Climate Threat to the Planet *

Implications for Energy Policy

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3 June 2008

PACON International

Honolulu , Hawaii

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

Global Warming Status

1. Knowledge Gap Between

- What is Understood (scientists)
- What is Known (public/policymakers)

2. Planetary Emergency

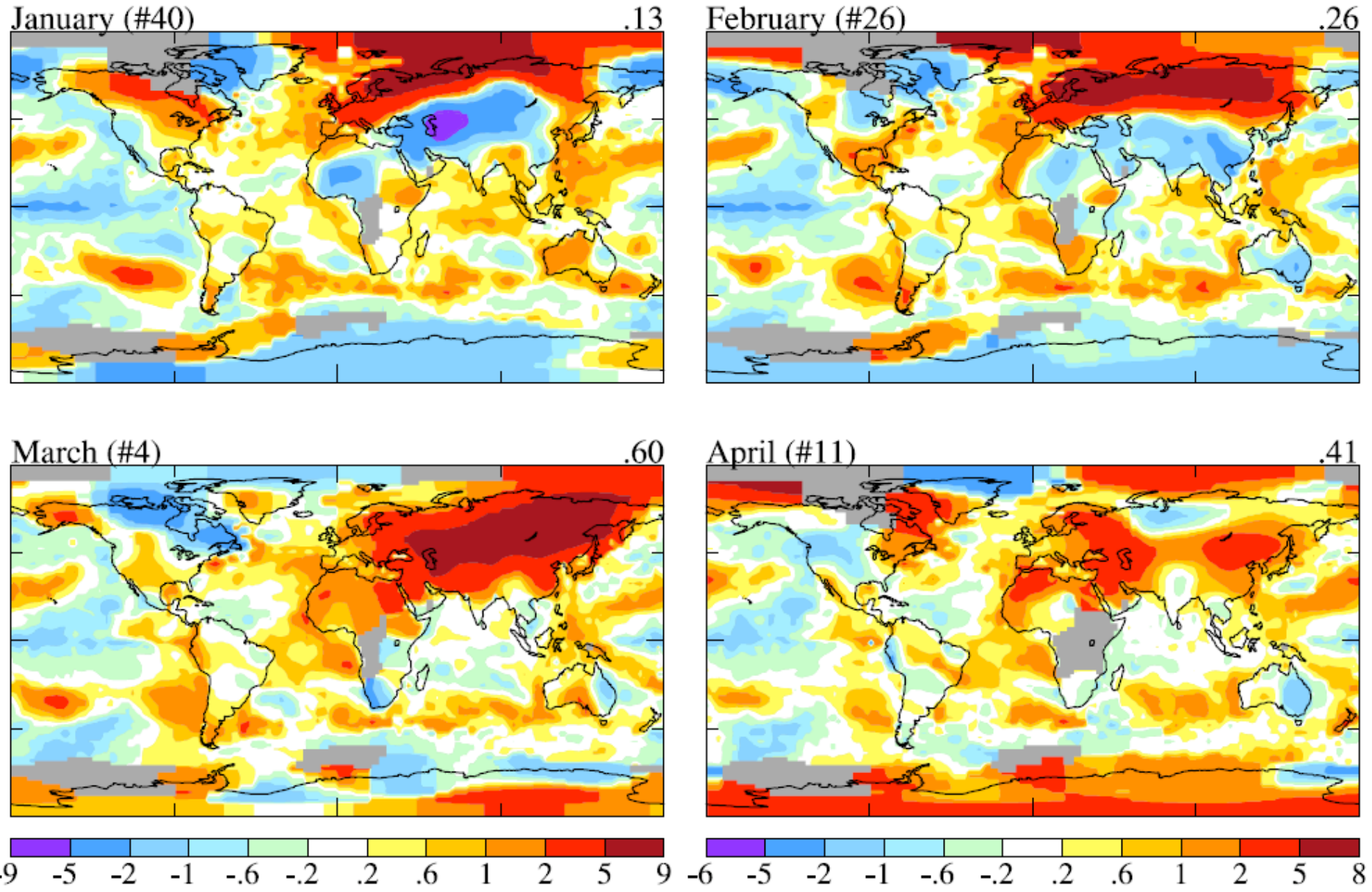
- Climate Feedbacks → Climate is Sensitive
- Climate Inertia → Warming in Pipeline
- CO_2 & Energy Infrastructure Long Lifetime

Danger: Tipping Points → Lose Control

3. Good News in Bad News

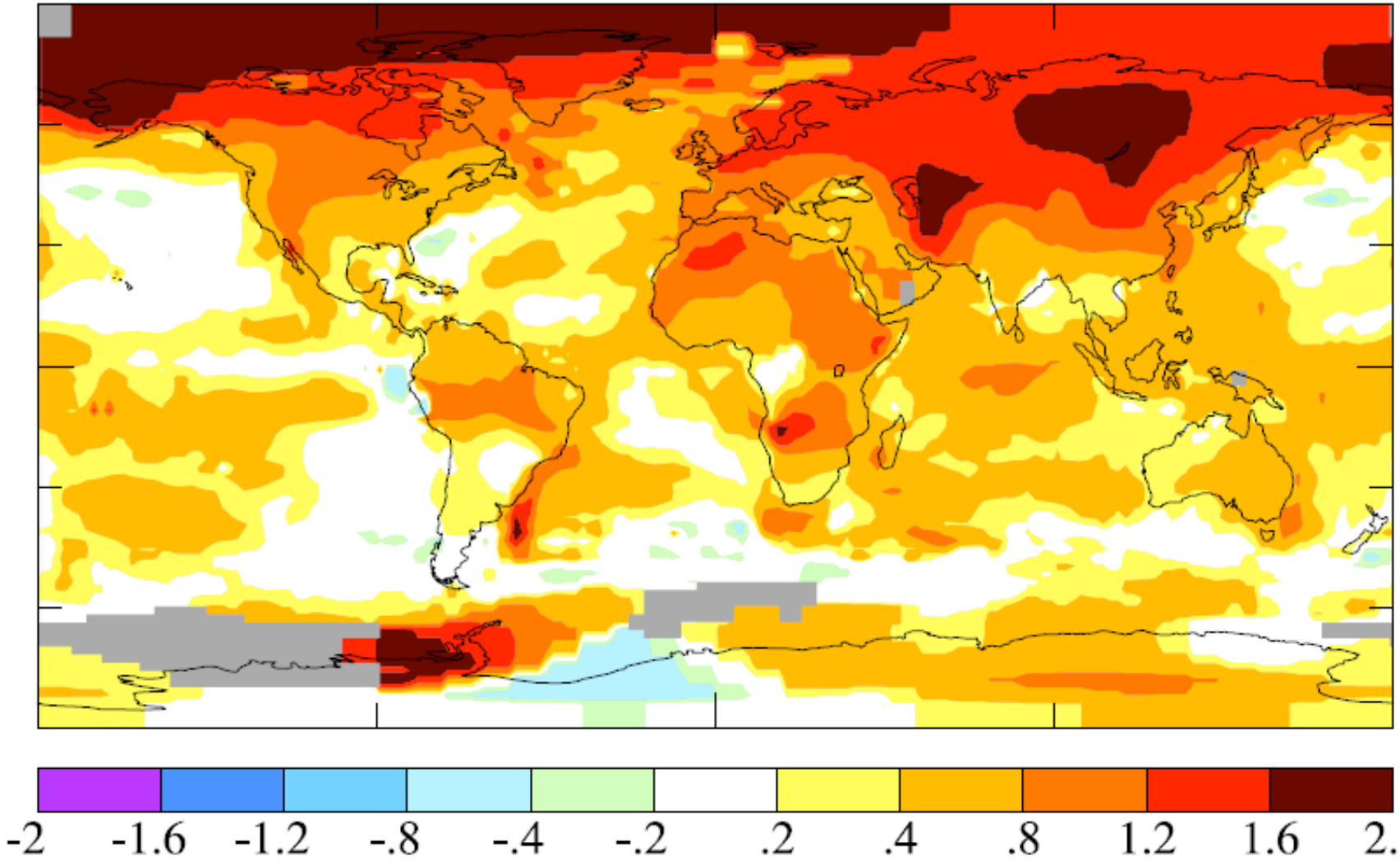
- Climate Inertia → Time to Act (barely)
- Multiple Benefits (Clean Air & Water, Energy Independence)

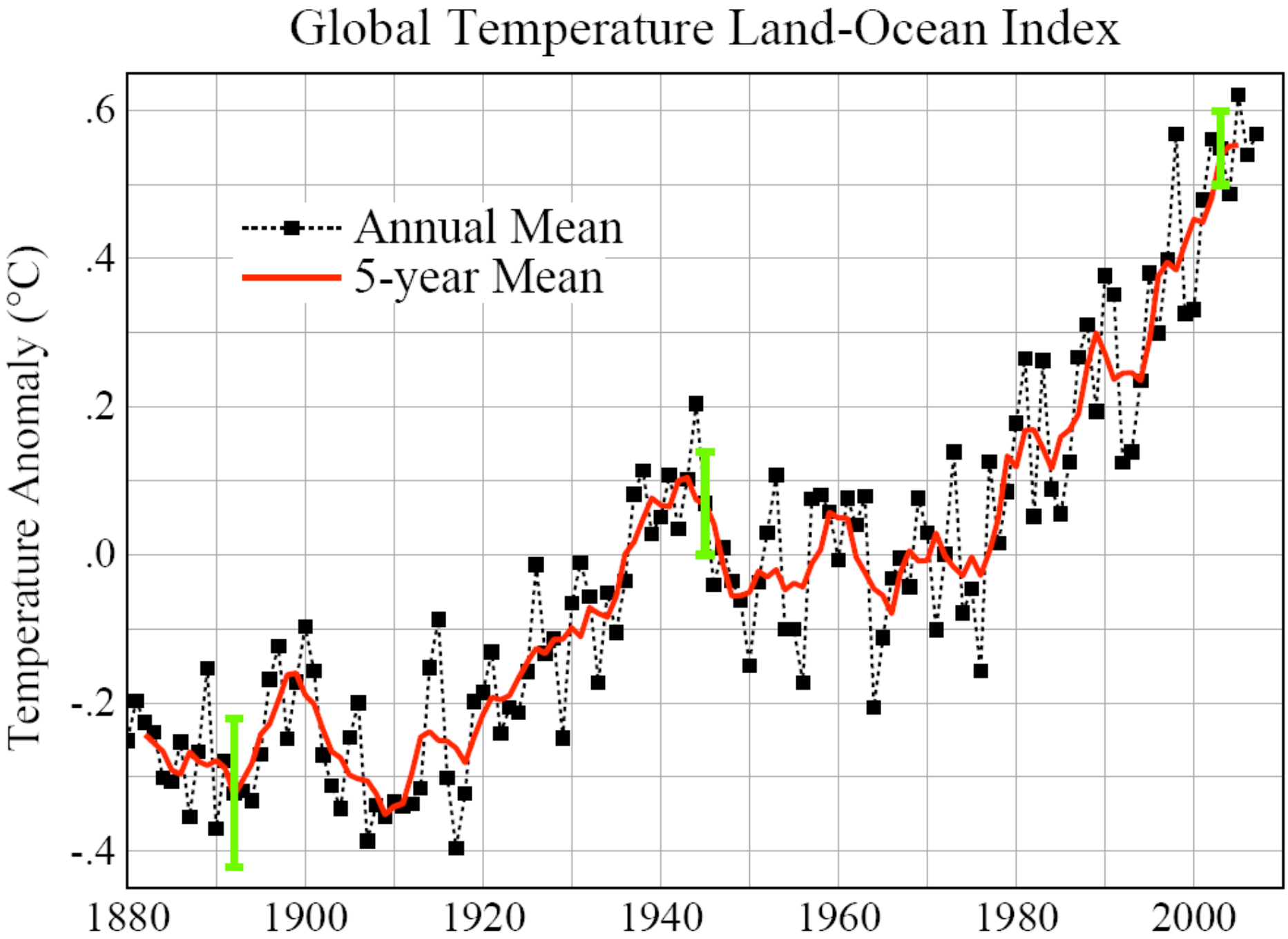
2008 Surface Temperature Anomalies (°C) [Base Period 1951-80]



2001-2007 Mean Surface Temperature Anomaly (◦C)

Base Period = 1951-80, Global Mean = 0.54




Global Temperature Land-Ocean Index
Temperature Anomaly (°C)
.6
.4
.2
.0
-.2
-.4
Annual Mean
5-year Mean
1880
1900
1920
1940
1960
1980
2000

Tipping Point Definitions

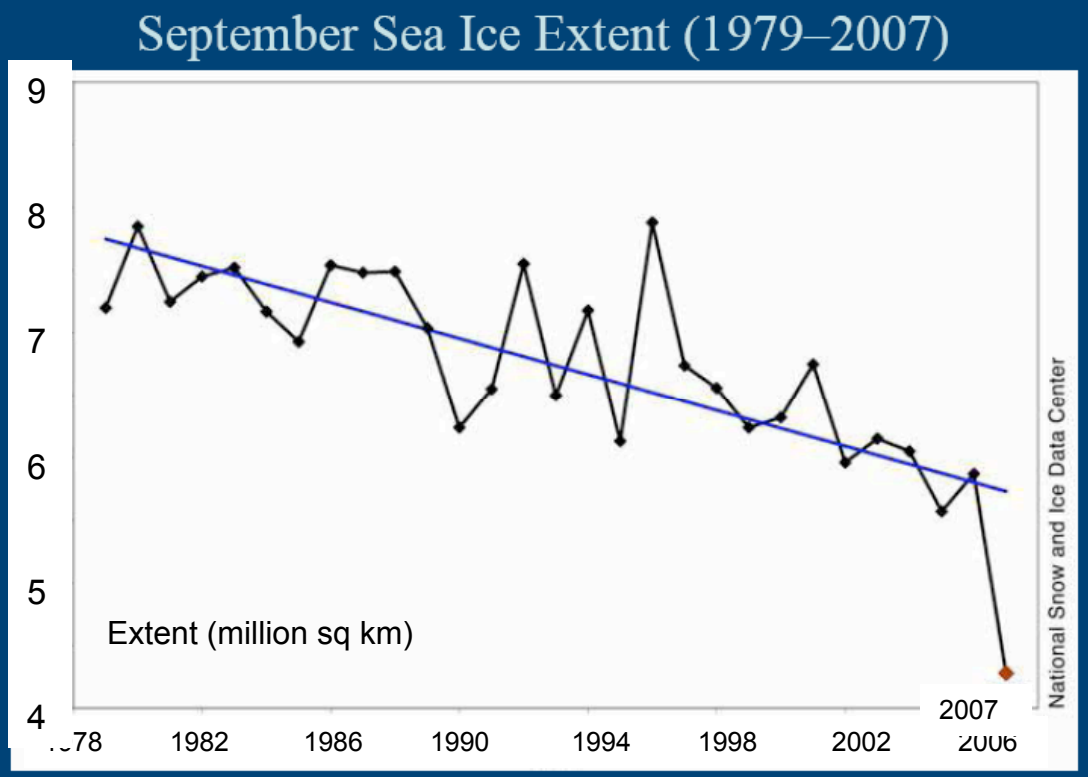
1. Tipping Level

- Climate forcing (greenhouse gas amount) reaches a point such that no additional forcing is required for large climate change and impacts

2. Point of No Return

- Climate system reaches a point with unstoppable irreversible climate impacts (irreversible on a practical time scale)
  Example: disintegration of large ice sheet

2007 Sea ice conditions in context



September 2007
4.28 million km^2

Mark Serreze, Julienne Stroeve, Walt Meier, Ted Scambos, Marika Holland, Jim Maslanik, Stephanie Renfrow, Matt Savoie

NSIDC

Arctic Sea Ice Criterion*

1. **Restore Planetary Energy Balance**

   → CO_2: 385 ppm → 325-355 ppm

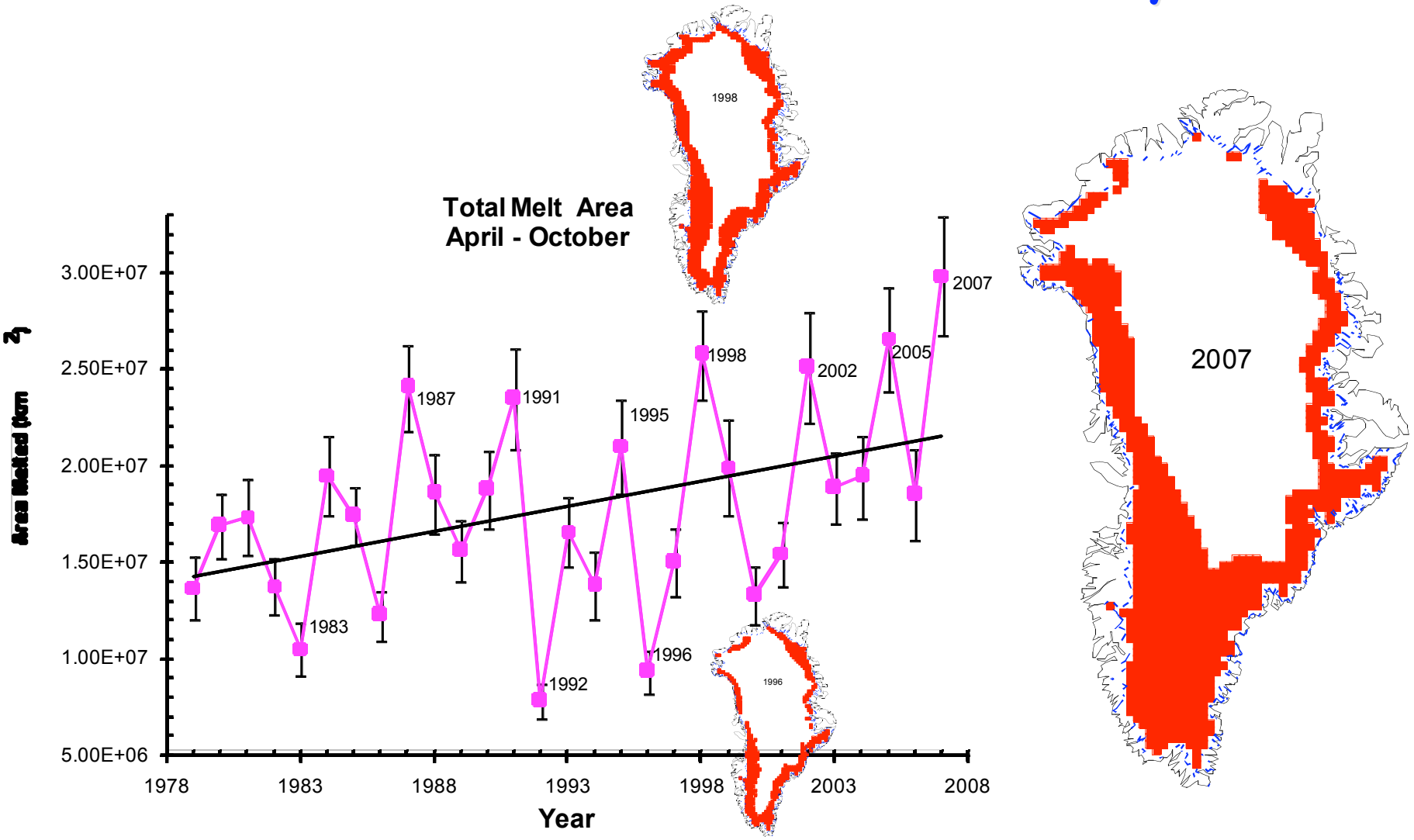
2. **Restore Sea Ice: Aim for -0.5 W/m^2**

   CO_2: 385 ppm → 300-325 ppm

Range based on uncertainty in present planetary energy imbalance (between 0.5 and 1 W/m^2)

*Assuming near-balance among non-CO_2 forcings

Greenland Total Melt Area –
2007 value exceeds last maximum by 10%



Konrad Steffen and Russell Huff, CIRES, University of Colorado at Boulder

Surface Melt on Greenland

Melt descending
into a moulin,
a vertical shaft
carrying water
to ice sheet base.

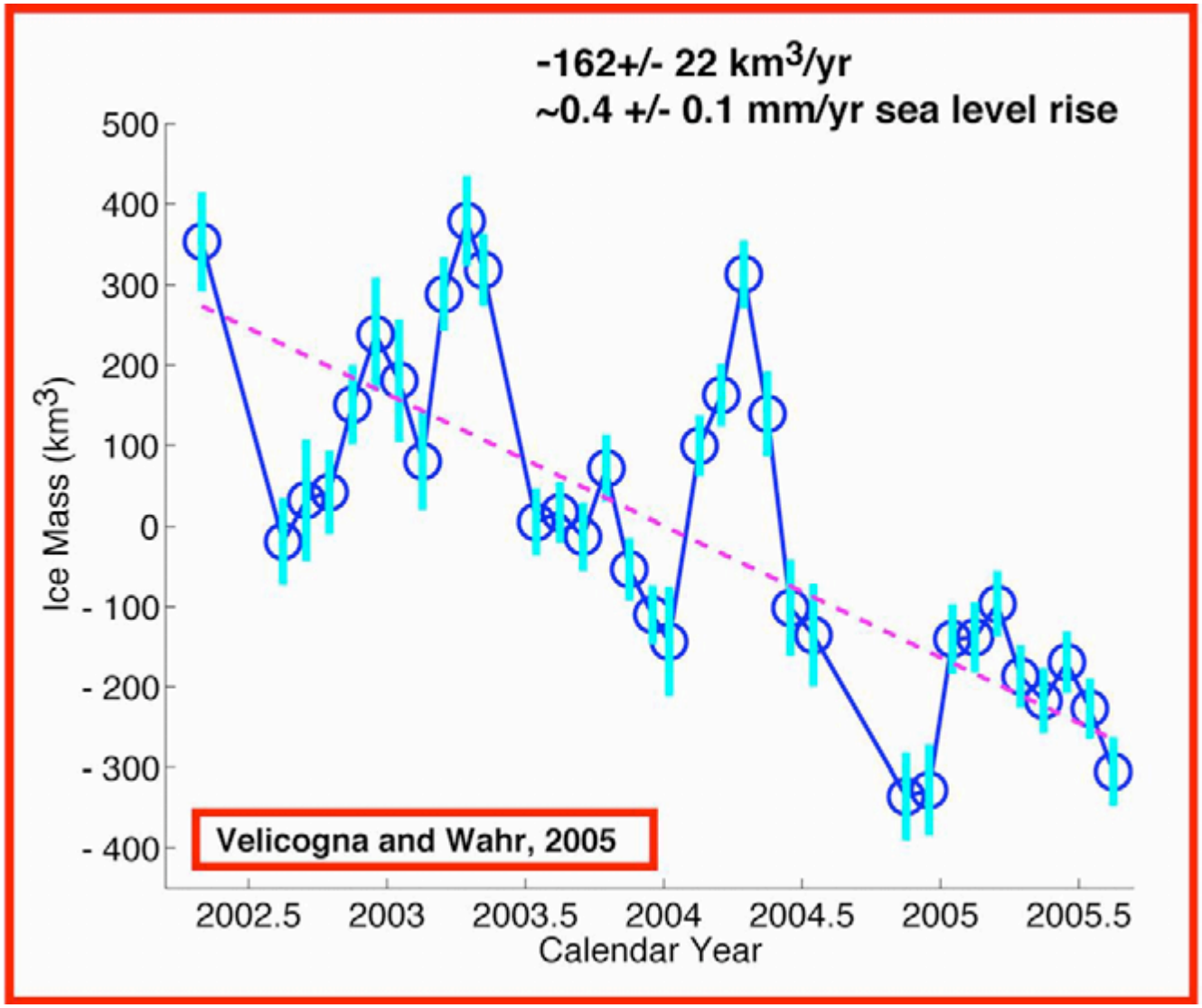
Source: Roger Braithwaite,
University of Manchester (UK)

Jakobshavn Ice Stream in Greenland

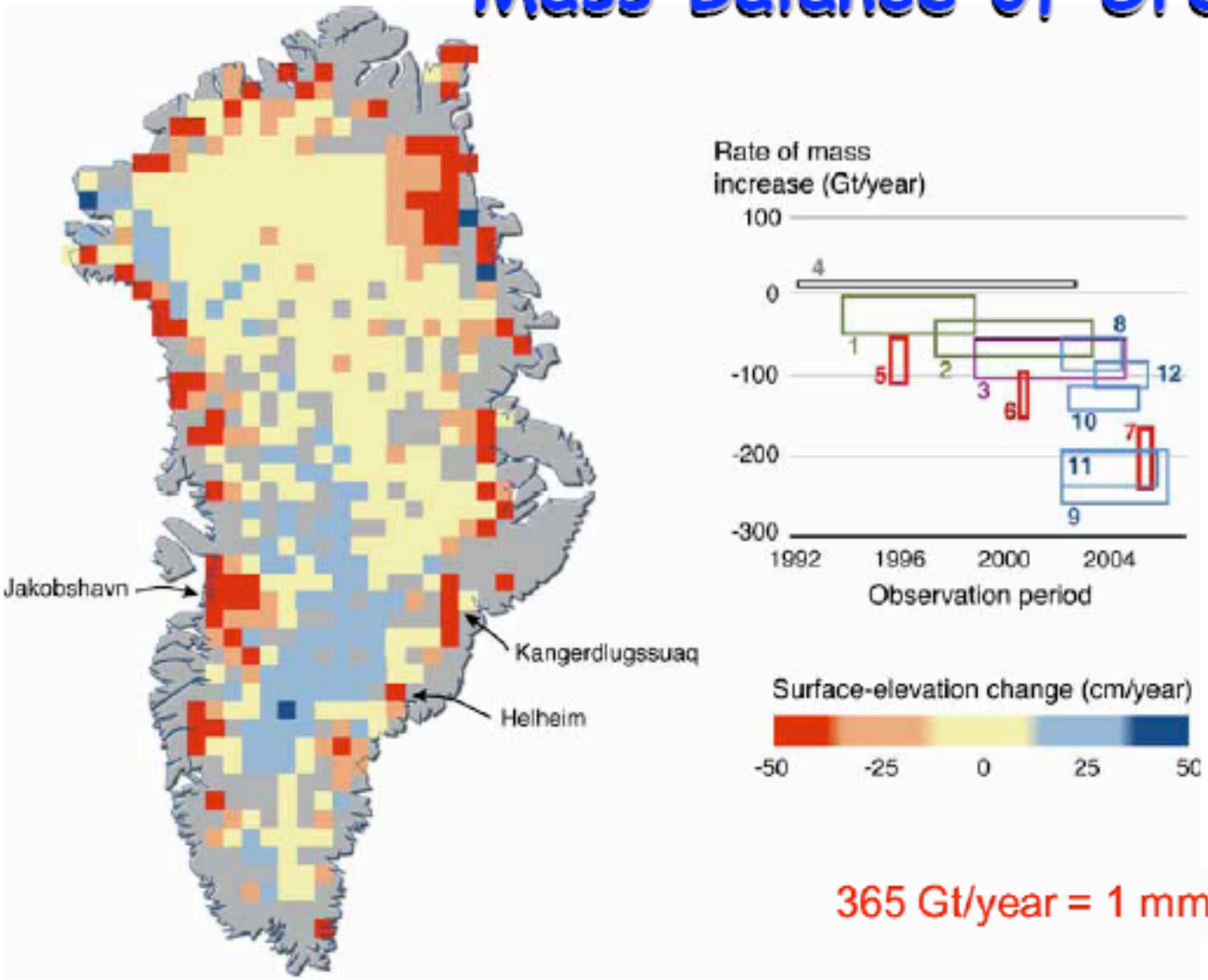
Discharge from major Greenland ice streams is accelerating markedly.

Source: Prof. Konrad Steffen, Univ. of Colorado

Greenland Mass Loss – From Gravity Satellite



Mass Balance of Greenland



365 Gt/year = 1 mm SLR

Greenland ice-sheet: rate of change from airborne laser-altimeter surveys (green), airborne/satellite laser-altimeter surveys (purple), mass-budget calculations (red), temporal changes in gravity (blue).

Sources (corresponding to numbers on rectangles): 1 and 2 Krabill and others 200016 and 2004[; 3 Thomas and others 200617; 4 Zwally and others 20055; 5 to 7 Rignot and Kanagaratnam 200618; 8 and 9 Velicogna and Wahr 2005[and 2006b; 11 Chen and others 2006]; 10 Ramillien and others 200632; 12 Luthke and others 2006[

Sea Level Criterion*

1. **Prior Interglacial Periods**
   → CO_2 <~ 300 ppm
2. **Cenozoic Era**
   → CO_2 <~ 300 ppm
3. **Ice Sheet Observations**
   → CO_2 < 385 ppm

*Assuming near-balance among non-CO_2 forcings

Pier on Lake Mead.

Assessment of Target CO_2

Phenomenon	Target CO_2 (ppm)
1. Arctic Sea Ice	300-325
2. Ice Sheets/Sea Level	300-350
3. Shifting Climatic Zones	300-350
4. Alpine Water Supplies	300-350
5. Avoid Ocean Acidification	300-350

→ **Initial Target CO_2 = 350* ppm**

*assumes CH_4, O_3, Black Soot decrease

Stresses on Coral Reefs

Coral Reef off Fiji (Photo: Kevin Roland)

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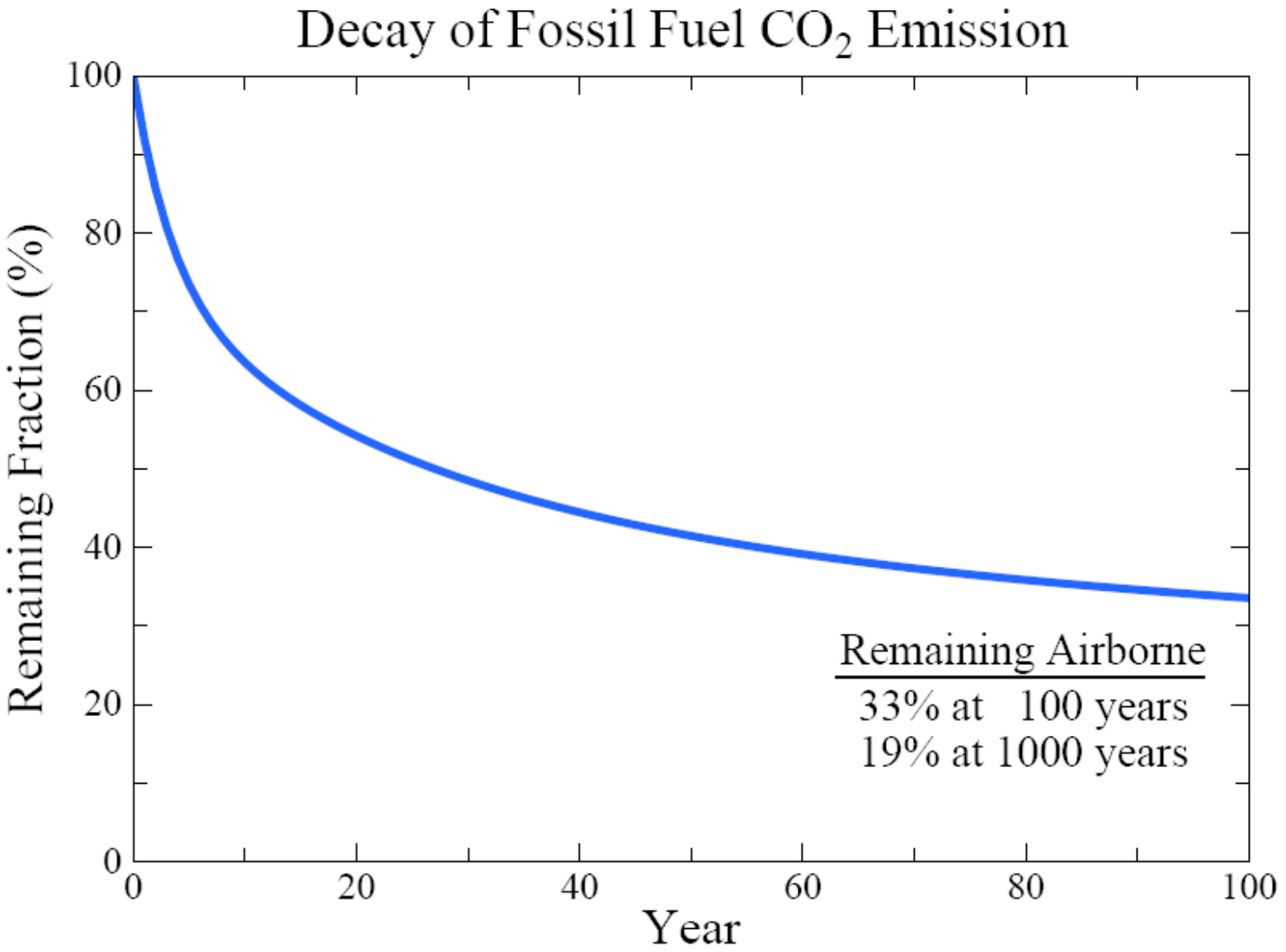
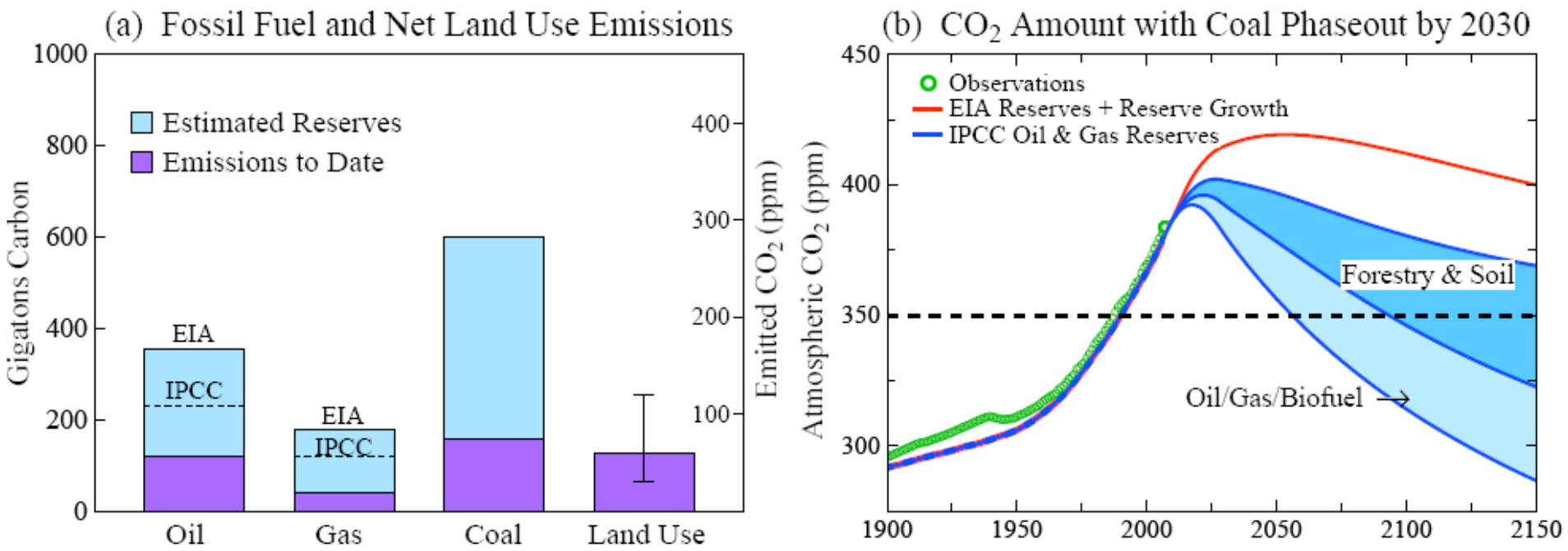


The fraction of CO_2 remaining in the air, after emission by fossil fuel burning, declines rapidly at first, but 1/3 remains in the air after a century and 1/5 after a millennium (*Atmos. Chem. Phys.* **7**, 2287-2312, 2007).


(a) Fossil Fuel and Net Land Use Emissions
Gigatons Carbon
Emitted CO_2 (ppm)
Estimated Reserves
Emissions to Date
EIA
IPCC
EIA
IPCC
Oil
Gas
Coal
Land Use
(b) CO_2 Amount with Coal Phaseout by 2030
Atmospheric CO_2 (ppm)
Observations
EIA Reserves + Reserve Growth
IPCC Oil & Gas Reserves
Forestry & Soil
Oil/Gas/Biofuel

Initial Target CO_2: 350 ppm

Technically Feasible

(but not if business-as-usual continues)

Quick Coal Phase-Out Critical

(long lifetime of atmospheric CO_2)
(must halt construction of any new coal plants that do not capture & store CO_2)

"Free Will" Alternative

1. Phase Out Coal CO_2 Emissions
   - by 2025/2030 developed/developing countries
2. Rising Carbon Price
   - discourages unconventional fossil fuels & extraction of every last drop of oil (Arctic, etc.)
3. Soil & Biosphere CO_2 Sequestration
   - improved farming & forestry practices
4. Reduce non-CO_2 Forcings
   - reduce CH_4, O_3, trace gases, black soot

Carbon Tax & 100% Dividend

1. **Tax Large & Growing (but get it in place!)**
   - tap efficiency potential & life style choices
2. **Entire Tax Returned**
   - equal monthly deposits in bank accounts
3. **Limited Government Role**
   - keep hands off money!
   - eliminate fossil subsidies
   - technology support (no Manhattan projects!)
   - change profit motivation of utilities
   - watch U.S. modernize & emissions fall!

Basic Conflict

Fossil Fuel Special Interests

vs

Young People & Nature (Animals)

Fossil Interests: God-given fact that all fossil fuels will be burned (no free will)

Young People: Hey! Not so fast!
Nice planet you are leaving us!

What are the Odds?

Fossil Interests: have influence in capitals world-wide

Young People: need to organize, enlist others (parents, e.g.), impact elections

Animals: not much help (don't vote, don't talk)

The Challenge

We can avoid destroying creation!

(+cleaner planet, + good jobs!)

We have to figure out how to live without fossil fuels someday…

Why not now?

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 Disruptions

1. Increase of Extreme Events
2. Shifting Zones/Freshwater Shortages

Arctic Change:

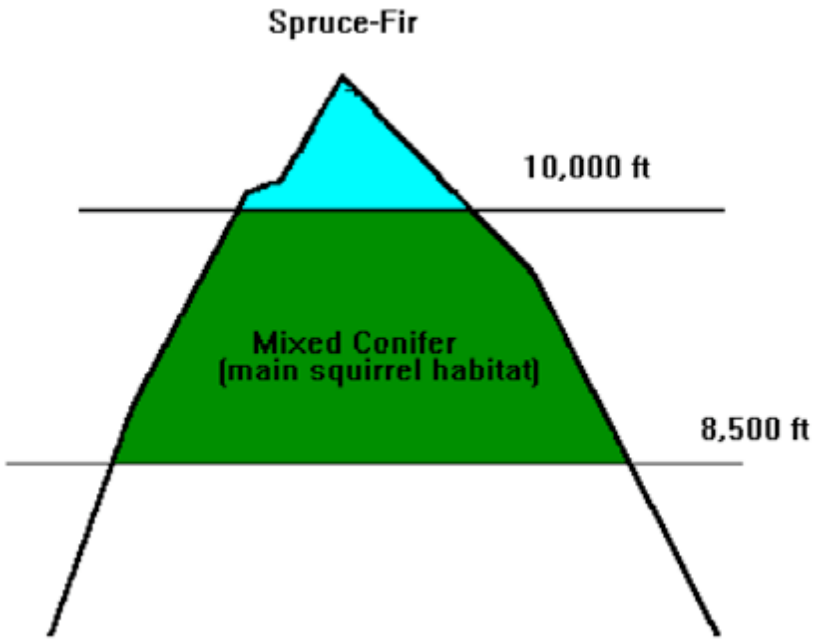
Future loss of Arctic sea ice could result in a loss of 2/3 of the world's polar bears within 50 years.

Source: U.S. Geological Survey
www.usgs.gov/newsroom/special/polar%5Fbears/

Images:
Sea Ice: Claire Parkinson & Robert Taylor
Polar Bears: Unknown

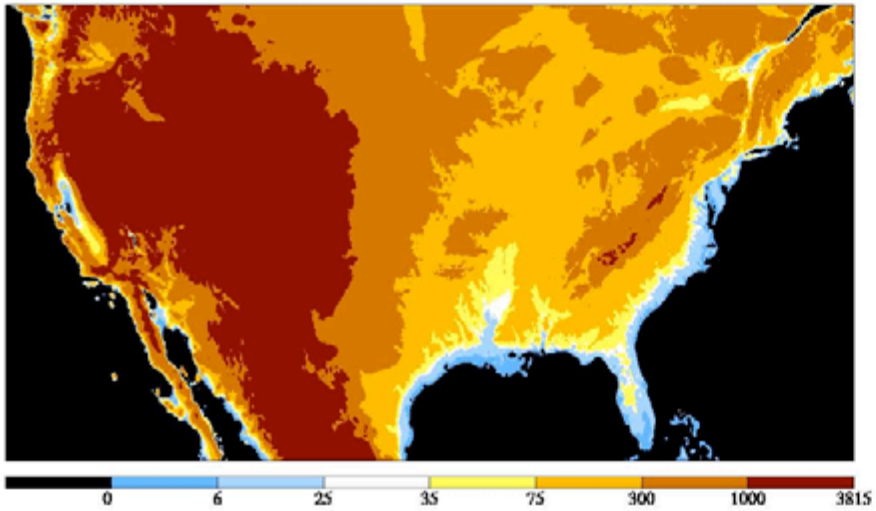
Mt. Graham Red Squirrel

Mount Graham Red Squirrel (Credit: Claire Zugmeyer)

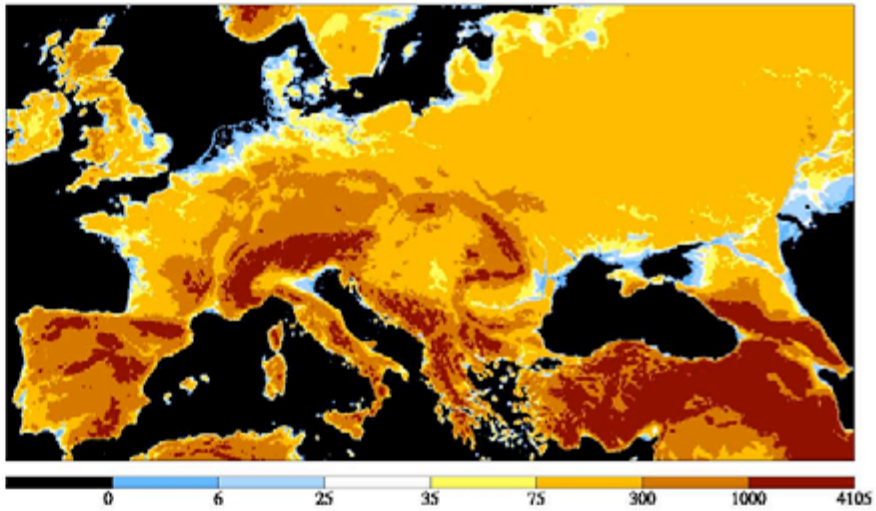


Areas Under Water: Four Regions

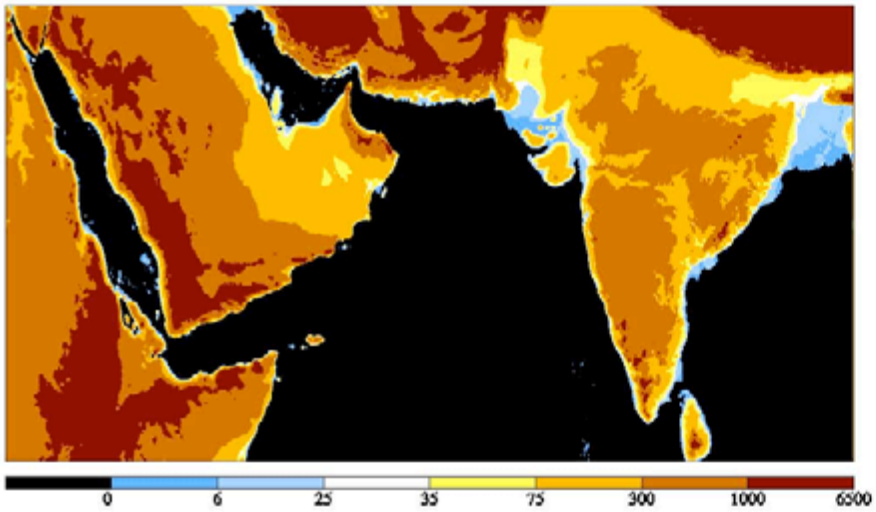
U.S. Area Under Water



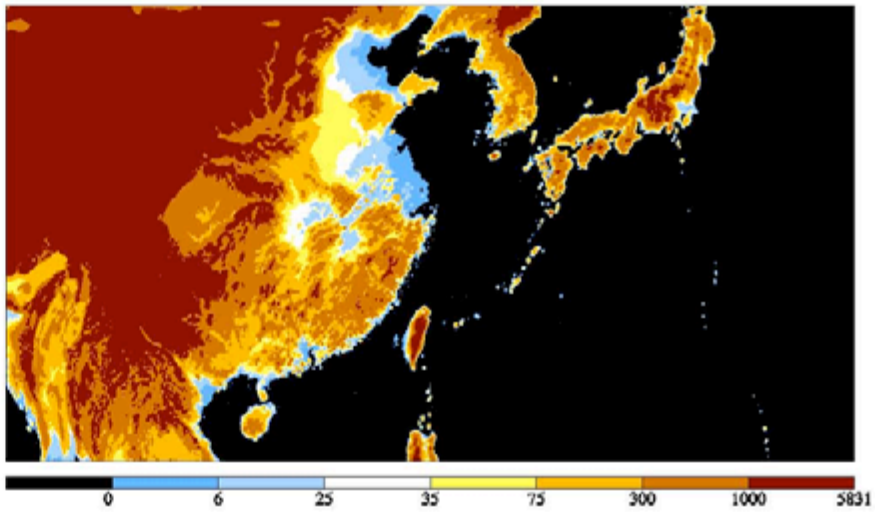
Europe Area Under Water



Central Asia: Area under Water



Far East: Area under Water



Scientific Reticence & Sea Level

How Much Sea Level Rise in 100 Years in BAU Scenario (3-4C global warming)

Community Response: <or~ 1m

<or~ = less than or of the order of

Reasonable Response: >or~ 1m

My opinion: BAU → much more than 1 meter