

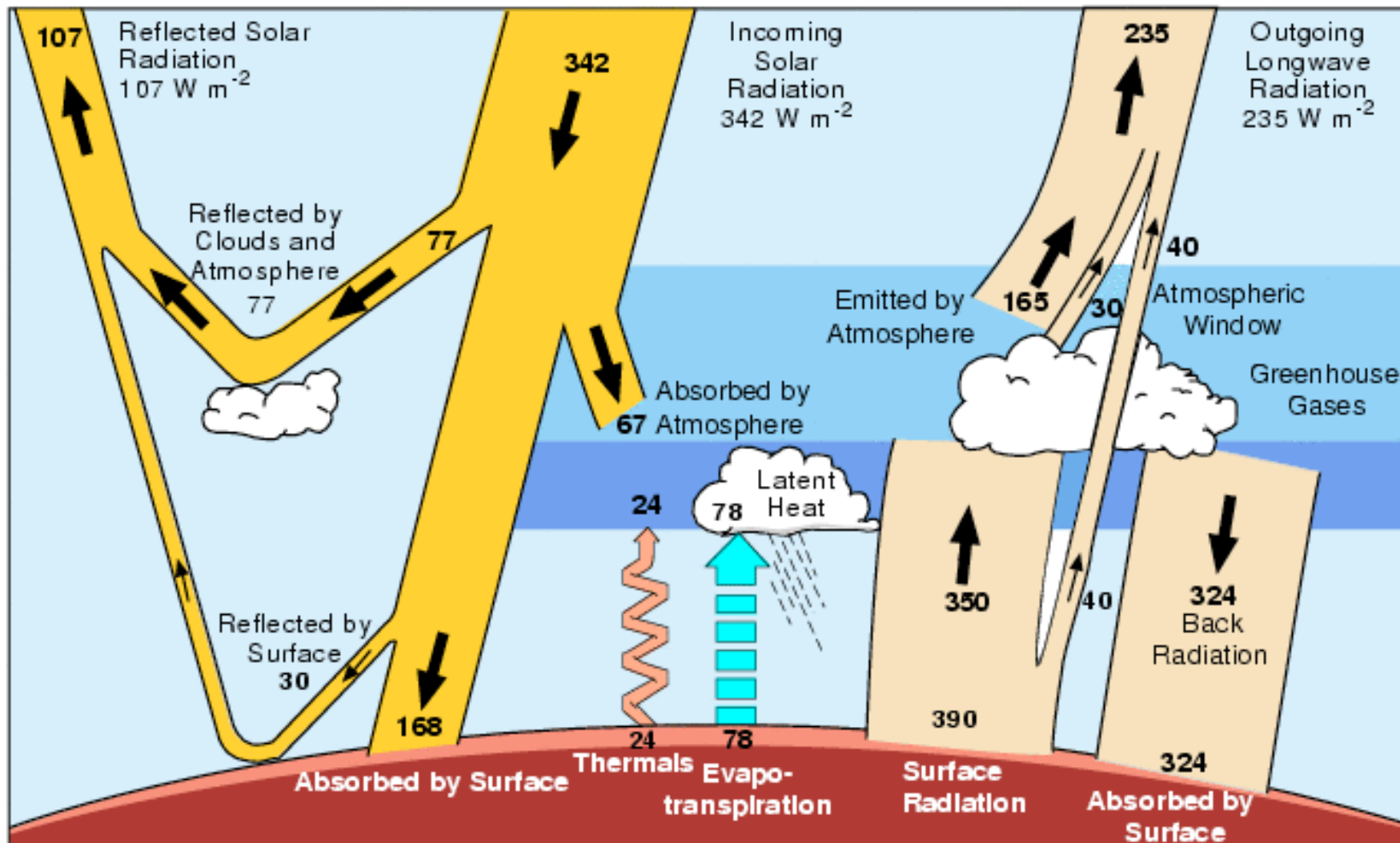
THE SCIENCE OF GLOBAL CLIMATE CHANGE

Philip Mote
Climate Impacts Group

OUTLINE

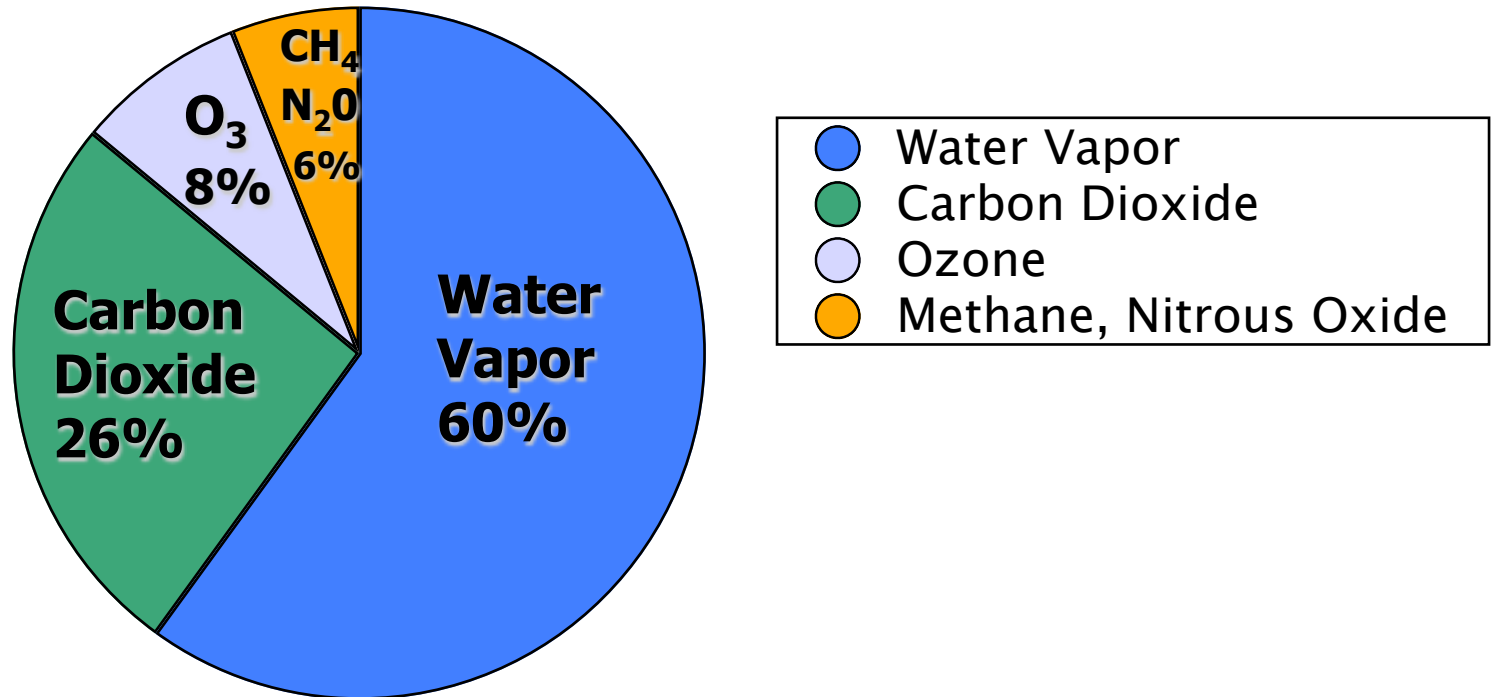
- Physics of the greenhouse effect
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Global Heat Flows



Kiehl and Trenberth 1997

The Natural Greenhouse Effect: clear sky



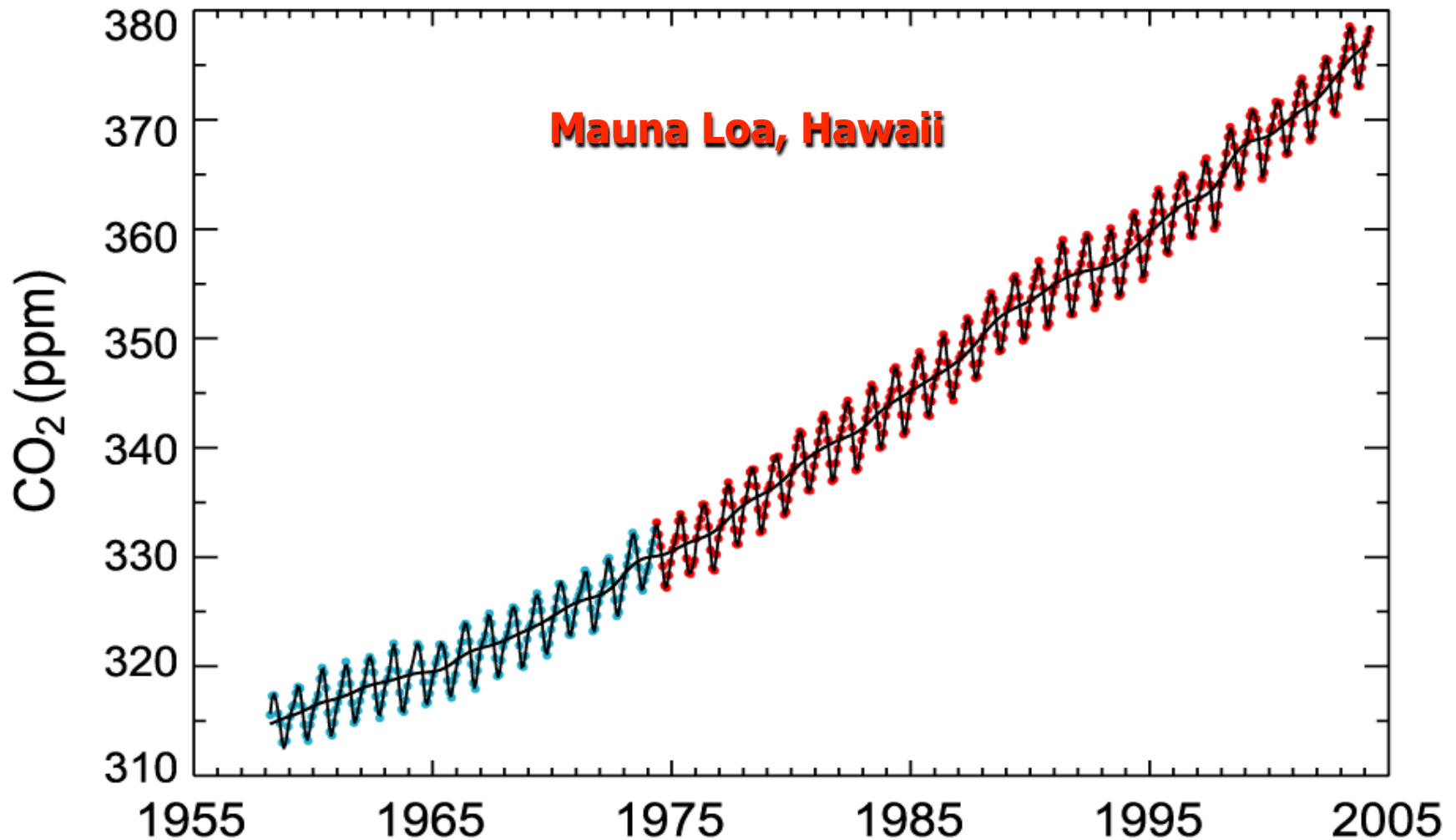
Clouds also have a greenhouse effect

Kiehl and Trenberth 1997

OUTLINE

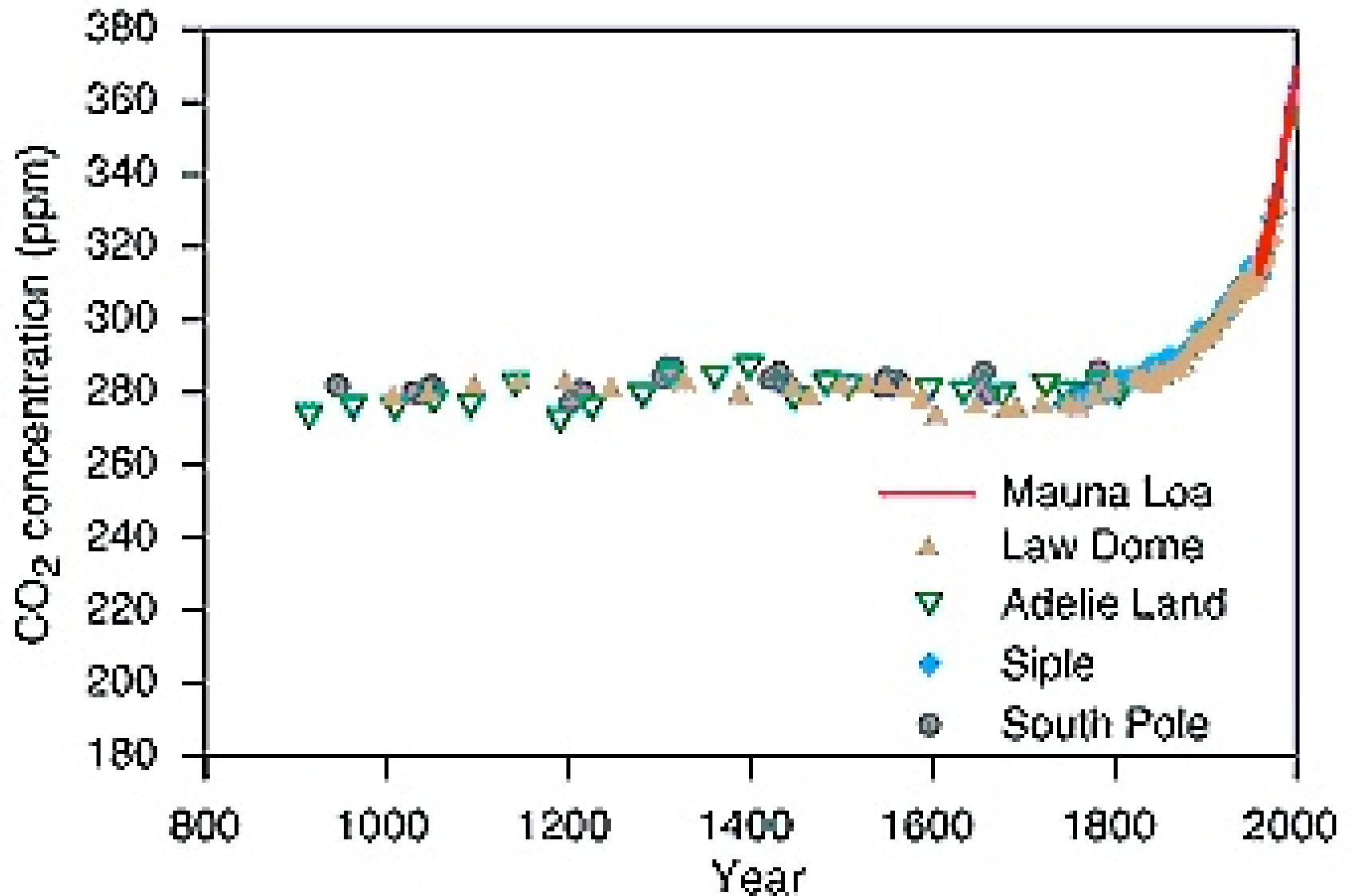
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Changing atmospheric composition: CO₂

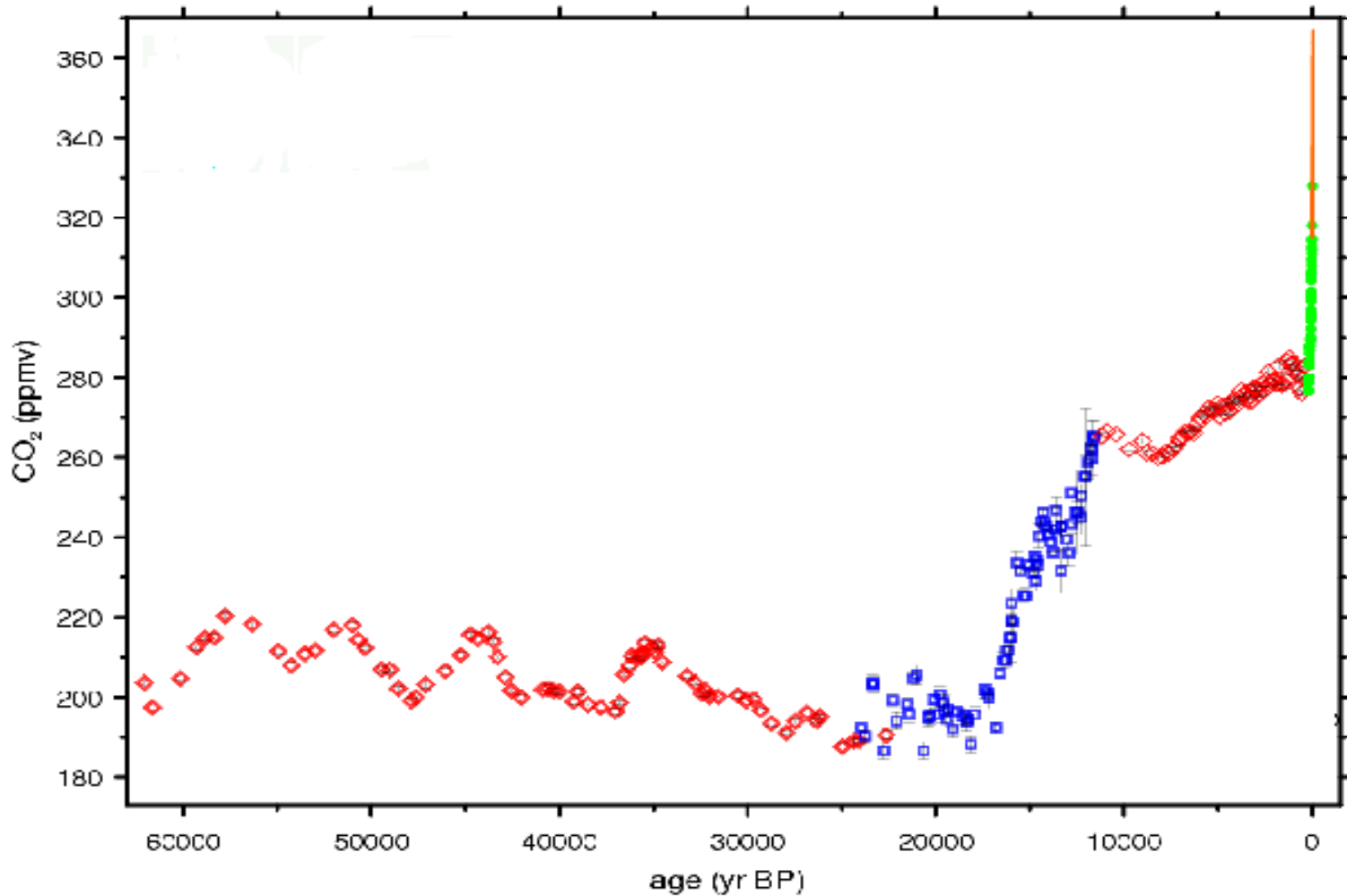


Data from Climate Monitoring and Diagnostics Lab., NOAA.
Data prior to 1973 from C. Keeling, Scripps Inst. Oceanogr.

Carbon dioxide: up 37%

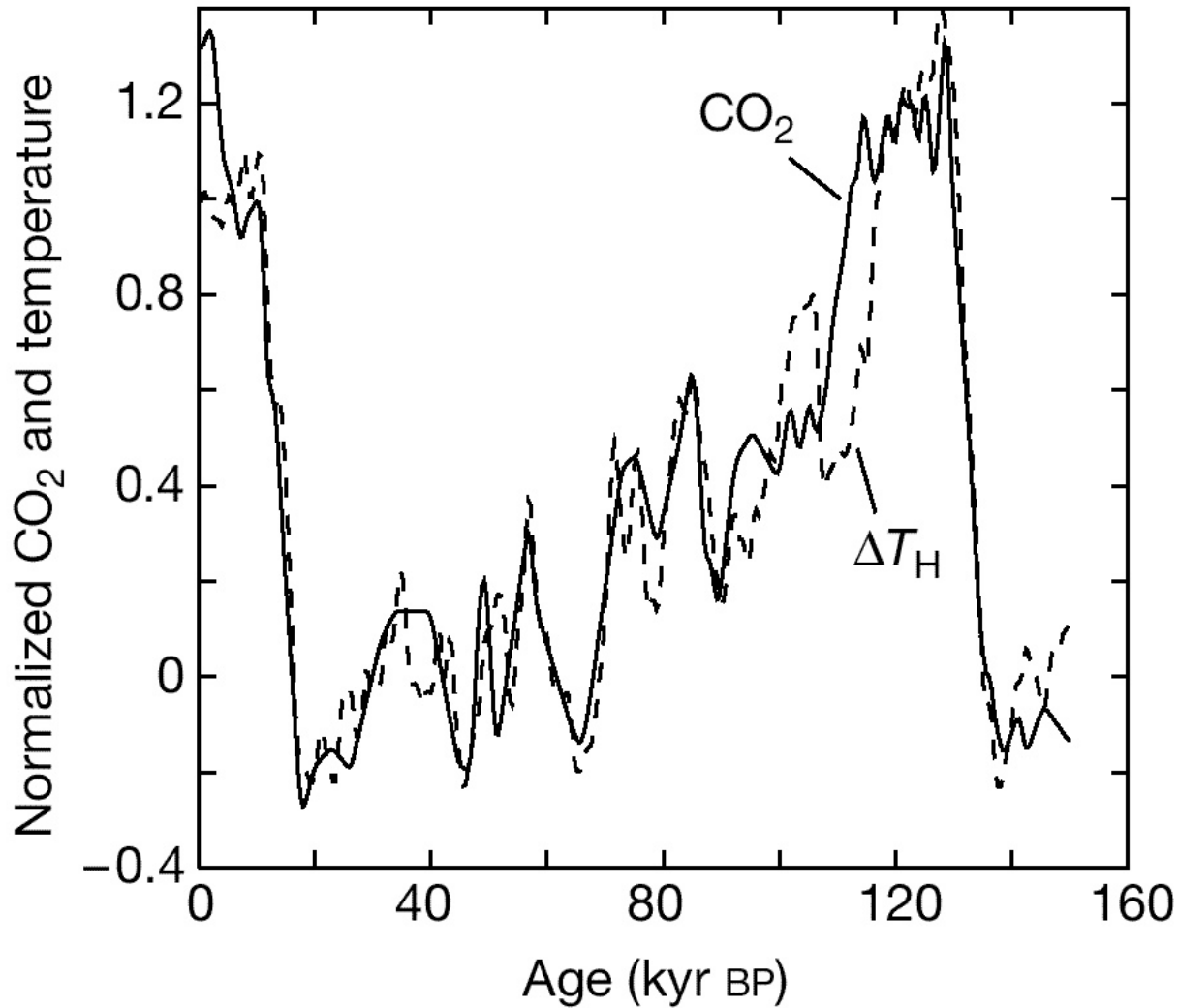


Carbon Dioxide Levels Over The Last 60,000 Years

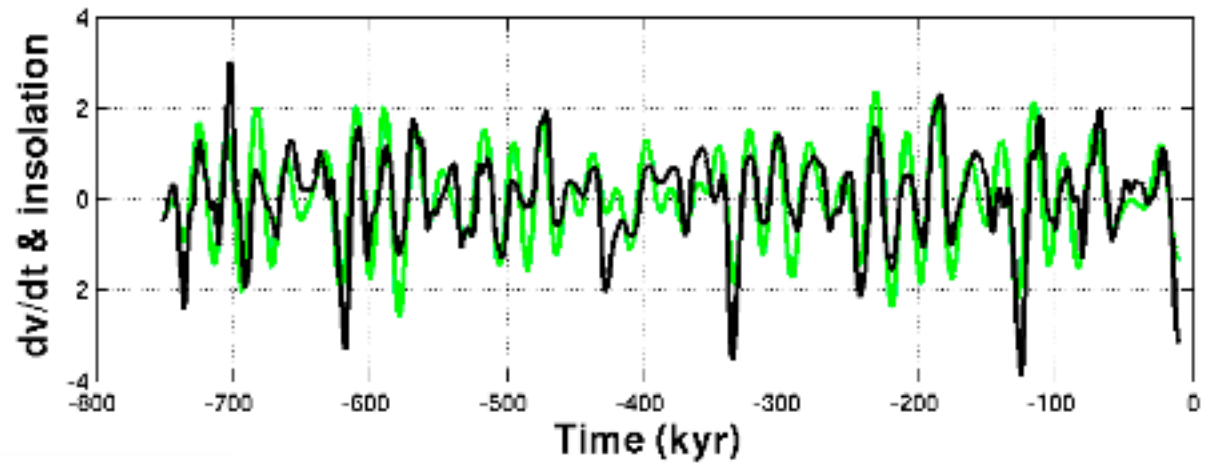


Source: University of Berne and National Oceanic and Atmospheric Administration

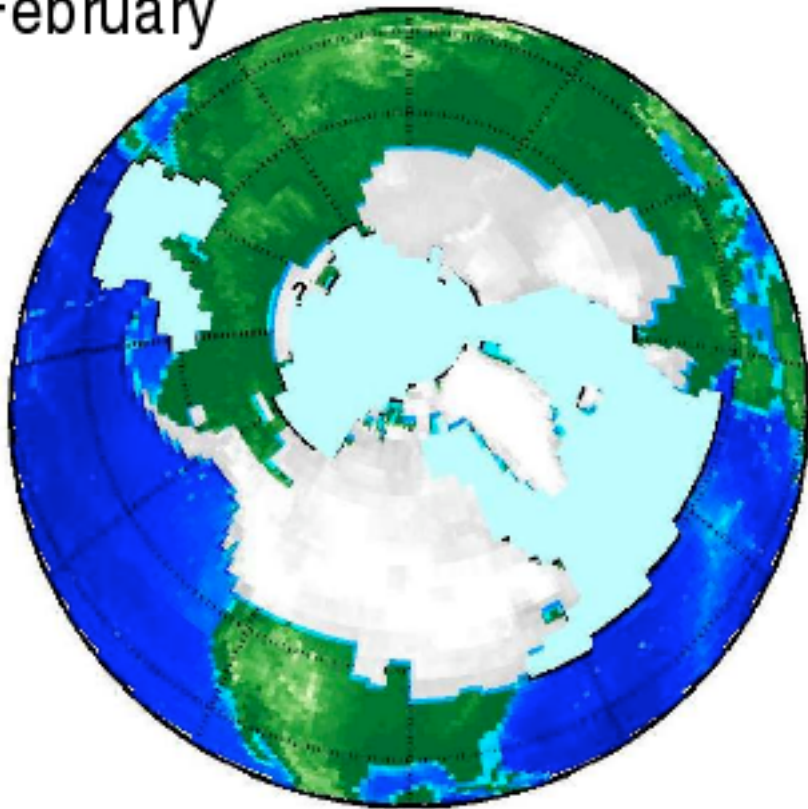
Temperature and CO₂ vary together over glacial cycles



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



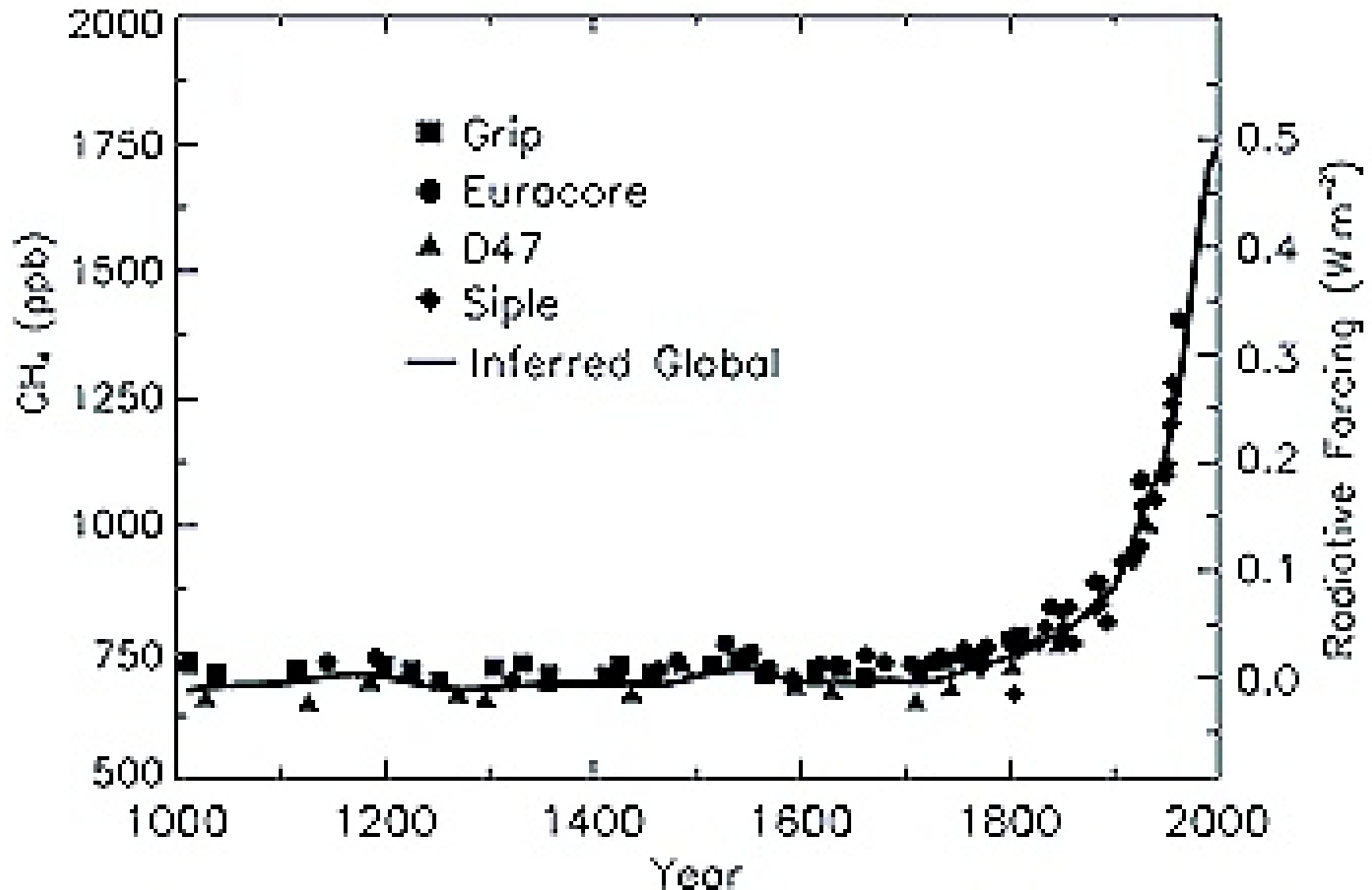
February



Ice sheets and solar forcing

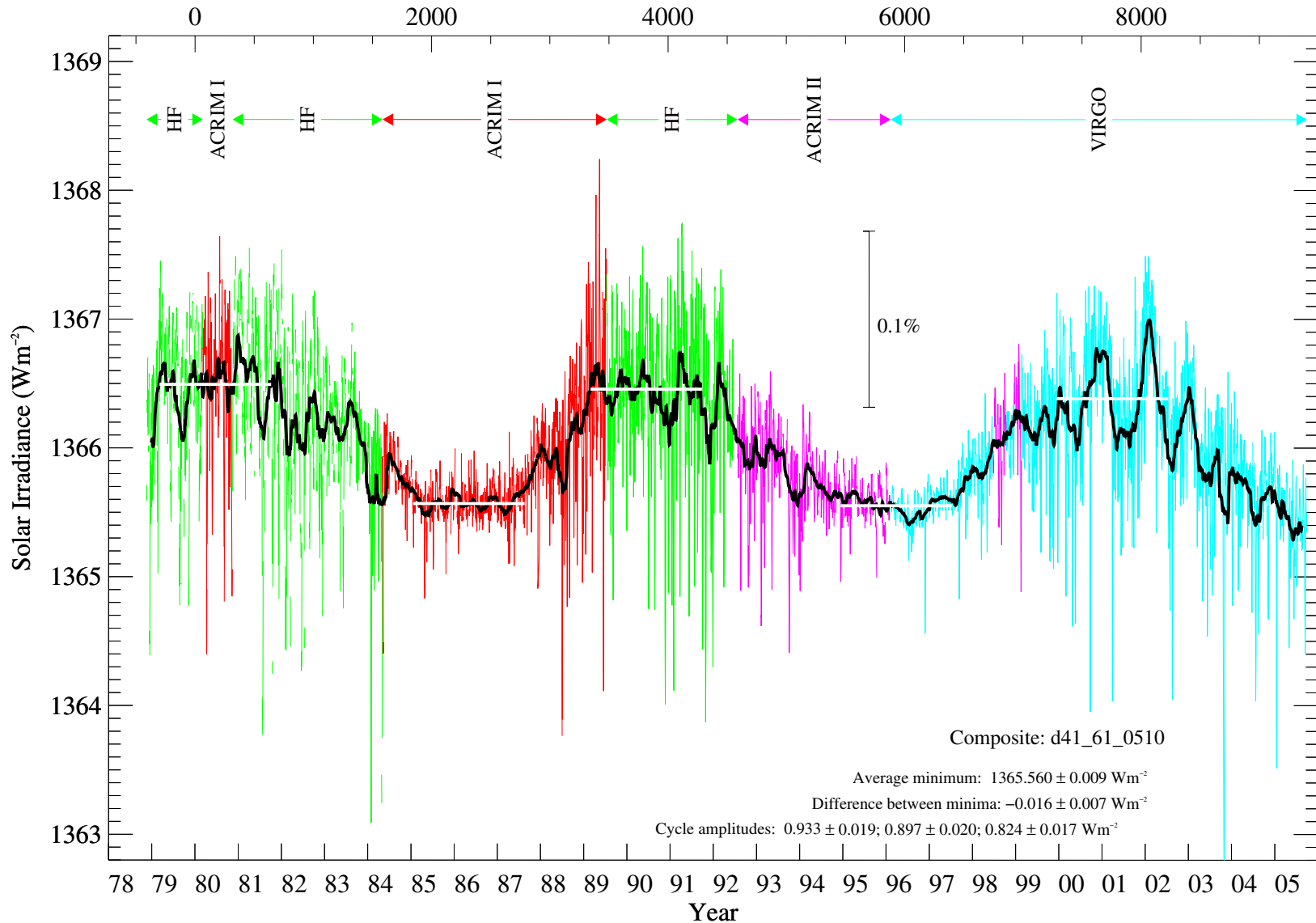
from Gerard Roe, UW

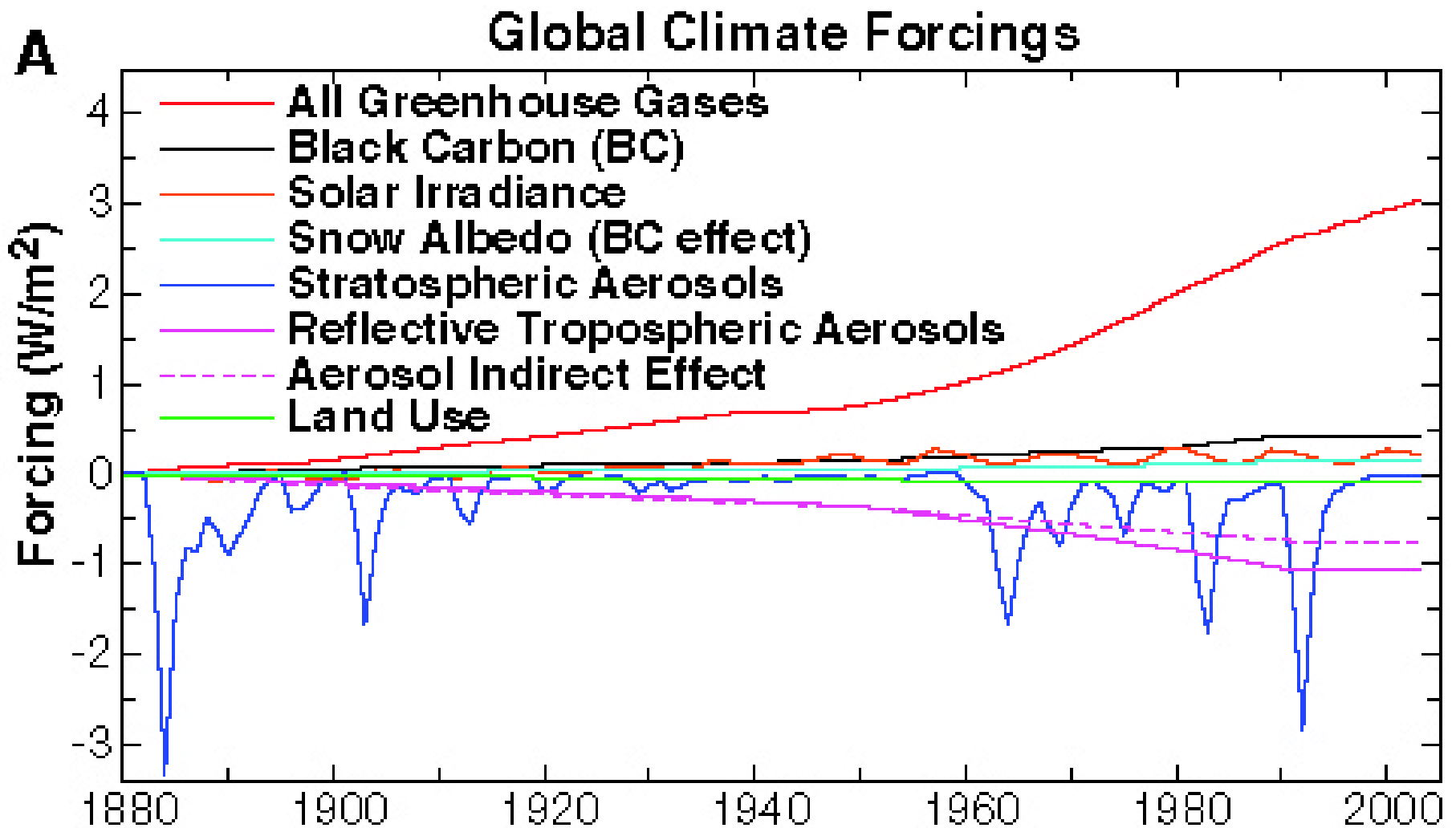
Methane: up 150%



Total Solar Irradiance Data (referred to SARR via ACRIM-II)

Days (Epoch Jan 0, 1980)



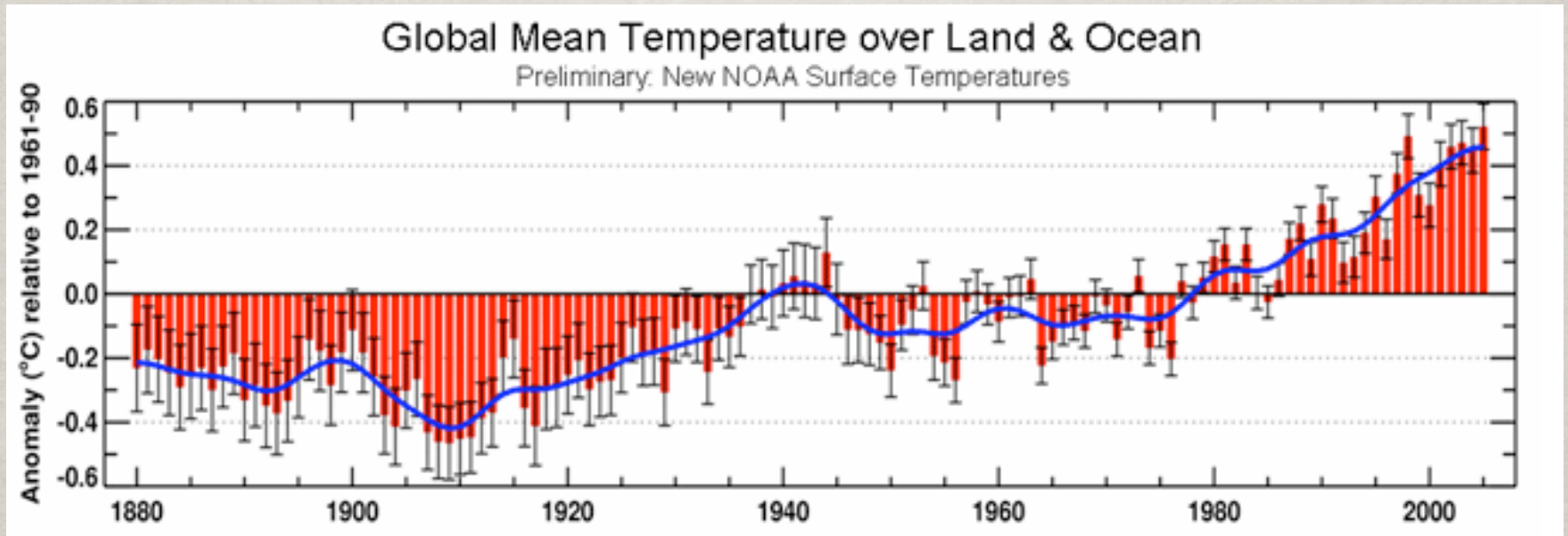


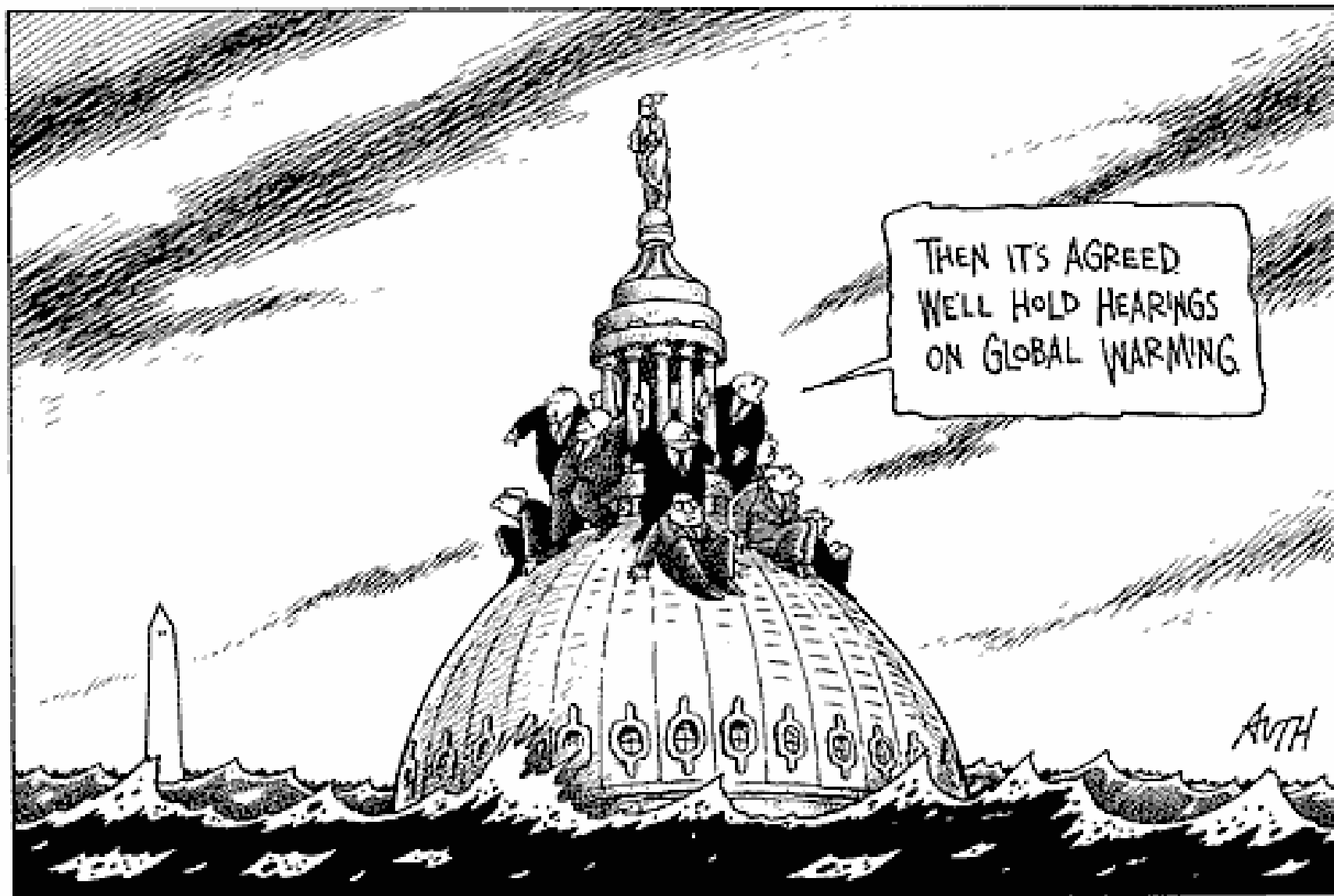
Hansen et al. 2005

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Variations of the Earth's surface temperature

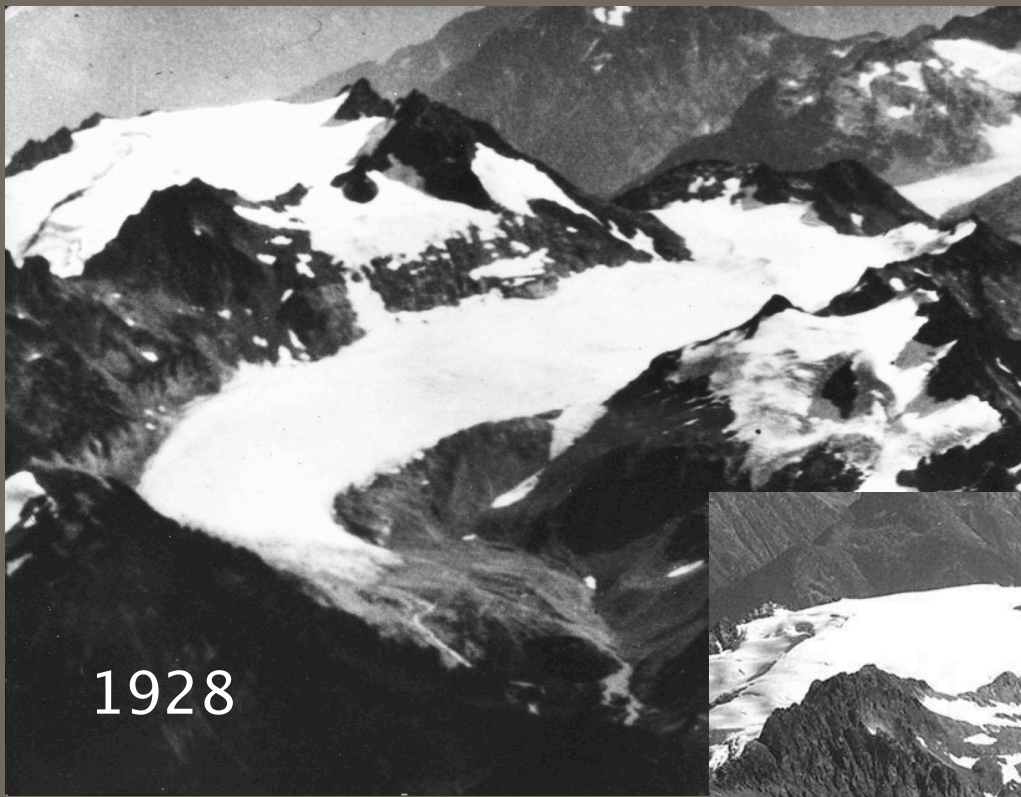






“We know the surface temperature of the Earth is warming... We do not know how much our climate will change in the future...”

– President Bush,
June 11, 2001



The South
Cascade glacier
retreated
dramatically in
the 20th century

1928

Courtesy of the USGS
glacier group



2000

USGS

Sphinx Glacier

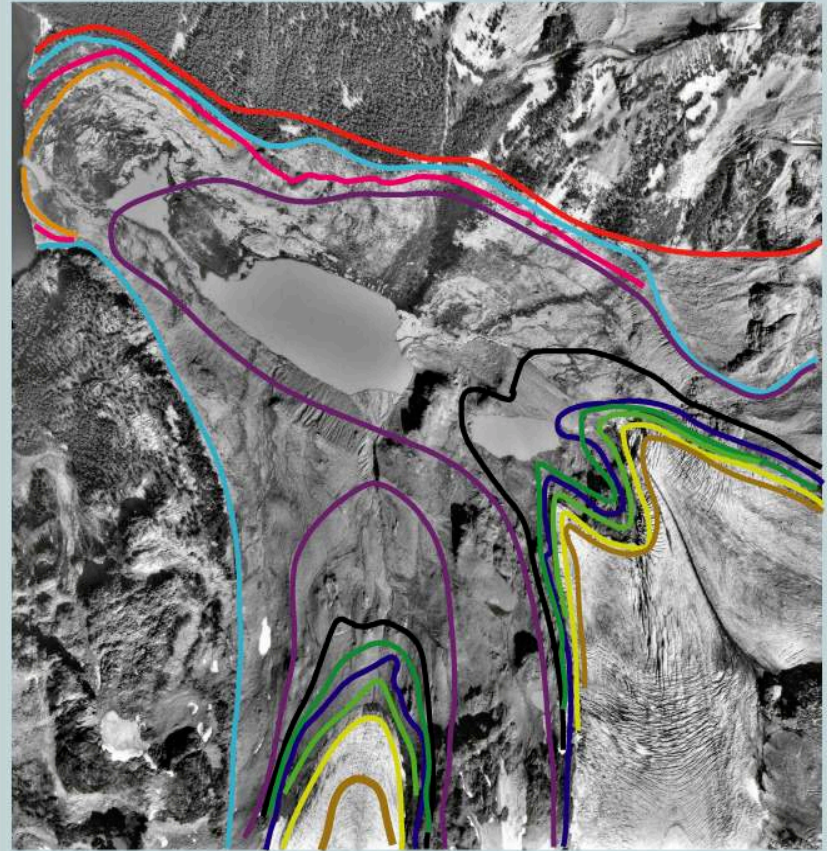
1928/29



2002

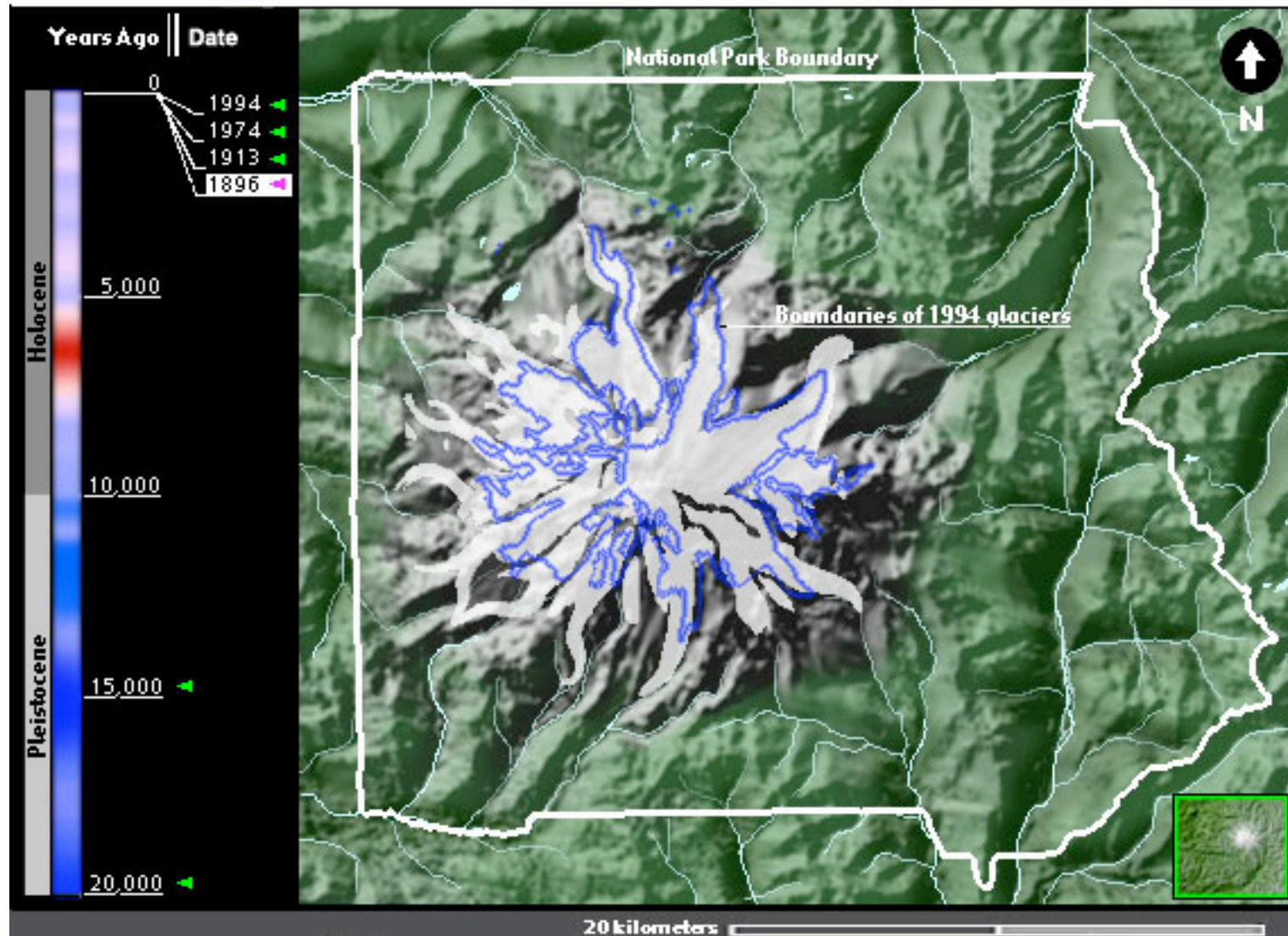


1698	1809	1863	1904
1928/9	1949	1964	1969
1973	1996	2002	



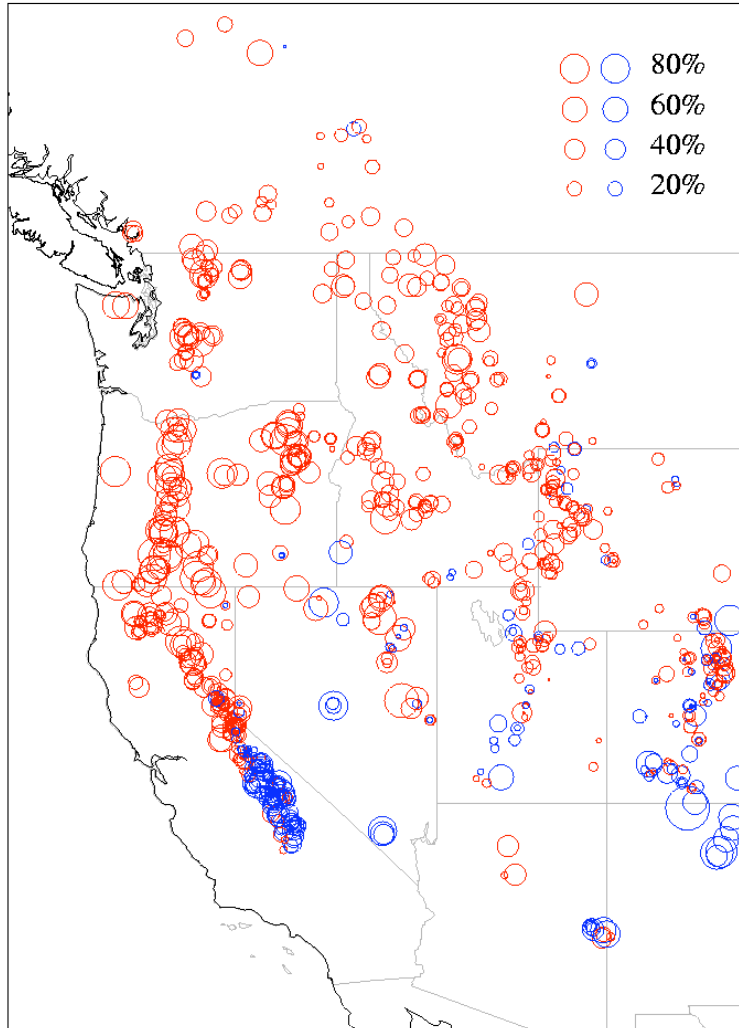
From John Clague, Simon Fraser Univ.

Glaciers at Mt Rainier

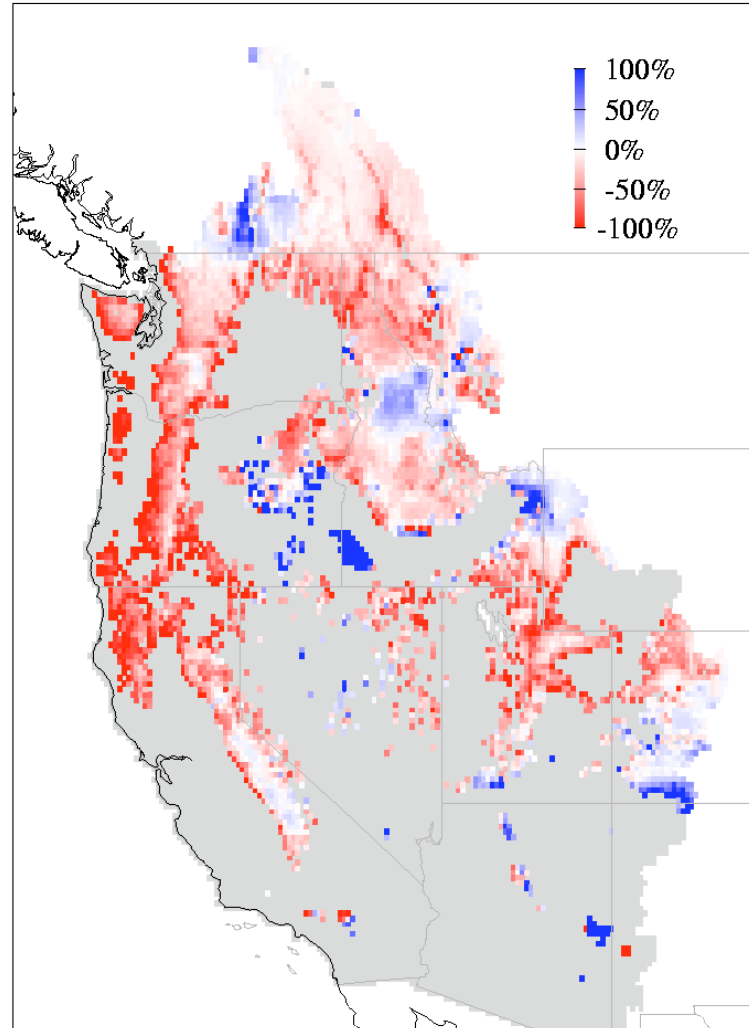


Declining April 1 snowpack, 1950–1997

a. Observations

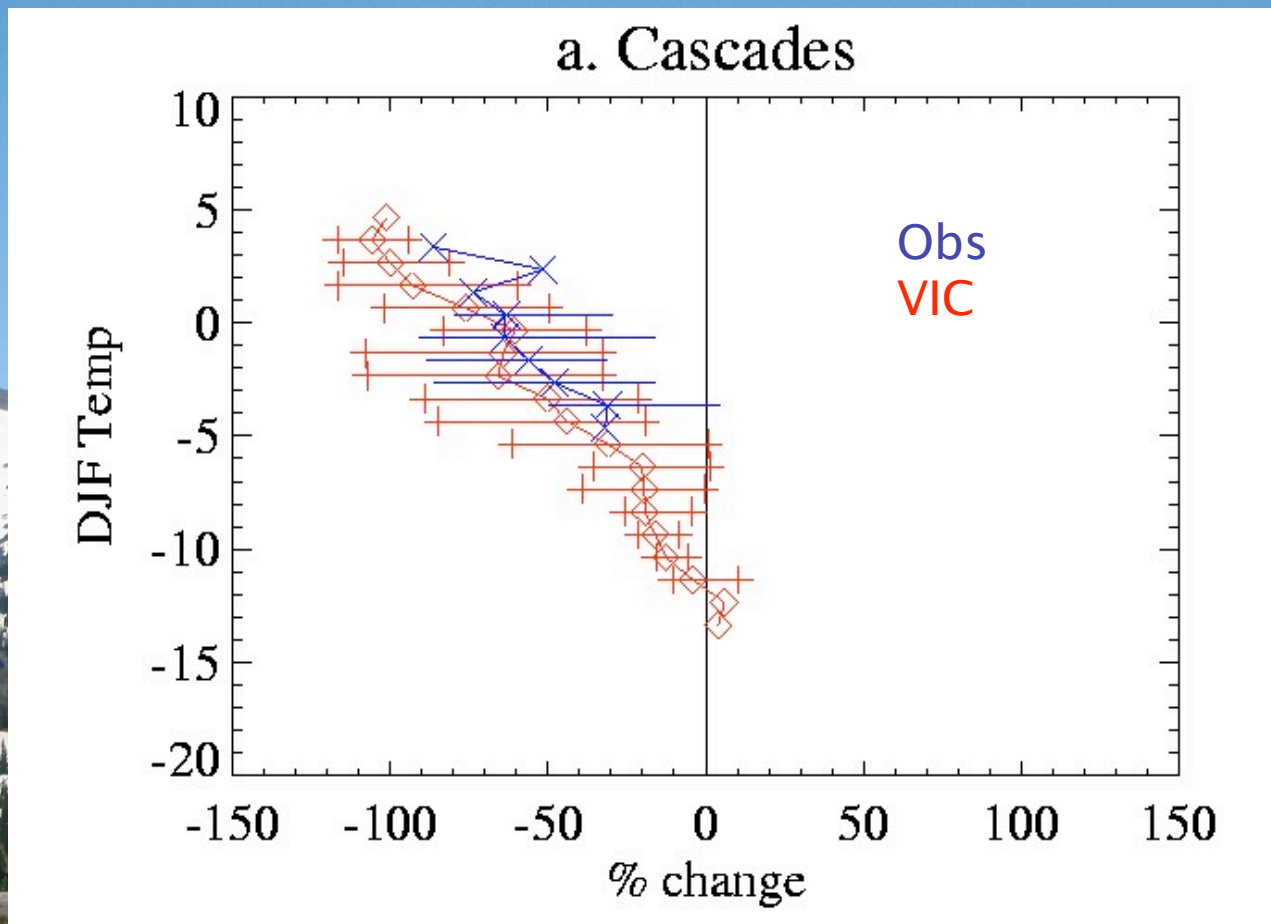


b. VIC



Mote et al., BAMS 2005

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



Mote et al., BAMS 2005



Larsen B
Ice shelf
Antarctica

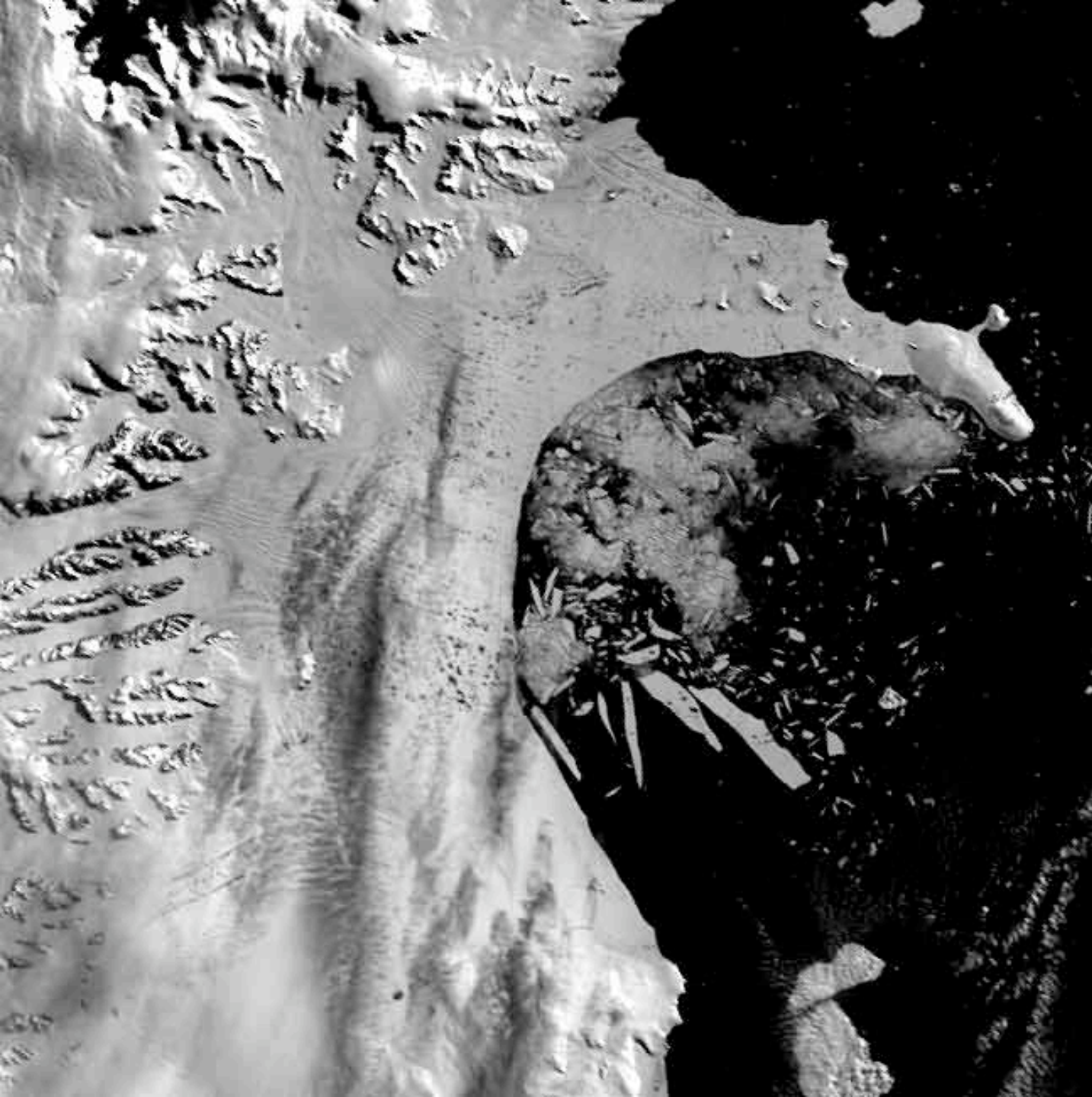
January 31, 200

MODIS data
Courtesy
NSIDC

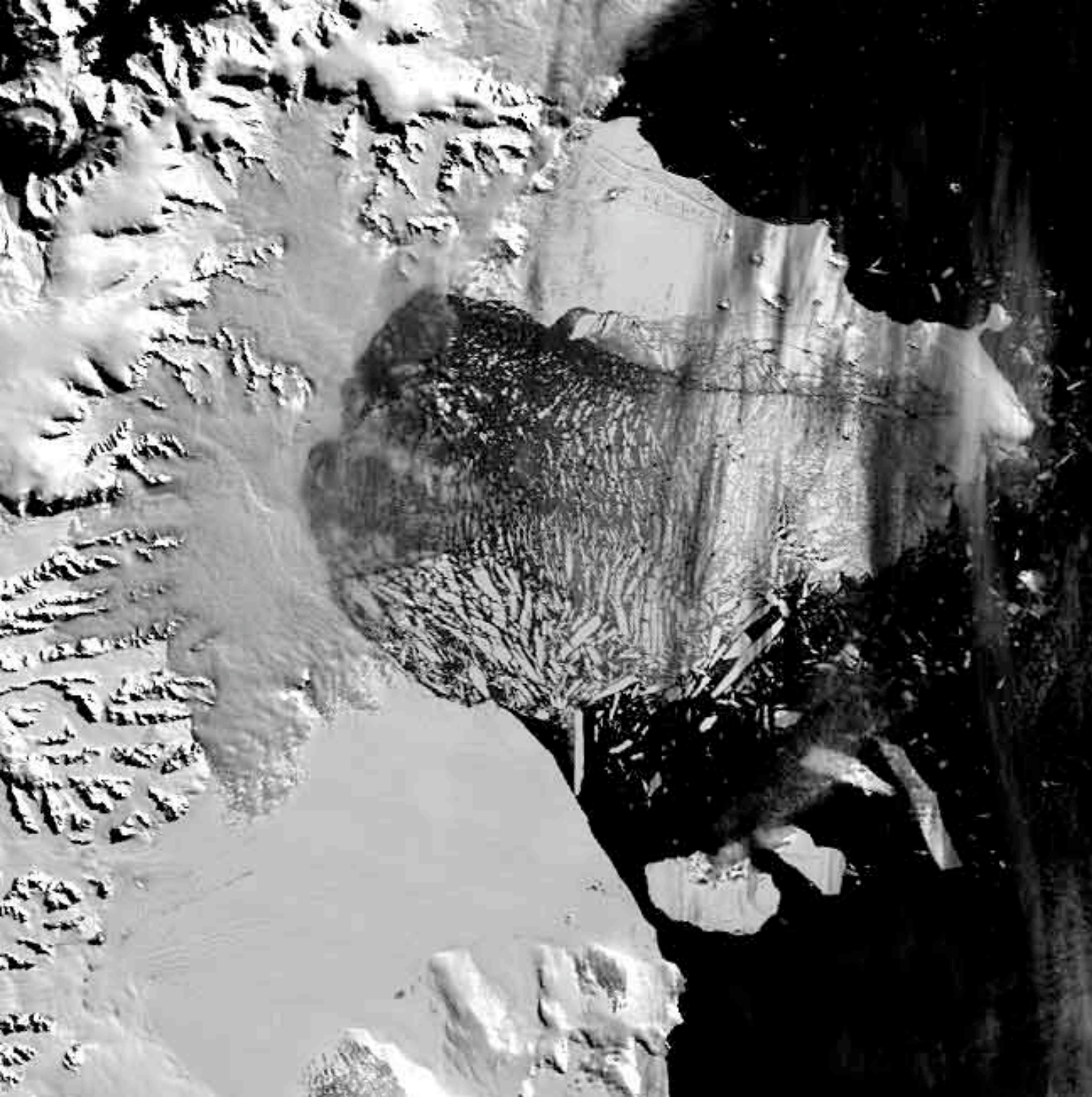
February
17



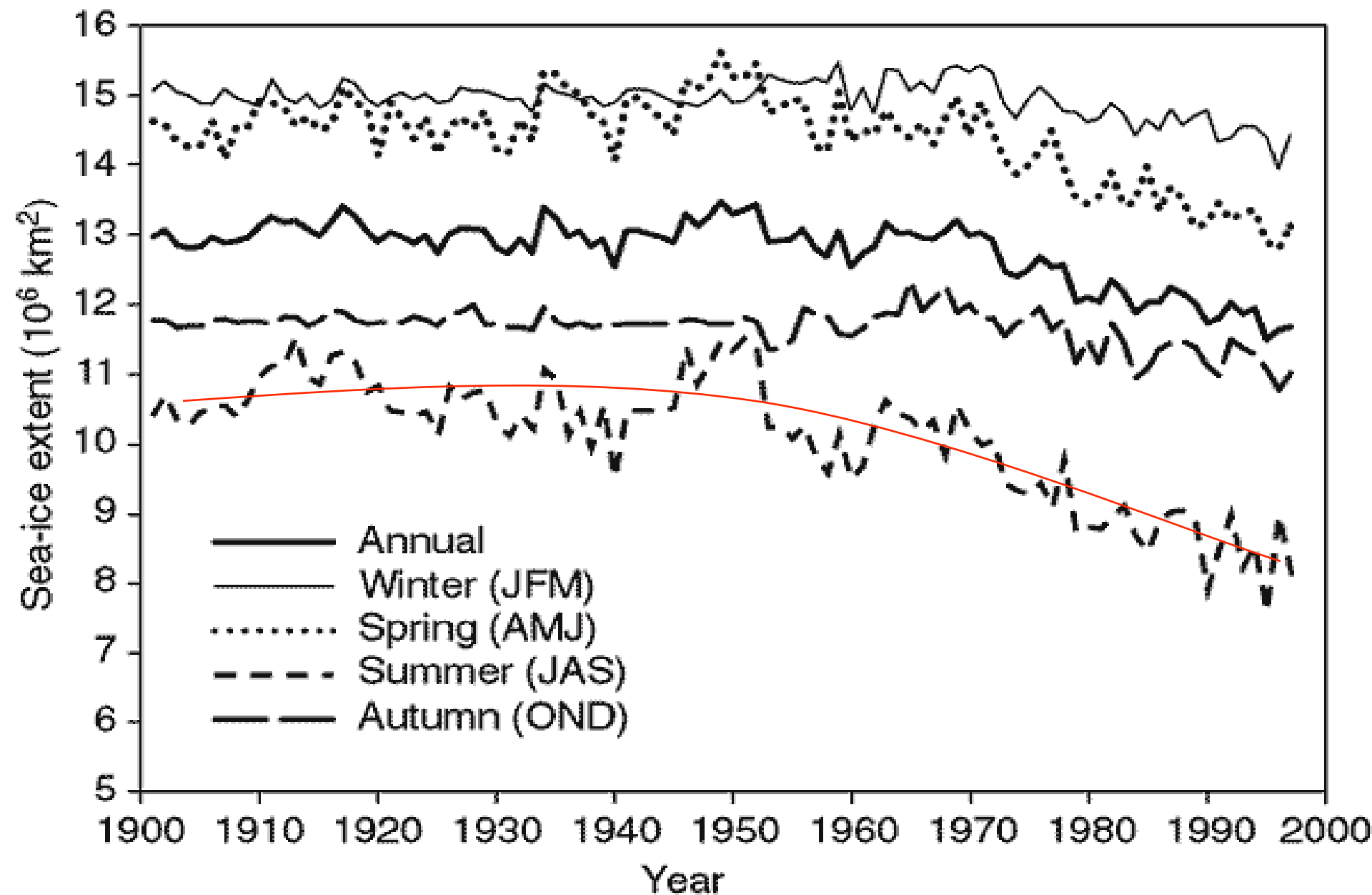
February
23



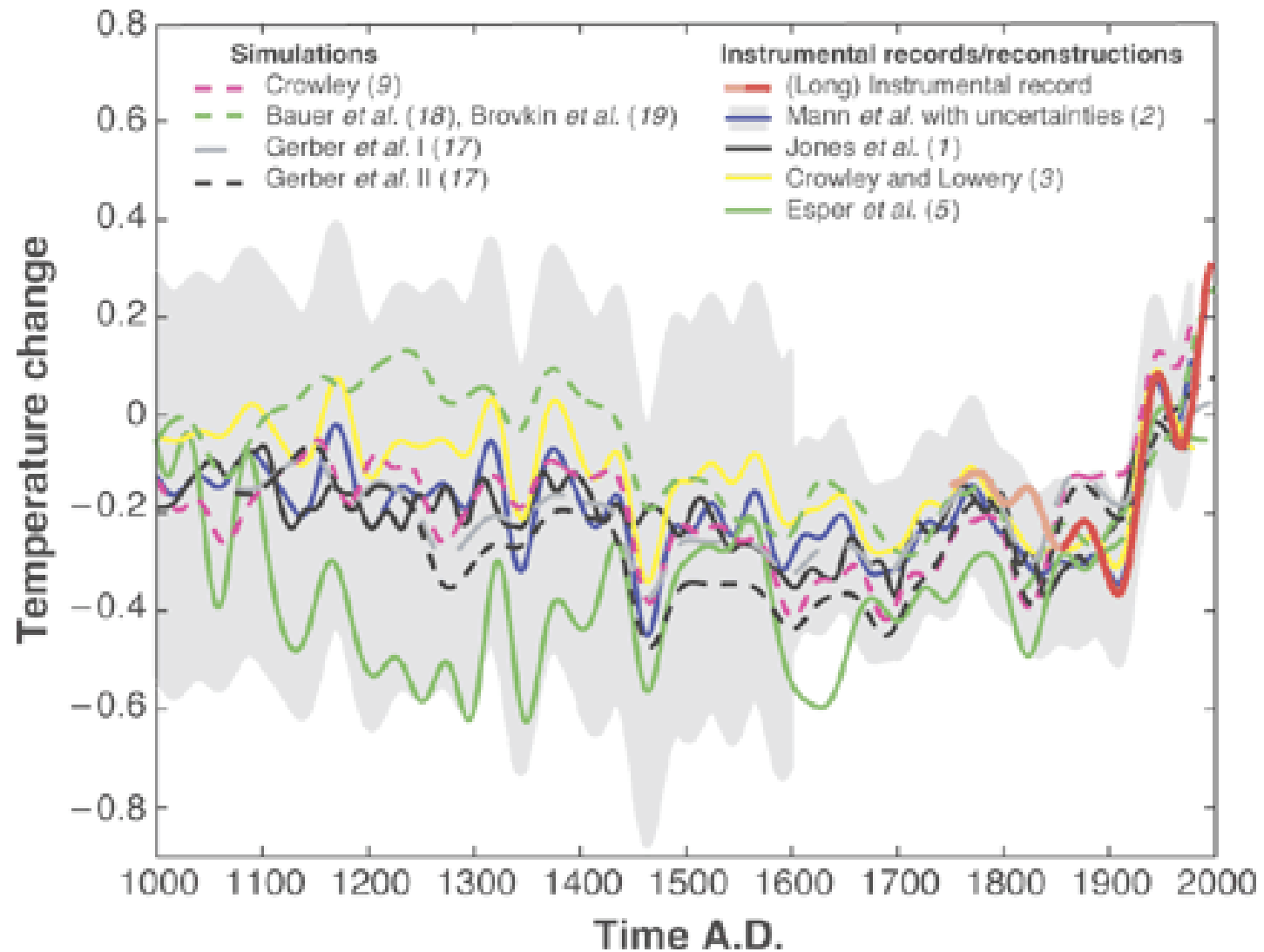
March 5



Arctic sea ice



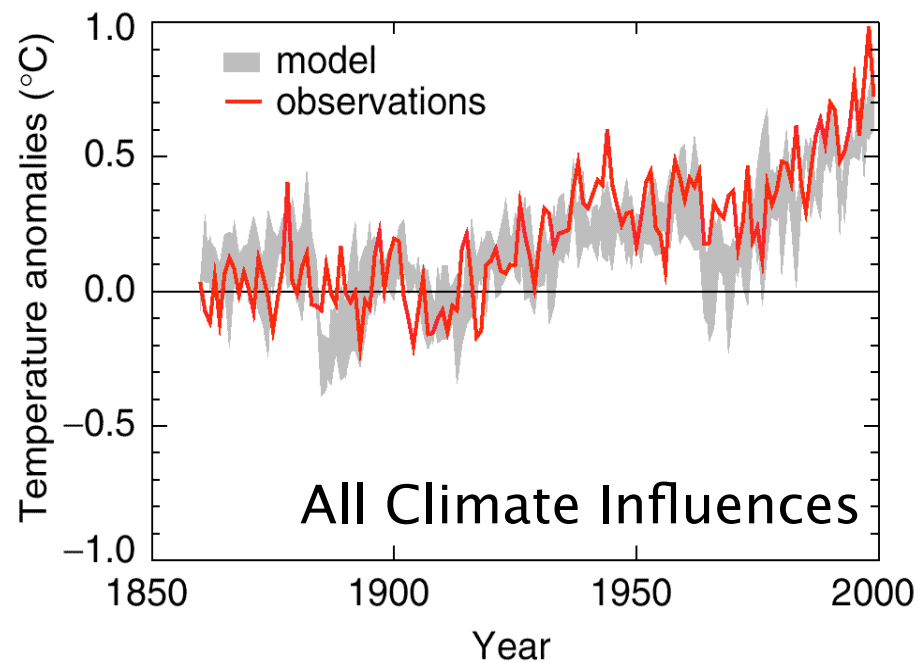
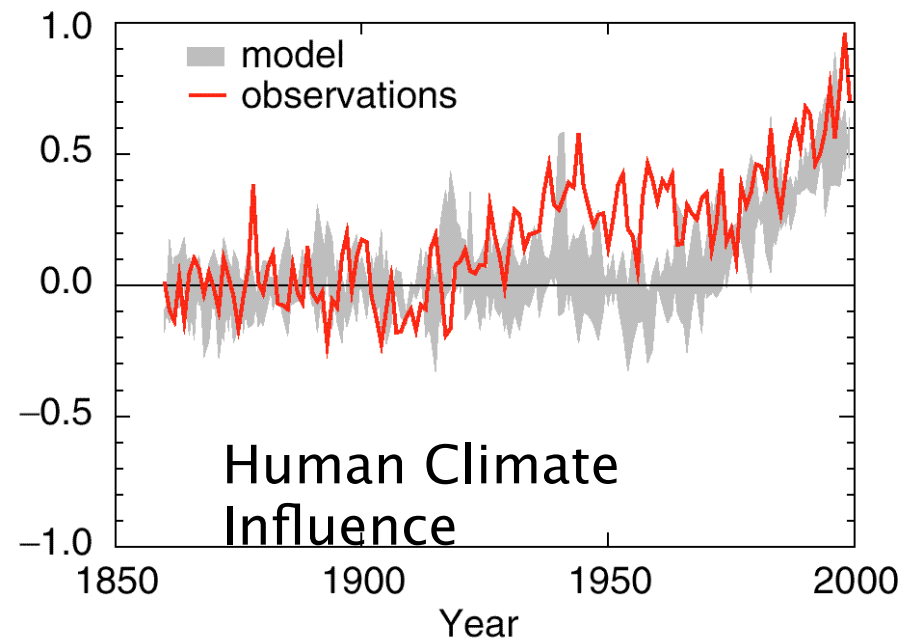
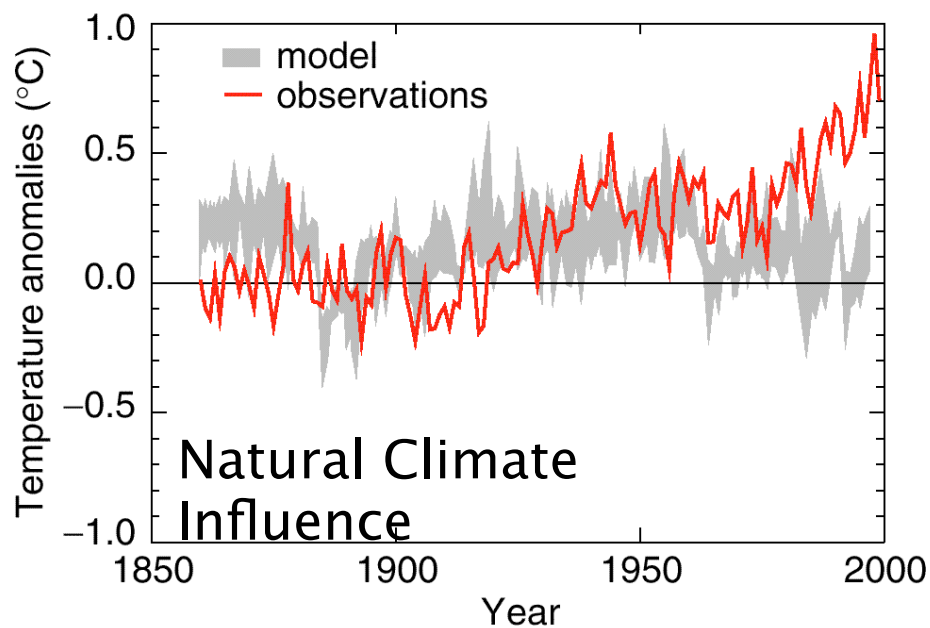
longer-term view



source: Mann et al., EOS

OUTLINE

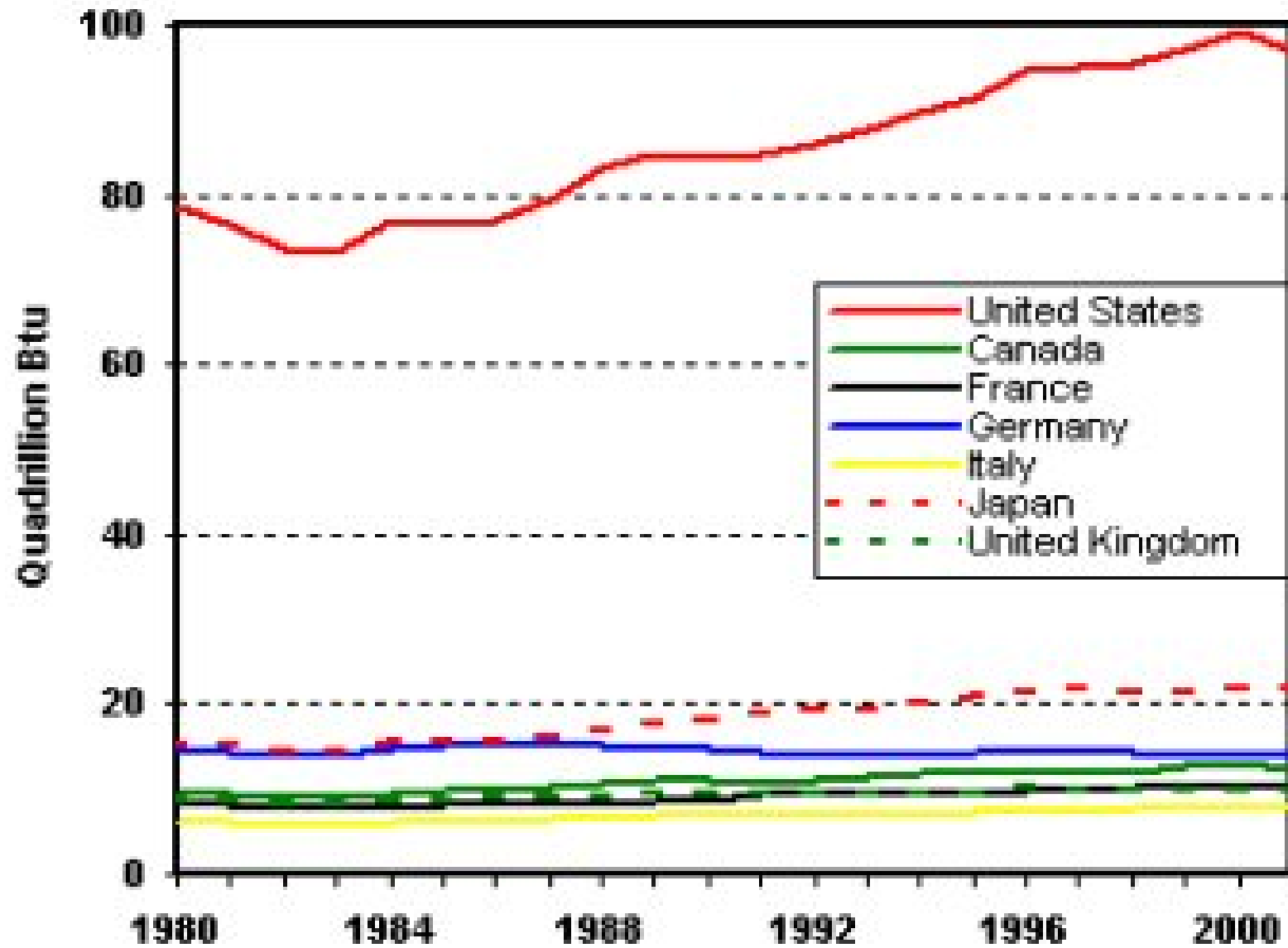
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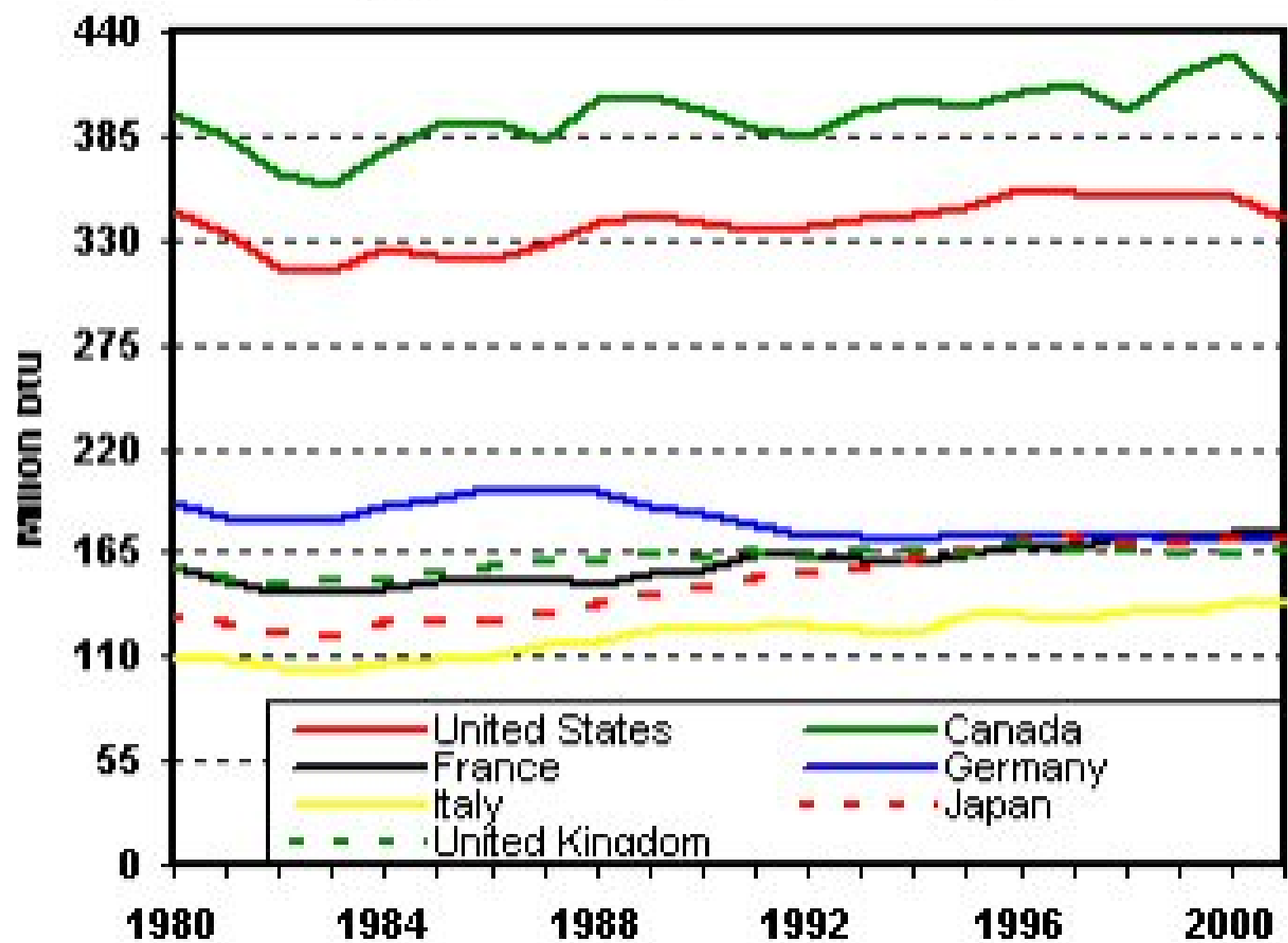
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Energy Consumption



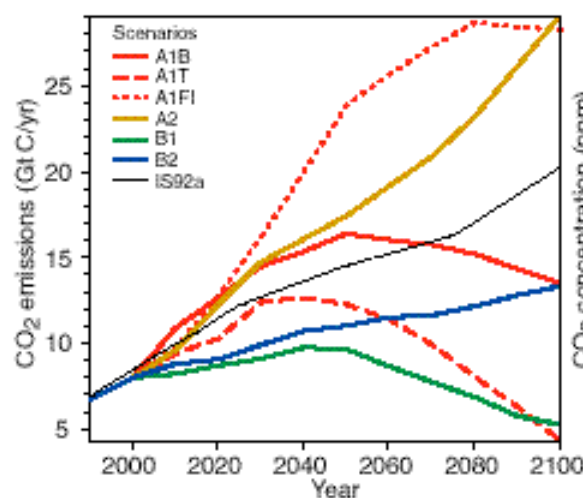
Energy Consumption Per Capita



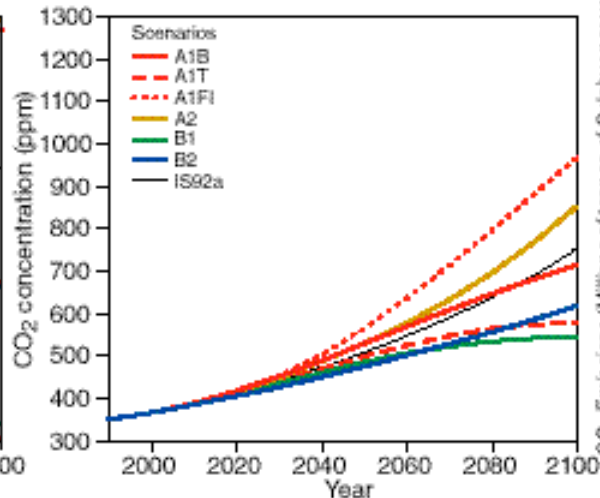


The global climate of the 21st century

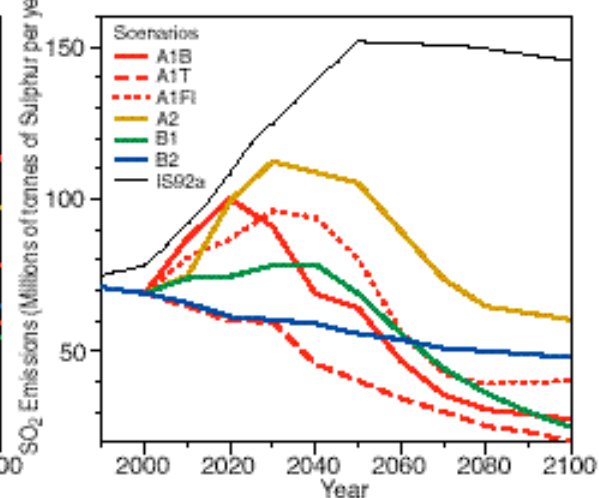
(a) CO₂ emissions



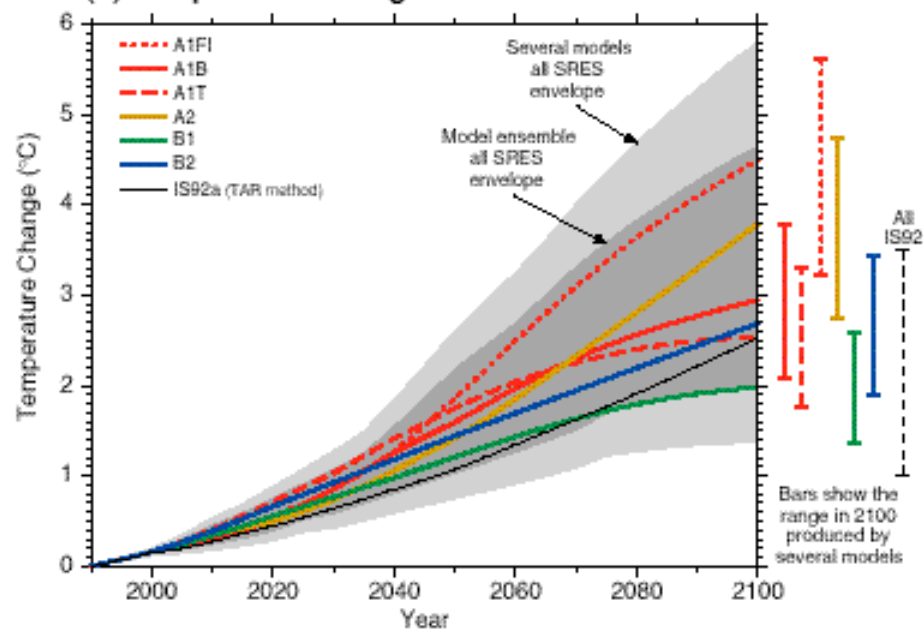
(b) CO₂ concentrations



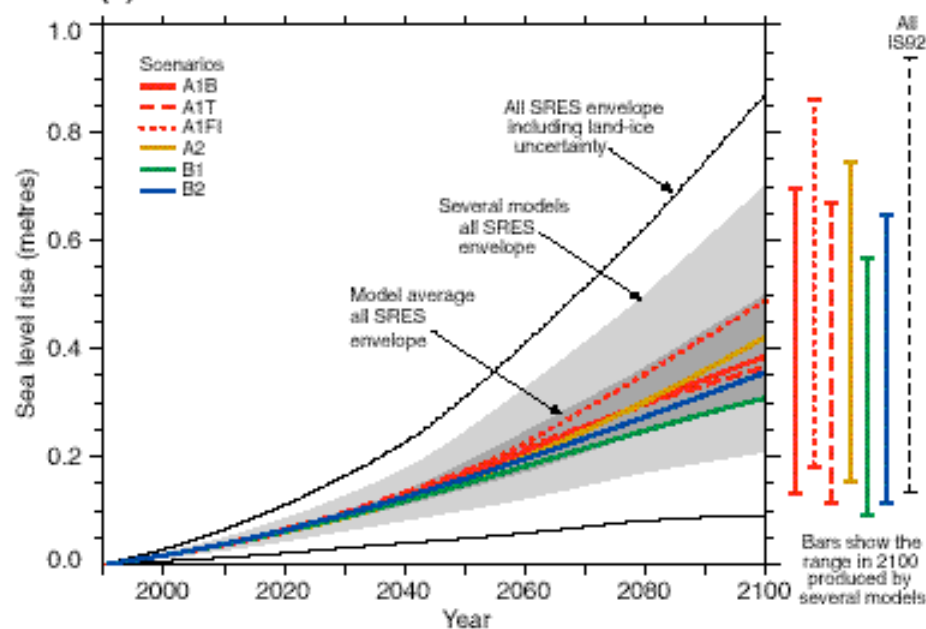
(c) SO₂ emissions



(d) Temperature change



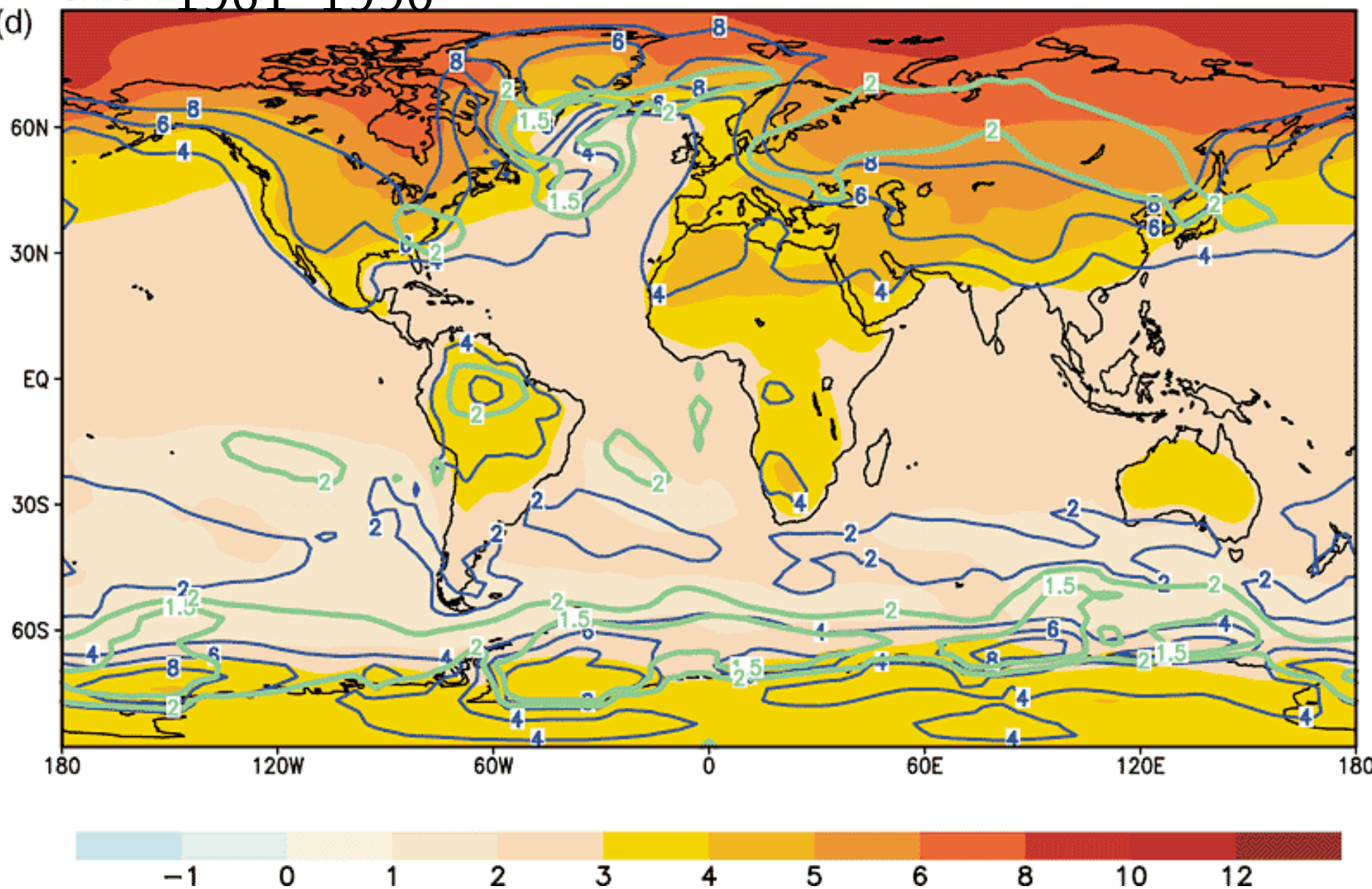
(e) Sea level rise



Temperature change, 2071–2100 minus

SRES A2 1961–1990

(d)



Post-stabilisation temperature evolution

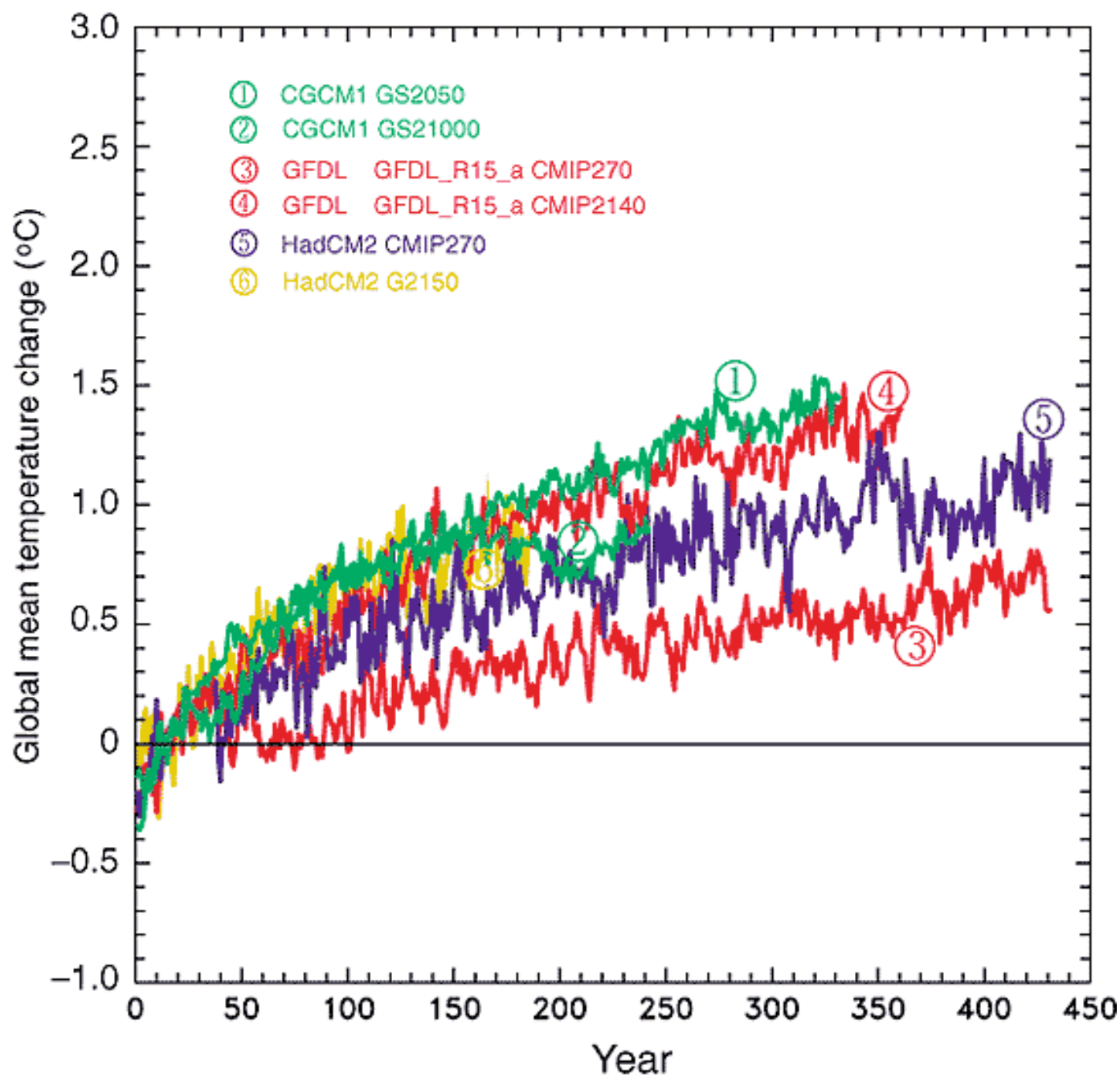
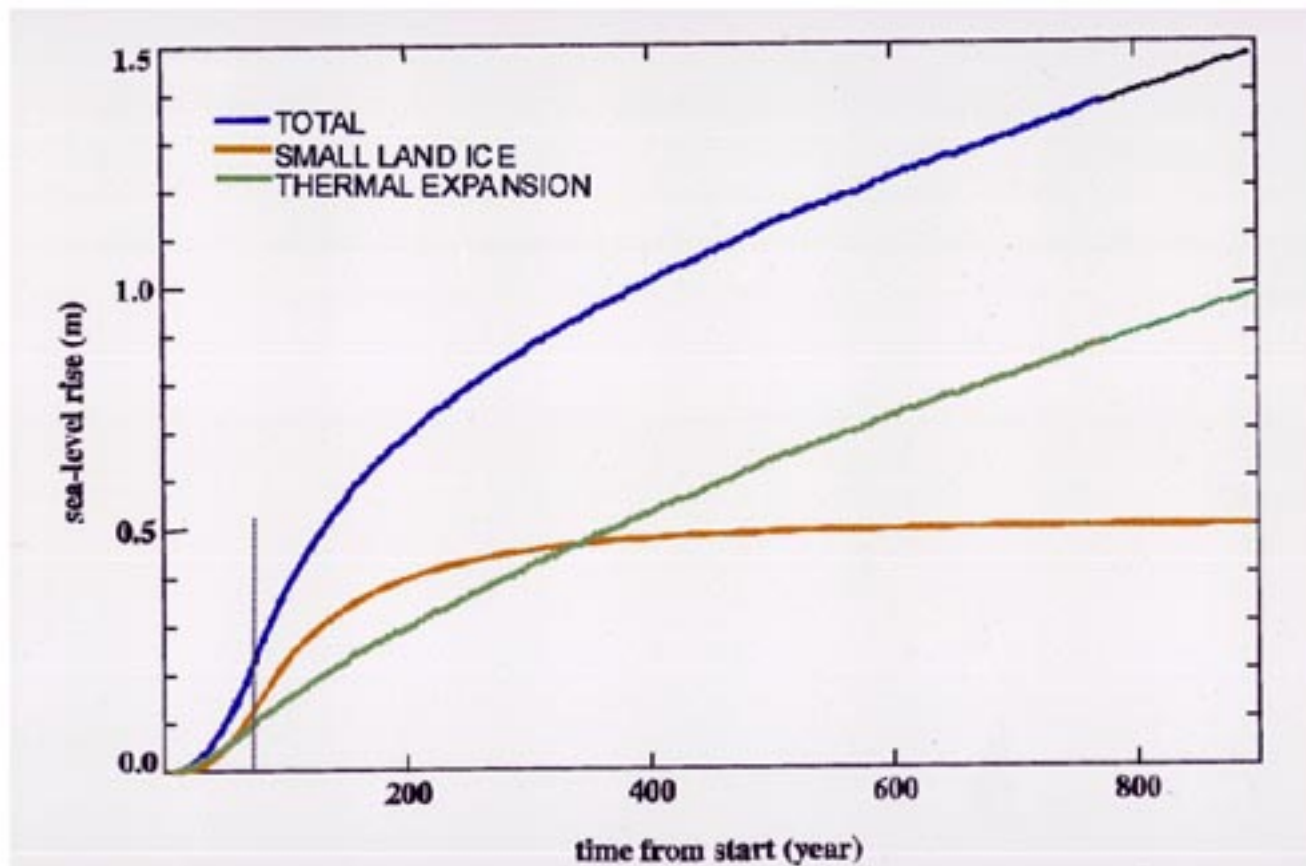


Figure 13: Sea Level Rise Commitment

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



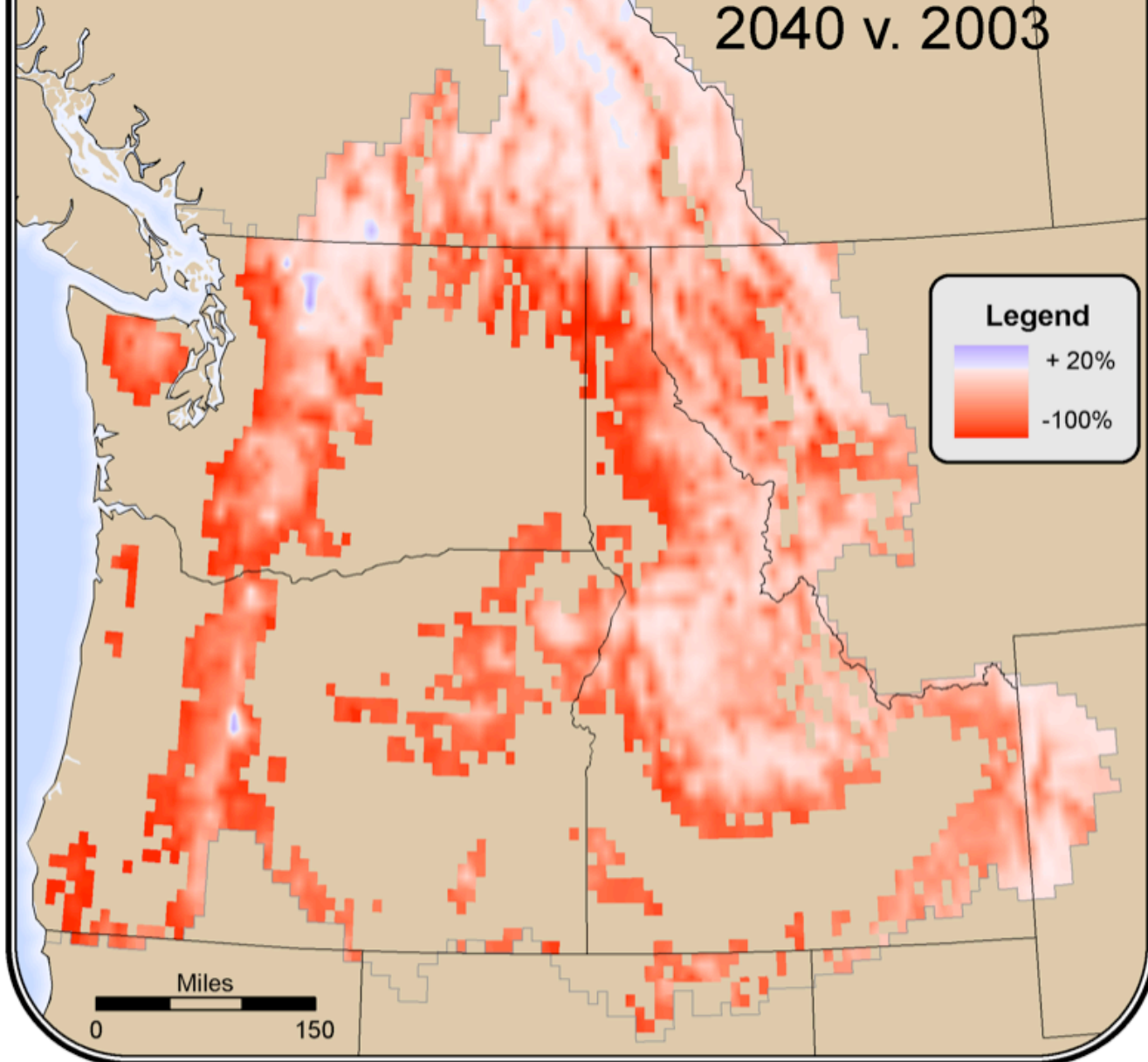
The Met Office. Hadley Centre for Climate Prediction and Research.



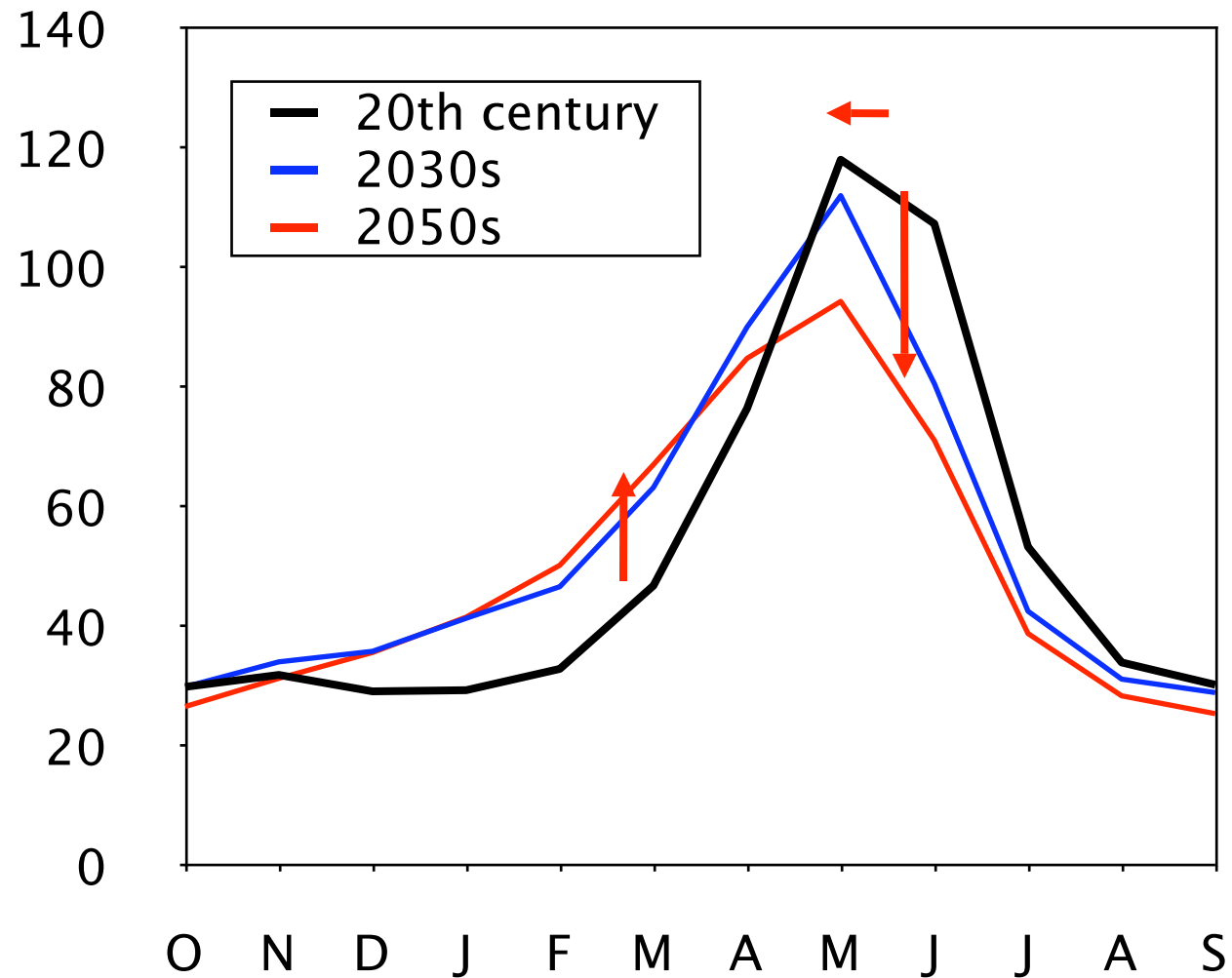
NORTHWEST IMPACTS

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

% Change April 1 Snowpack 2040 v. 2003



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