Global Warming

The Impact on Engineering

Have We Had an Impact?

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

Radiation from Sun

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

Reflection from Earth (no heating)

Radiation from Sun

T^4 Radiation (cools the earth)
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 greenhouse gas)
- Oxygen – 21% (not a greenhouse gas)
- $H_2O$ – Up to 4% (greenhouse gas)
- $CO_2$ – trace – (greenhouse gas)
- Methane – trace – (greenhouse 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
CO₂ Concentrations Mauna Loa

Ice Coring at Vostok Antarctica

Measure CO₂ and Temperature
- Measure CO₂ in small bubbles
- Measure isotope of Oxygen – O₁₈
  - Heavier than normal Oxygen – O₁₆
  - Water with O₁₈ heavier than normal water

Movement of Moisture from equator to higher latitudes

Atmospheric CO₂ Concentrations

Temperature and CO₂
Current and Projected CO₂ 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 CO₂ 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 ???