

**Global Warming:
Connecting the Dots
from Causes to Solutions***

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26 February 2007

National Press Club

&

American University

Washington, DC

***Any statements relating to policy are personal opinions**

References (Hansen, J. & Co-Authors)

Available: www.columbia.edu/~jeh1

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8. Global warming: Connecting the dots from causes to solutions, 26 February 2007, National Press Club & American University, Washington DC
(http://www.giss.nasa.gov/~jhansen/docs/dots_feb2007.ppt)

Global Warming: Connecting the Dots*

Outline

- 1. Climate Sensitivity:** Charney ('fast feedback') problem 'solved'; $3\pm 1\text{C}$ for $2\times\text{CO}_2$
Charts 5,6: H_2O , clouds, sea ice, aerosols yield net positive feedback factor 2.5
- 2. Slow Feedbacks:** Paleoclimate \gg more sensitive due to 'slow' ice sheet, GHG, vegetation feedbacks – these slow feedbacks are already beginning to appear today
Chart 7: Plio-Pleistocene fluctuations due to weak orbital forcing; ice feedback grows as planet cools; Pliocene CO_2 probably only 350-450 ppm, sea level $+25\pm 10\text{ m}$
- 3. System Inertia:** 1.4F global warming so far; 1F more in pipeline due to existing GHGs, another 1F due to infrastructure, even if we begin aggressive action now
Charts 8,9,10: Global T, Dec/Jan maps, 5-years (land/ocean, high lat., NH/SH)
- 4. Climate Impacts:** extinctions & sea level rise irreversible, large regional effects
Charts 11,12,13,14: Framework Convention, Metrics, Arctic, Sea Level
- 5. Scenarios:** BAU vs Alternative – dichotomy will mushroom due to feedbacks
Chart 15: 21st century global warming
- 6. Fossil Fuel Constraints:** a quarter of CO_2 remains in air 'forever' (>500 years); oil and gas reservoirs sufficient to yield ~ 450 ppm; others must be left in ground
Charts 16,17: CO_2 pulse-response function + fossil fuel reservoirs

Global Warming: Connecting the Dots*

Outline (continued)

7. **Responsibility**: U.S. has produced more than 3X more fossil fuel CO₂ than any other country, long-lasting moral/legal burden for today's children

Chart 18: time-integrated emissions (on right) determine climate impact

8. **Solutions**: 3 ways to reduce CO₂; max CO₂ will be exceeded; suggest 'natural' geoengineering: cellulosic biofuel power plants – red states to rescue - red/white/blue

Chart 19-21: Methods to reduce CO₂, Status of CO₂, Geo-Engineering

Chart 22: Red, White & Blue Solution: Red States Rescue Blue States

9. **Communication**: premise of democracy = (honestly) informed public; (1) testimony reviewed by OMB!, (2) Public Affairs Offices staffed by political appointees

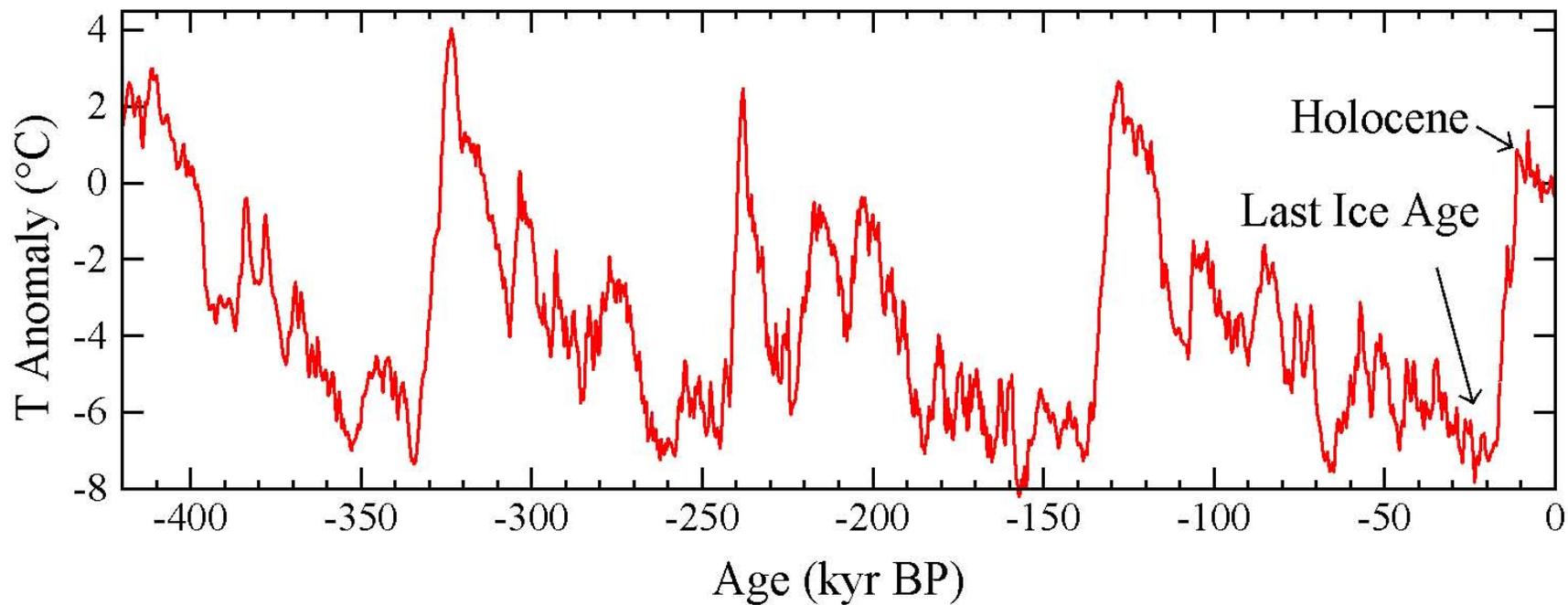
Chart 23: Does the public want professionals or Offices of Propaganda?

10. **Recommendations**: (1) Moratorium on new coal-fired power plants, (2) Carbon Tax/Technology Investment, (3) Energy Efficiency Standards, (4) NAS study on ice sheets, (5) Address Threats to American Democracy

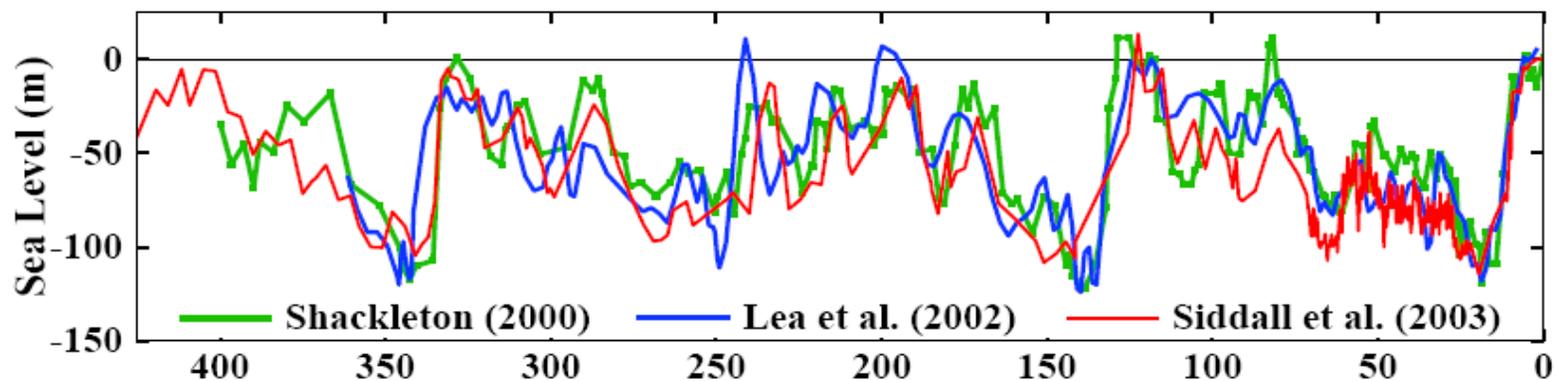
Charts 24-29 on each recommendation

*Statements related to policy are personal opinion; charts available www.columbia.edu/~jeh1

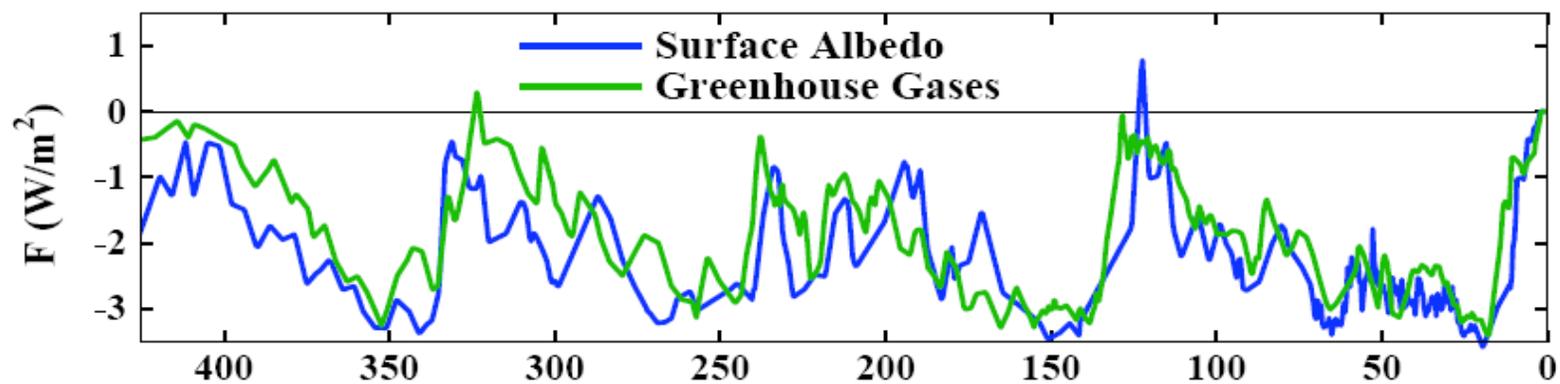
Antarctic (Vostok) Temperature



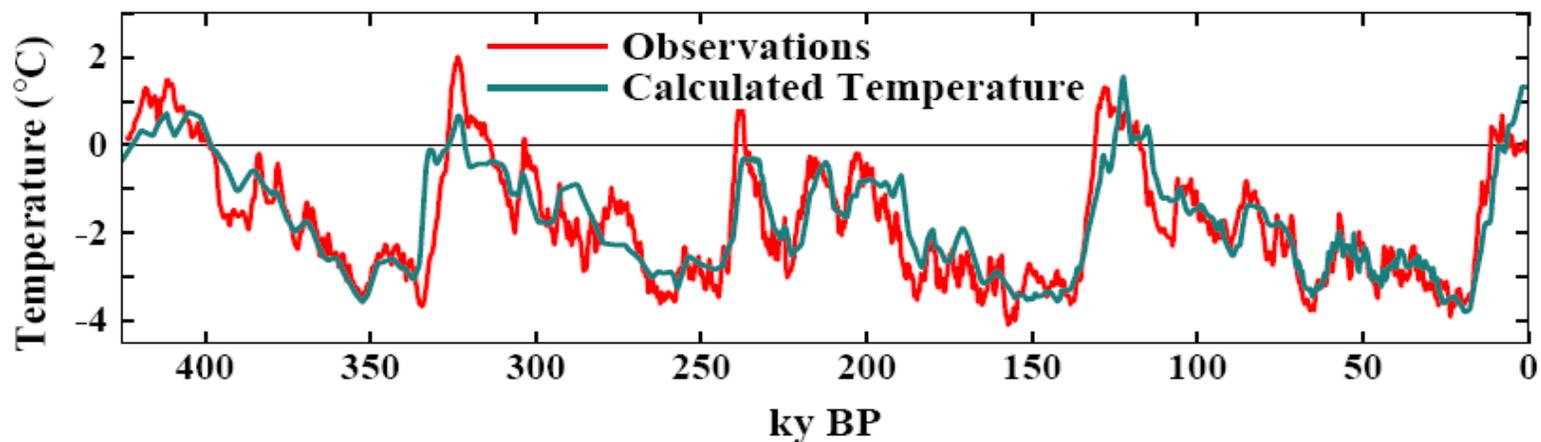
(a) Sea Level Records



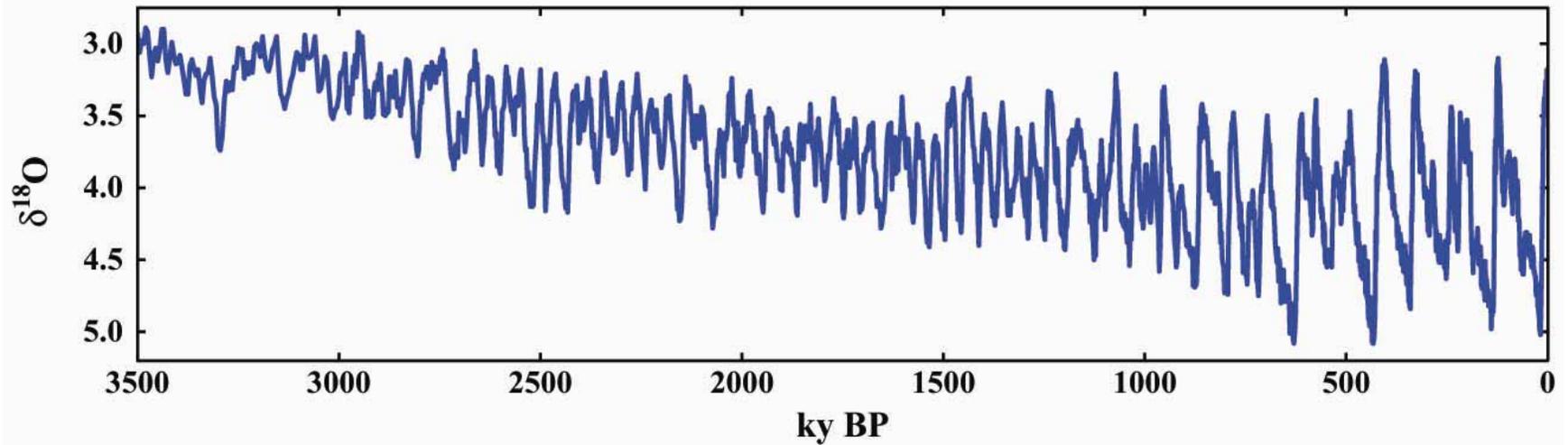
(b) Climate Forcings



(c) Paleoclimate Temperature Change

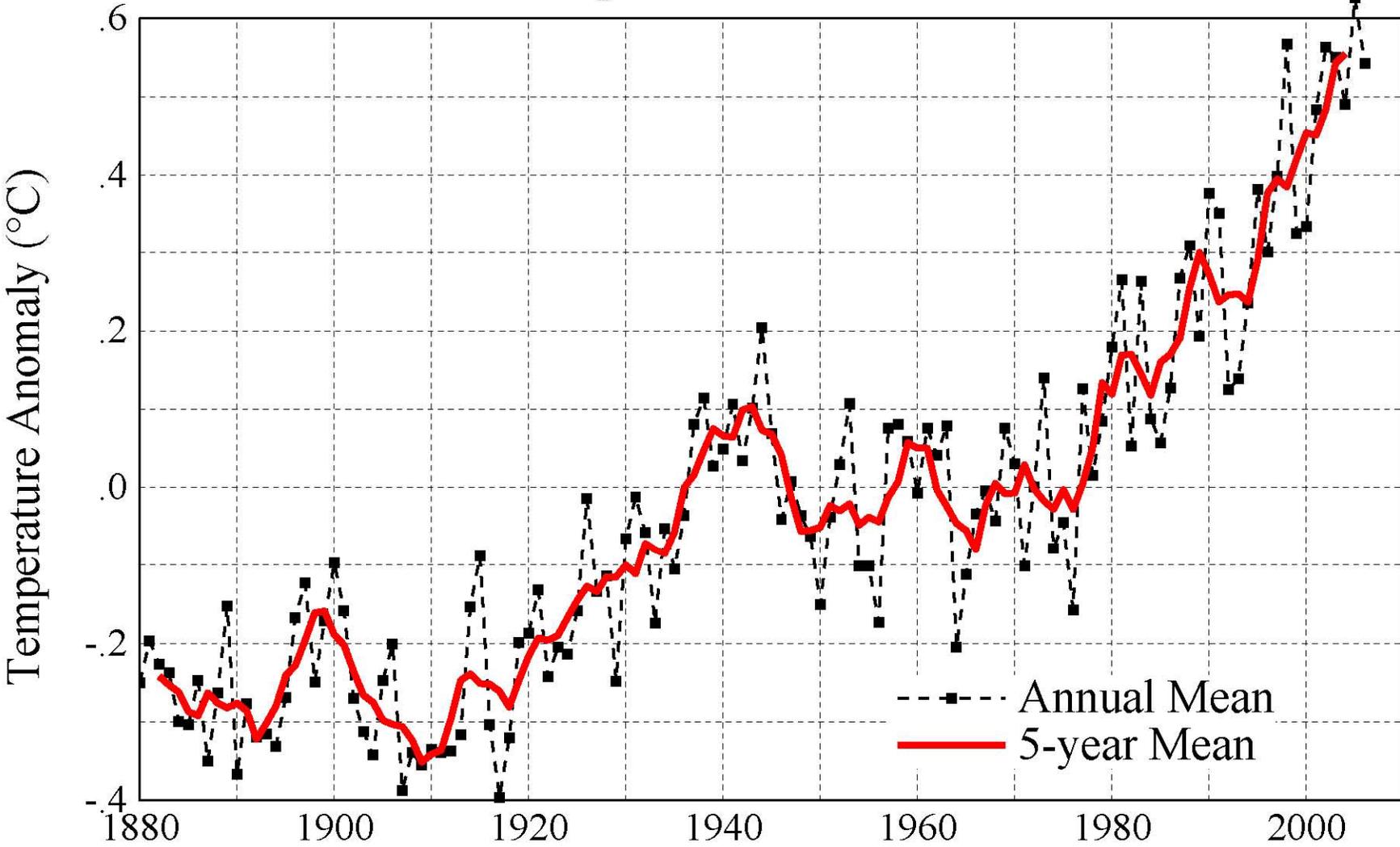


$\delta^{18}\text{O}$ Global Sea Level/Temperature Proxy



Proxy record of Plio-Pleistocene (3.5 million years) temperature and ice volume. Based on oxygen isotope preserved in shells of benthic (deep ocean dwelling) foraminifera.

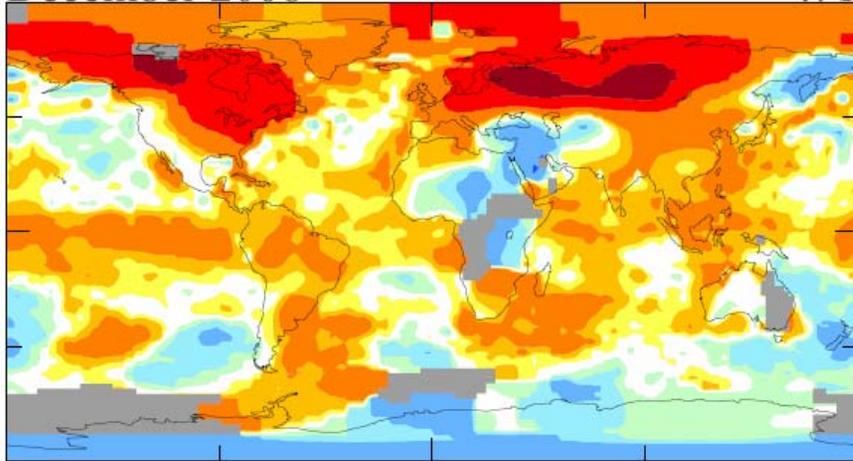
Global Temperature: Land-Ocean Index



Surface Temperature Anomaly (°C) [Base Period 1951-80]

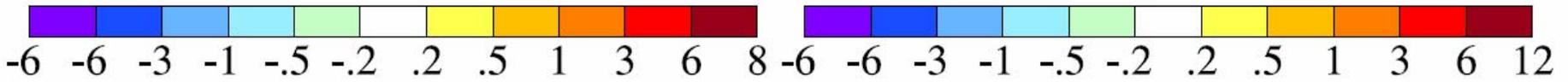
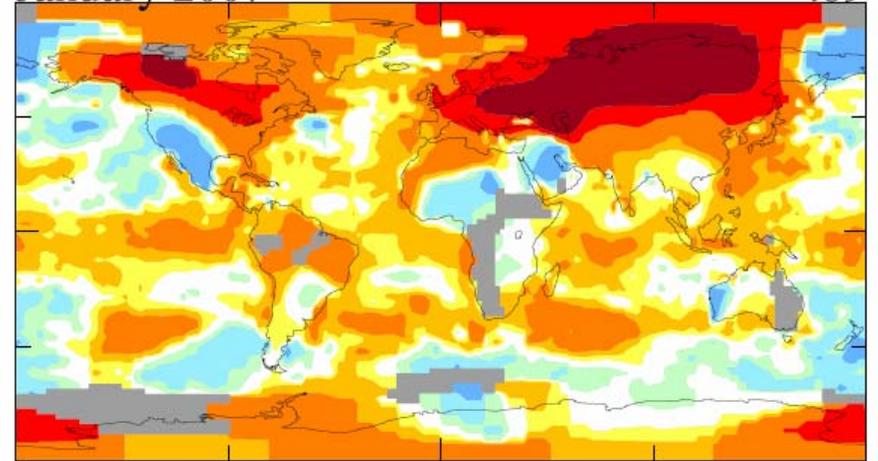
December 2006

.71



January 2007

.89

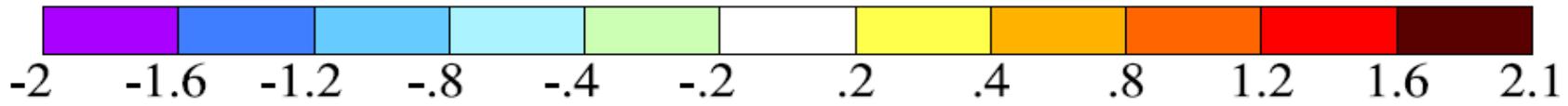
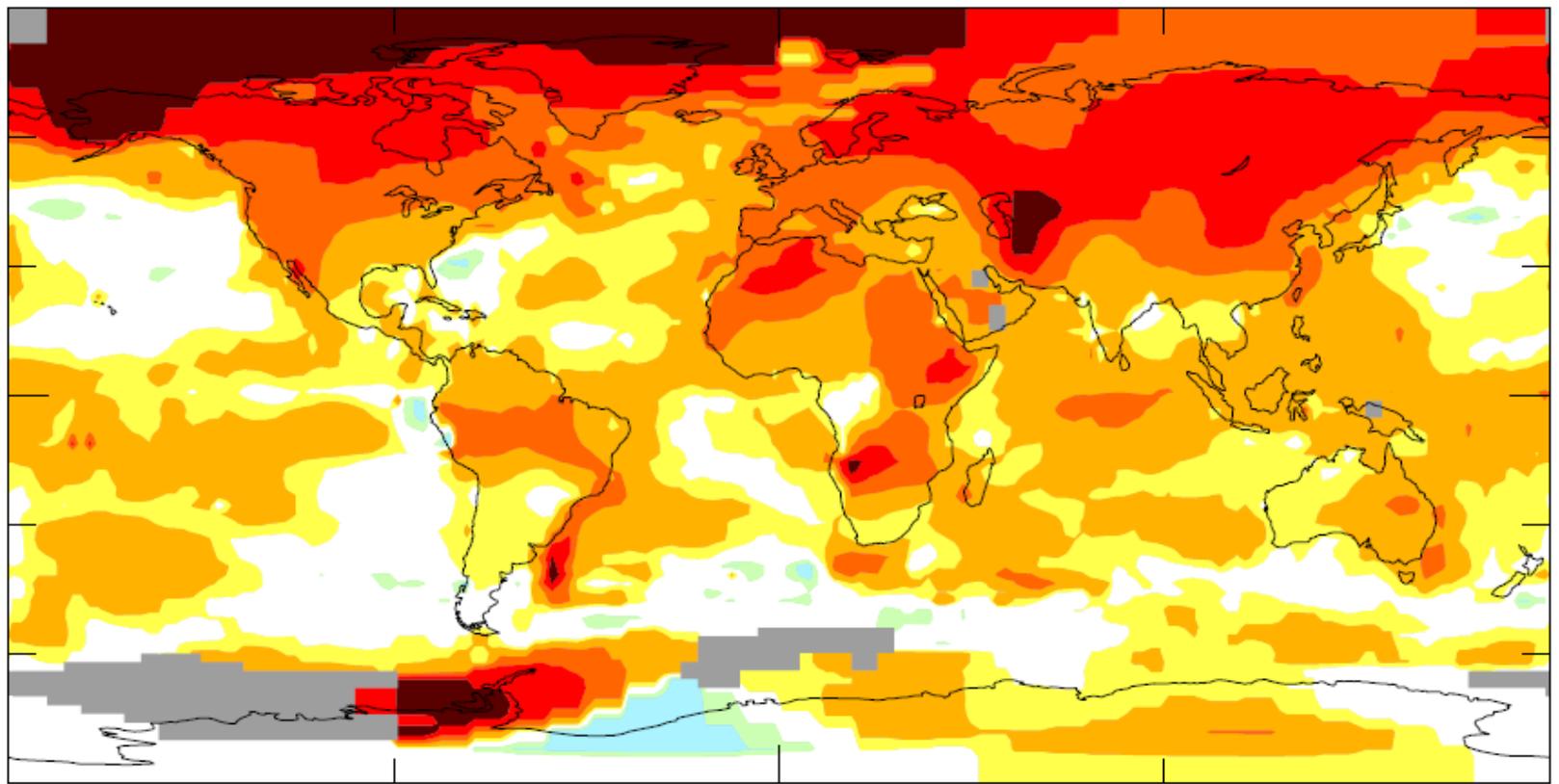


December 2006 was the Warmest December on Record
and January 2007 was the Warmest January on Record.

2001-2006 Mean Surface Temperature Anomaly (°C)

Base Period = 1951-1980

Global Mean = 0.54



United Nations Framework Convention on Climate Change

Aim is to stabilize greenhouse gas emissions...

“...at a level that would prevent dangerous anthropogenic interference with the climate system.”

Metrics for “Dangerous” Change

Extermination of Animal & Plant Species

1. Extinction of Polar and Alpine Species
2. Unsustainable Migration Rates

Ice Sheet Disintegration: Global Sea Level

1. Long-Term Change from Paleoclimate Data
2. Ice Sheet Response Time

Regional Climate Change

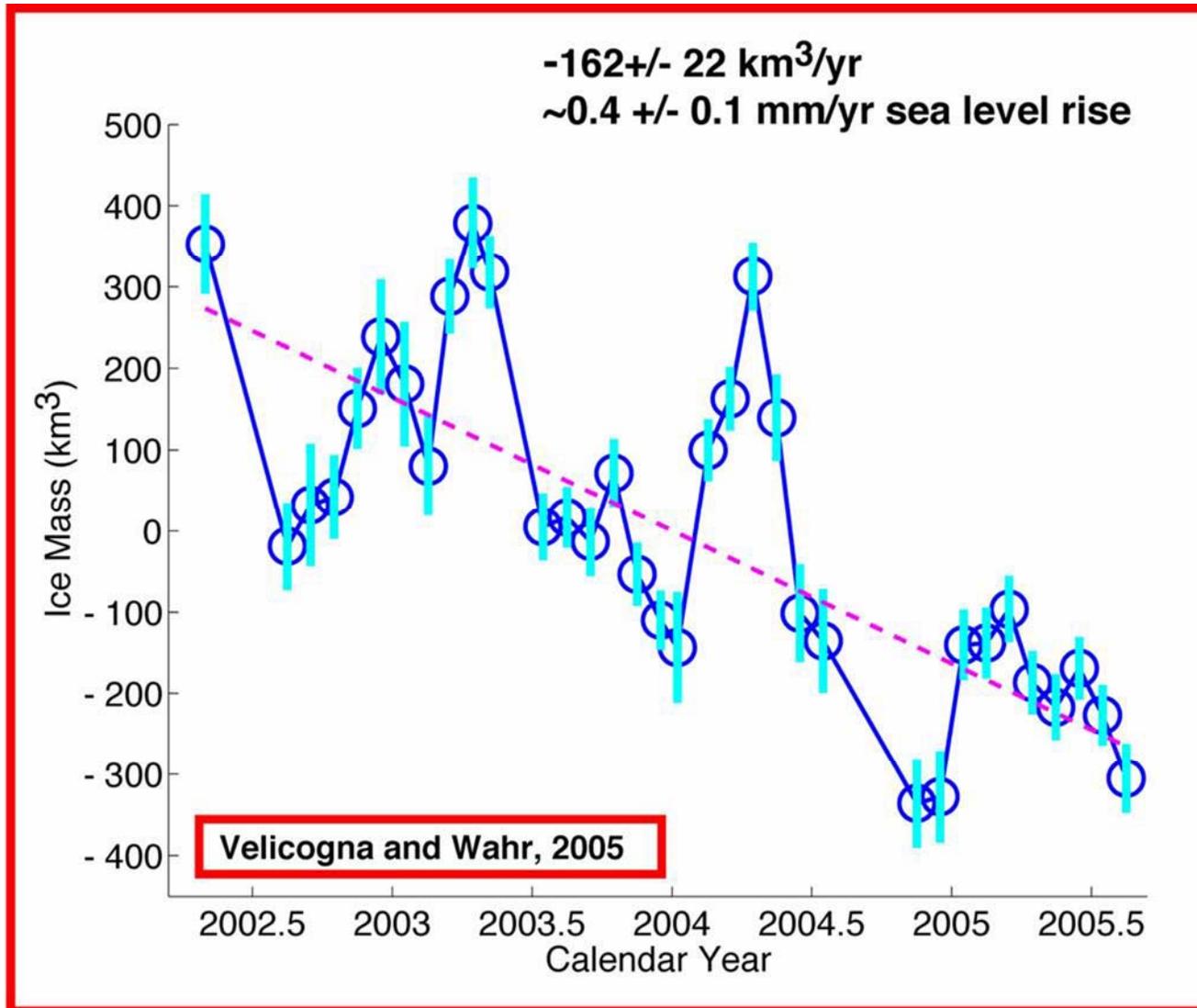
1. General Statement
2. Droughts/Floods

Arctic Climate Impact Assessment (ACIA)

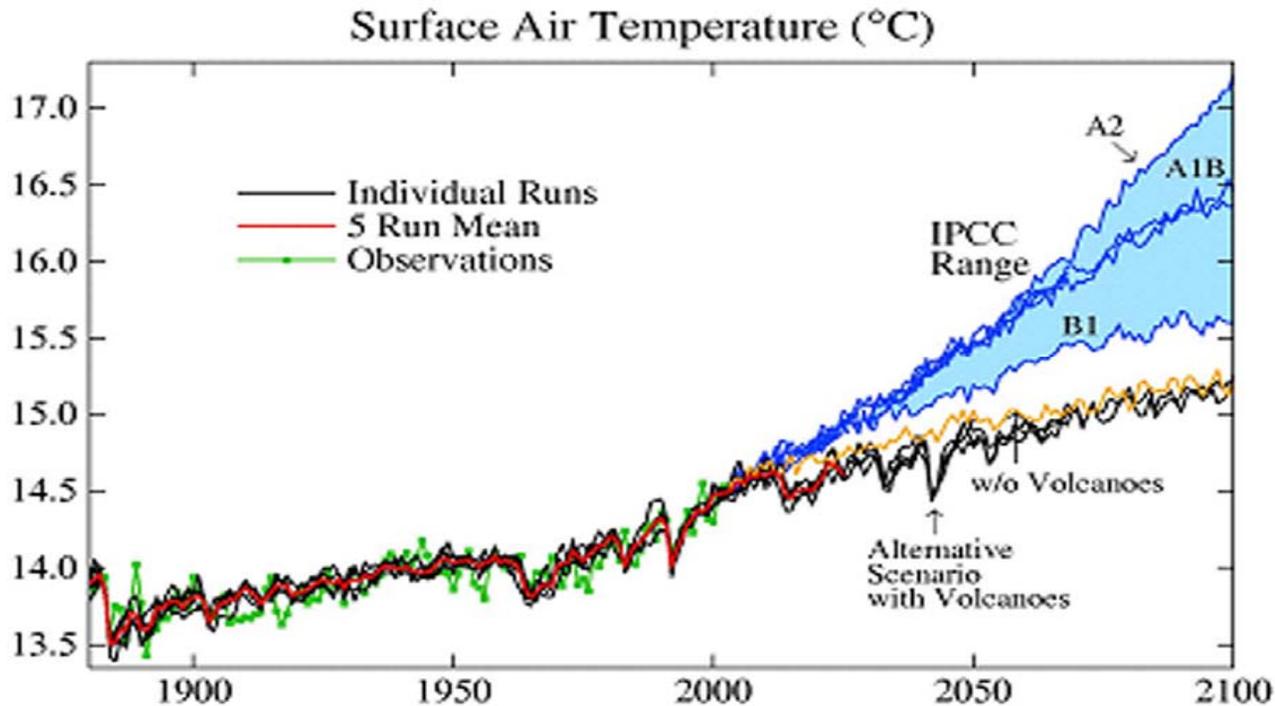


Sources: Claire Parkinson and Robert Taylor

Greenland Mass Loss – From Gravity Satellite



21st Century Global Warming



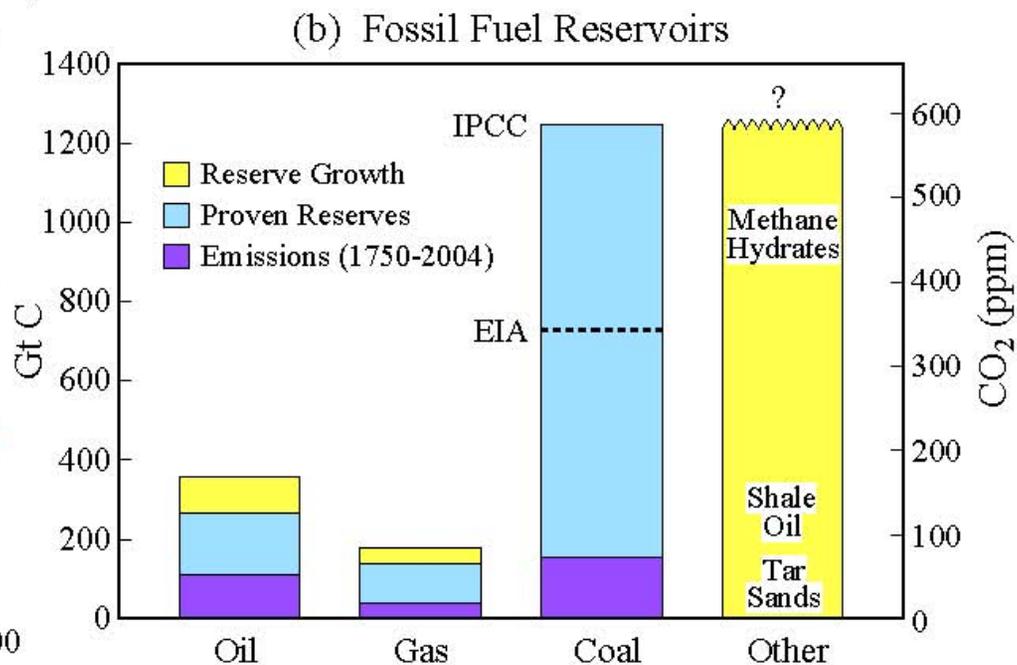
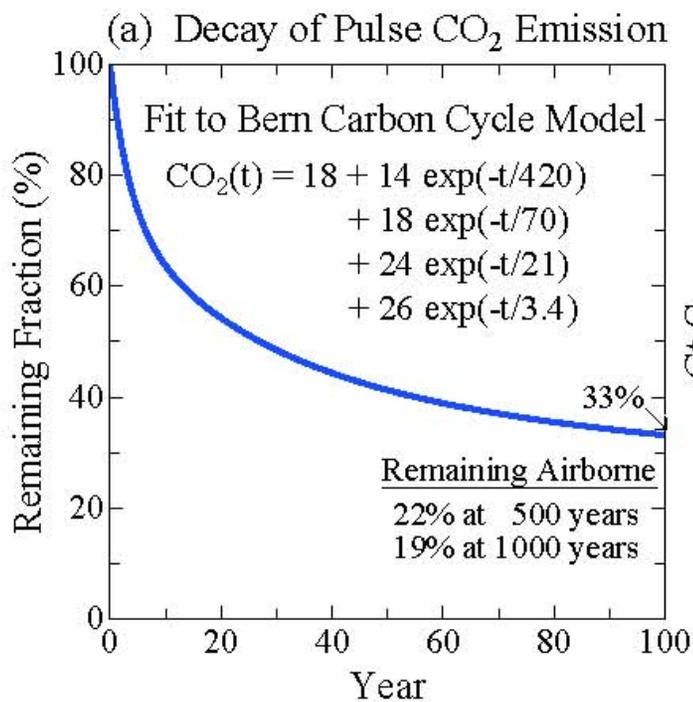
Climate Simulations for IPCC 2007 Report

- ▶ **Climate Model Sensitivity 2.7-2.9°C for 2xCO₂**
(consistent with paleoclimate data & other models)
- ▶ **Simulations Consistent with 1880-2003 Observations**
(key test = ocean heat storage)
- ▶ **Simulated Global Warming < 1°C in Alternative Scenario**

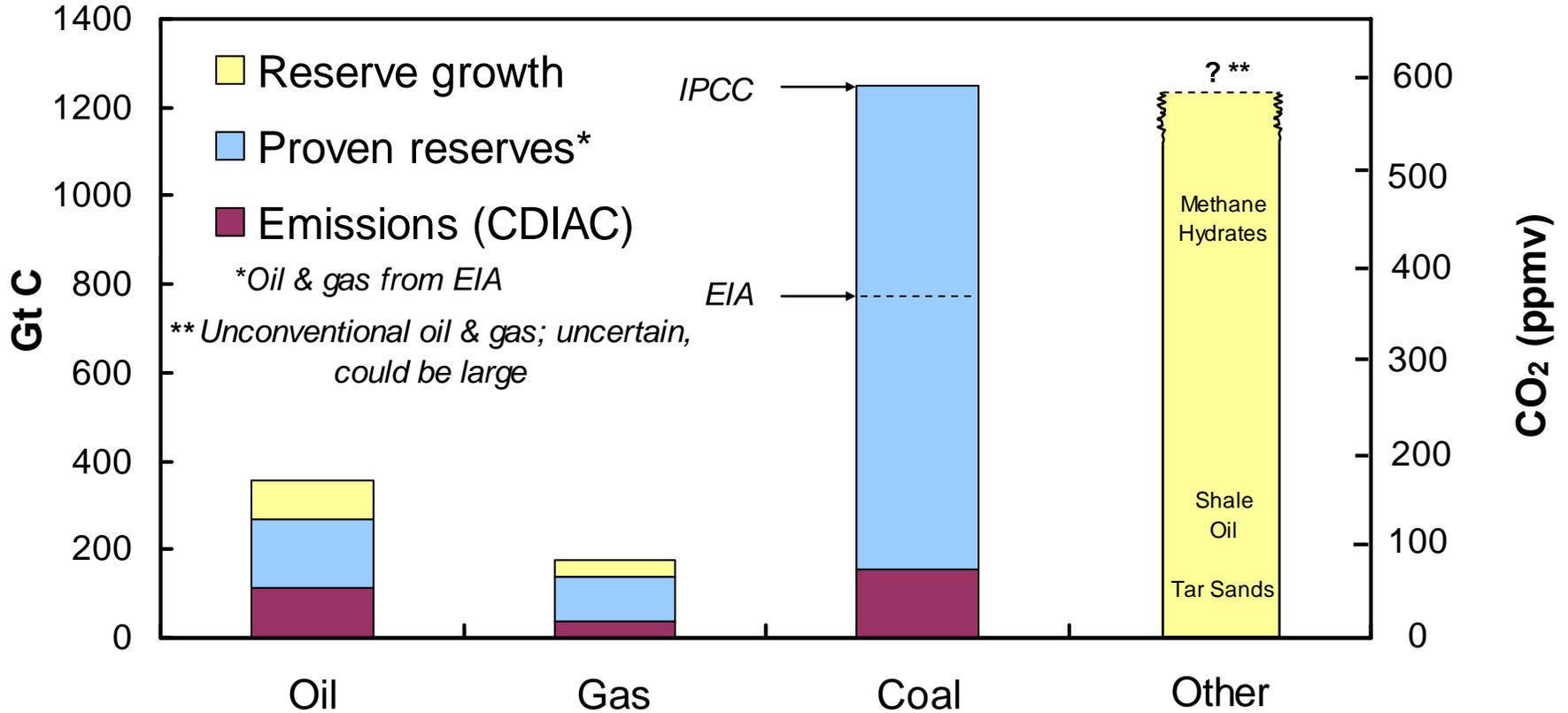
Conclusion: Warming < 1°C if additional forcing ~ 1.5 W/m²

Source: Hansen et al., to be submitted to *J. Geophys. Res.*

Carbon Cycle Constraints

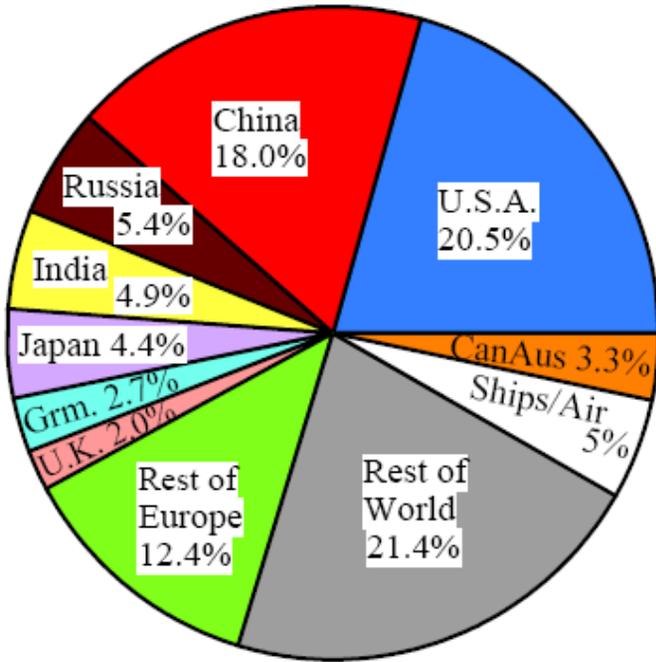


Fossil Fuel Reservoirs and 1750–2004 Emissions

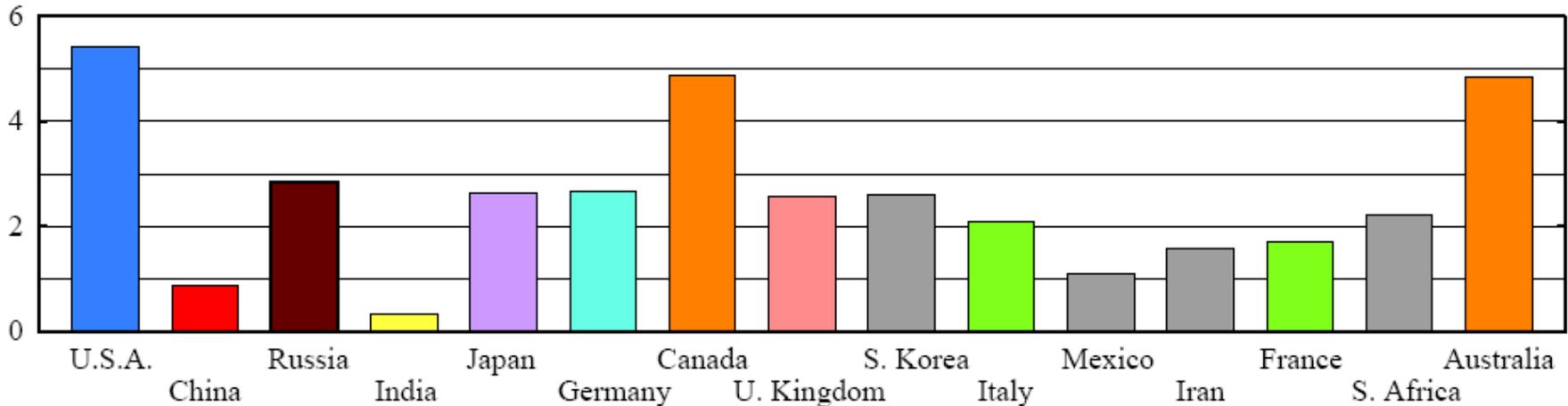
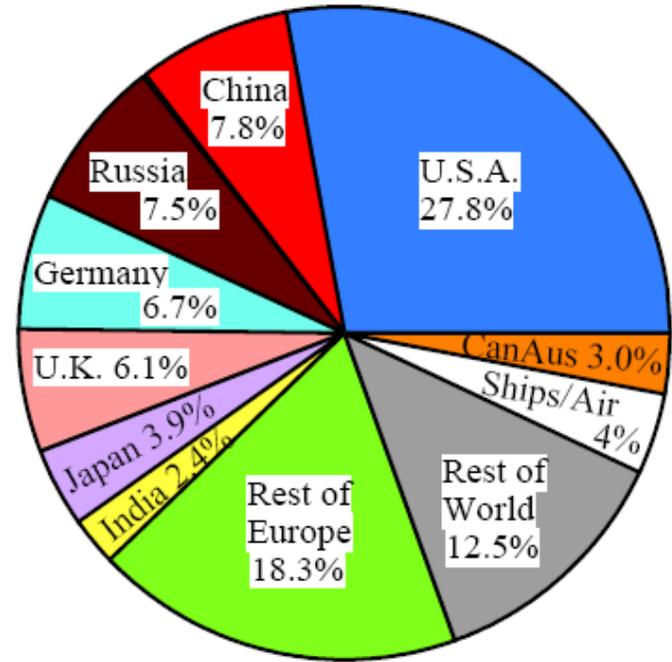


Responsibility for CO₂ Emissions and Climate Change

2005 CO₂ Emissions



Total CO₂ Emissions



Per Capita Fossil Fuel CO₂ Emissions in Order of Total Emissions

Methods to Reduce CO₂ Emissions

1. Energy Efficiency & Conservation

More Efficient Technology

Life Style Changes

2. Renewable & CO₂-Free Energy

Hydro

Solar, Wind, Geothermal

Nuclear

3. CO₂ Capture & Sequestration

→ No Silver Bullet

→ All Three are Essential

Status of CO₂

Pre-industrial Amount: 280 ppm

Present Amount: 382 ppm

Maximum Allowable \leq 450 ppm

**Rate of Change: +2 ppm/year
(and growing)**

→ Maximum Will Be Exceeded!

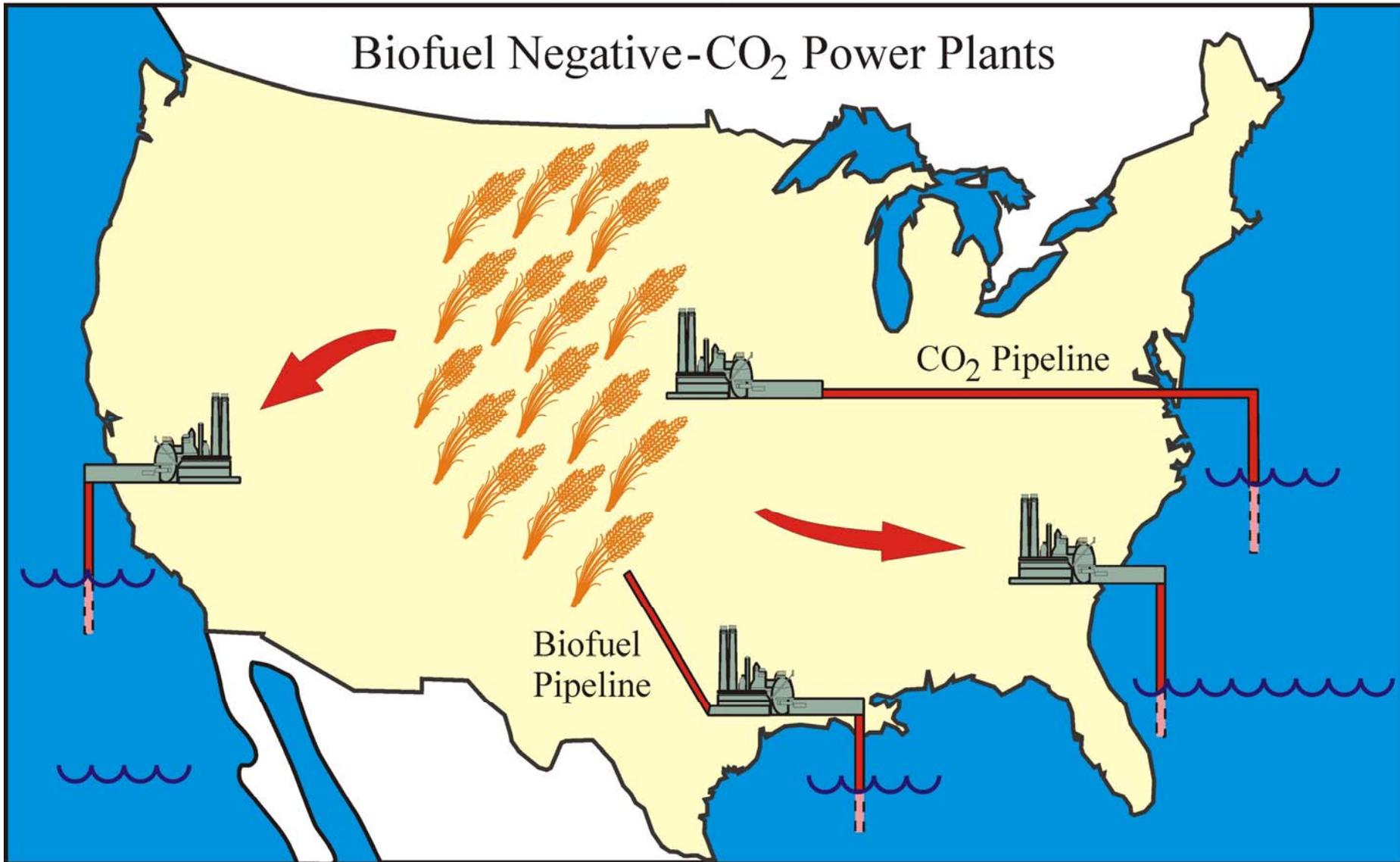
→ 'Geoengineering' Probably Needed

Geo-Engineering

1. **Human Volcano (SO₂ to Stratosphere)**
Unintended Consequence? Cost?
2. **Mirrors in Space**
Technical Challenge! How Soon? Cost?
3. ****Negative CO₂ Power Plants****
Red, White & Blue Solution!
Competition with Vehicular Ethanol?
 - **Solution Not Near**
 - **Must Slow Down Emissions!**

Red, White & Blue Solution

Biofuel Negative-CO₂ Power Plants



Cellulosic Biofuels Electrical Power Generation
Fail-Safe CO₂ Sequestration in Deep-Sea Sediments

WORLD·WATCH

Volume 19, Number 6

Vision for a Sustainable World

November/December 2006

Swift Boating, Stealth Budgeting, Unitary & Executives

by James Hansen

Illustrations by William Bramhall

Excerpted from the November/December 2006 issue of *World Watch* magazine

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Recommendation #1

Moratorium on Coal-Fired Power Plants

Technology w Sequestration ~ Decade Away

All Plants w/o Sequestration must eventually be bulldozed (before mid-century)

Efficiency Can Handle Needs during Interim (and is necessary on the long run)

→ This should be done by Congress

→ In interim Citizens must accomplish it

Recommendation #2

Carbon Tax & Technology Investment

Gradually Rising Price on Emissions Drives Innovation & Efficiency

Result: Hi-Tech Hi-Pay Jobs, Technologies to Export, Energy Independence, National Security, Balance of Payments

Present Government Technology Investment:

Fossil Fuels, Nuclear Power: ~\$1B each

Renewables, Efficiency: chicken feed

- Government should not pick “Winners”
- Need a Leader who will Level with Public

Recommendation #3

Energy Efficiency Standards

Buildings: Adopt “2030 Challenge”

- 50% less CO₂ new/renovated buildings
- endorsed by U.S. Conference of Mayors

Vehicles: Adopt California Standards

Remove Structural Barriers to Efficiency

Recommendation #4

National Academy of Sciences Study: Stability of Ice Sheets

A Driver of “Dangerous” Climate Change

Urgent: cannot wait for slow IPCC process

Panel of Physicists, Climatologists, etc.

**Report: Status of Understanding, Implications,
Needed Research & Possible Actions**

National Academy of Sciences: “In Service To The Nation”



The National Academy of Sciences (NAS) was signed into being by President Abraham Lincoln on March 3, 1863. As mandated in its [Act of Incorporation](#), the Academy has, since 1863, served to "investigate, examine, experiment, and report upon any subject of science or art" whenever called upon to do so by any department of the government.

Source: NAS website. <http://www7.nationalacademies.org/archives/nasfounding.html>

Recommendation #5

Address Threats to American Democracy

The Public's Right to Know

- a. Professional Public Affairs Offices
- b. Unfiltered Congressional Testimony

True, Effective Campaign Finance Reform

Climate problem cannot be solved as long as
Special Interests are calling the tunes

Suggestion for Concerned Citizens

Look into www.stepitup07.org

April 14 Nationwide Rallies

Initiated by Bill McKibben

Coordinated with Earth Day Network

Demonstrate that the public cares about
what we leave for our children,
and wants to preserve creation