Global Climate and Climate Change: Drivers and Variability

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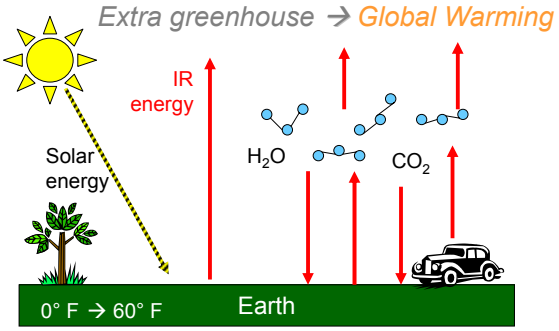
Outline

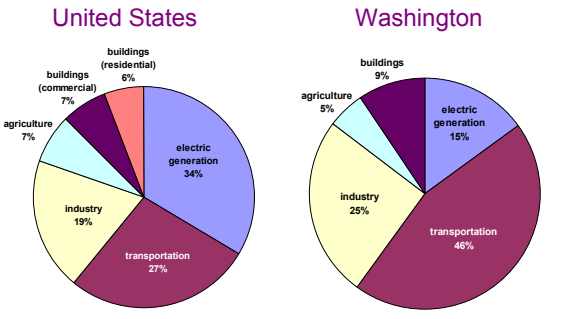
- What controls the Earth's climate?
  - the greenhouse effect
  - forcings and feedbacks
- How does climate change on different timescales?
  - ice ages, el niño, and weather
  - natural versus human-induced changes
- What do we know about future climate?
  - climate model predictions
  - global impacts of climate change
- Activity

The Greenhouse Effect



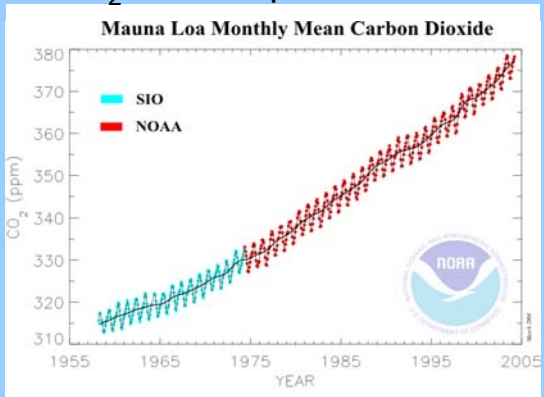
GH gases absorb infrared and emit it back to earth, warming us up

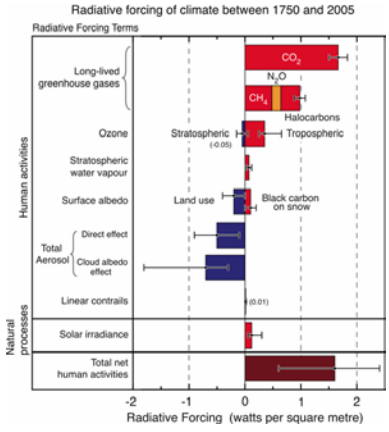
Greenhouse gas emissions by sector



Source: U.S. EPA 2005; Washington State 2004

CO_2 1958 to present





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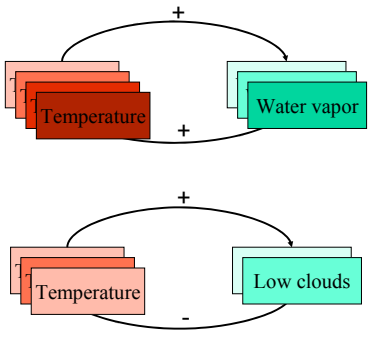
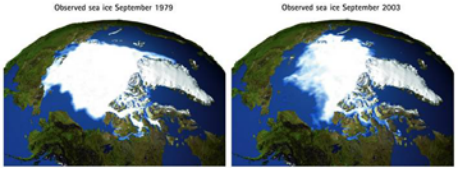
Climate Feedbacks



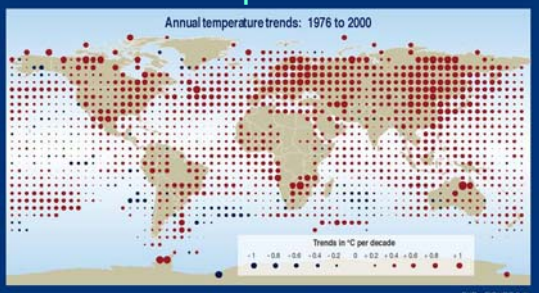
Loss of Sea Ice: a positive feedback



Source: Arctic Climate Impact Assessment (ACIA) (2004)

- 60% loss of summer sea-ice expected by 2050, its **complete disappearance** is expected by 2060-2080 during the summer months
- Loss of arctic habitat, animal and plant species

Observed temperature increase



IPCC INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

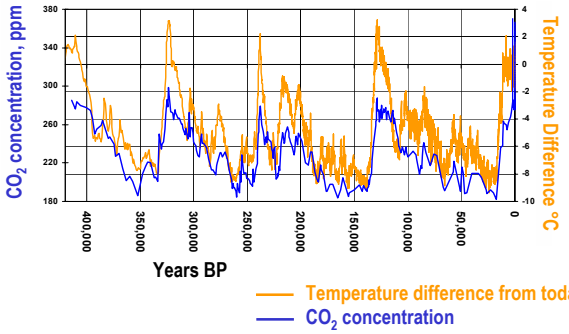
WMO UNEP

Part 2: Climate variability

Question:

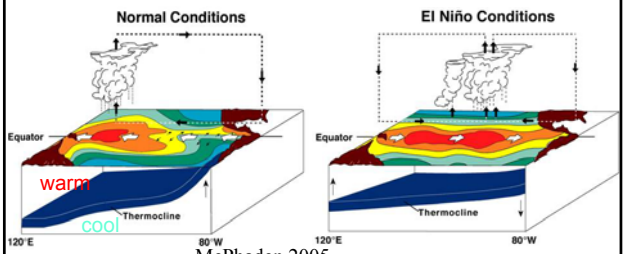
What is the difference between climate and weather?

CO_2 and temperature, 420,000 Before Present to present



Source: various, assembled by Davies 2000

Interannual variability: El Niño

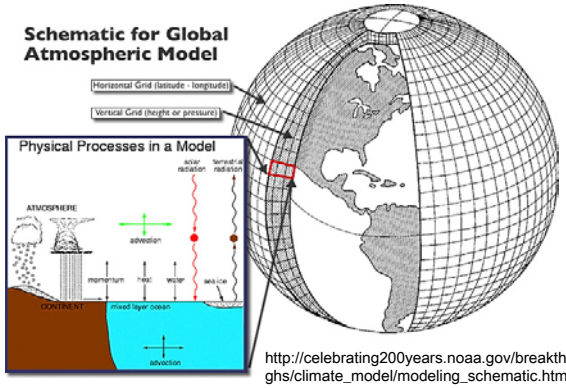


McPhaden 2005

- El niño approximately every 2-7 years, lasts 1-1.5 years
- Feedbacks between wind, sea surface temperature, thermocline
- Impacts: declining fish populations, drought, flooding
- Will global warming affect the frequency of el niño events?

Putting it all together: Climate Models

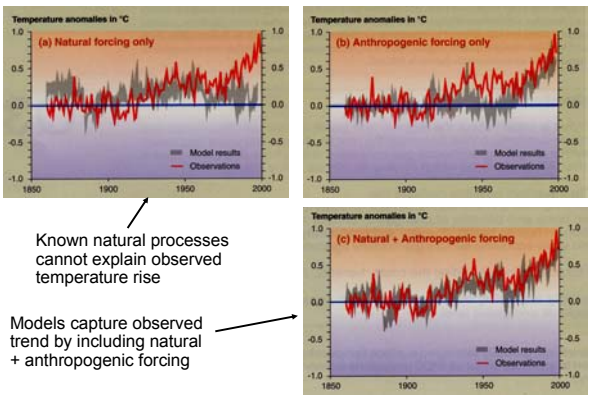
- Describe the physics underlying the earth system using equations
- Computer program that solves equations to get temperature, rainfall, etc. for different regions of the world
- Include natural and anthropogenic effects
- Predict average values (climate, not weather) for the future
- Test our understanding of current climate



http://celebrating200years.noaa.gov/breakthroughs/climate_model/modeling_schematic.html

Advection = transport (by wind, ocean currents)

Observed vs. modeled temperature rise since 1860

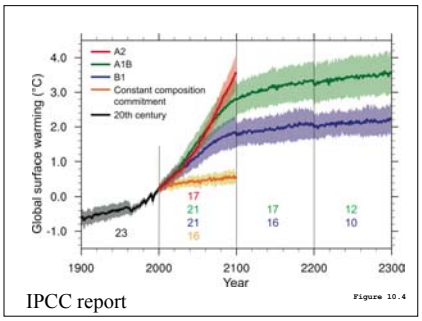


Known natural processes cannot explain observed temperature rise

Models capture observed trend by including natural + anthropogenic forcing

Source: IPCC

Climate model predictions



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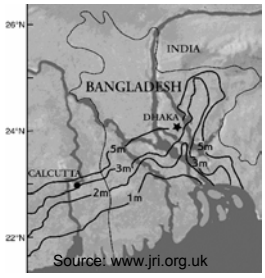
- Shaded envelope represents model uncertainty
- Different colors represent our choices

Sea Level Rise

Sea level is already rising and is predicted to accelerate!



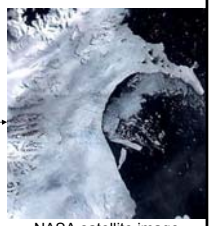
1-5 meters in Bangladesh

•1994-2004: 3 mm/yr sea level rise: 40% glacial melt, 60% thermal expansion of water

• Assuming no major melting of Greenland/ West Antarctic ice sheet: 3.5" - 35" (0.09 - 0.89 m) rise by 2100.

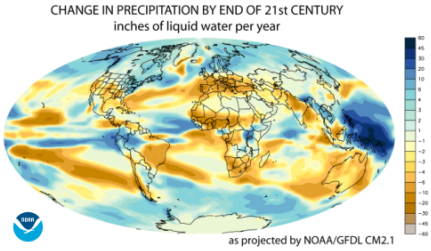
• Greenland or Antarctic ice sheets could add ~6.5 m and 8 m respectively

Larsen ice sheet collapse →



NASA satellite image

Changing Precipitation



- Dry areas get drier, wet areas get wetter
- More uncertainty in precipitation changes than temperature changes
- More intense hurricanes?