

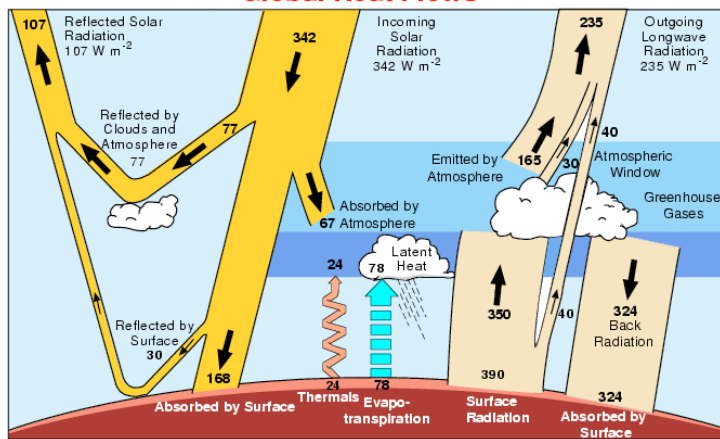
THE SCIENCE OF GLOBAL CLIMATE CHANGE

Philip Mote
Climate Impacts Group

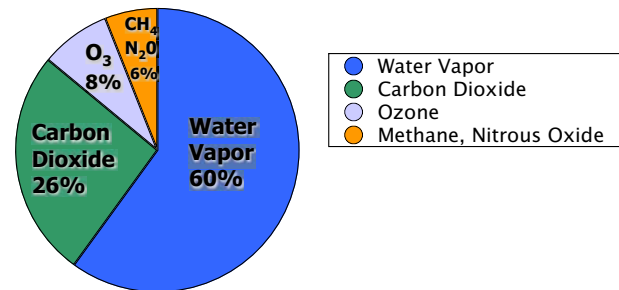
OUTLINE

- Physics of the greenhouse effect
- Observed changes in greenhouse gases and other forcing agents
- Observed changes in climate
- Climate models
- Predictions of future climate and impacts

Global Heat Flows



The Natural Greenhouse Effect: clear sky



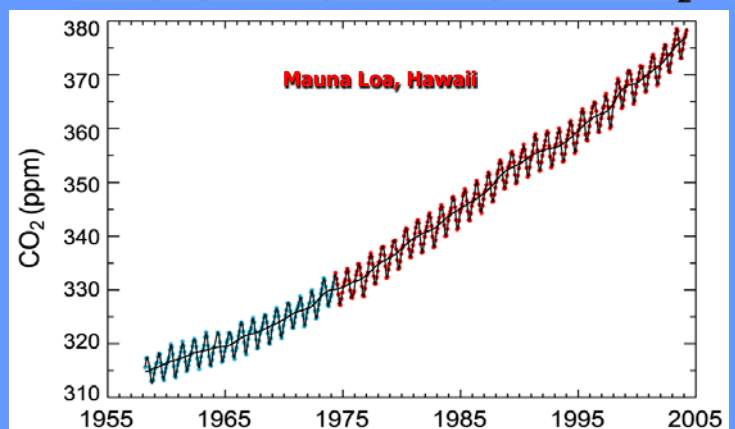
Clouds also have a greenhouse effect

Kiehl and Trenberth 1997

OUTLINE

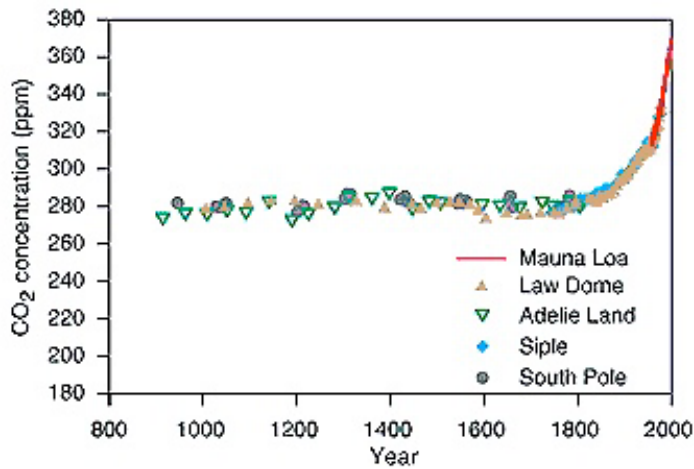
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Changing atmospheric composition: CO₂

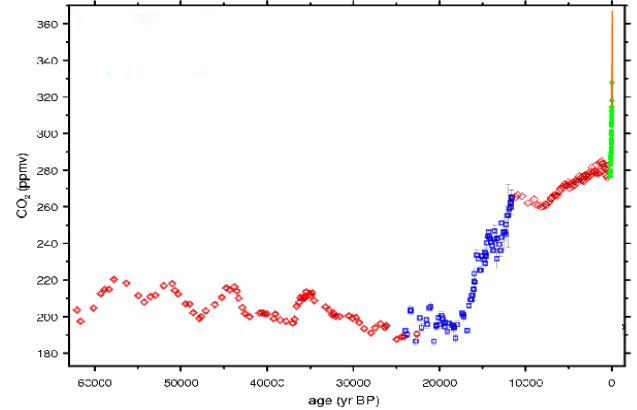


Data from Climate Monitoring and Diagnostics Lab., NOAA.
Data prior to 1973 from C. Keeling, Scripps Inst. Oceanogr.

Carbon dioxide: up 37%

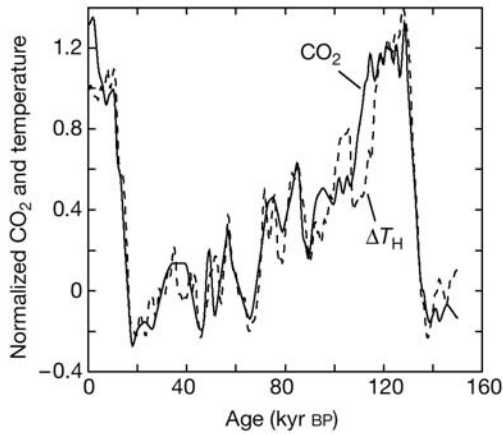


Carbon Dioxide Levels Over The Last 60,000 Years

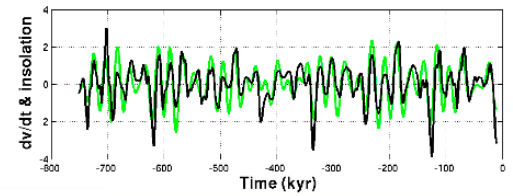


Source: University of Berne and National Oceanic and Atmospheric Administration

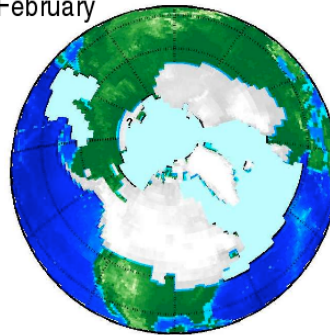
Temperature and CO2 vary together over glacial cycles



Source: Cuffey and Vimeux, Nature 412:523, 2001.



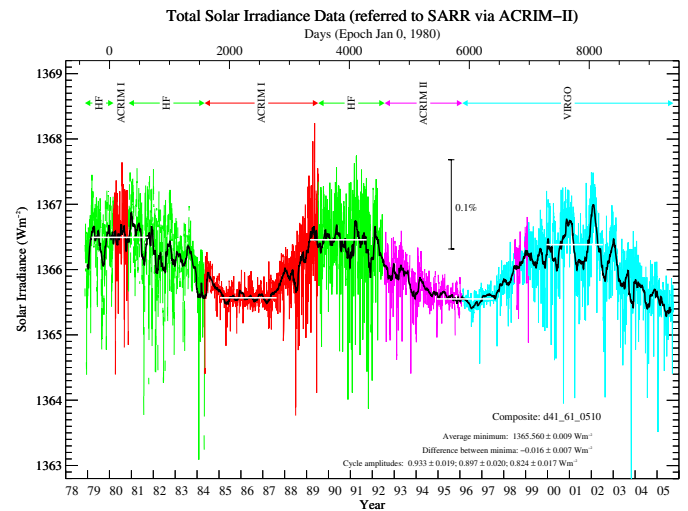
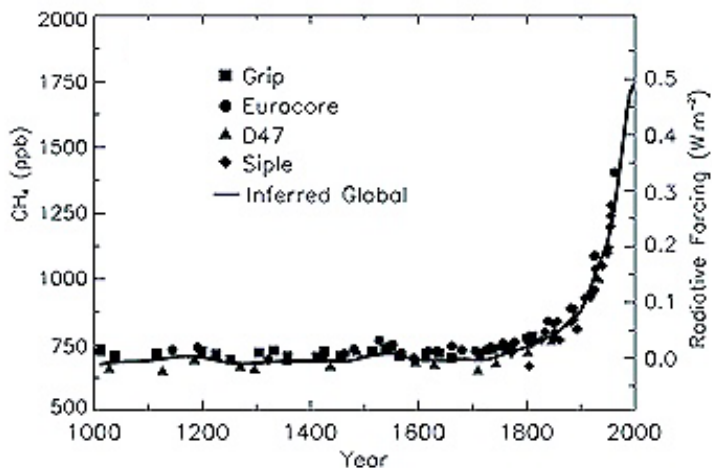
February



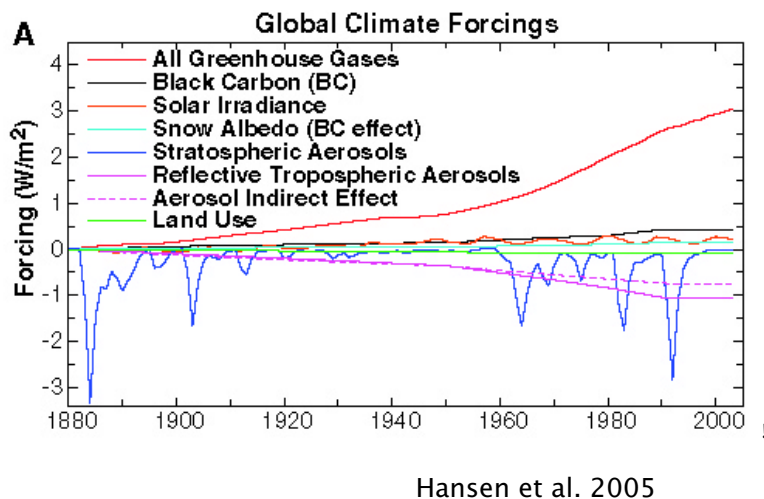
Ice sheets and solar forcing

from Gerard Roe, UW

Methane: up 150%



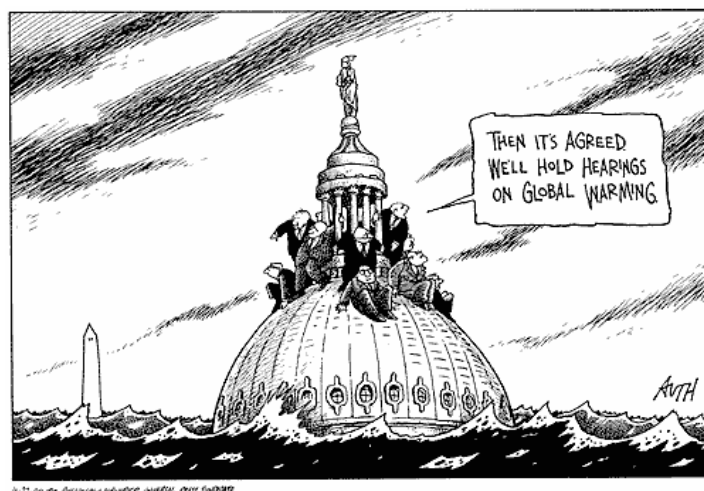
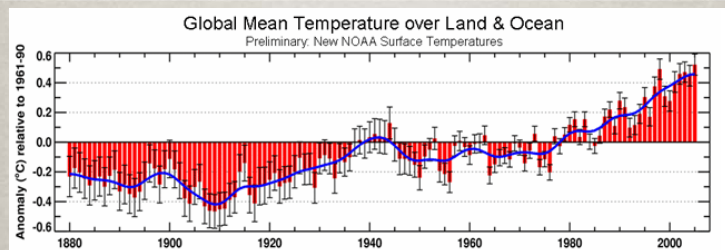
from: C. Frohlich, Space Science Reviews, 94, pp.15-24, 2000, with composite (vers d41_61_0510), ACRII-II (vers R-1010001) and VIRGO 6_001_0510 data (Oct 07, 2005)



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Variations of the Earth's surface temperature



"We know the surface temperature of the Earth is warming... We do not know how much our climate will change in the future..."
– President Bush, June 11, 2001

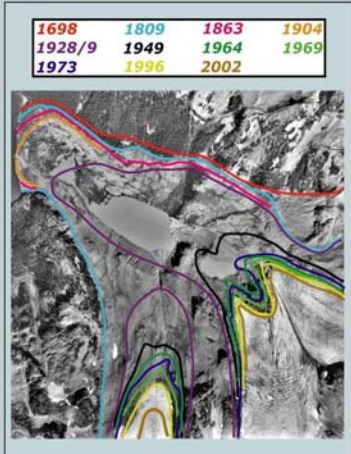


Courtesy of the USGS glacier group



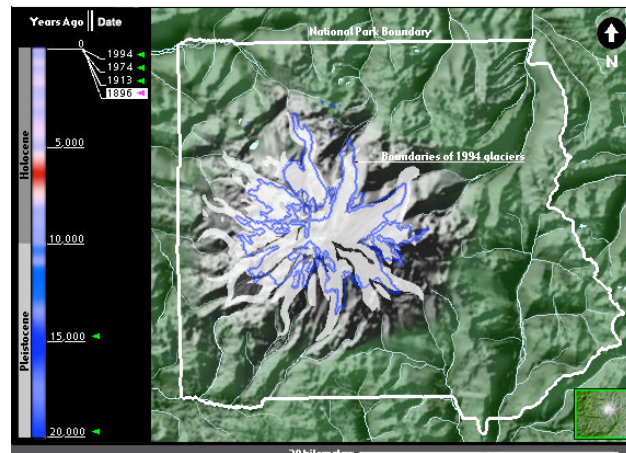
The South Cascade glacier retreated dramatically in the 20th century

Sphinx Glacier

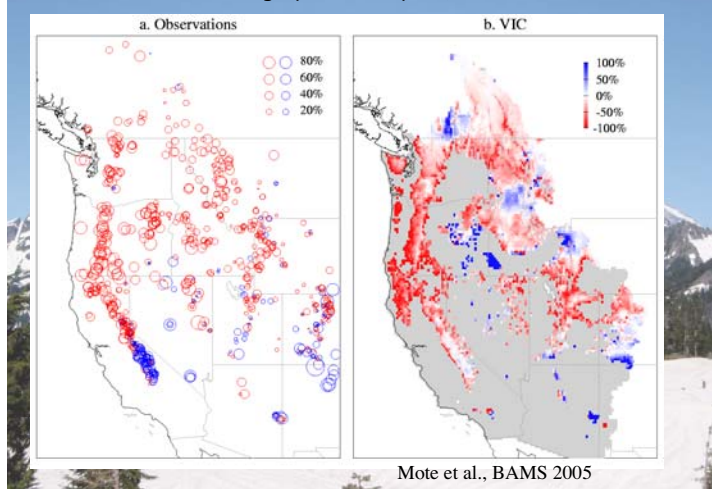


From John Clague, Simon Fraser Univ.

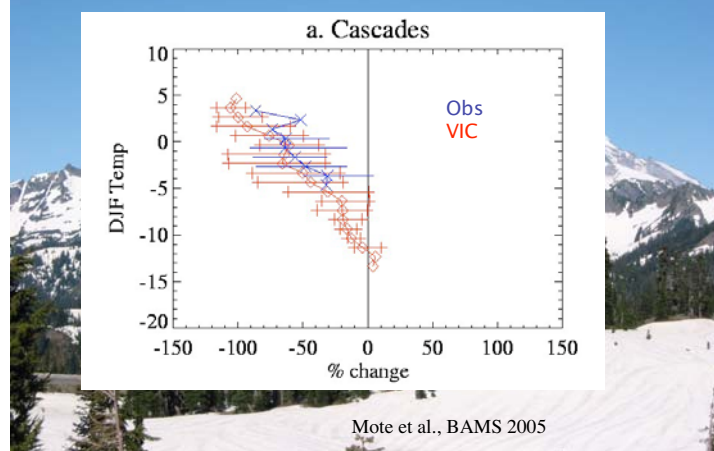
Glaciers at Mt Rainier



Declining April 1 snowpack, 1950–1997



1950–1997 relative trends in April 1 SWE vs winter temperature

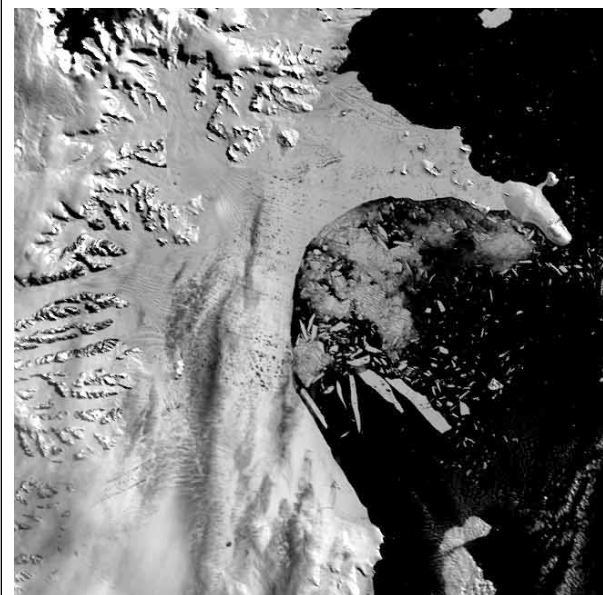


Larsen B
Ice shelf
Antarctica

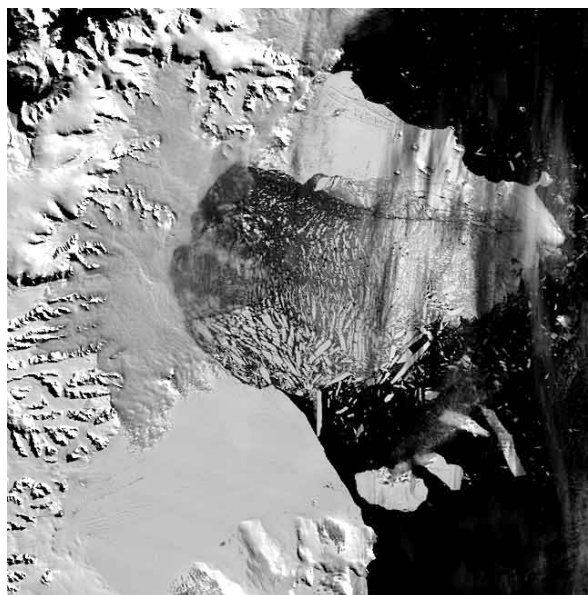
January 31, 200

MODIS data
Courtesy
NASA

February
17

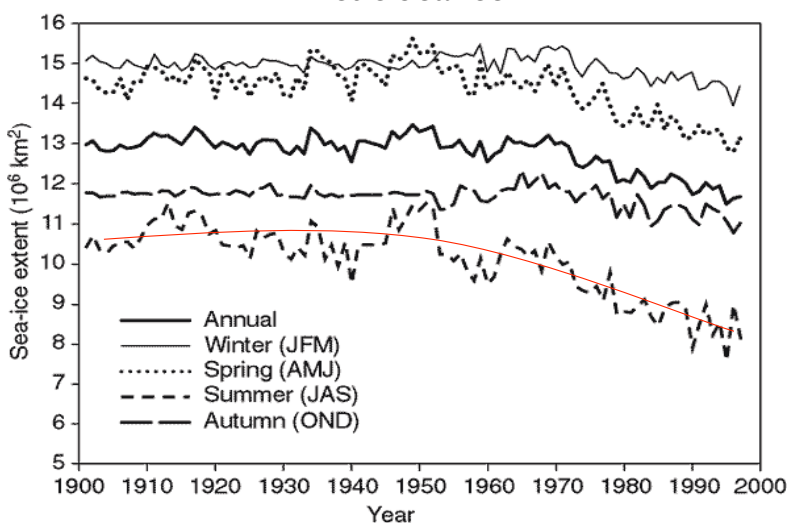


February
23

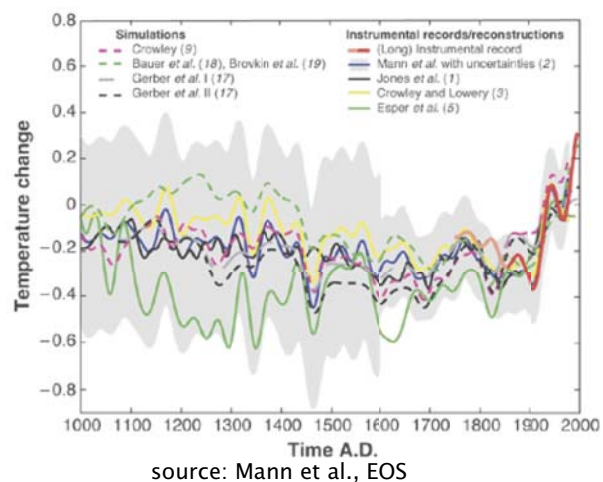


March 5

Arctic sea ice

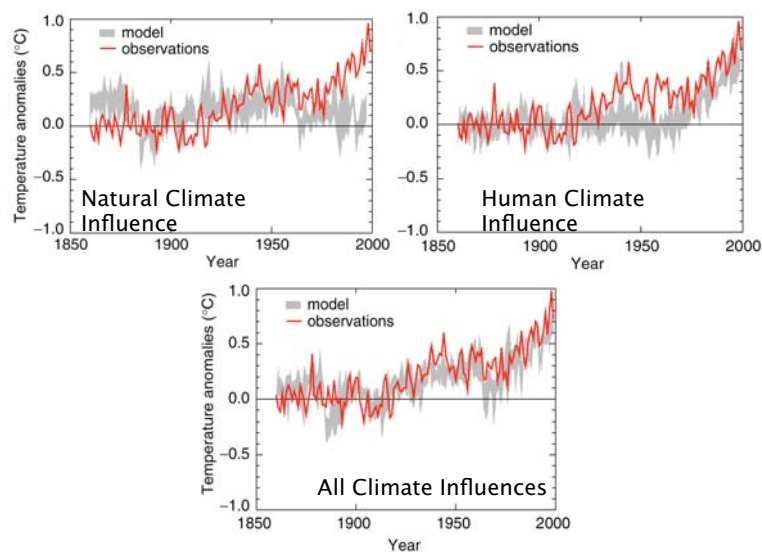


longer-term view



OUTLINE

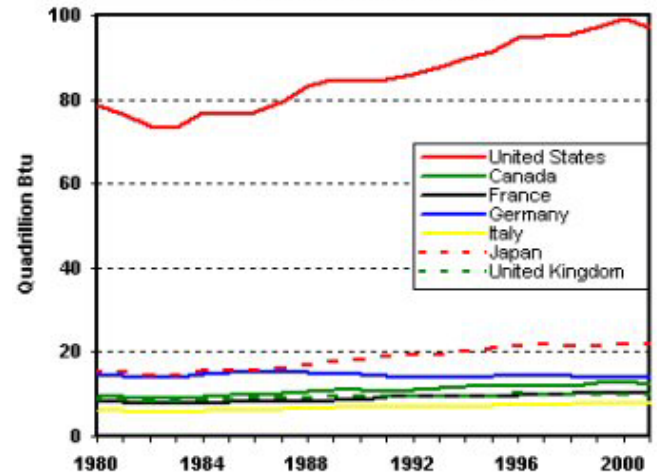
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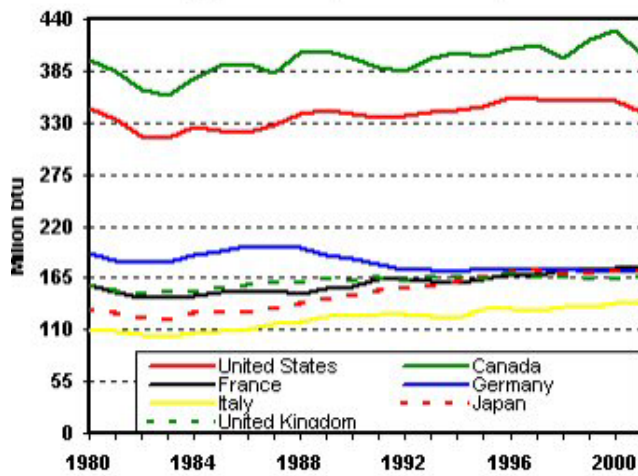
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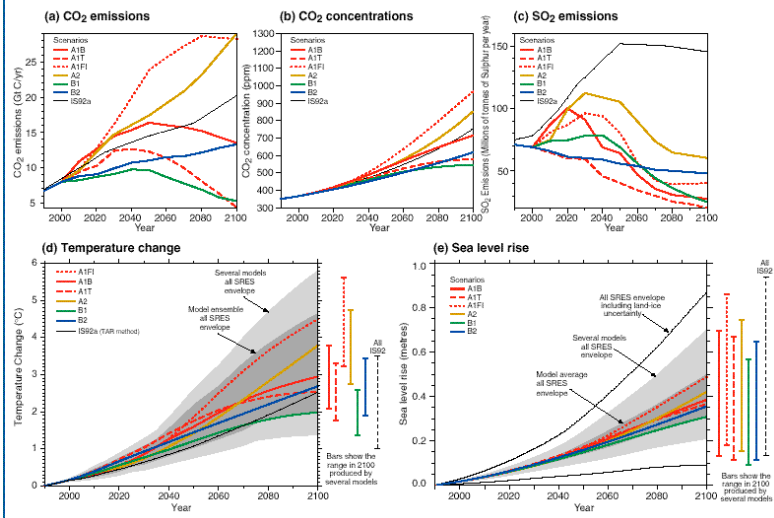
Energy Consumption



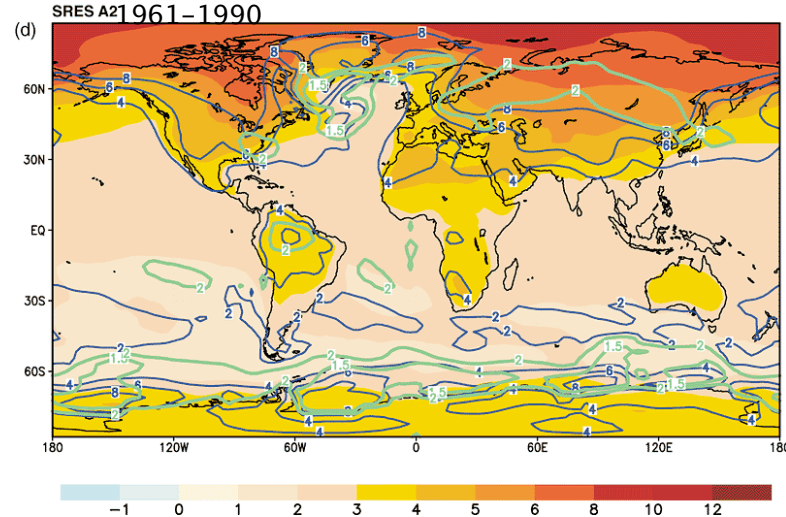
Energy Consumption Per Capita



The global climate of the 21st century



Temperature change, 2071-2100 minus SRES A2[1961-1990]



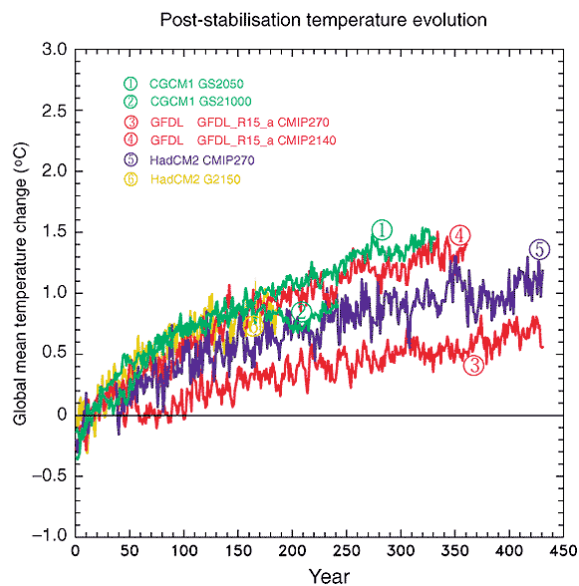
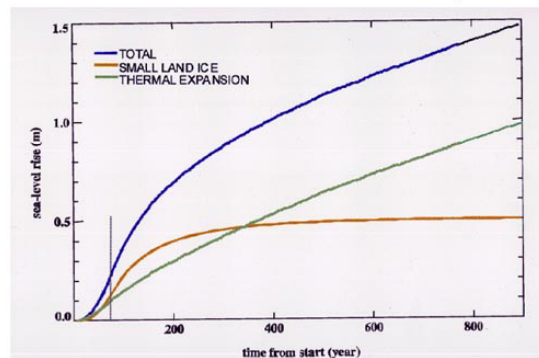


Figure 13: Sea Level Rise Commitment

Thermal expansion and land ice melt
after an initial 1% increase in CO₂ for 70 years

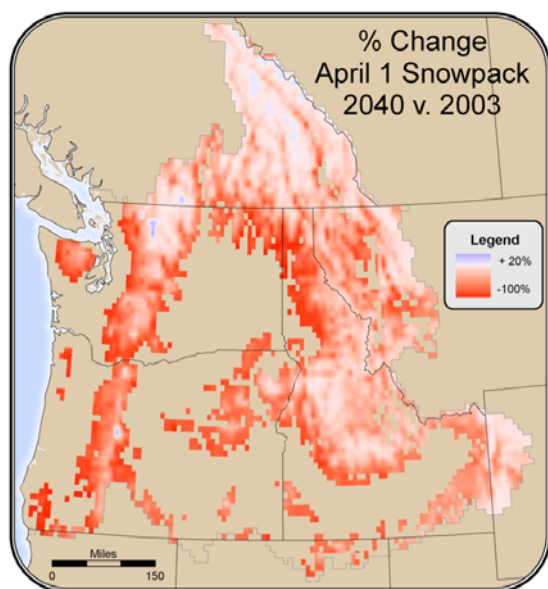


The Met Office Hadley Centre for Climate Prediction and Research

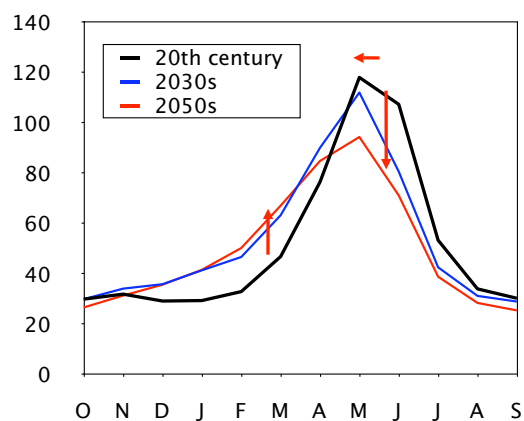


NORTHWEST IMPACTS

- Snow
- Summer water supply - ag, fish, hydro,...
- Coastal problems
- Forest changes



Snake River at Ice Harbor



CONCLUSIONS

- Human influence on global climate is growing
- Range of future effects: unprecedented rate of change poses challenges
- Some additional change already locked in: but decisions now could stabilize climate post-2040