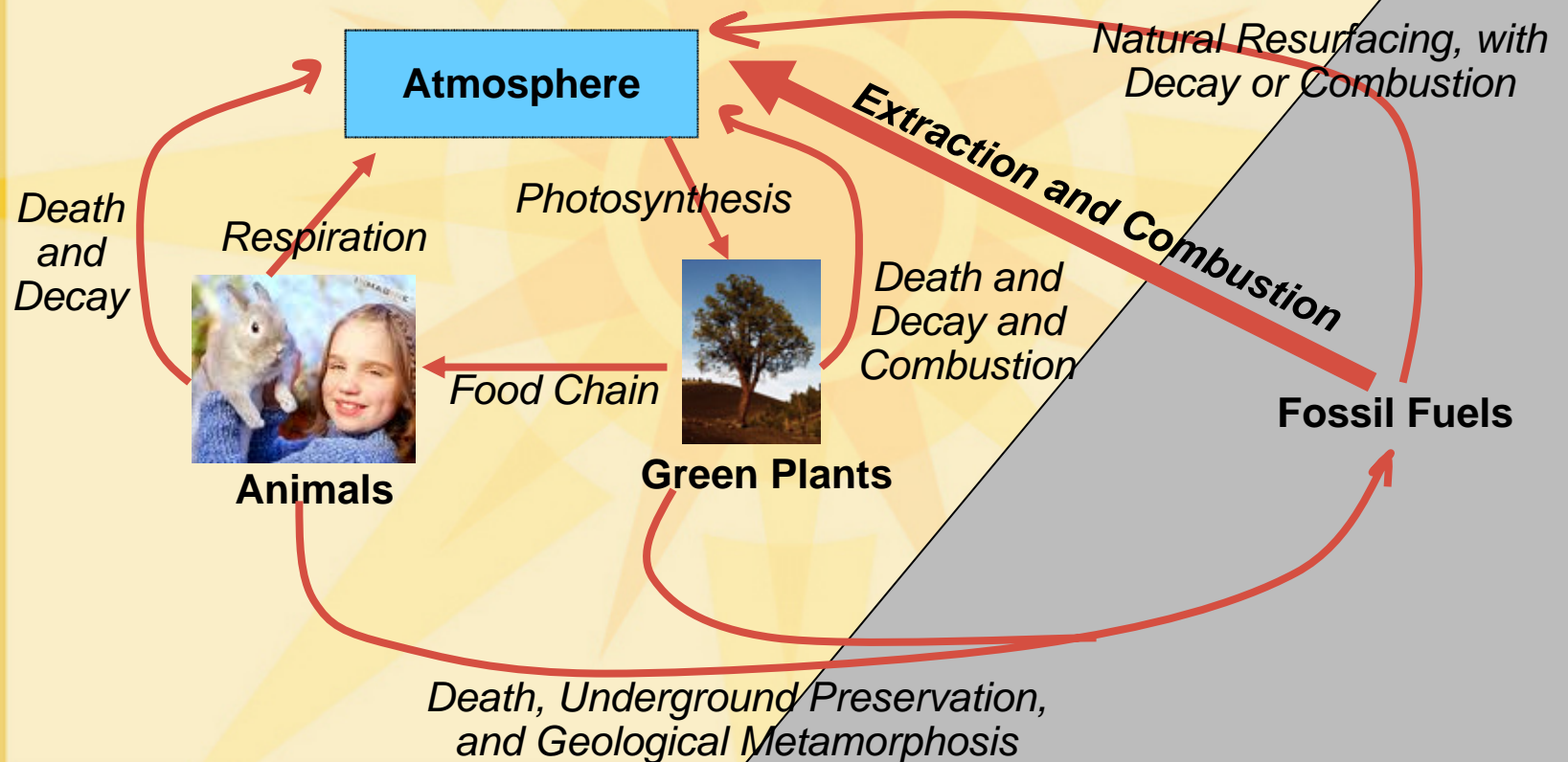
# Carbon Cycle and Fossil Fuel

- A long-timescale loop in the carbon cycle:  
**Geologic storage of carbon in fossil fuels.**



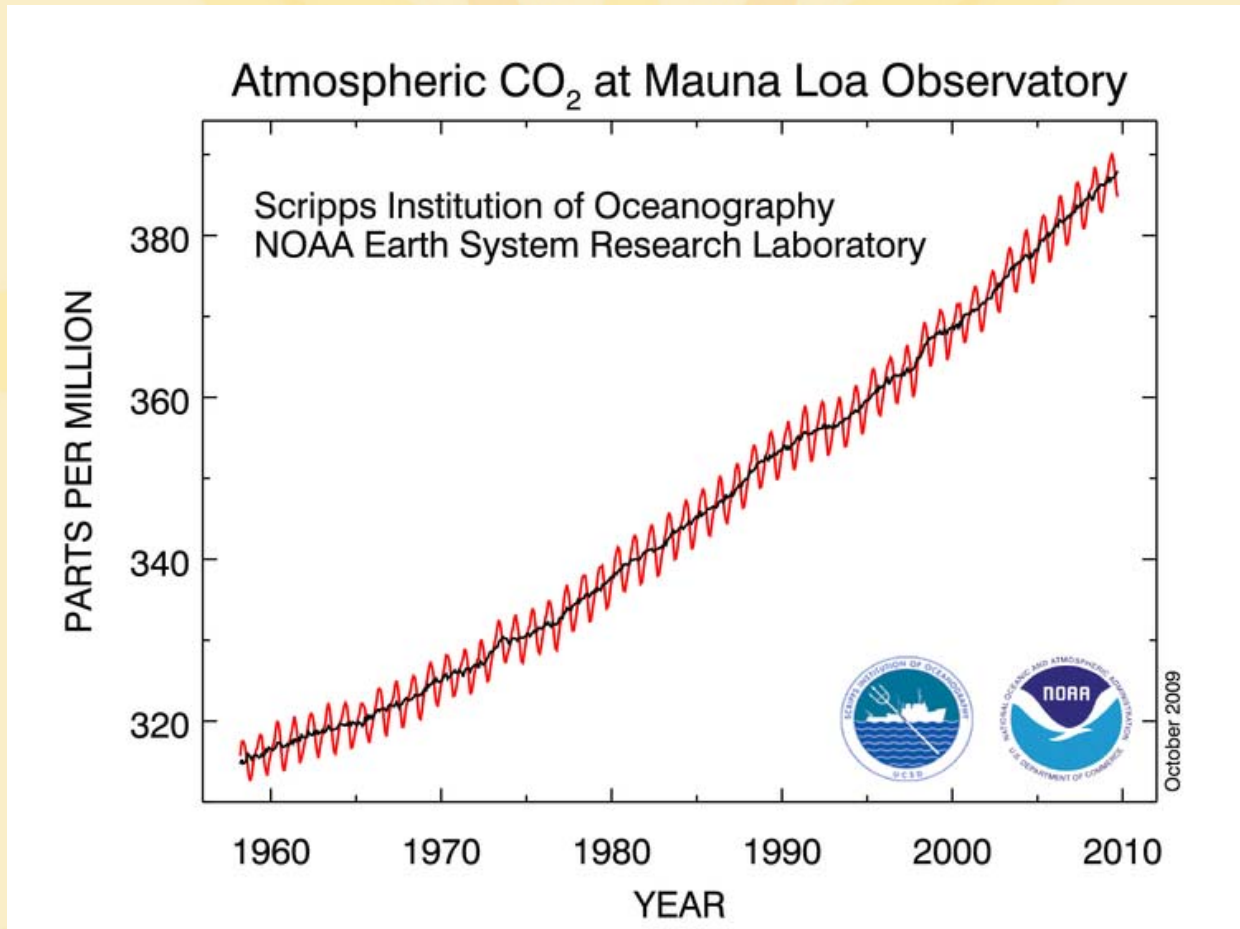
# Carbon Cycle and Fossil Fuel

- A modern addition to the carbon cycle:  
**Extraction and Combustion**



# Carbon Cycle and Fossil Fuel

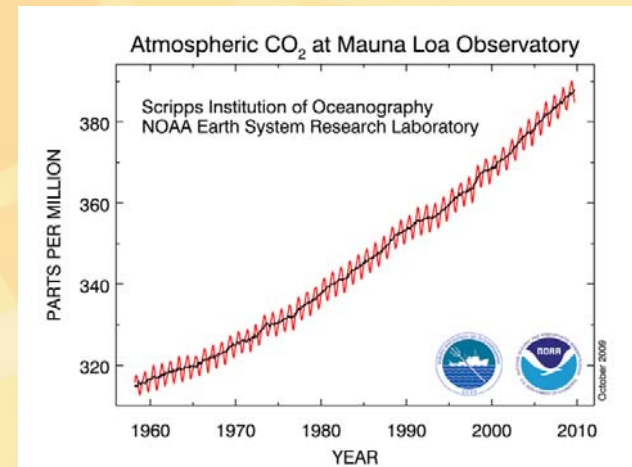
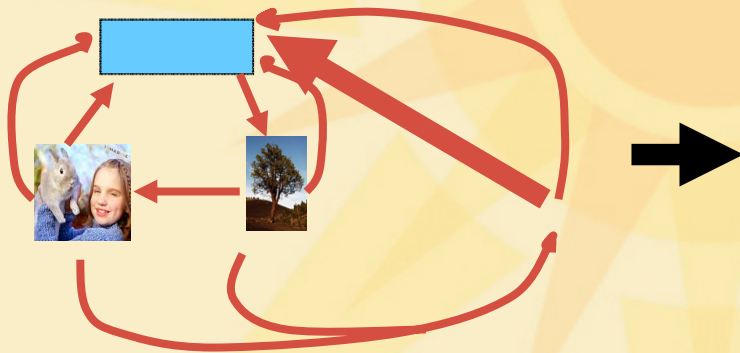
- What ideas do we have now?



# Oceans and the Carbon Cycle

## Warning:

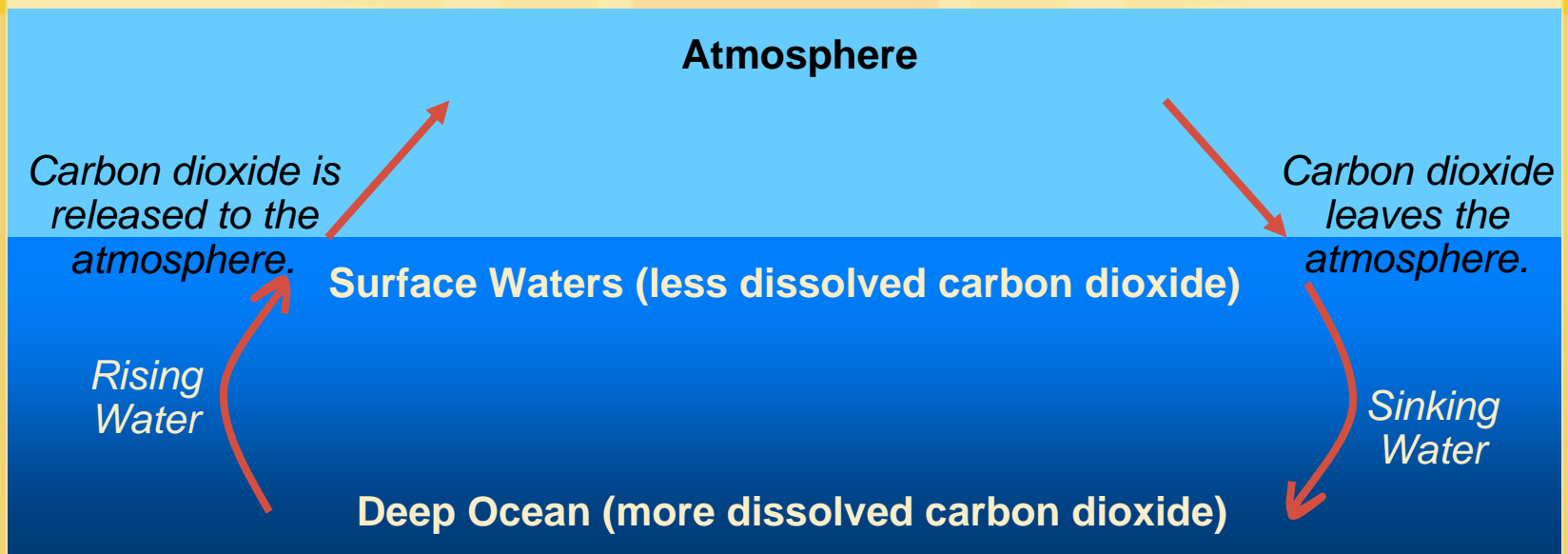
What we just saw is not the whole carbon cycle. It is the part that accounts for the rising carbon dioxide in the atmosphere over the last 50 years. (Actually, the last 100 years, by other measures.)



But there is more...

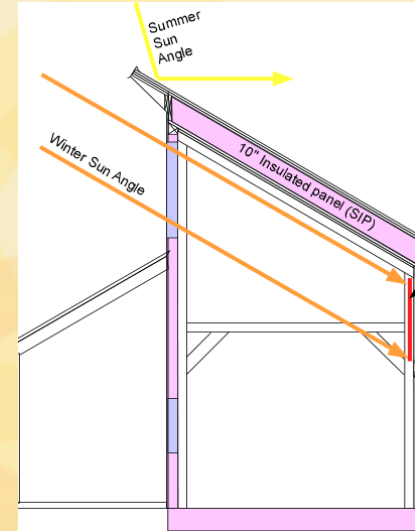
# Oceans and the Carbon Cycle

- There is an exchange of carbon dioxide between the atmosphere and the ocean.
- The amount of carbon dioxide (and related compounds) in the ocean depends on the ocean temperature, and on the amount of carbon dioxide in the atmosphere.



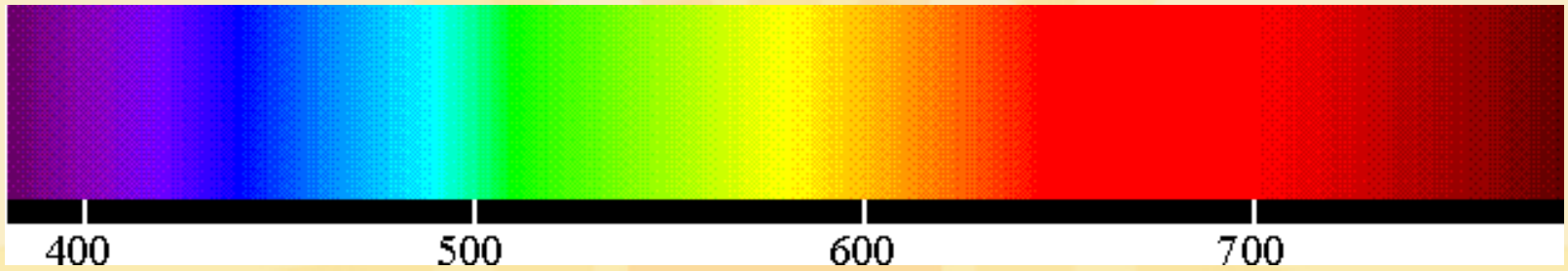


# Light and Matter Interactions



- When light meets matter the light can be **absorbed, reflected, and/or transmitted.**
- Matter warms up when it absorbs light.

# Light and Matter Interactions



- Sunshine comes in a ***spectrum*** of colors.

# Light and Matter Interactions



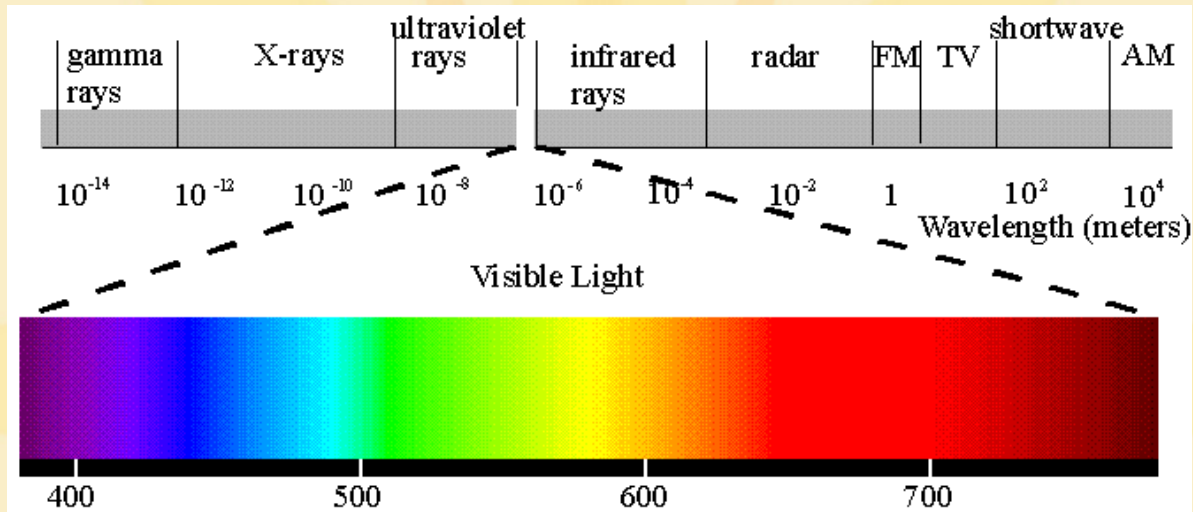
- Different colors of light interact with matter in different ways.
- Ice and clouds are white, trees are green, and pavement is dark colored. What color is air?

# Light and Matter Interactions



- Air is *transparent*, and yet:  
The sky is blue.  
The Sun is orange at sunset.

# Light and Matter Interactions



- Sunshine comes in a spectrum of energies including all the colors that we see, and more.
- **Infrared** and **ultraviolet** light are in sunshine, but are invisible to human eyes.

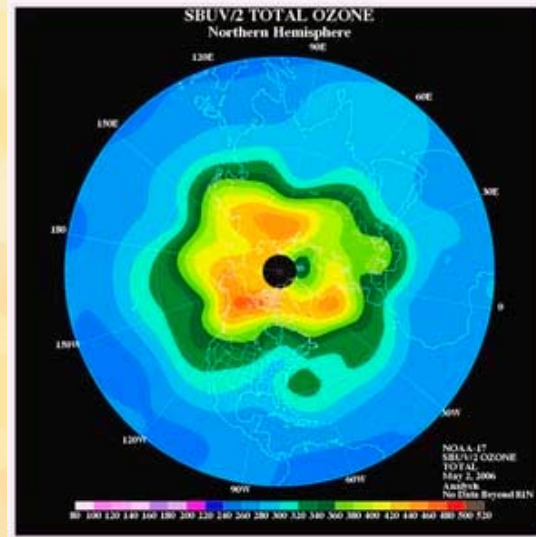


# Light and Matter Interactions



- Ultraviolet light tends to cause chemical changes in matter that absorbs it
- Fading colors, degrading materials, suntan, sunburn, cancer.

# Light and Matter Interactions



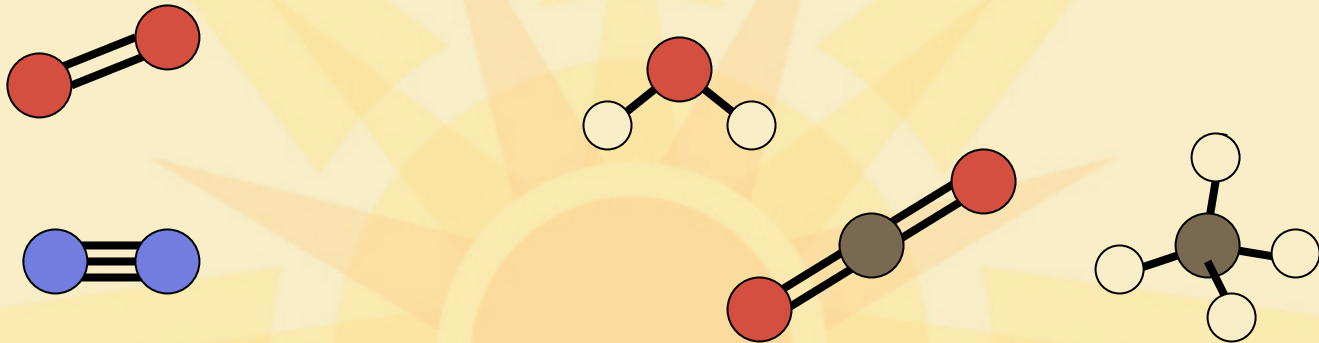
- The atmosphere, specifically **ozone**, absorbs much of the Sun's ultraviolet light.
- The thinning of the **ozone layer** is a global climate issue that is different from the one people are talking about when they talk of global climate change.

# Light and Matter Interactions



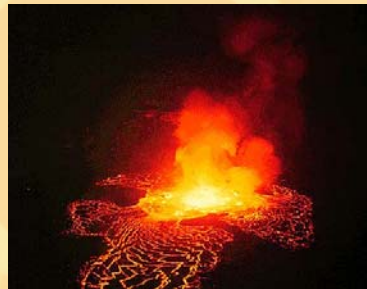
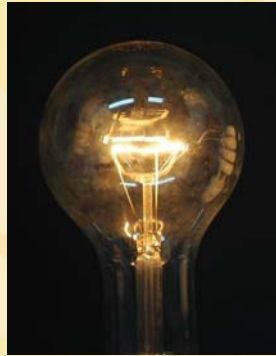
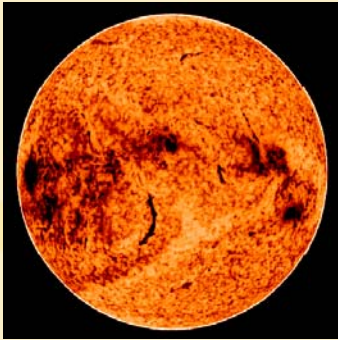
- Infrared light warms up matter that absorbs it. This is true for visible light too, but infrared light tends to be absorbed by more types of matter.
- What about air? How does it interact with infrared light?

# Light and Matter Interactions



- Oxygen and Nitrogen make up most of the atmosphere. They are transparent to infrared light.
- Some gases in the air absorb infrared light. Among them are carbon dioxide, methane, water vapor, and CFCs.
- Gases that absorb infrared light are called greenhouse gases.

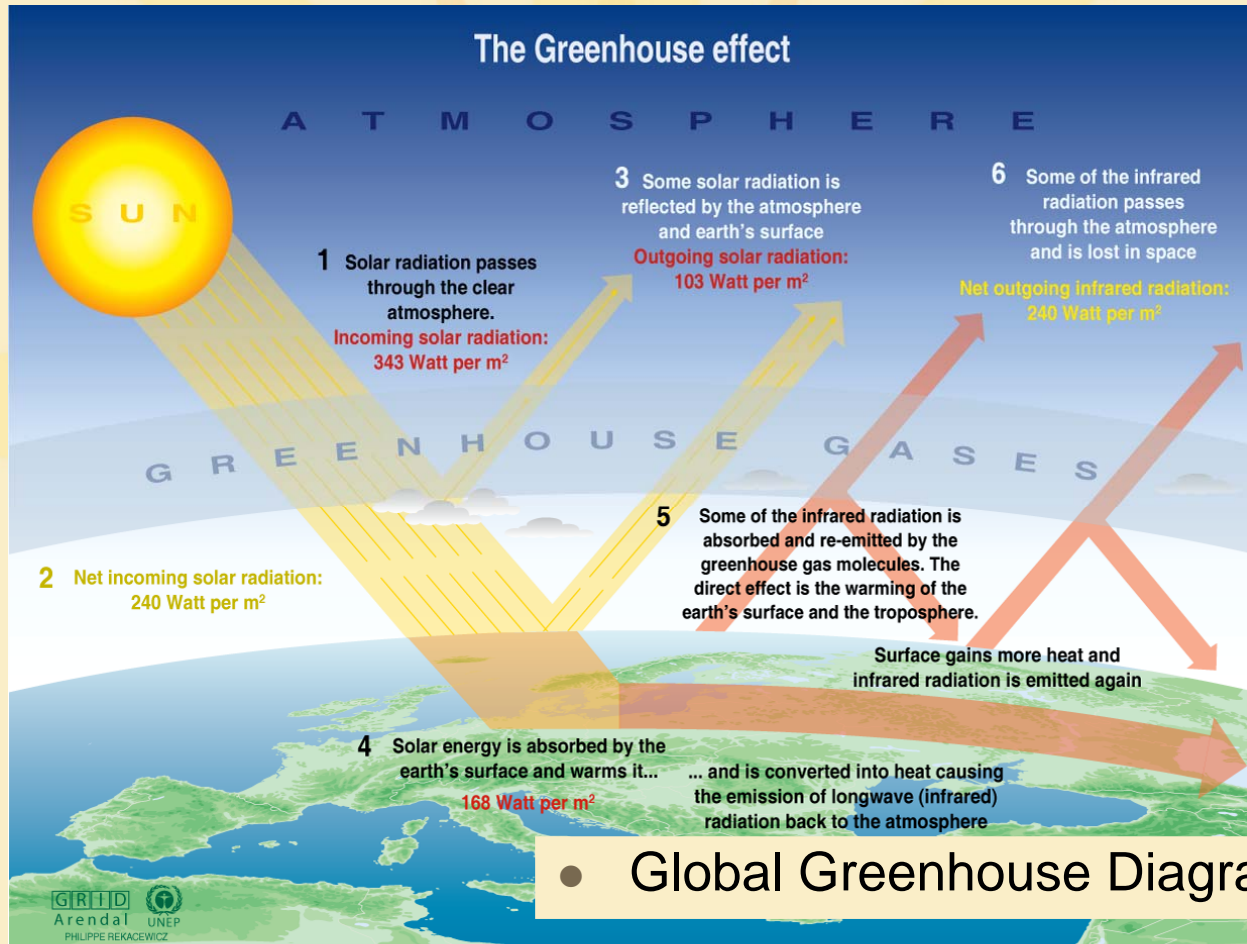
# Light and Matter Interactions



- Matter emits radiation according to its temperature.
- Objects that are very hot give off visible light. That is what **incandescent** means. Incandescent objects also give off infrared light.
- Objects at “normal Earth” temperatures give off only infrared light.

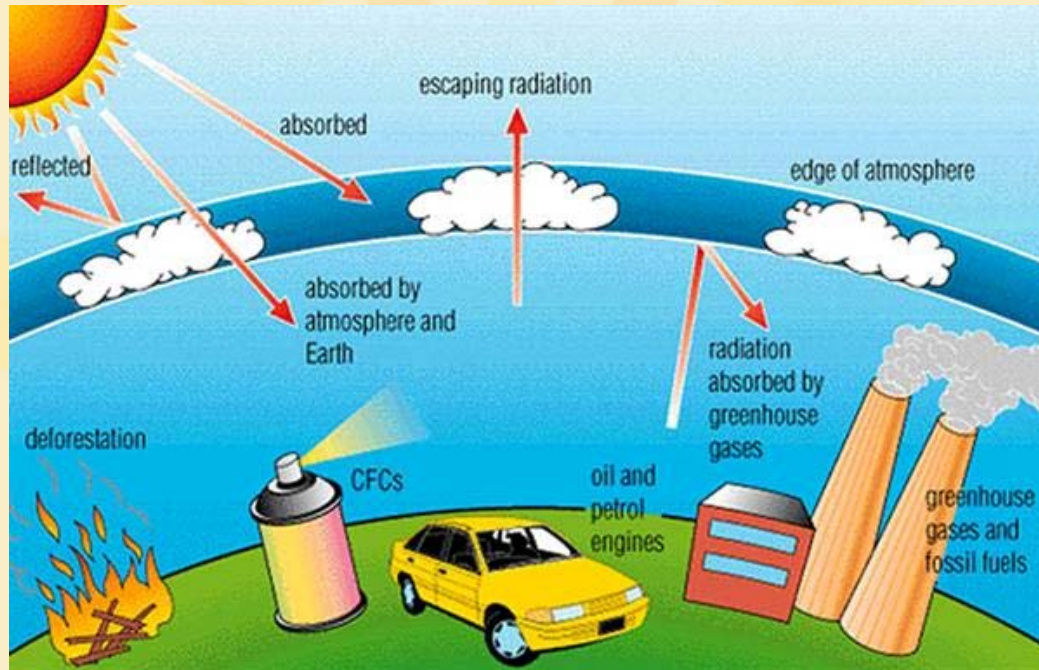


# Light and Matter Interactions



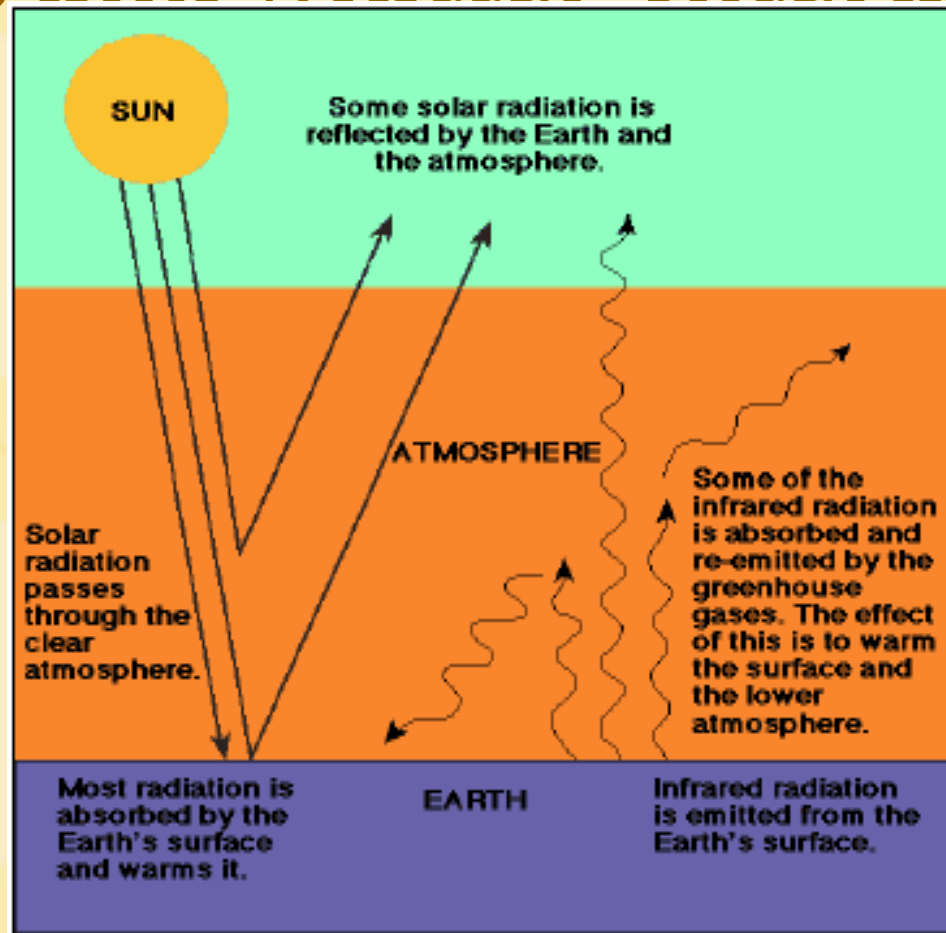
Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

# Light and Matter Interactions



- Global Greenhouse Diagram 2

# Light and Matter Interactions

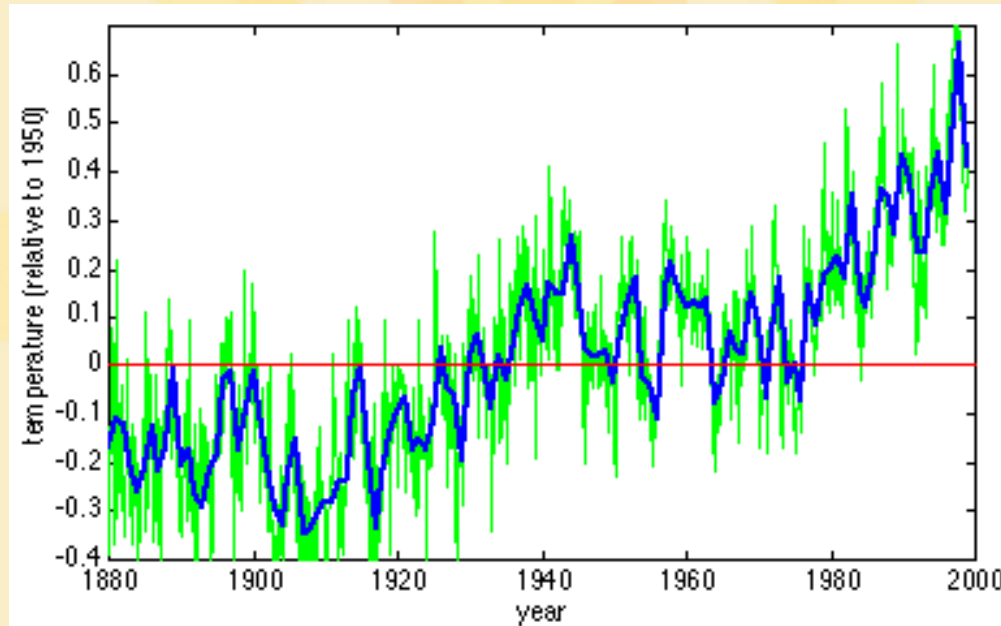


- Global Greenhouse Diagram 3

# Broad Summary of Matter and Energy in the Earth System:

- **Energy flows.** It arrives in the system, it lingers a while in different places in the system, and it leaves the system.
- **Matter cycles.** It goes from place to place in the system, staying a while in each one, then moving on to a new place in the system.
- The amount of energy in the Earth system changes. The amount of matter does not. (Meteorites excepted.)

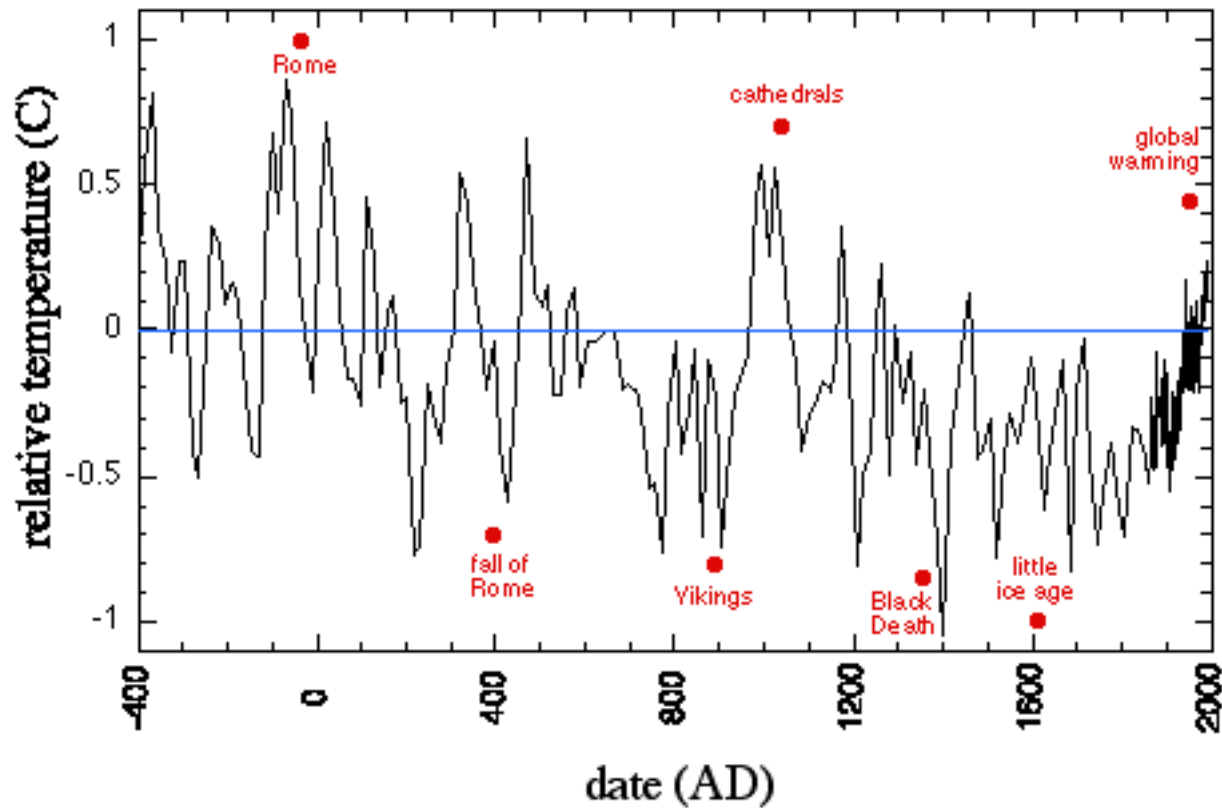
# Change Over Different Time Scales



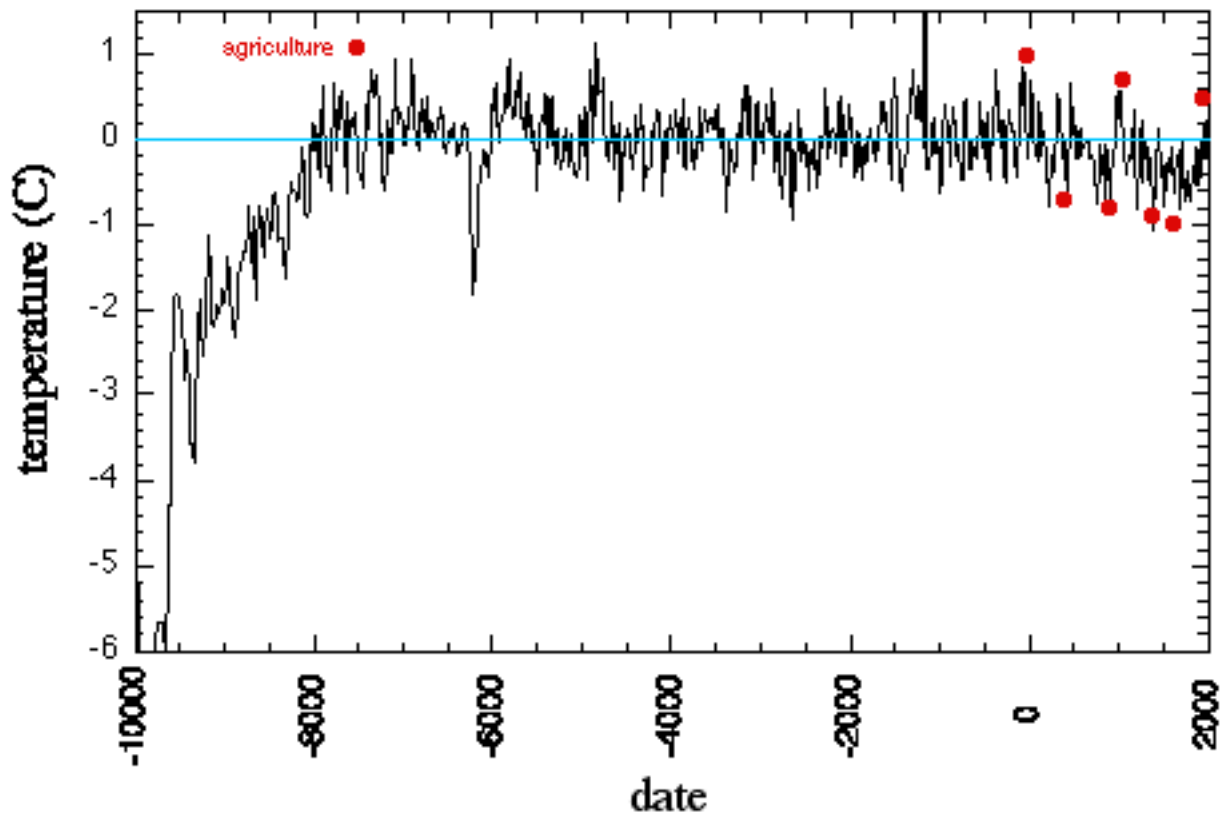
- [http://muller.lbl.gov/pages/IceAgeBook/history\\_of\\_climate.html](http://muller.lbl.gov/pages/IceAgeBook/history_of_climate.html)



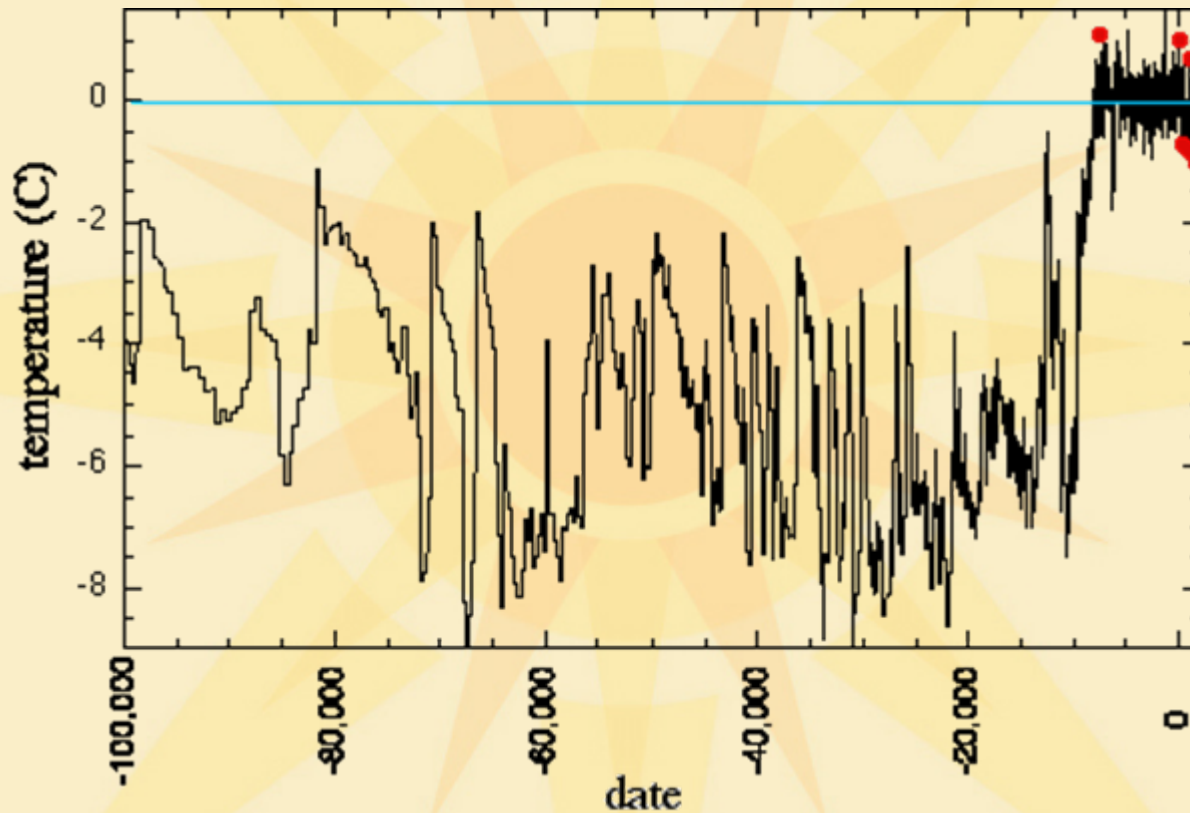
# Change Over Different Time Scales



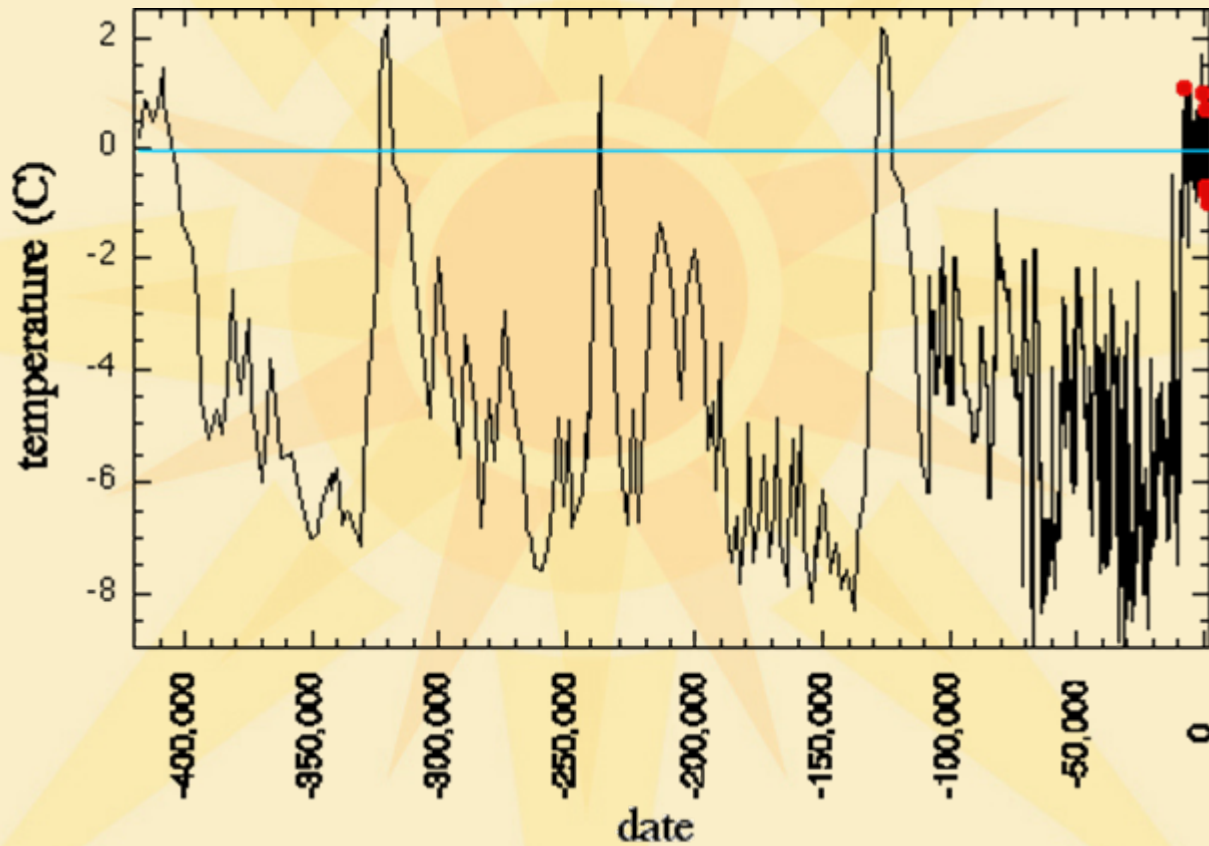
# Change Over Different Time Scales



# Change Over Different Time Scales



# Change Over Different Time Scales



# Effects of Climate Change



- Habitat loss/alteration/relocation
- Sea level rise
- Extreme events
- Social changes



# Effects of Climate Change

- **Habitat loss/alteration/relocation**
- Some habitats are gone. Polar sea ice.
- Some habitats become hospitable to new organisms. Jellyfish, bark beetles.
- Some habitats become less hospitable to organisms. Ocean acidification, desertification.

# Effects of Climate Change

- **Sea level rise**
- Mostly due to thermal expansion of water.
- Coastlines shift.
- Low islands are lost.
- Inland water becomes salty.

# Effects of Climate Change



- **Extreme events**
- Drought
- Heat waves
- Hurricanes

# Effects of Climate Change

- **Social changes**
- Siberia and Canada become more agriculturally productive.
- Human migration. Refugees from islands, coastlines, and areas of reduced land productivity.
- Global economic divide more extreme.
- Positive and negative consequences of policy choices that attempt to mitigate climate change.

# Monitoring Climate Change

- How do we know what we know about the past?
- How are we keeping track of the present?
- How do we predict the future?





"Earth has been called the Green Planet; in the vast reaches of the universe, perhaps the universe, it is a solitary world uniquely clothed in a mantle of vegetation. And because of its plants, other forms of life are able to inhabit this place." - Bruce Capon, Botany for Gardeners, 1990, Timber Press, page 11.



<a href="#">Home</a>	<a href="#">Announcements</a>	<a href="#">Challenges</a>	<a href="#">For Educators</a>	<a href="#">Site Map</a>
<a href="#">Investigations</a> ▼	<a href="#">Data Links</a> ▼	<a href="#">Free Software</a> ▼	<a href="#">Partners</a> ▼	<a href="#">Useful Tools</a> ▼


 MVH  Web

April 15, 2008

[View Print Version](#)

**April 2008 Updates:**  
**New ISU, Forest Watch, and more workshops**  
**Announcements**  
**New Software**  
**Help Movies**

Plants are like "green canaries"— if they die, then other organisms will likely follow. By measuring the health of plants, we are measuring the environmental conditions that affect all nearby organisms, including humans.

Modern technologies let us monitor plant health using the proportions of light reflected from leaves. Combining this data with our understanding and observations of plant behavior and physiology helps us to quickly assess the quality of the local environment.

**Measuring Vegetation Health** brings together biology, physics, chemistry, technology, art, engineering, and math in a project that predominantly supports field studies in middle to high school and self-guided education in environmental science. Many tools such as free software and ideas for activities and student challenge questions are provided on this website.

**Explore activities and resources for Measuring Vegetation Health:**



**SCIENCE OF PLANTS**



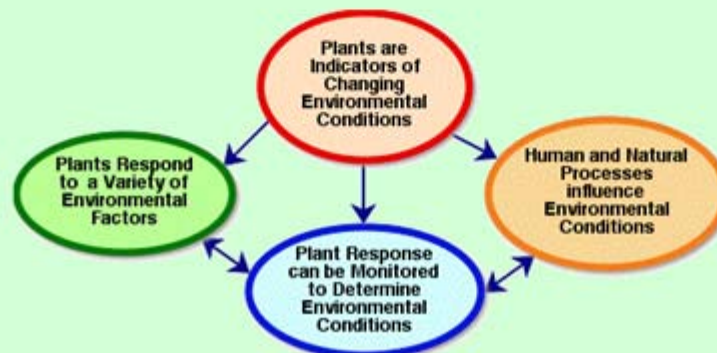
**SCIENCE OF LIGHT**



**TOOLS & TECHNOLOGIES**



**ENVIRONMENTAL MONITORING**



# Solutions for Climate Change

- Use less fossil fuel. That's pretty much it.



# Solutions for Climate Change



- Use less fossil fuel.
- Individuals/households
- Communities
- Cities
- Countries
- The world

# Solutions for Climate Change

- Use less fossil fuel.
- **Individuals/households**
- Energy efficiency, Lighting, heating, appliances
- Building efficiency/Weather stripping, roofing, shade...
- Transportation choices
- Recycling
- Household energy generation
- Reduction

# Solutions for Climate Change



- Use less fossil fuel.
- **Communities**
- Recycling
- Energy efficiency
- Organization/Interacting with the city
- Painting everything white
- (Civano, Tuscan, Arizona)

# Solutions for Climate Change



- Use less fossil fuel.
- **Cities**
  - Transportation choices
  - Housing plan
  - Energy Infrastructure and generation



# Solutions for Climate Change



- Use less fossil fuel.
- Countries
- Developed? Developing?

# Solutions for Climate Change



- Use less fossil fuel.
- The world