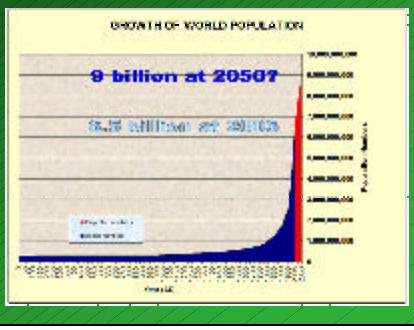
Global Warming

The Impact on Engineering

Have We Had an Impact?



Have We Had an Impact?

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Thickness of Earth's Atmosphere

The Earth's atmosphere is very thin. At 7 miles high you are above 75% of the atmosphere

3 Forms of Heat Transfer

- Conduction
- Convection
- Radiation

Space is a vacuum. The earth can only gain or loose heat through radiation.

Solar Heating

Some reflected back to space – no heating

Some absorbed by atmosphere or planet surface – causes heating

Solar Heating

Heat Reflection

Oceans are dark and reflect little energy back to space – 90% absorption

Heat Reflection

Forested areas are lighter and reflect more back to space

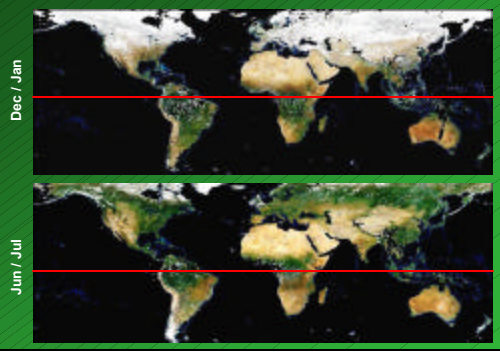
Heat Reflection

Desert areas reflect more light

Heat Reflection

Ice reflects the most amount of light back to space – 10% absorption

Albedo of the Earth



Heat Input = Heat Output

Reflection from Earth

Radiation from Sun

T^4 Radiation – radiates what was absorbed

Atmosphere Absorbs Sun's Energy

- Nitrogen – 78% (not a green house gas)
- Oxygen – 21 % (not a green house gas)
- H_2O – Up to 4% (green house gas)
- CO_2 – trace – (green house gas)
- Methane – trace – (green house gas)

Temperature Without Greenhouse Gases

Average Temperature -18 Centigrade

Energy Production Byproducts

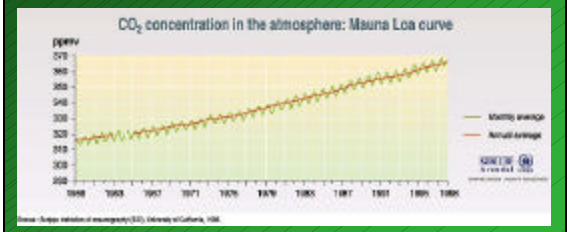
Petroleum → CO_2, H_2O

Coal → CO_2

Measuring CO_2 in Air

- 1958 International Geophysical Year
- Charles David Keeling
- Mauna Loa – Hawaii
  - High altitude – clean air
  - Far away from industrial output

CO_2 Concentrations Mauna Loa



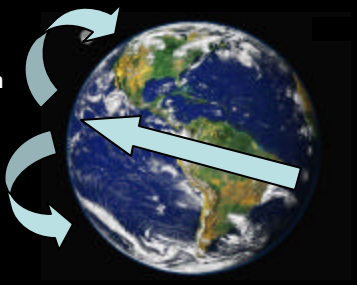
Ice Coring at Vostok Antarctica

Measure CO_2 and Temperature

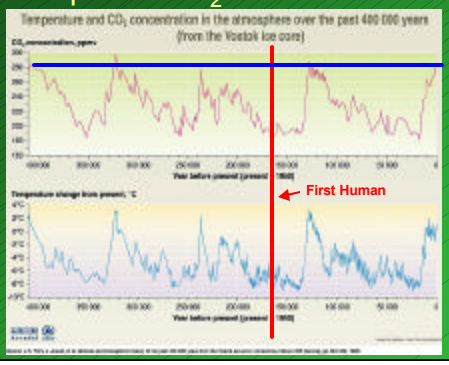
- Measure CO_2 in small bubbles
- Measure isotope of Oxygen – O_{18}
  - Heaver than normal Oxygen – O_{16}
  - Water with O_{18} heaver than normal water

O_{18} Content

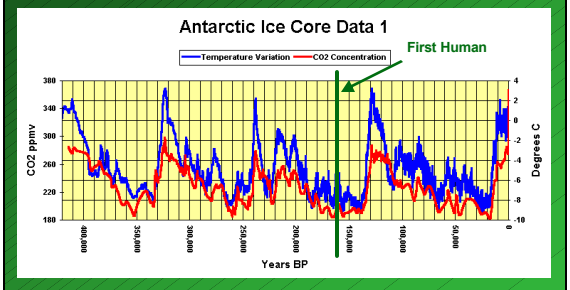
Movement of Moisture from equator to higher latitudes

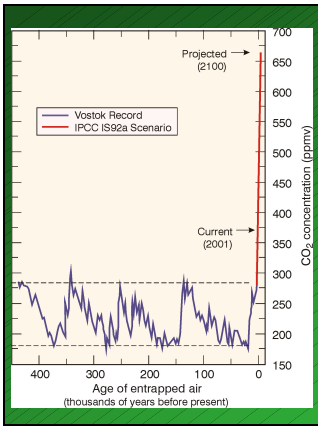


Atmospheric CO_2 Concentrations



Temperature and CO_2



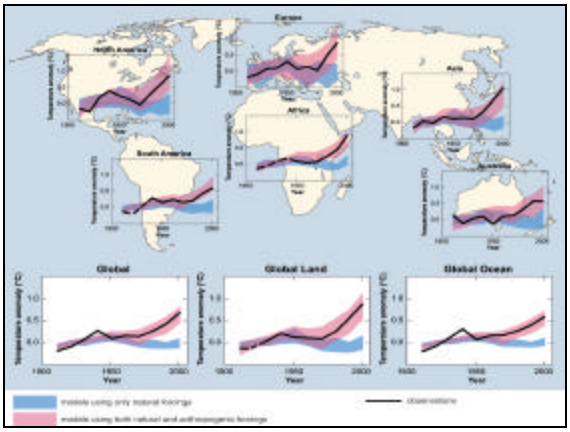


Current and Projected CO_2 Concentration

IPCC Intergovernmental Panel on Climate Change

IPCC – Report 4

- 2500 Scientific expert reviewers
- 600 contributing authors
- 450 lead authors
- 113 countries
- 6 years of work



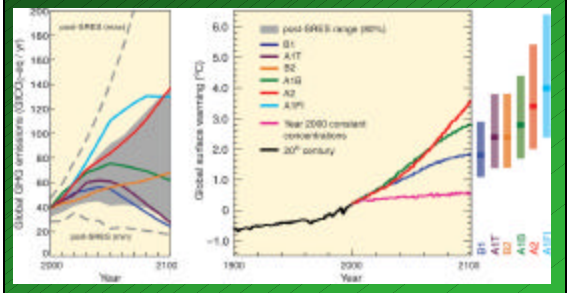
What Is the Future?

- IPCC IS92a – business as normal – 1% increase in CO_2 per year
- A1F1 – The future is heavily dependent upon fossil fuels
- A1T – Most energy comes from non fossil sources
- A1B – A balanced approach with fossil and non fossil fuels

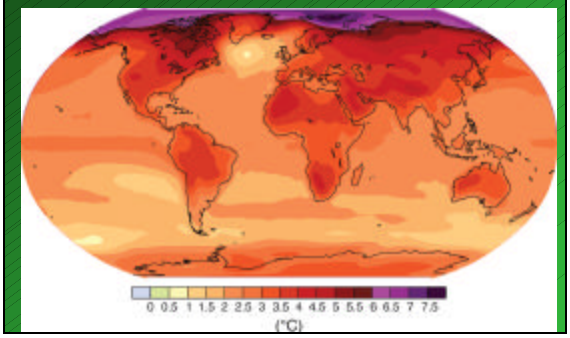
More Scenarios

- A2 – World remains culturally divided and population in underdeveloped countries continues to grow
- B1 – World cultures converge and population peaks at mid century
- B2 – Emphasis on local solution to problems – population continue to grow but not as fast as A2

Projected Global Temperatures



A1B – Moderate Scenario



Questions ???