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Changing Climates



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Concepts

- What is climate change?
- How is it recorded/studied?
- What are the cause and effect relationships brought about by climate change?
- What does it all mean?

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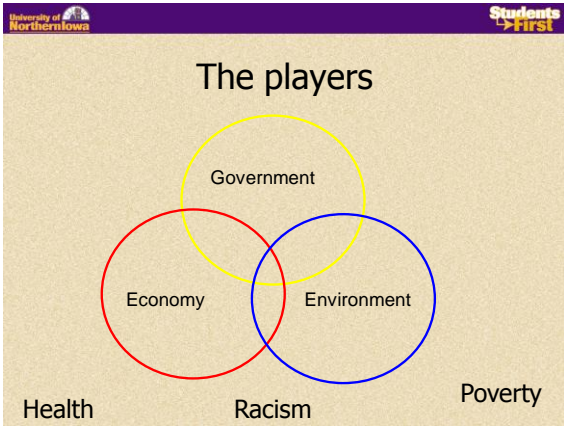
Global warming in the public eye

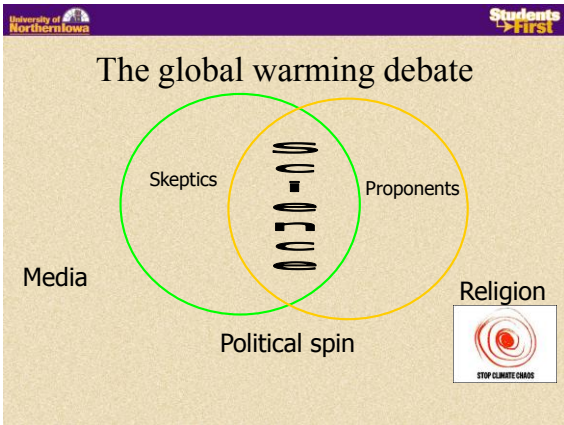
Science from Hollywood? Climate food crisis



disinformation Hurricane Katrina







Climate

- The average condition (temperature, precipitation, and wind) of a region.

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Global change

- Time scale
- Components
 - Oceans
 - Atmosphere
 - Landscape
 - Biology
 - Vegetation
 - Animals
 - Humans

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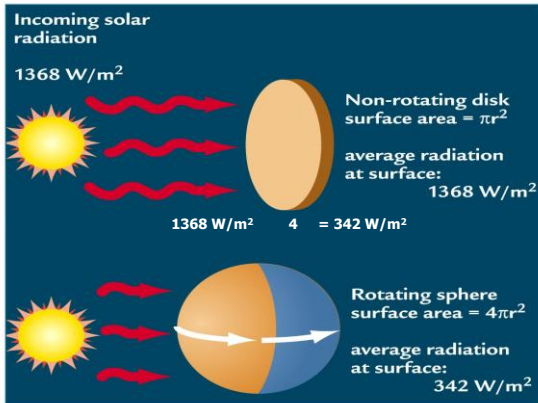
Driving forces behind climate change

- Tectonic processes
- Energy and Carbon Transfers in our Oceans
- Changes in the strength of the Sun
- Humans

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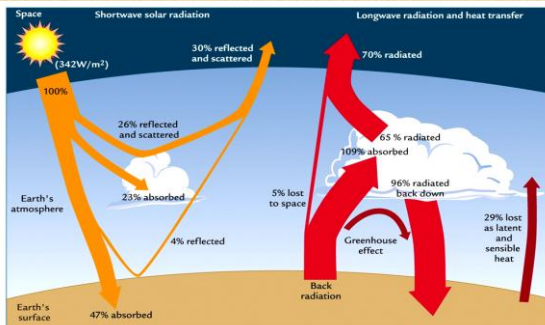
The nuts and bolts of our climate

Incoming energy
1368 W/m²



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342 W/m² $\times 0.7 = 240 \text{ W/m}^2$



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Calculating the average temperature of Earth

- Data from satellites and the space station
 - 16 C (257K or 3 F)
- Temperature data from the Earth's surface (averaged over the past 80 years)
 - 15 C (288K or 59 F)

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greenhouse effect

- Water Vapor (H₂O_v)
- Carbon dioxide (CO₂)
- Methane (CH₄)

Longwave radiation and heat transfer

70% radiated

65% radiated

109% absorbed

5% lost to space

96% radiated back down

Greenhouse effect

Back radiation

29% lost as latent and sensible heat

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Changes in the energy received from our Sun

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Earth-orbital changes

- Milutin Milankovitch (1920's)
- Observation: The Earth rotation around its Sun changes over time in a regular (cyclic) manner
- "The Milankovitch Cycle"

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The Milankovitch Cycle

- Three cycles;
 1. Orbital eccentricity 100,000 yrs
 2. Axial tilt (or obliquity) 41,000 yrs
 3. Precession 26,000 yrs

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Eccentricity

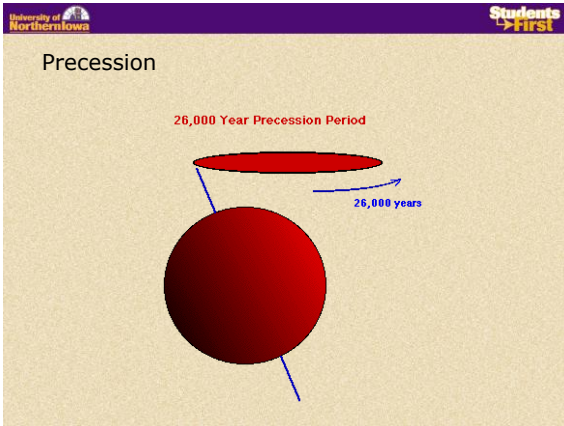
Time * 1000 years ago

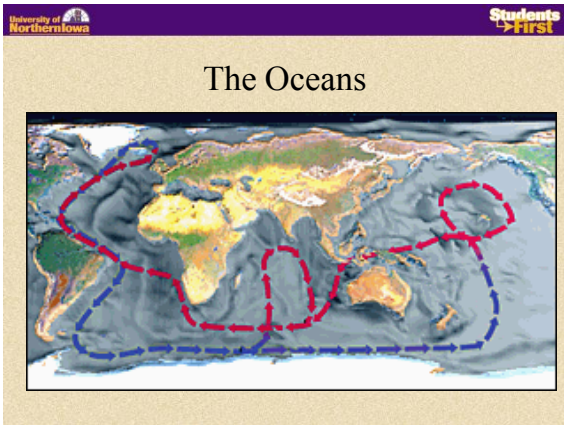
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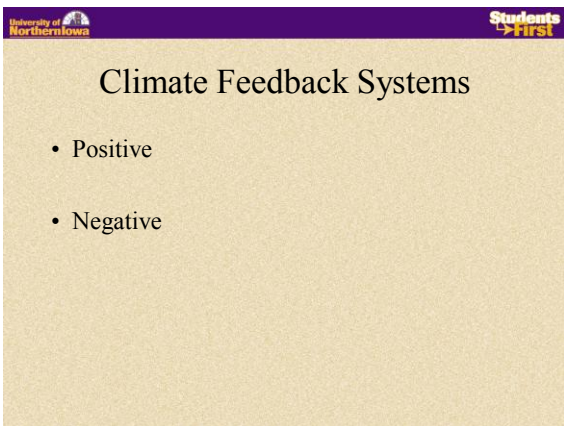
Obliquity (tilt)

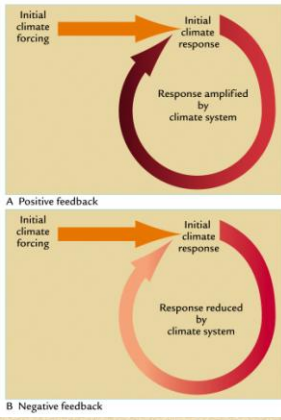
- Effect of tilt: Change in temperature range
- At minimum tilt = higher angles = decreasing the global temperature variation.

Minimum tilt Present tilt Maximum tilt









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black rock


vs.

white glacier

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How is past climate change recorded/studied?

- Climate Proxies
 - Ice cores
 - Deep sea cores
 - Vegetation, pollen and microfossils
 - More records exist.



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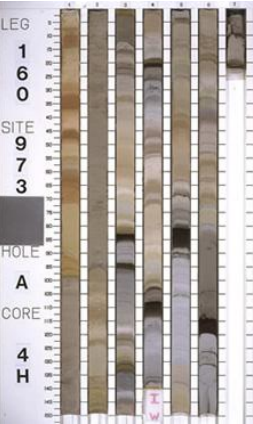

Ice cores



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Deep sea cores

- ODP (The Ocean Drilling Program)




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Foraminifera

The Oxygen Isotope Record




Courtesy Deep-Sea Drilling Project, Scripps Institution of Oceanography

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Vegetation

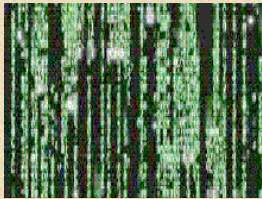
- Pollen
- Distributed by wind
- Deposited with sediment
 - E.g. Large lakes
- Influence most by
 - Climate
 - Human activity

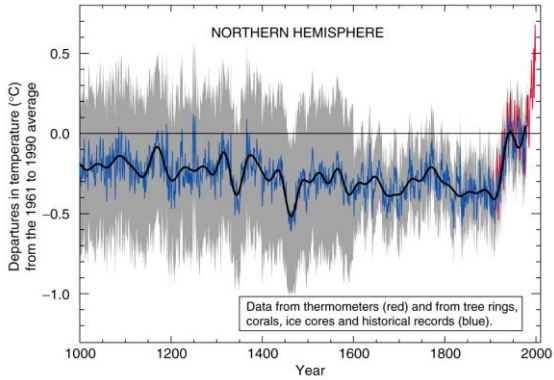


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The data

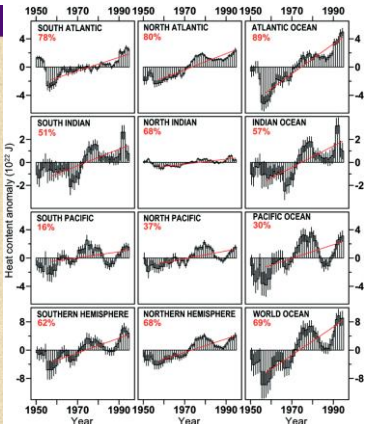
- Graphs
 - Why use them?

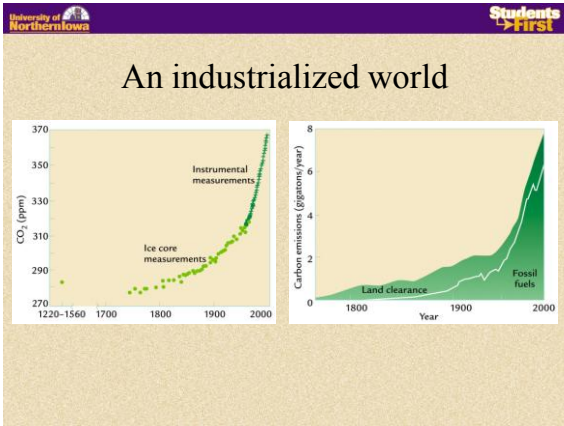




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Sea surface temperatures





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Products of a warming climate

A global perspective

