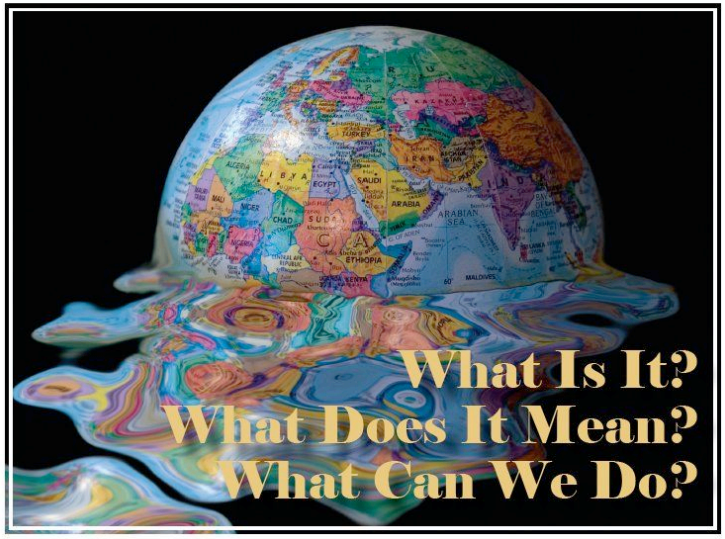
Understanding
CLIMATE CHANGE



Reducing Emissions for Climate Stabilization

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NC LCGCC, 22 April 2008

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DUKE UNIVERSITY

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DUKE UNIVERSITY

Recent reports conclude that increased greenhouse gas concentrations are warming the earth

"Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise."

National Academy of Sciences, 2001

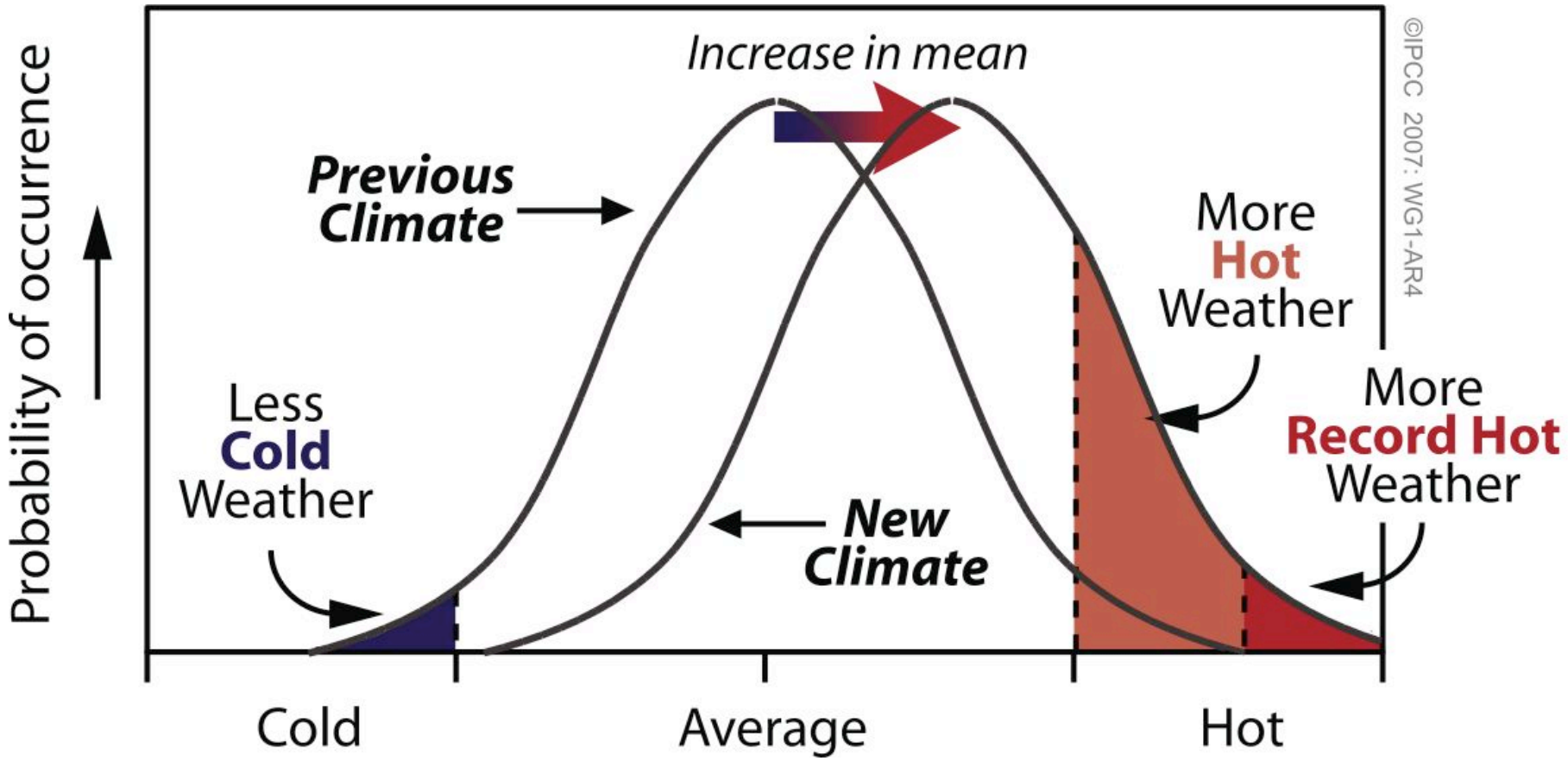
“Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.

Intergovernmental Panel on Climate Change, 2007 synthesis, >2,000 scientists

“Because human activities are contributing to climate change, we have a collective responsibility to develop and undertake carefully considered response actions.”

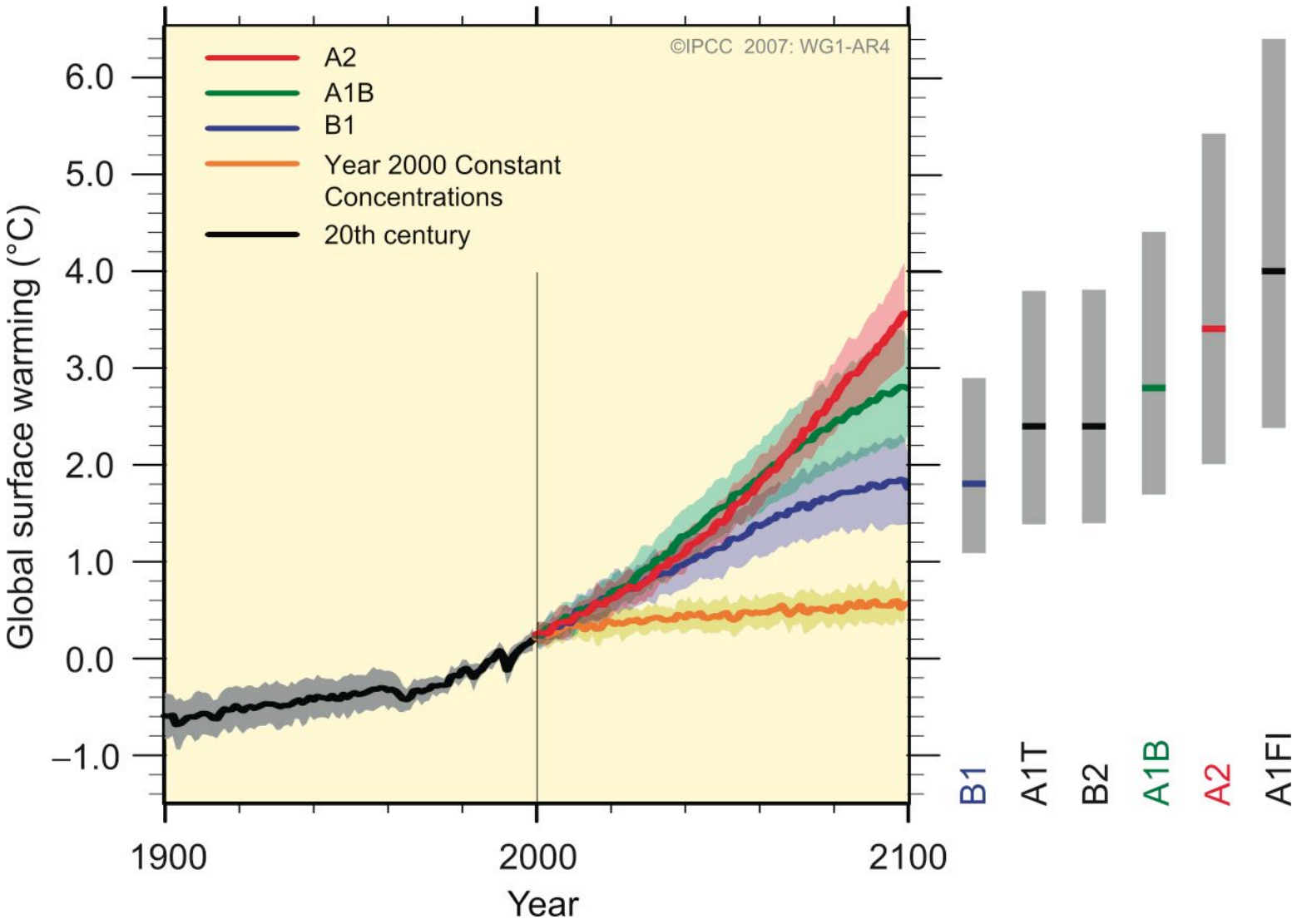
American Meteorological Society, Official statement, >11,000 meteorologists, 2003

“Scientific evidence strongly indicates that natural influences cannot explain the rapid increase in global near-surface temperatures observed during the second half of the 20th century.” American Geophysical Union, >42,000 Earth scientists, Official climate change statement, 2005


Probability of occurrence
Increase in mean
Previous Climate
New Climate
Less Cold Weather
More Hot Weather
More Record Hot Weather
Cold
Average
Hot
©IPCC 2007: WG1-AR4

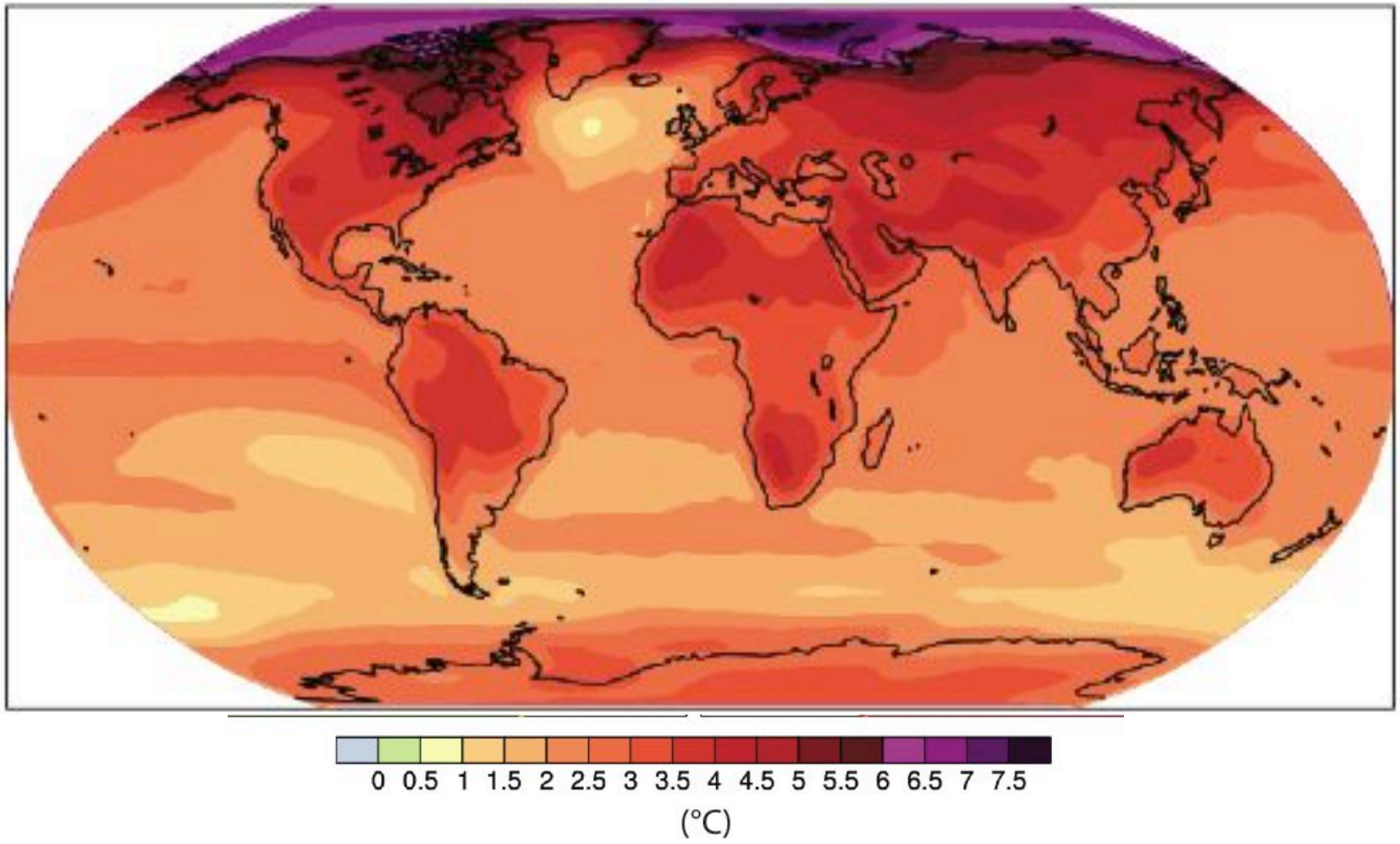
Preparation and Review of the WG1 AR4

- Each report is an assessment of the state of understanding based upon peer-reviewed published work. IPCC assesses published research but does not do research. Each assessment goes through multiple reviews and revision and re-review over a period of years.
- Informal draft prepared, comments sought from 6-12 outside experts for each chapter (Oct 2004 - Mar 2005).
- Formal first order draft (FOD) reviewed by about 600 reviewers worldwide (Sept -Nov 2005).
- Formal second order draft (SOD) re-reviewed by about 600 experts worldwide and by dozens of governments (April-May 2006).
- Govt comments on revised Summary for Policy Makers (Oct-Nov 2006).
- WG1 received and considered over 30000 comments in total.
- The assessment conclusions are not the views of any single scientist, but reflect a much broader process.

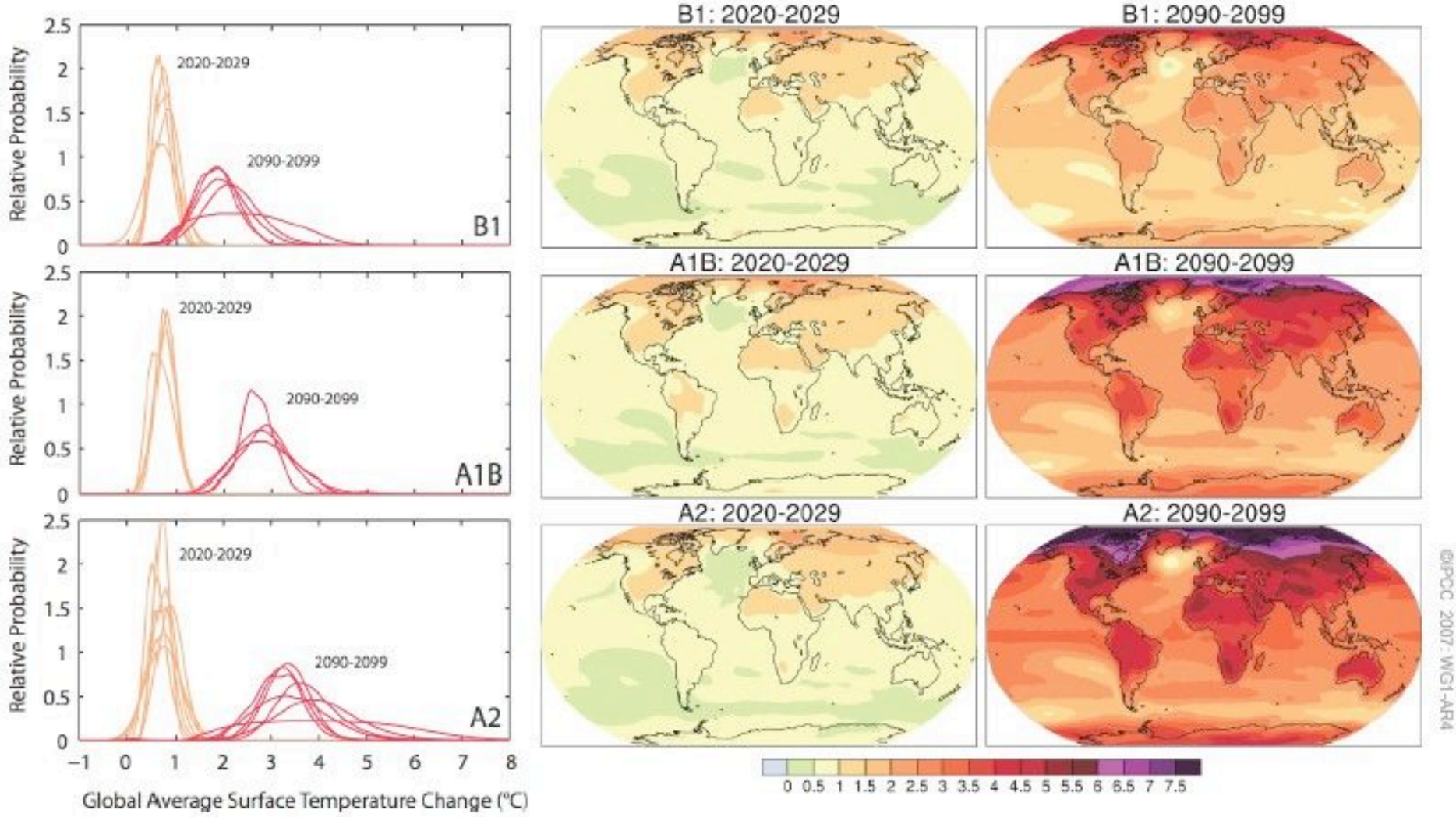

©IPCC 2007: WG1-AR4
A2
A1B
B1
Year 2000 Constant Concentrations
20th century
Global surface warming (°C)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
–1.0
1900
2000
2100
Year
B1
A1T
B2
A1B
A2
A1FI

A1B is a medium scenario: Global mean warming 2.8°C;
Much of land area warms by ~3.5°C
Arctic warms by ~7°C; would be less for less emissions

(Years 2090-2099)

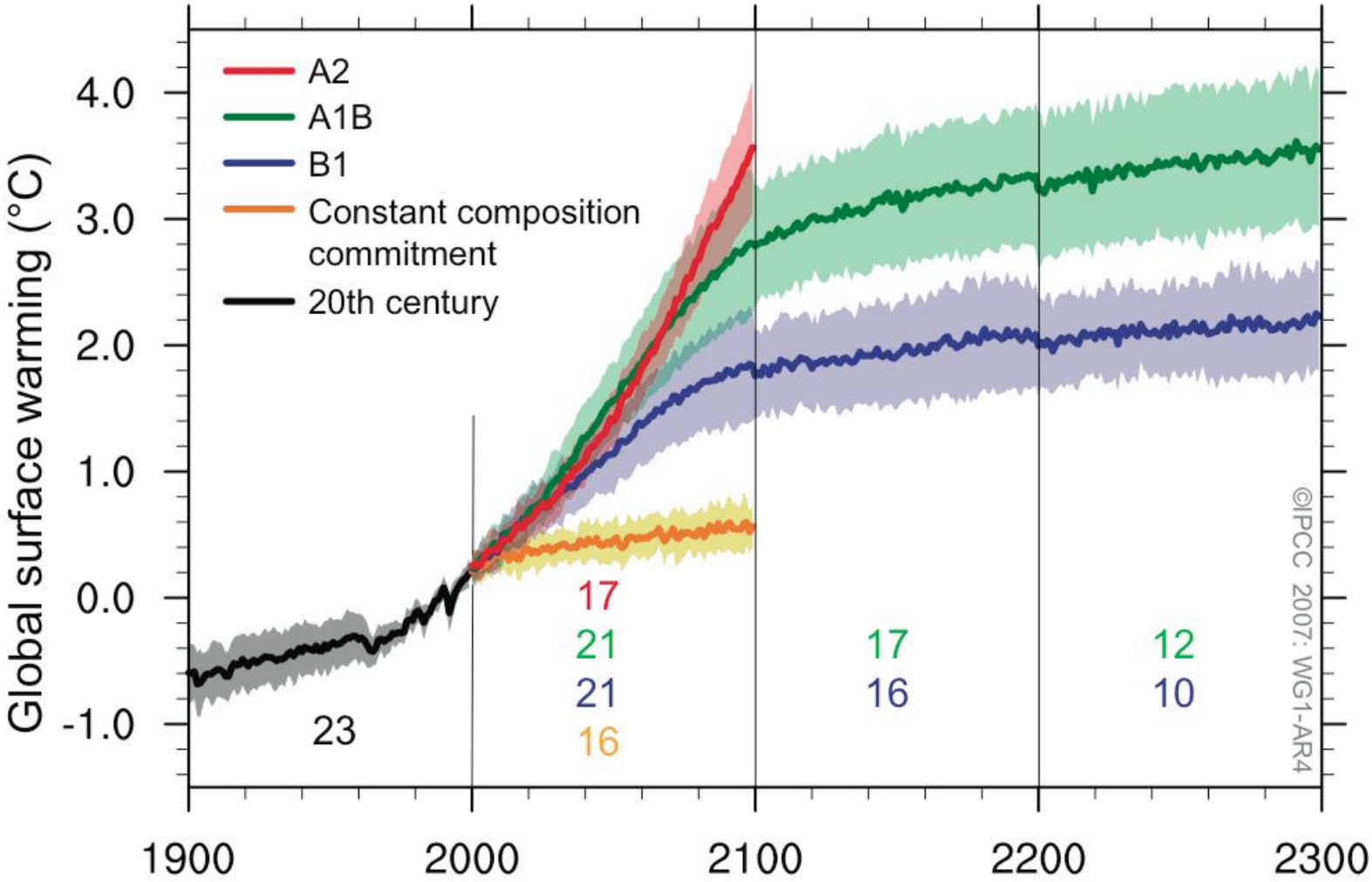


AOGCM Projections of Surface Temperatures

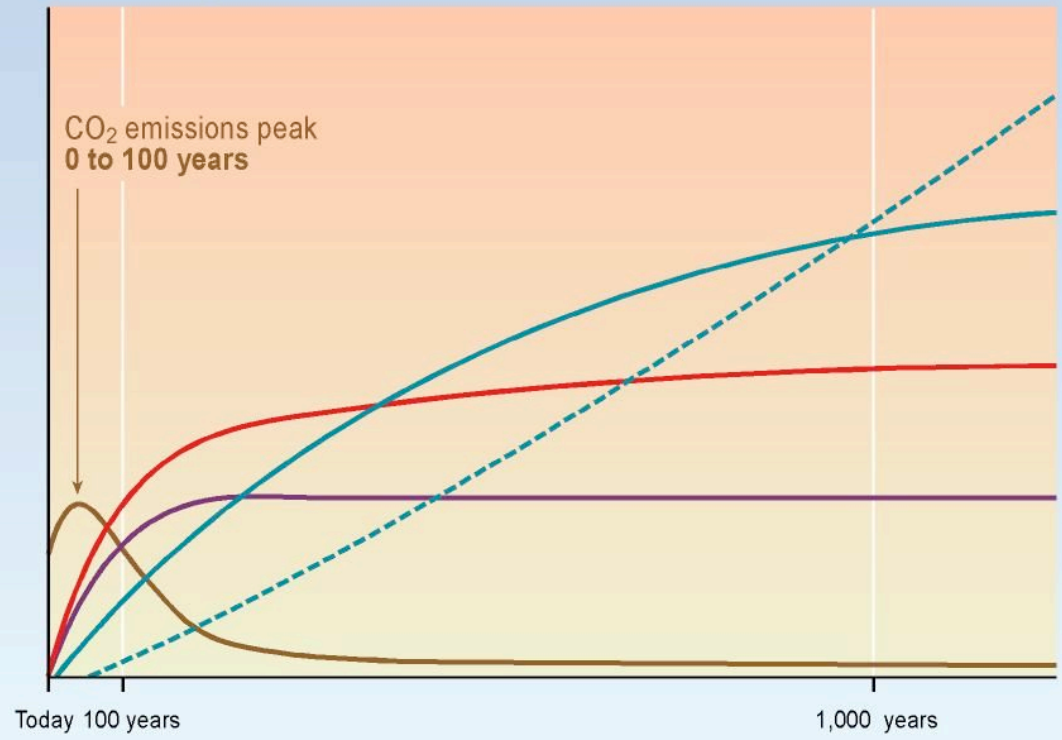


What's in the pipeline and what could come

Warming will increase if GHG increase. If GHG were kept fixed at current levels, a committed 0.6°C of further warming would be expected by 2100. More warming would accompany more emissions.



CO_2 concentration, temperature, and sea level continue to rise long after emissions are reduced



Time taken to reach equilibrium

Sea-level rise due to ice melting:
several millennia

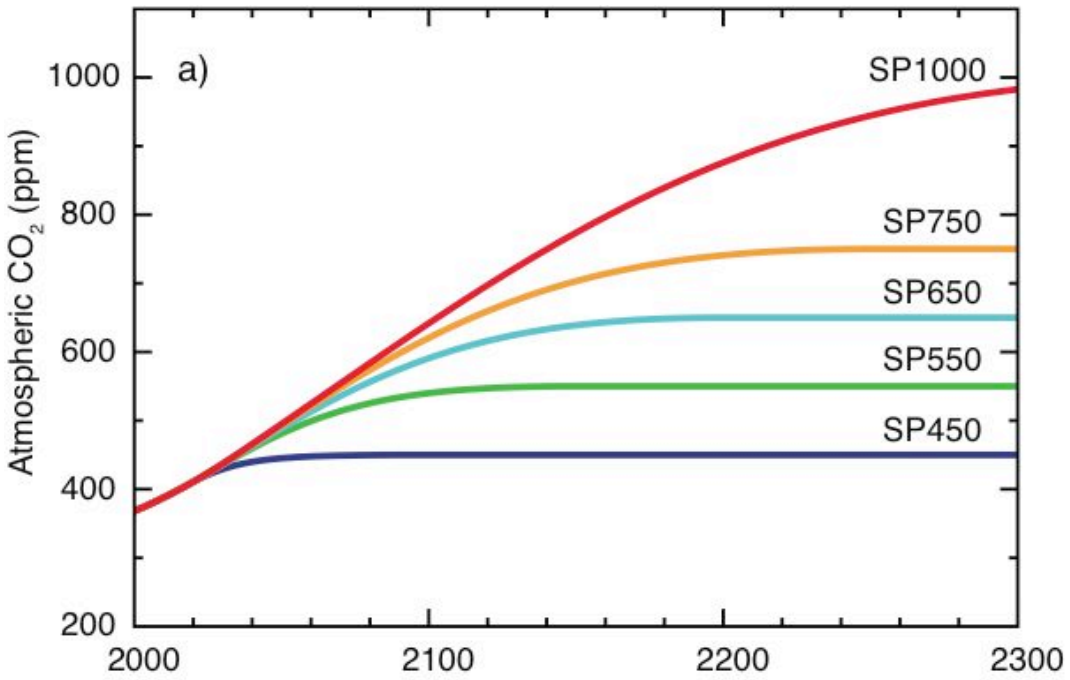
Sea-level rise due to thermal expansion:
centuries to millennia

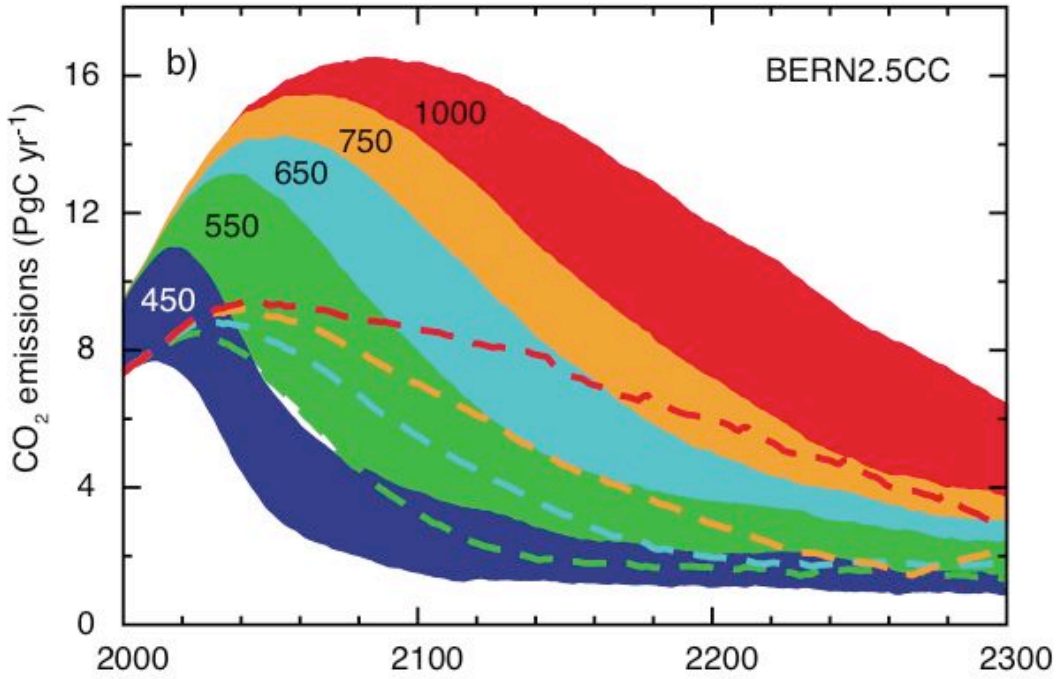
Temperature stabilization:
a few centuries

CO_2 stabilization:
100 to 300 years

CO_2 emissions

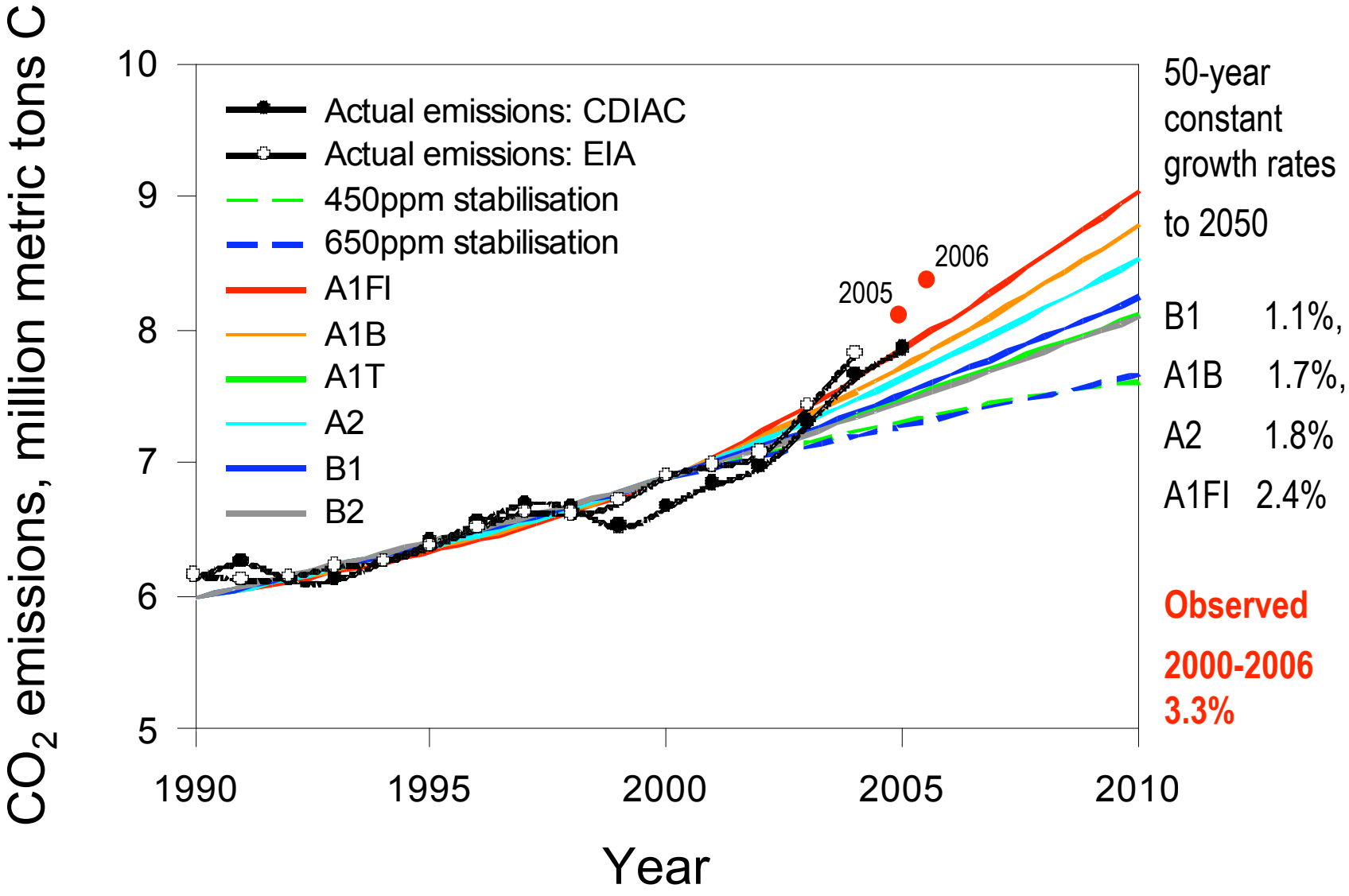
SYR - FIGURE 5-2





Emission trajectories to stabilization

Trajectory of Global Fossil Fuel Emissions

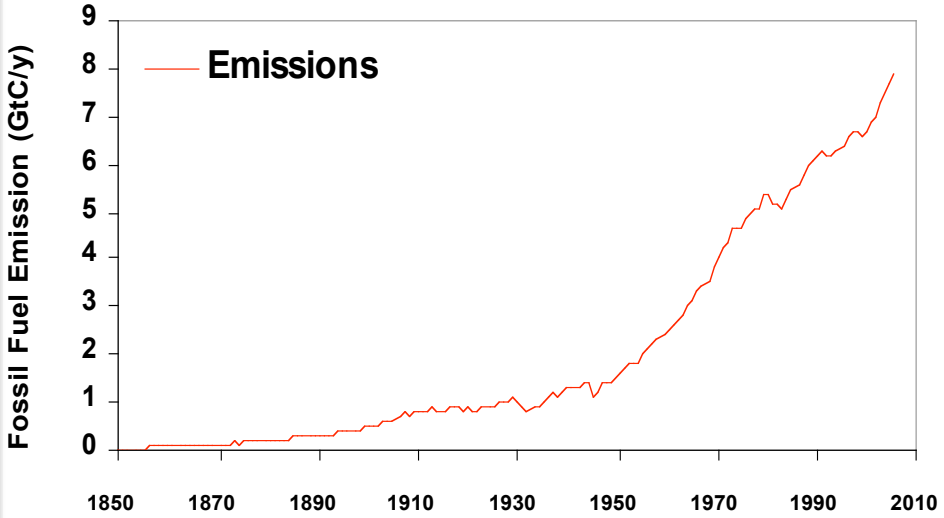


Raupach et al. 2007, PNAS

Anthropogenic C Emissions: Fossil Fuel

2006 Fossil Fuel: 8.4 Pg C

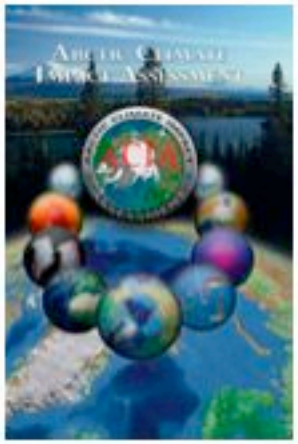
[2006-Total Anthrop. Emissions:8.4+1.5 = 9.9 Pg]



1990 - 1999: 1.3% y^{-1}

2000 - 2006: 3.3% y^{-1}

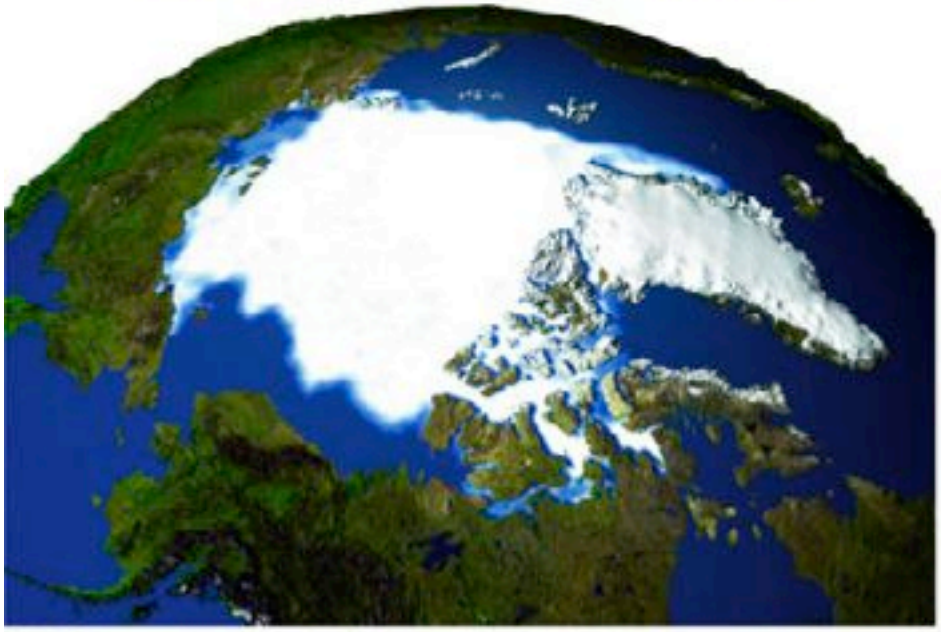
Raupach et al. 2007, PNAS; Canadell et al 2007, PNAS



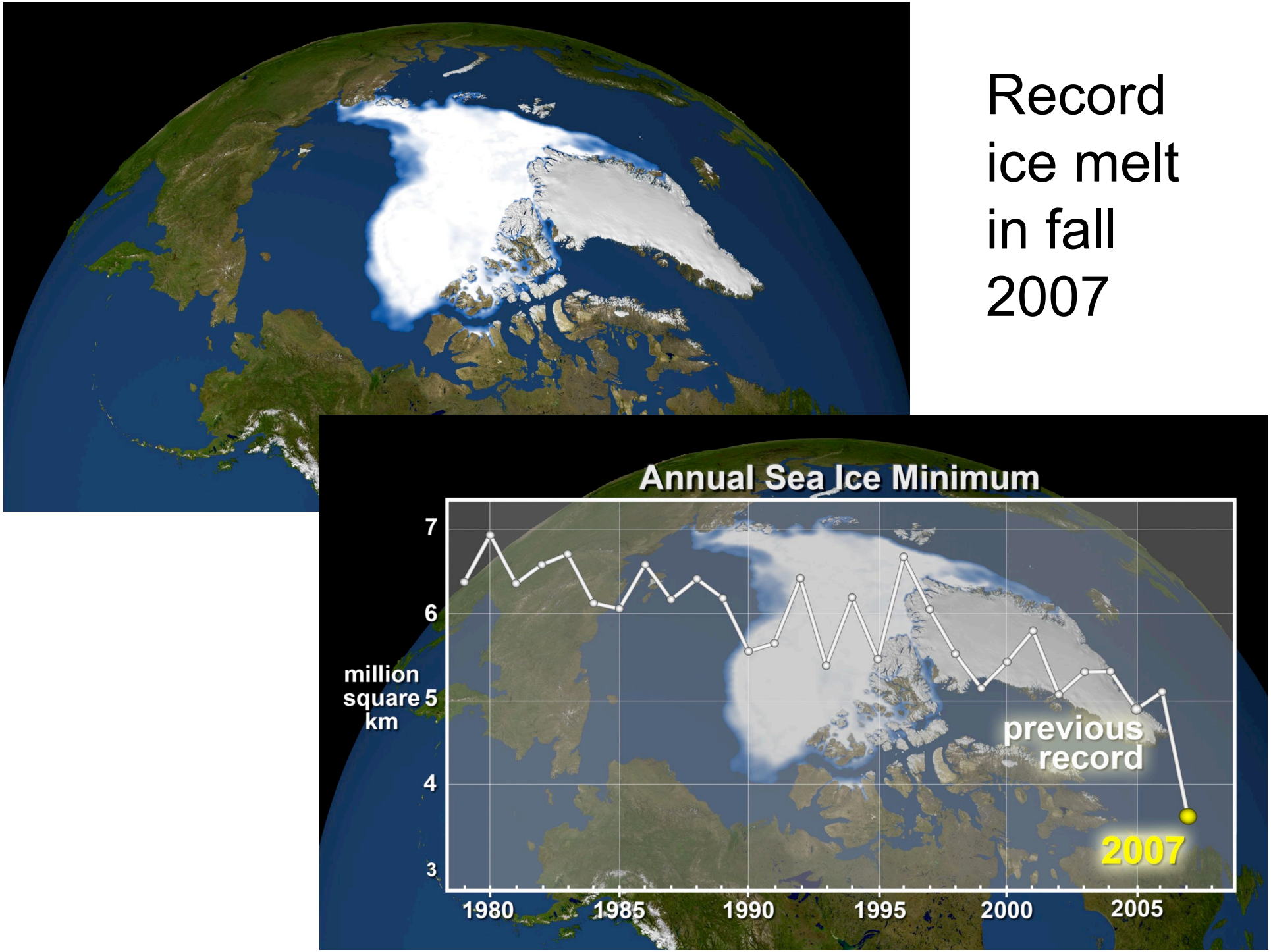
The Scientific Report

Arctic Sea Ice

Observed Sea Ice September 1979

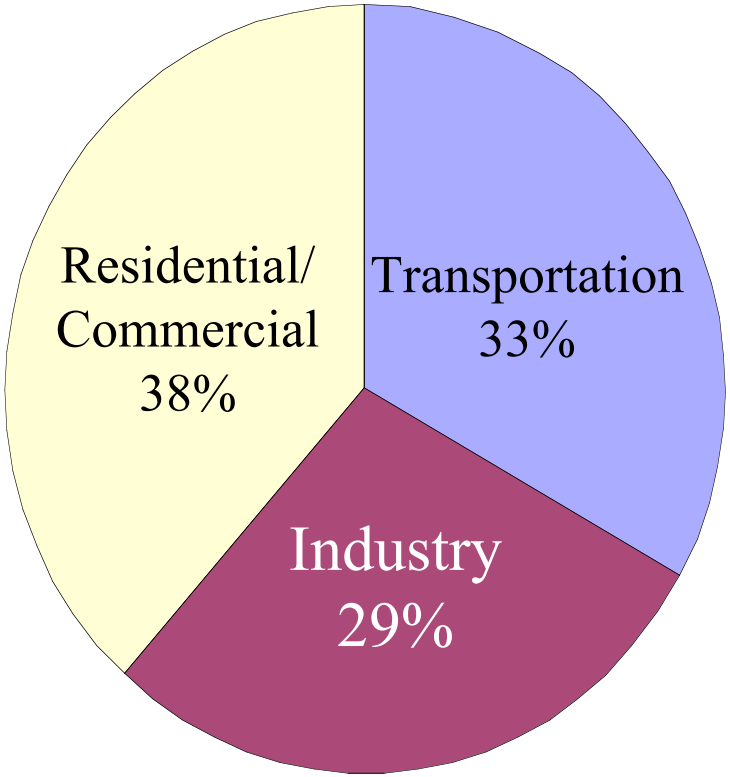


Observed Sea Ice September 2005

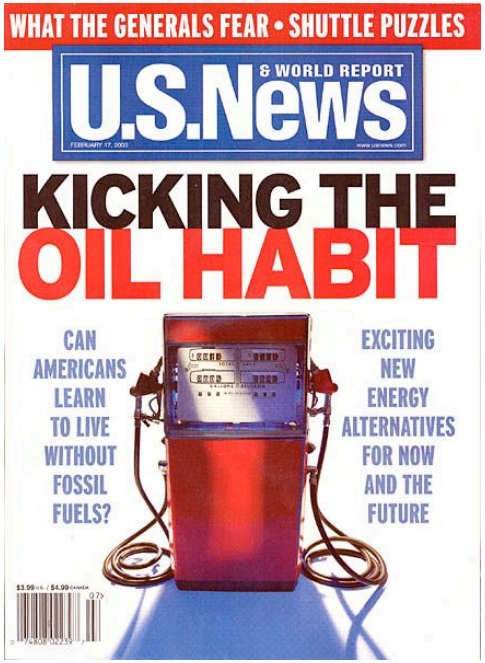


Record ice melt in fall 2007

2002 U.S. CO_2 Emissions

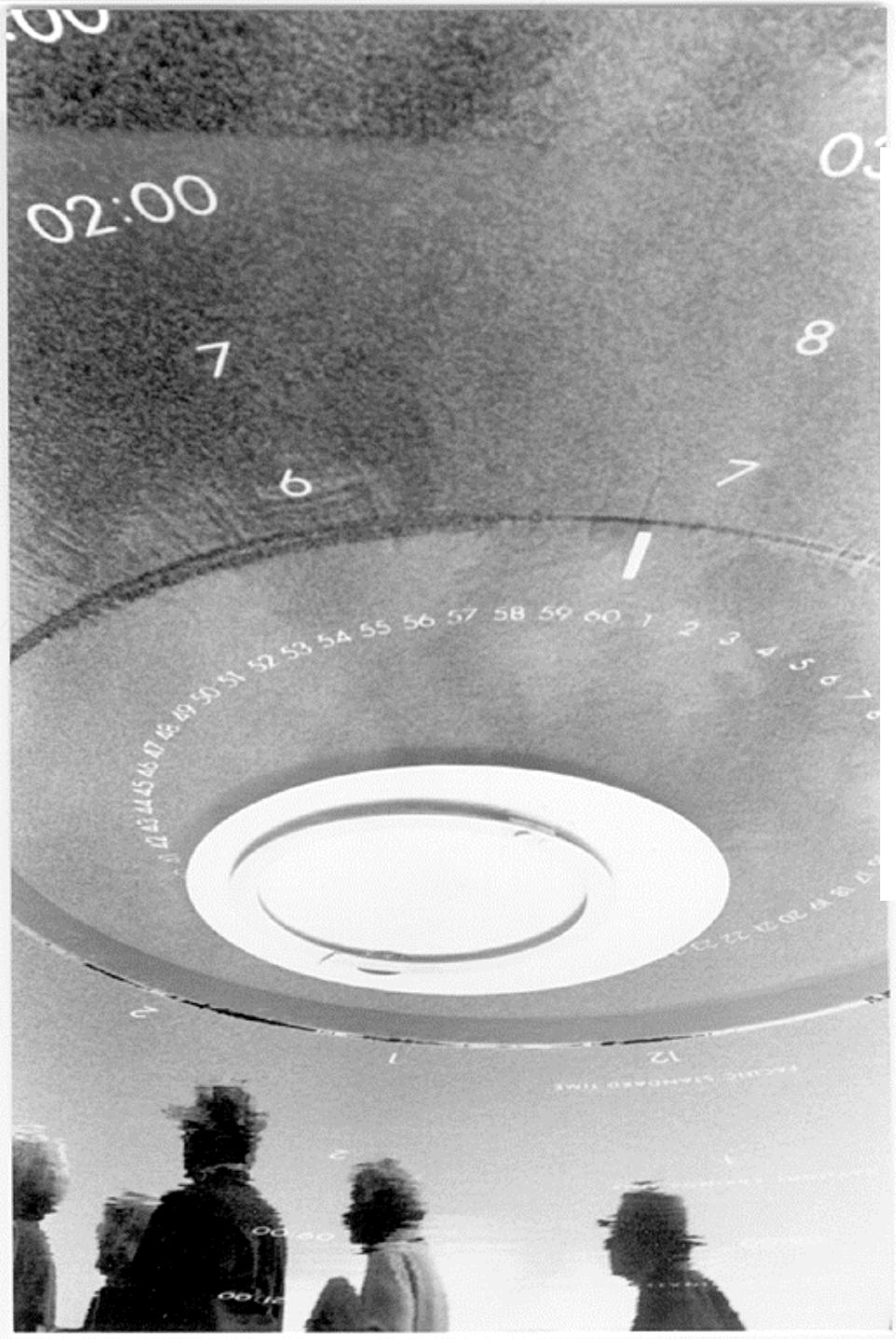


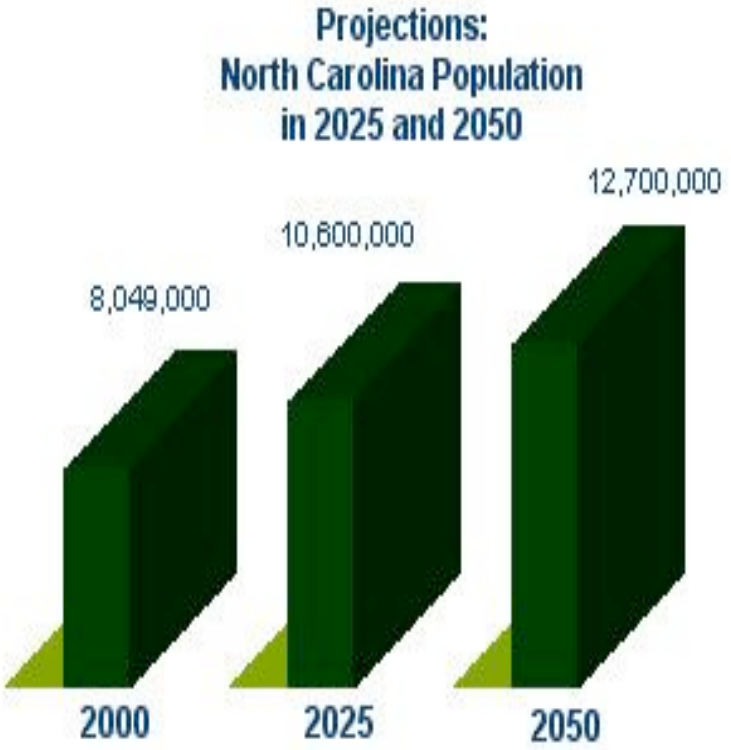
Transportation: 0.6 Pg C/yr
(19% growth in the 1990s)



1.6 Pg C of U.S. CO_2 Emissions in 2004

Source: DOE 2003. U.S. Carbon Dioxide Emissions from Energy Sources





North Carolina population in 2050:

13 million people?

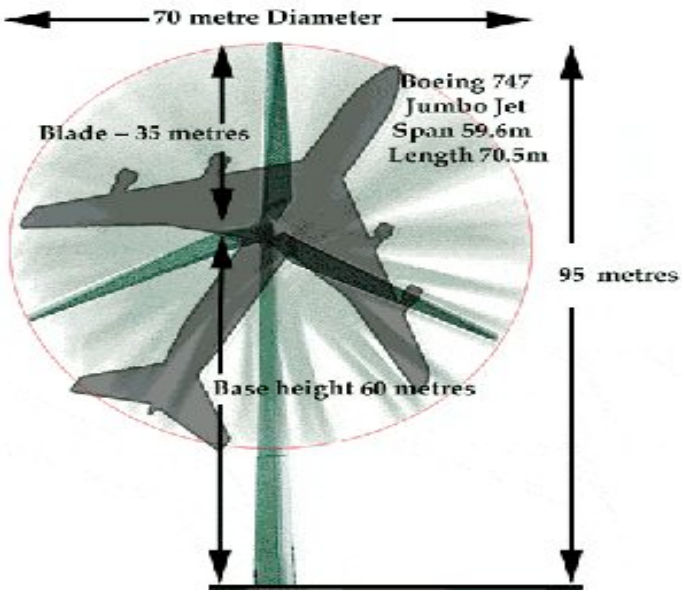
New “Renewable” Technologies

Dish Engine System

Ocean Tides

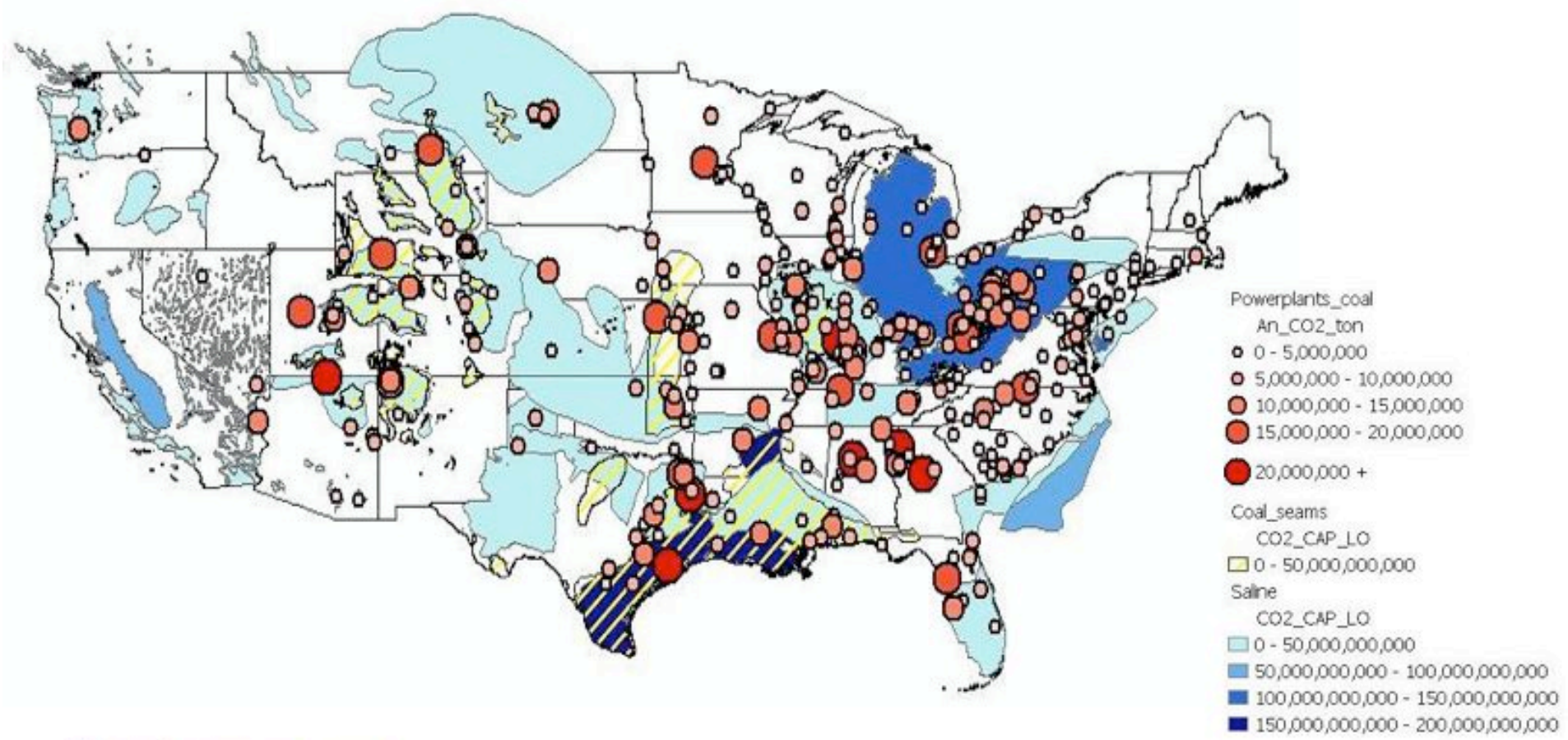
Solar Trough

Wind



Opportunities for Land-based Carbon Sequestration

Point Sources & Reservoirs



CENTER ON GLOBAL CHANGE

Climate Change Policy Partnership

Vehicle Emission Reductions

1908 Ford Model T (~20mpg)

Today

2005 U.S. fleet average (~20 mpg)

"Tomorrow" is here

Hybrid Technology, Diesel (50 mpg)

Cut U.S. fossil fuel emissions by 10% with existing technology:
0.15 PgC/yr

Tackling Global Warming Will Improve Air Quality (regional policy)

photo from NREL/PIX

- In the U.S. coal-fired power and car exhaust are the two biggest sources of the "big six": ozone, particulates, carbon monoxide, nitrogen oxides, sulfur dioxides and lead.
- During the 2003 blackout in the northeast, visibility improved by twenty-five miles. Smog and ozone pollution dropped by half within a day, and gases contributing to haze and acid rain plummeted 90%.
- Urban/regional ozone formation is highly correlated with temperature. Climate change increases temperatures on the worst ozone days as well as the number of bad ozone days

Local Opportunities

Building Efficiency

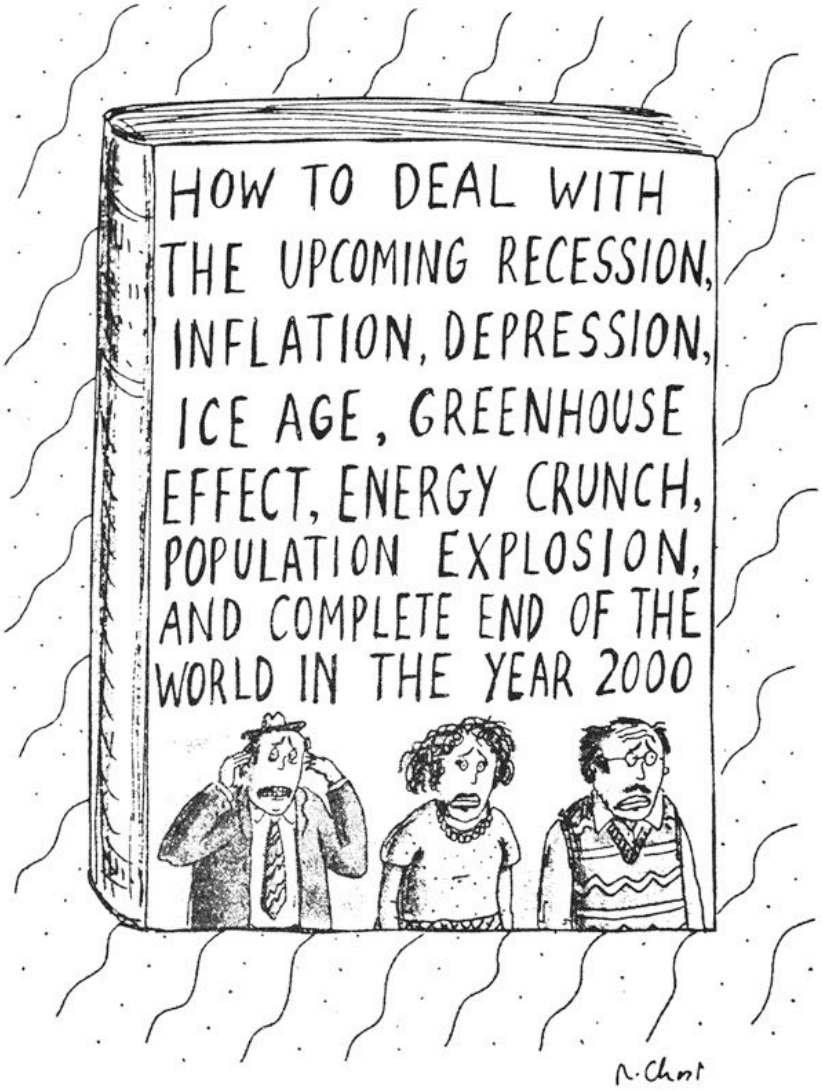
Water/Energy Savings

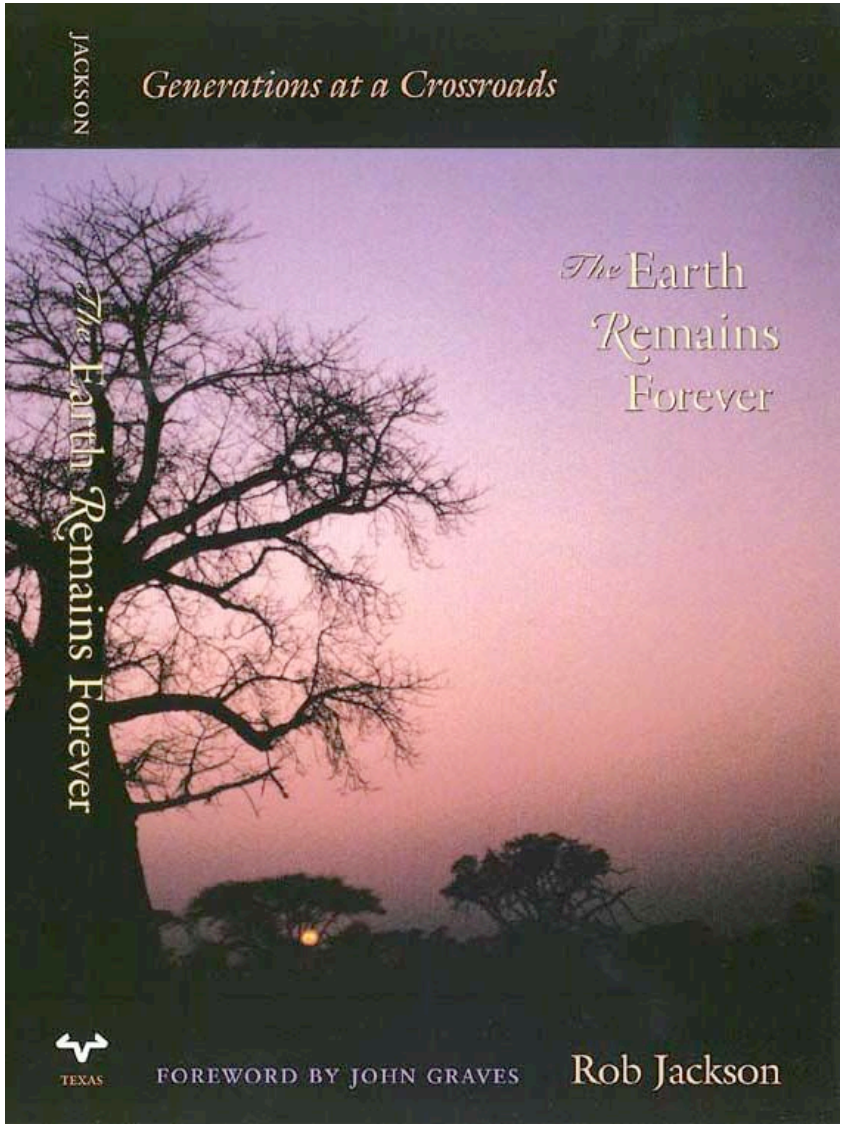
Waste Management

City Planning

Fleet Vehicles

Lighting





"The world was scheduled to end today, but something must have gone wrong."
Robertson Davies, The Papers of Samuel Marchbanks.