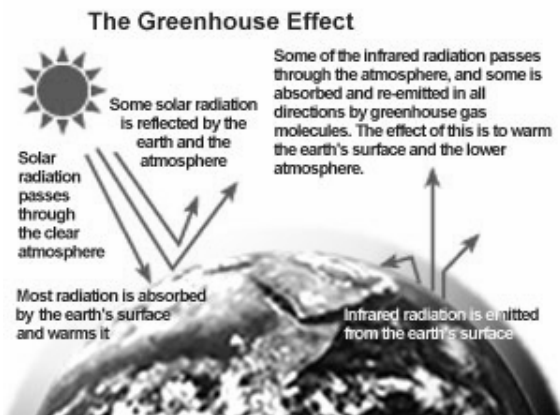


Global Warming Outline

- Non-toxic effects of CO₂
- Greenhouse effect ? global warming
- Climate history of earth (a bit of review)
- Are we changing the atmosphere?
- How could this affect the climate?
- How might that affect ecosystems?
- Have we already seen changes due to humans?
- What is likely to happen in the future?



Radiation

- For the Earth's temperature to remain constant over a long period of time (decades), the amount of solar radiation absorbed must equal the amount of long wave radiation emitted to space.

Solar absorbed = Long Wave emitted

Input = Output

"Greenhouse Effect"

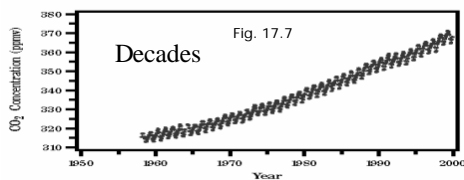
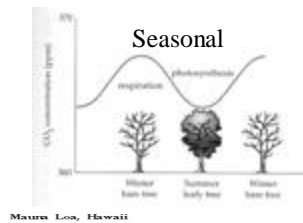
Definition

Greenhouse Effect: The name applied to the process which causes the surface of the earth to be warmer than it would have been in the absence of an atmosphere. → **Atmosphere Effect**

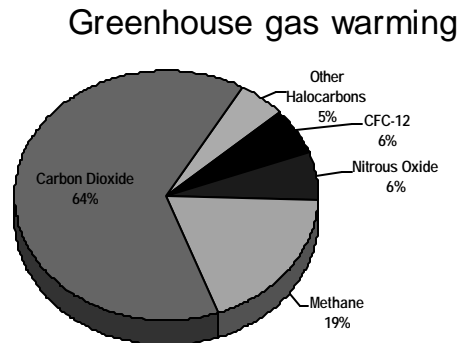
Global Warming: The (expected) increase in the magnitude of the greenhouse effect whereby the surface will become warmer than it is now.

Are we changing the atmosphere?

- CO₂ up 30%
- CH₄ up >100%
- NO₂ up 15%



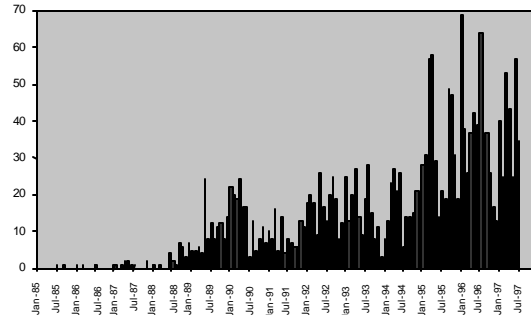
Source: Dave Keeling and Tim Whorf (Scripps Institution of Oceanography)



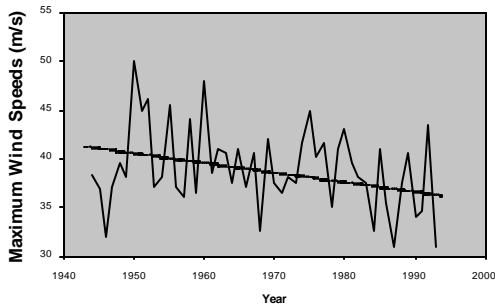
Organisms are responding to recent warming

- Thomas, C.D. and Lennon, J.J. 1999. Birds extend their ranges northwards. *Nature* 399: 213.
- Mexico -- Dengue fever spreads to higher elevations. Dengue fever has spread above its former elevation limit of 3,300 feet (1,006 m) and has appeared at 5,600 feet (1,707 m).
- Olympic Mountains, Washington -- Forest invasion of alpine meadow. Sub-alpine forest has invaded higher-elevation alpine meadows, partly in response to warmer temperatures.
- Monterey Bay, California -- Shoreline sea life shifting northwards. Changes in invertebrate species such as limpets, snails, and sea stars in the 60-year period between 1931-1933 and 1993-1994 indicate that species' ranges are shifting northwards, probably in response to warmer ocean and air temperatures.
- Colorado - Earlier emergence from hibernation. Marmots are emerging from hibernation on average 23 days earlier than 23 years ago. This coincides with an increase in average May temperatures of about 1.8°F (1°C) over the same time period.

Hurricanes

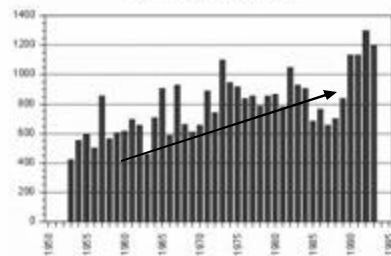


Maximum Wind Speeds in Atlantic Hurricanes

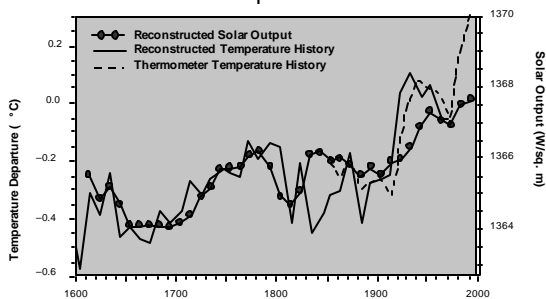


Tornadoes

NUMBER OF OBSERVED TORNADOES - U.S.
Annual Total, 1953 - 1993



Solar activity highly correlated with global temperatures



Does the evidence prove global warming?

1. Too big of scale to answer accurately - are data accurate?
 2. Models are based on real data, but don't perfectly predict the past/future
 3. Nearly impossible to answer with short term data - climate changes happen at scales of centuries to millions of years
 4. Natural fluctuations in solar flares, sun spots, Milankovich cycles, volcanic activity, tectonic activity, ocean currents
- Scientists expect that the average global surface temperature could rise 1-4.5°F (0.6-2.5°C) in the next fifty years, and 2.2-10°F (1.4-5.8°C) in the next century, with significant regional variation.

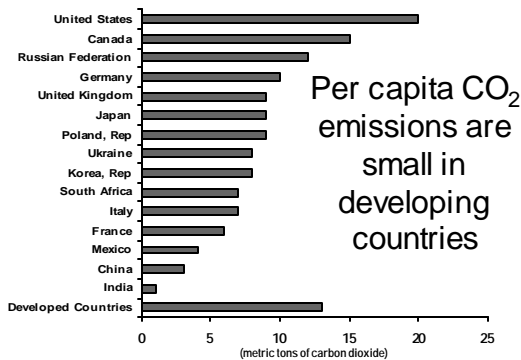
IPCC 2001 major scientific conclusions

- "Increasing body of observations gives a collective picture of a warming world and other changes in the climate system"
- Current emissions are expected to affect climate
- Global ave temp and sea level are projected to rise under all emissions scenarios
- Predicting When / How Fast / How Much climate change is difficult
- Anthropogenic climate change will persist for many centuries

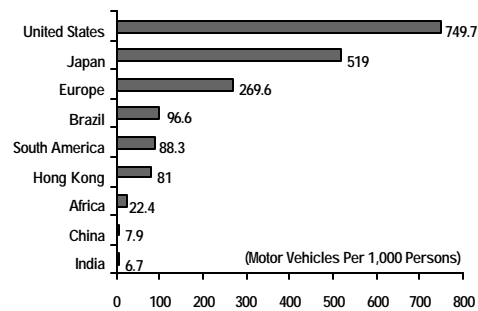
The scientific questions

- Are we changing the atmosphere?
 - Yes, definitely
- Do we know how this might affect the climate?
 - We think we have a pretty good idea
- How might that affect ecosystems?
 - range expansions, extinctions
- Have we already seen changes due to humans?
 - Probably
- What is likely to happen in the future?
 - Continued warming, even if we stop emitting now
 - Possibility of surprises: positive feedbacks

If CO₂ is the culprit, then who is responsible?.....



Motor vehicle use is highest in developed countries



Some things to think about...

- Should we take expensive steps in alternate fuels given science doesn't even know if humans are altering climate?
- Should developing countries have to reduce emissions too?
- What can YOU do to minimize YOUR contribution to global warming?

Risks To Humankind (EPA)

- I. High-risk problems
 - A. Habitat alteration and destruction
 - B. Loss of biological diversity
 - C. Stratospheric ozone depletion
 - D. Global climate change
- II. Medium-risk problems
 - A. Pesticides
 - B. Toxins and pollutants in surface waters
 - C. Acid deposition
 - D. Airborne toxins
- III. Low-risk problems
 - A. Oil spills
 - B. Groundwater pollution
 - C. Radionuclotides
 - D. Thermal pollution