

**Climate Threat to the Planet:\***  
**Implications for Intergenerational  
Equity and Justice**

**Jim Hansen**

**October 11, 2008**

**Virginia Tech, Blakesburg, VA**

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

Jake - 11 months



# Global Warming Status

## 1. Knowledge Gap Between

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

## 2. Planetary Emergency

- Climate Inertia → Warming in Pipeline
- **Tipping Points → Could Lose Control**

## 3. Good News & Bad News

- Safe Level of CO<sub>2</sub> < 350 ppm
- Multiple Benefits of Solution

# Sophie explains 2 Watts of forcing to brother Connor



Sophie Explains GH Warming



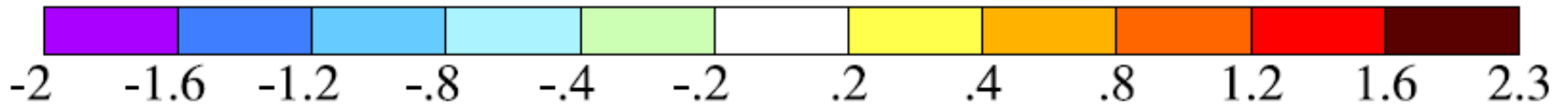
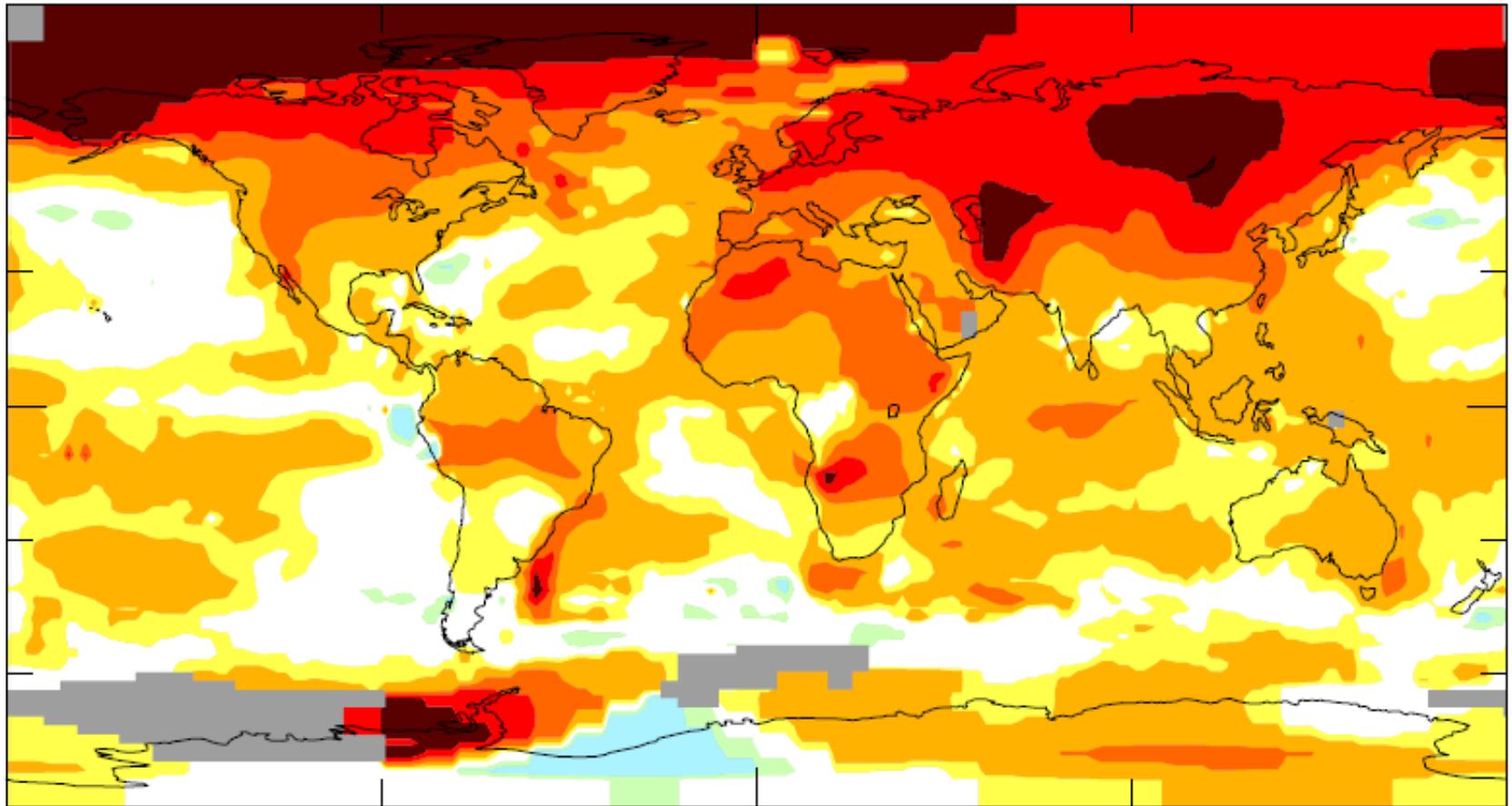
Connor gets it: 2 Watts



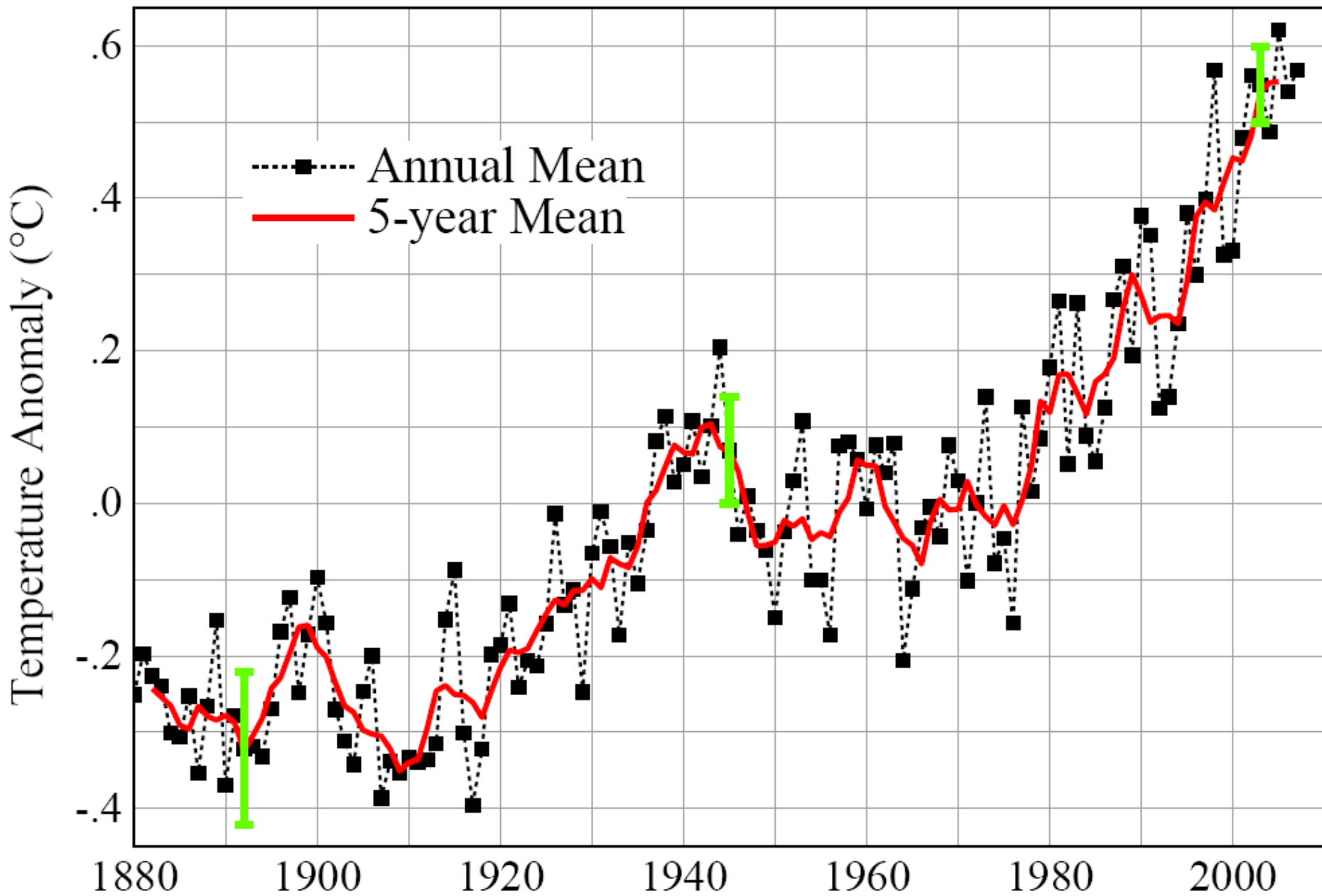
**Sophie and Connor this year**

# 2001-2007 Mean Surface Temperature Anomaly ( $^{\circ}\text{C}$ )

Base Period = 1951-80, Global Mean = 0.54



# Global Temperature Land-Ocean Index



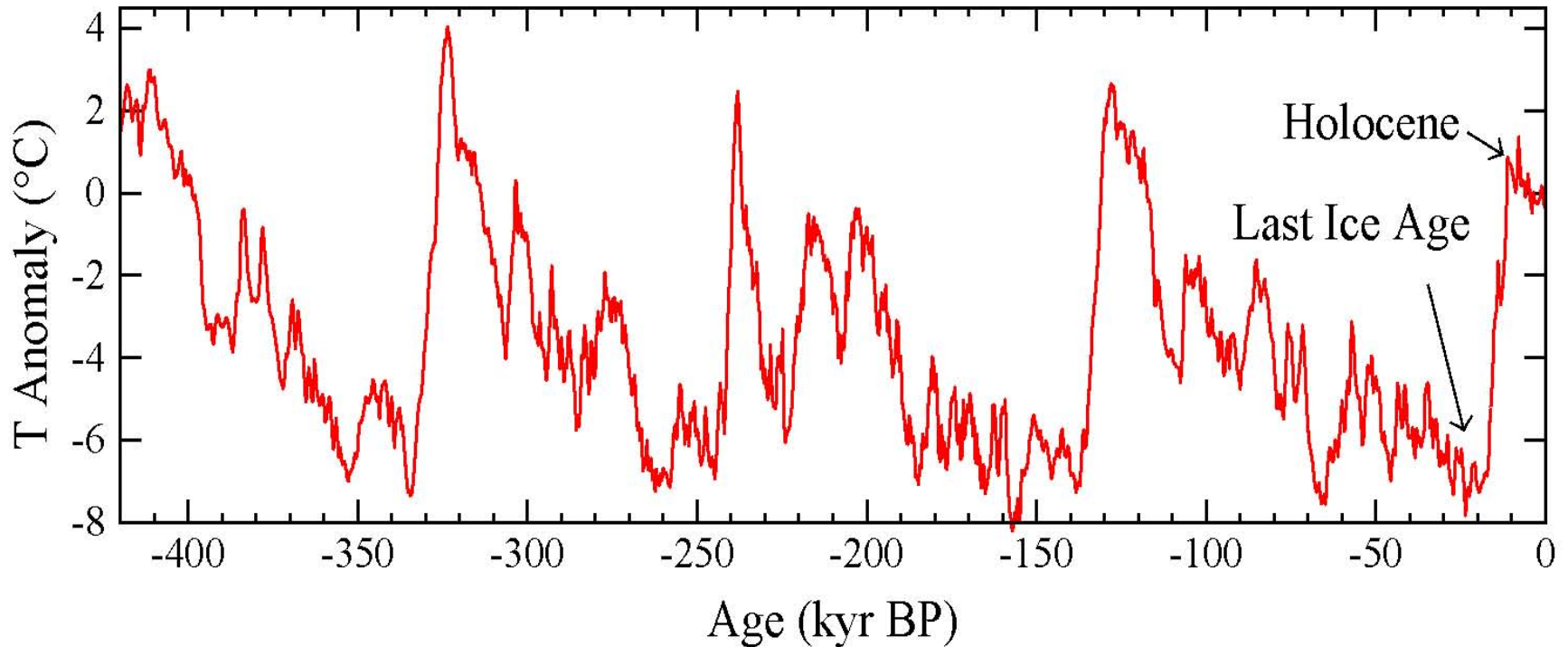
# **Why be concerned about human-made climate change?**

**There have been huge climate changes during Earth's history!**

It is arrogant to think that humans can control climate or that we know enough to say that today's climate is the best one for the planet.

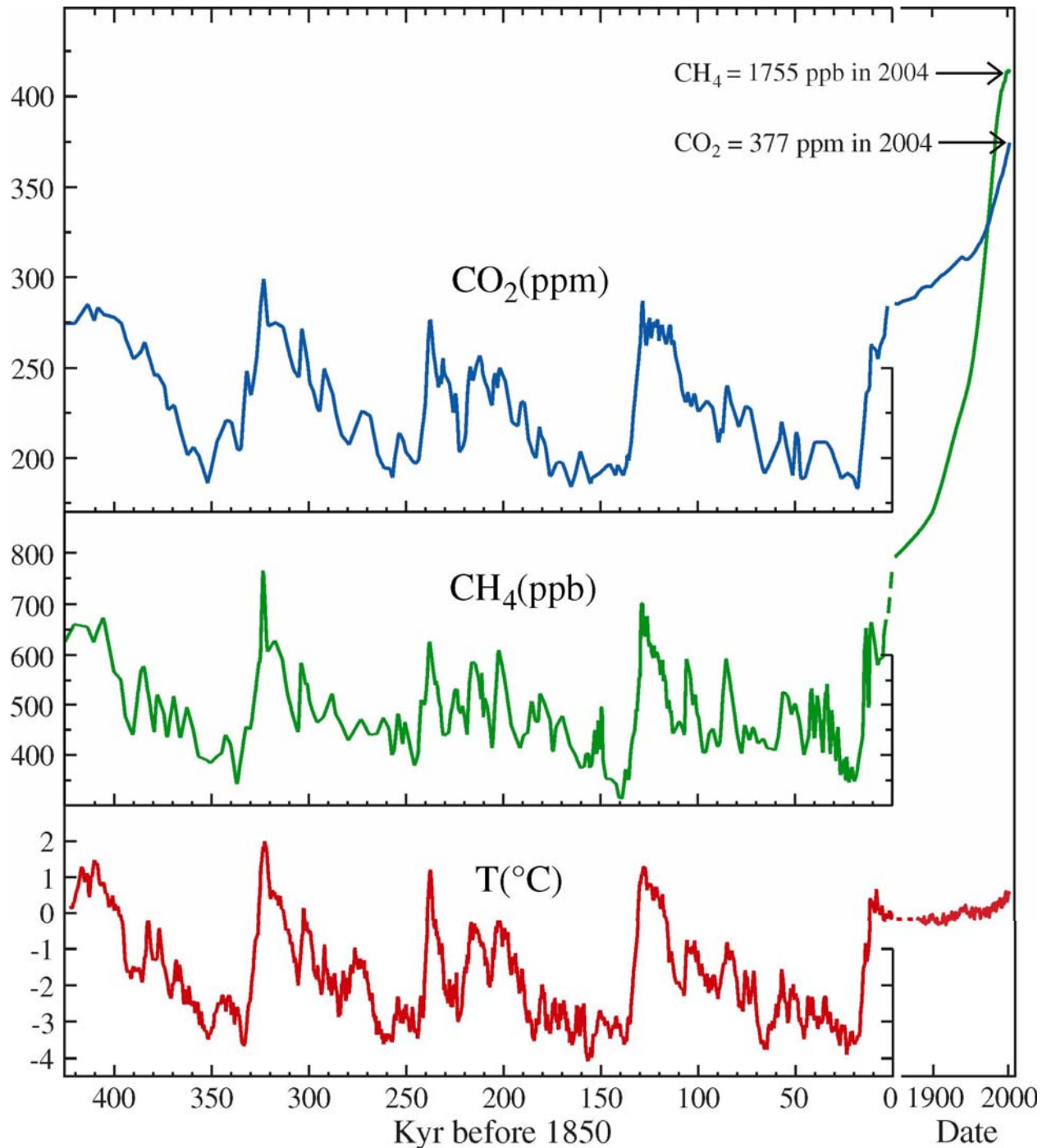


## Antarctic (Vostok) Temperature



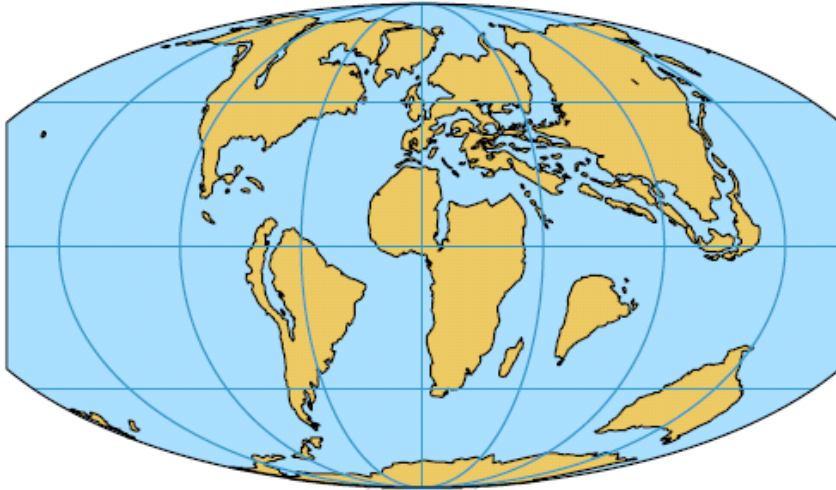
**Earth's history provides important information on global warming.  
Recorded human history occurs within the Holocene warm period.**

CO<sub>2</sub>, CH<sub>4</sub> and estimated  
global temperature  
(Antarctic  $\Delta T/2$   
in ice core era)  
0 = 1880-1899 mean.

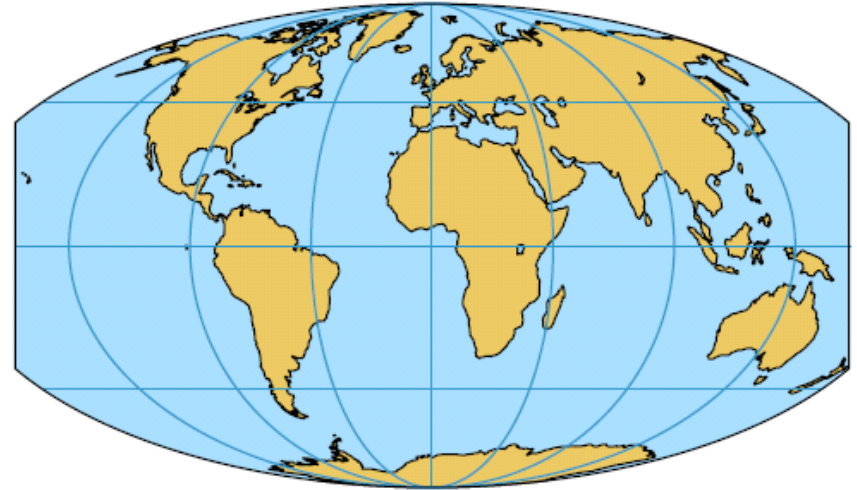


Source: Hansen, *Clim. Change*, **68**, 269, 2005.

# Cenozoic Era



End of Cretaceous (65 My BP)



Present Day

## **Global Climate Forcings**

External (solar irradiance):  $+1 \text{ W/m}^2$

Surface (continent locations):  $\sim 1 \text{ W/m}^2$

Atmosphere ( $\text{CO}_2$  changes):  $> 10 \text{ W/m}^2$

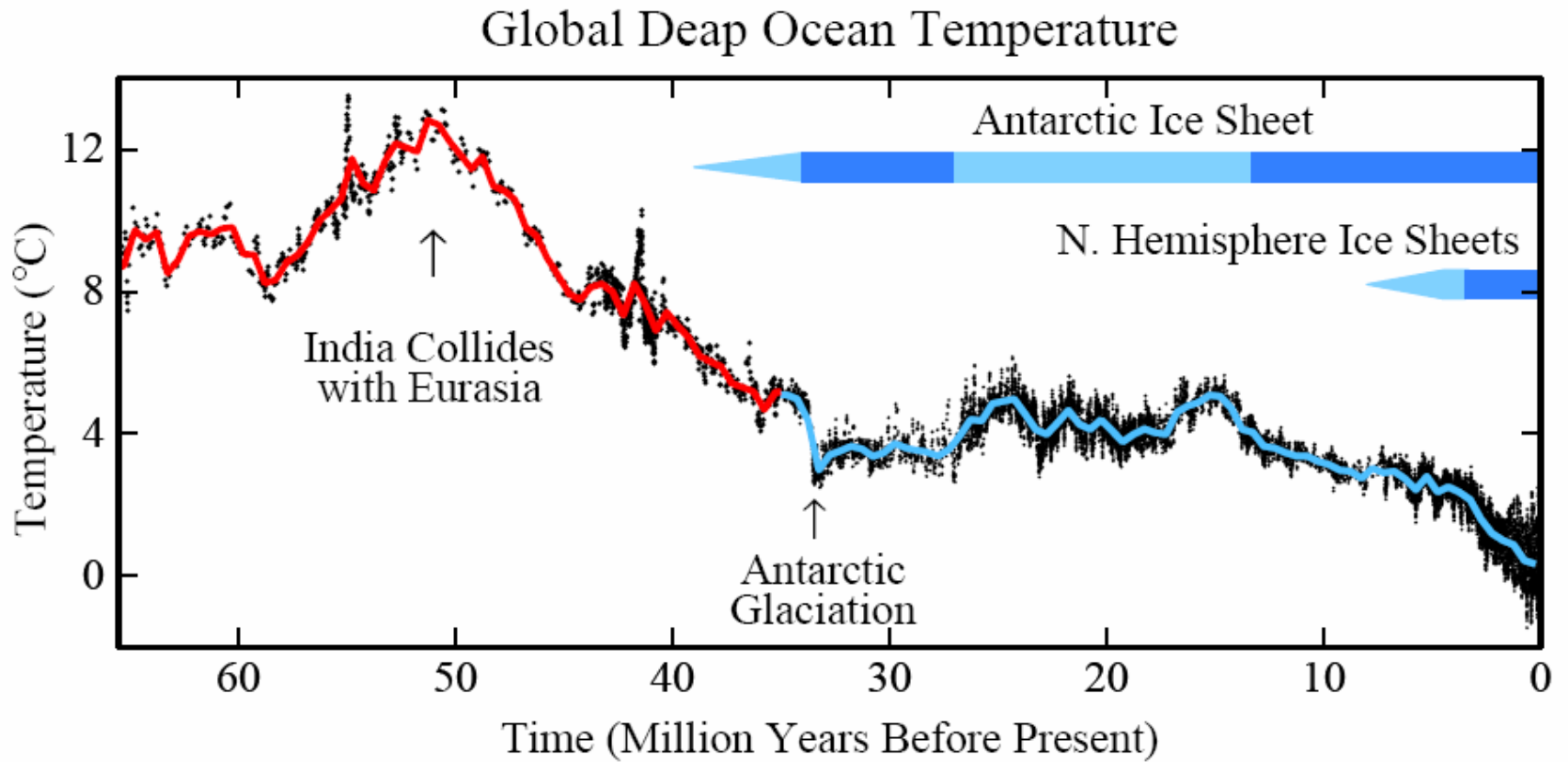


Fig. 1

# Summary: Cenozoic Era

## 1. Dominant Forcing: Natural $\Delta\text{CO}_2$

- Rate  $\sim 100$  ppm/My (0.0001 ppm/year)
- Human-made rate today:  $\sim 2$  ppm/year

Humans Overwhelm Slow Geologic Changes

## 2. Climate Sensitivity High

- Antarctic ice forms if  $\text{CO}_2 < \sim 450$  ppm
- Ice sheet formation reversible

Humans Could Produce “A Different Planet”

# 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

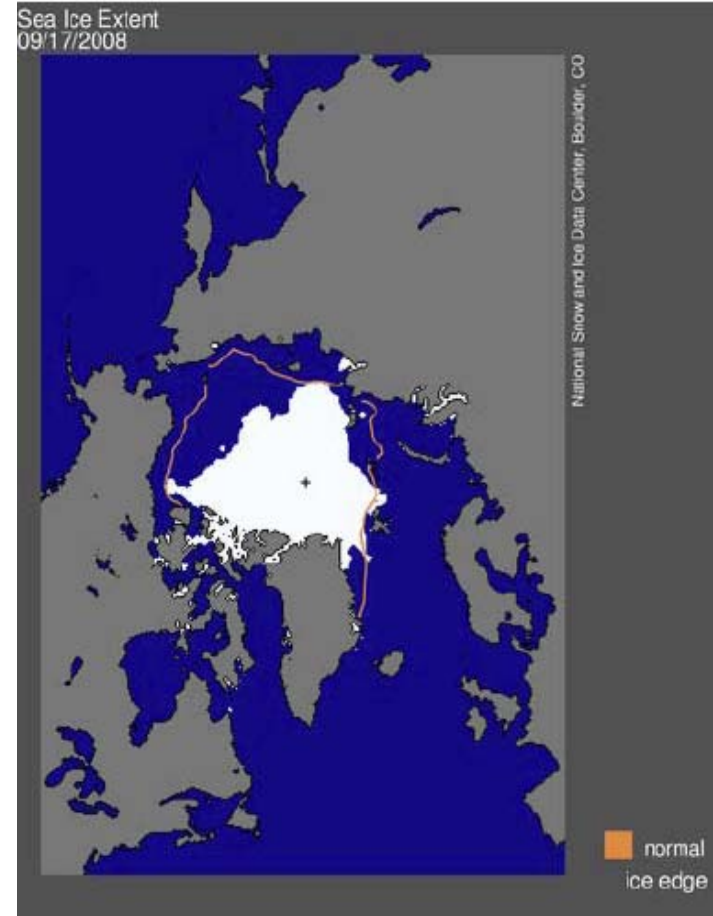
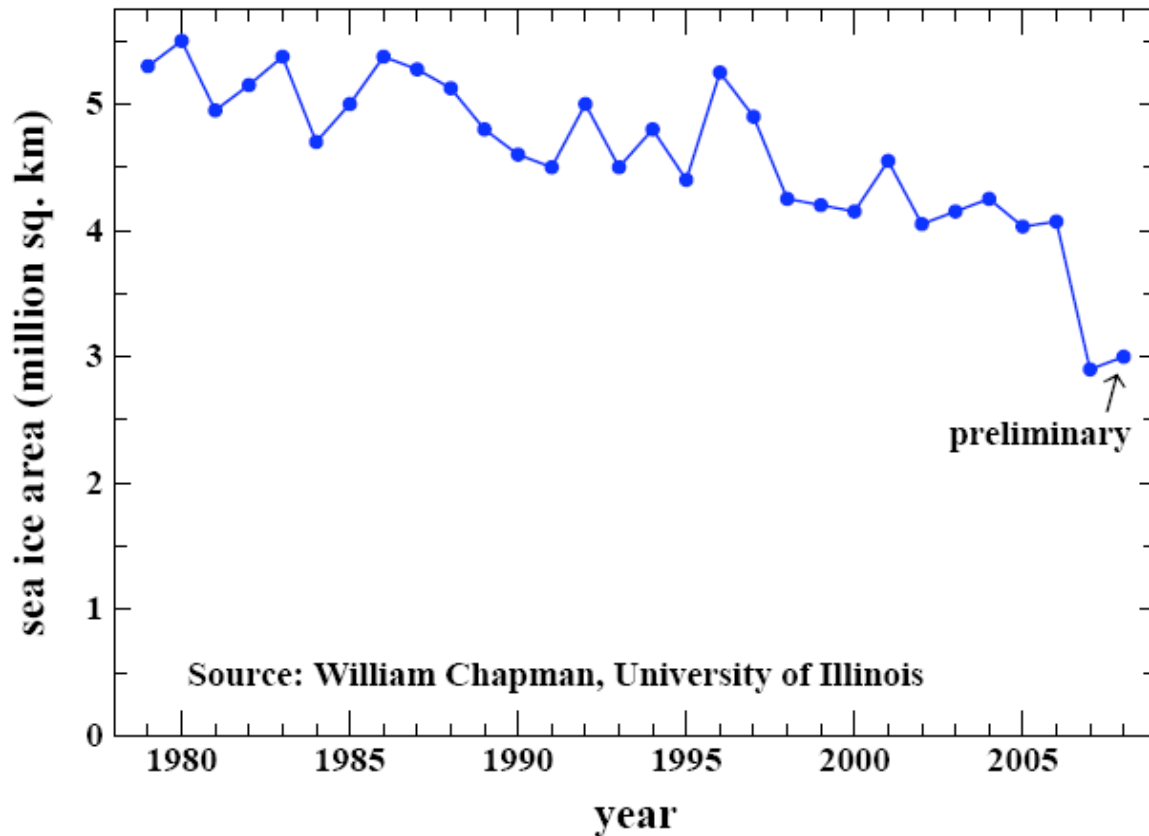
1. Long-Term Change from Paleoclimate Data
2. Ice Sheet Response Time

## Regional Climate Disruptions

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

# Arctic sea ice area at summer minimum.

## Sea ice area at summer minimum





# Arctic Sea Ice Criterion\*

## 1. Restore Planetary Energy Balance

→ CO<sub>2</sub>: 385 ppm → 325-355 ppm

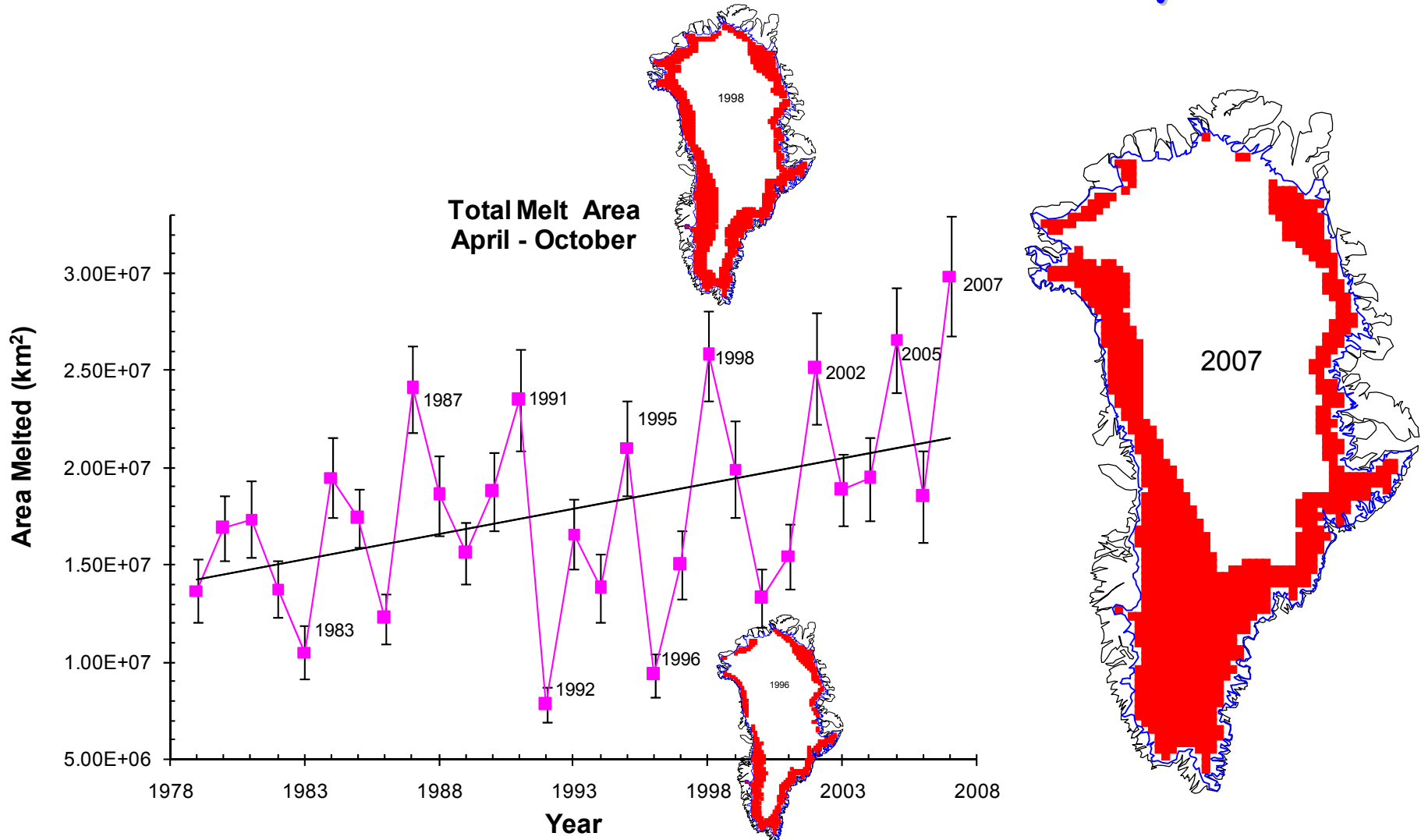
## 2. Restore Sea Ice: Aim for -0.5 W/m<sup>2</sup>

CO<sub>2</sub>: 385 ppm → 300-325 ppm

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

\* Assuming near-balance among non-CO<sub>2</sub> forcings

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



# 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)*

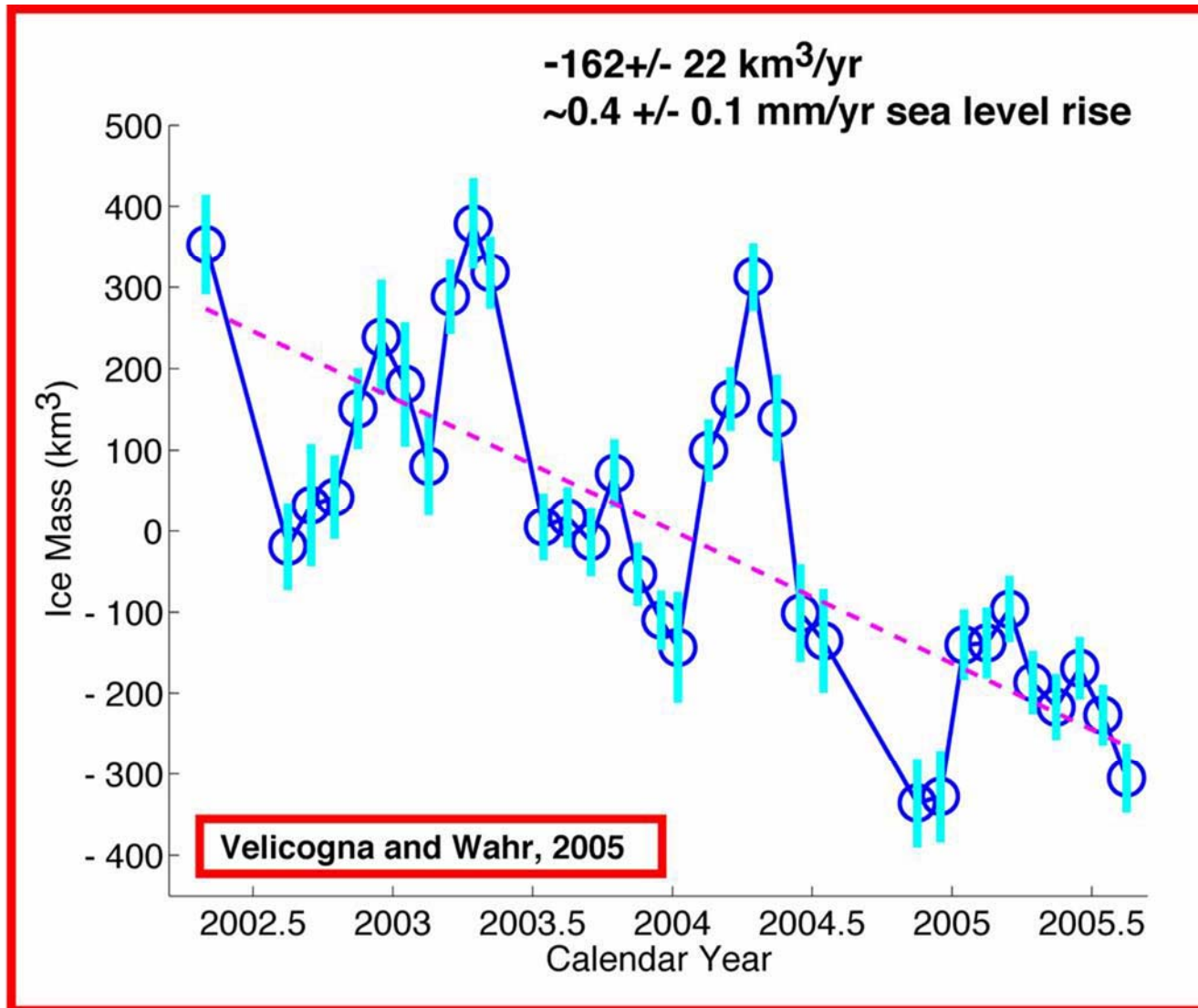
# Jakobshavn Ice Stream in Greenland

Discharge from major Greenland ice streams is accelerating markedly.

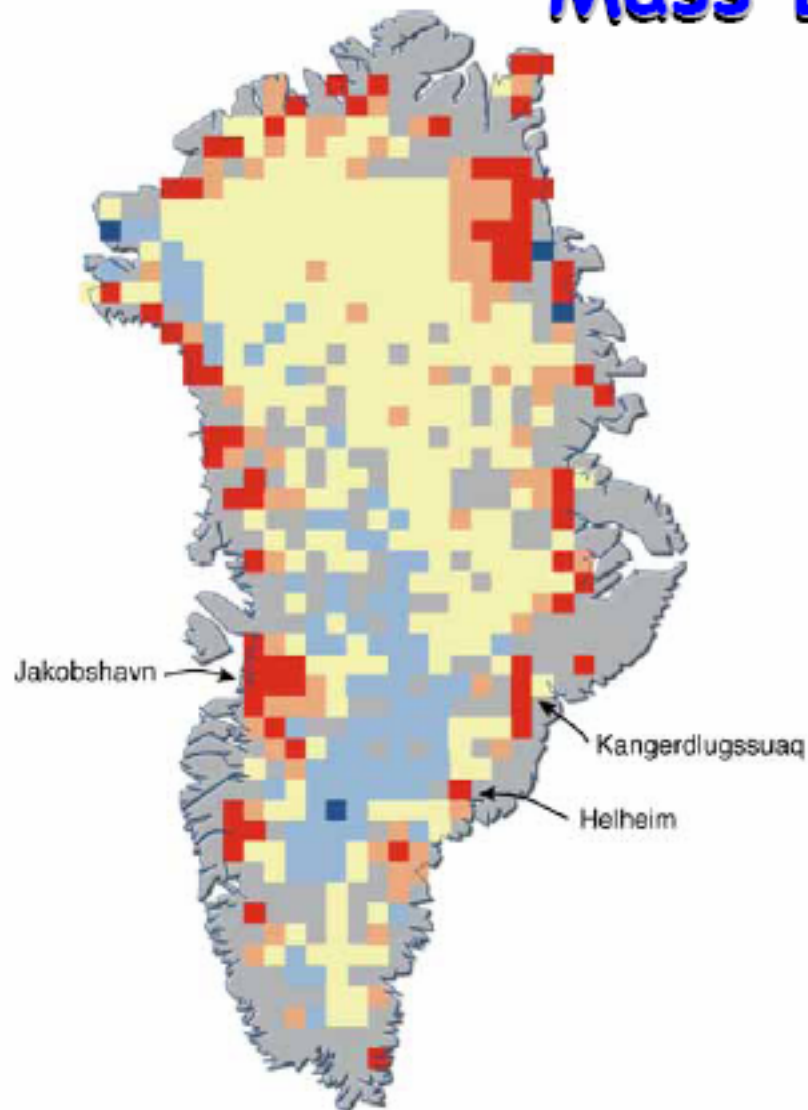


*Source: Prof. Konrad Steffen,  
Univ. of Colorado*

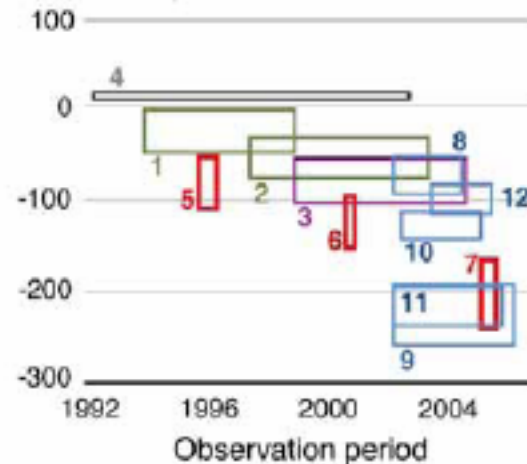
# Greenland Mass Loss – From Gravity Satellite



# Mass Balance of Greenland



Rate of mass increase (Gt/year)



**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

→  $\text{CO}_2 < \sim 300$  ppm

## 2. Cenozoic Era

→  $\text{CO}_2 < \sim 300$  ppm

## 3. Ice Sheet Observations

→  $\text{CO}_2 < 385$  ppm

\* Assuming near-balance among non- $\text{CO}_2$  forcings

## Pier on Lake Mead



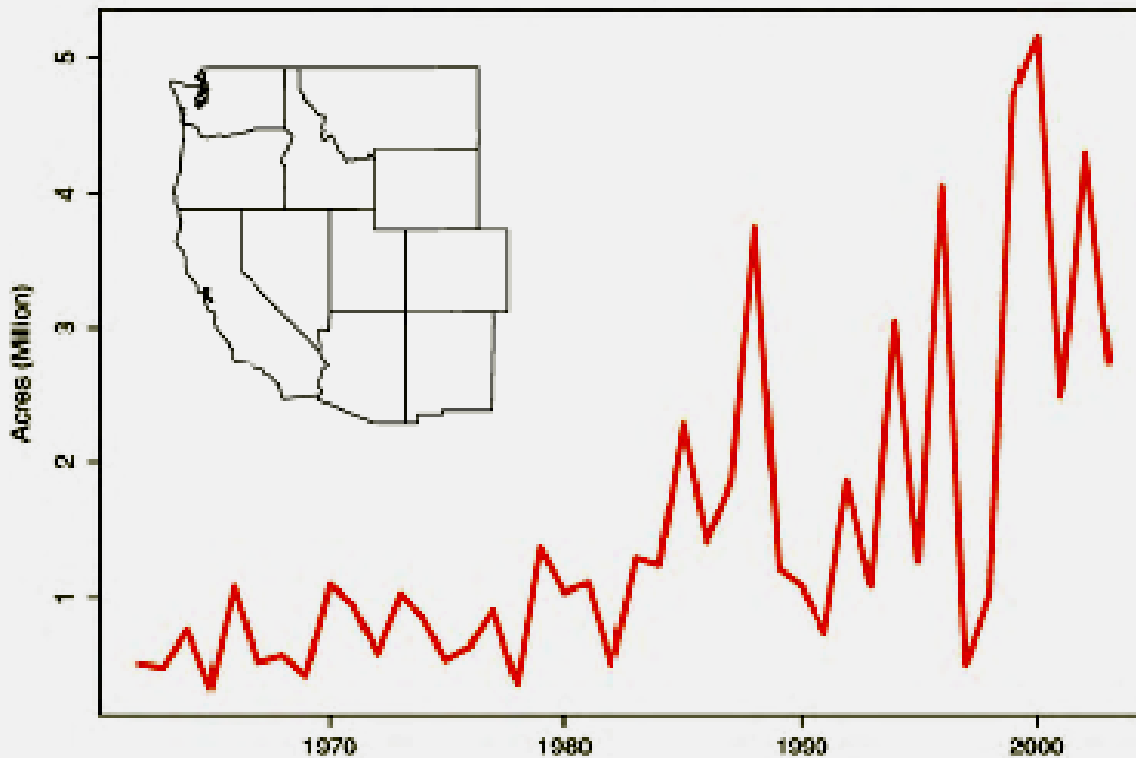
**Subtropics expected to expand with global warming.  
Observations show 4 degrees of latitude expansion.**



# Fires Are Increasing World-Wide

Wildfires in Western US have increased 4-fold in 30 years.

Western US area burned



Source: Westerling et al. 2006

# Rongbuk Glacier



Rongbuk glacier in 1968 (top) and 2007. The largest glacier on Mount Everest's northern slopes feeds Rongbuk River.

# Stresses on Coral Reefs



**Coral Reef off Fiji (Photo: Kevin Roland)**

# Assessment of Target CO<sub>2</sub>

## Phenomenon

## Target CO<sub>2</sub> (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<sub>2</sub> = 350\* ppm

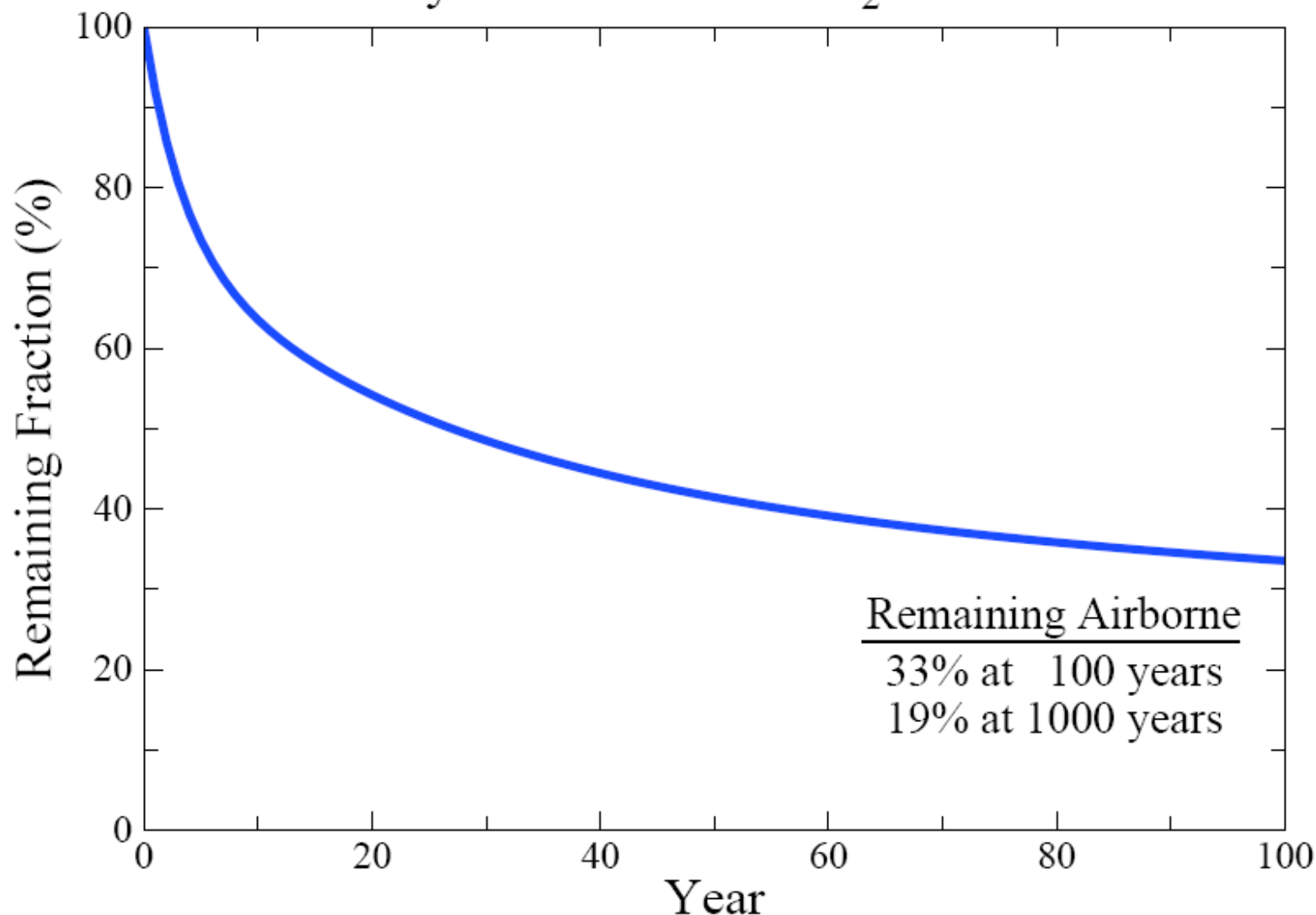
\*assumes CH<sub>4</sub>, O<sub>3</sub>, Black Soot decrease

**Target CO<sub>2</sub>:**

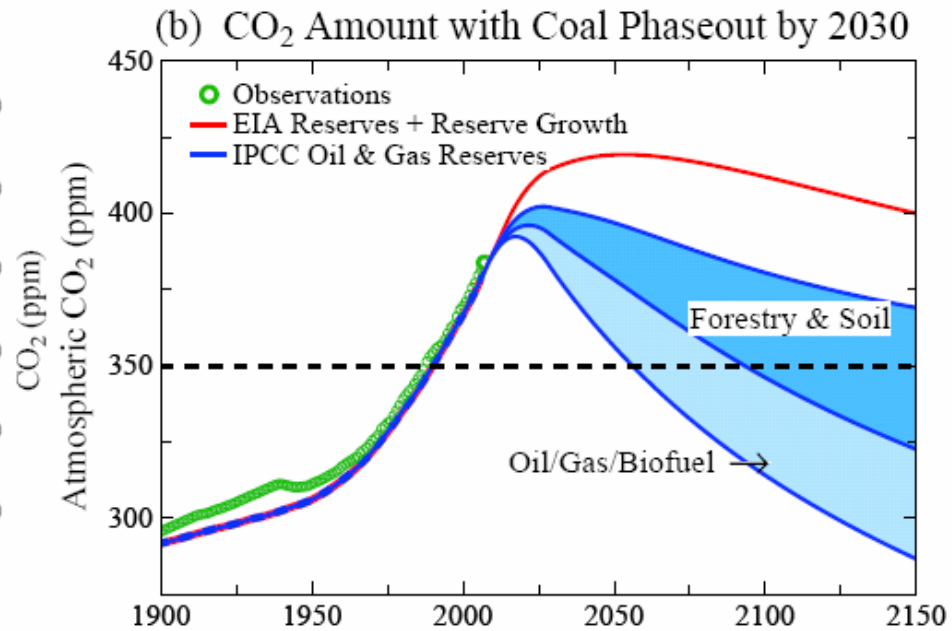
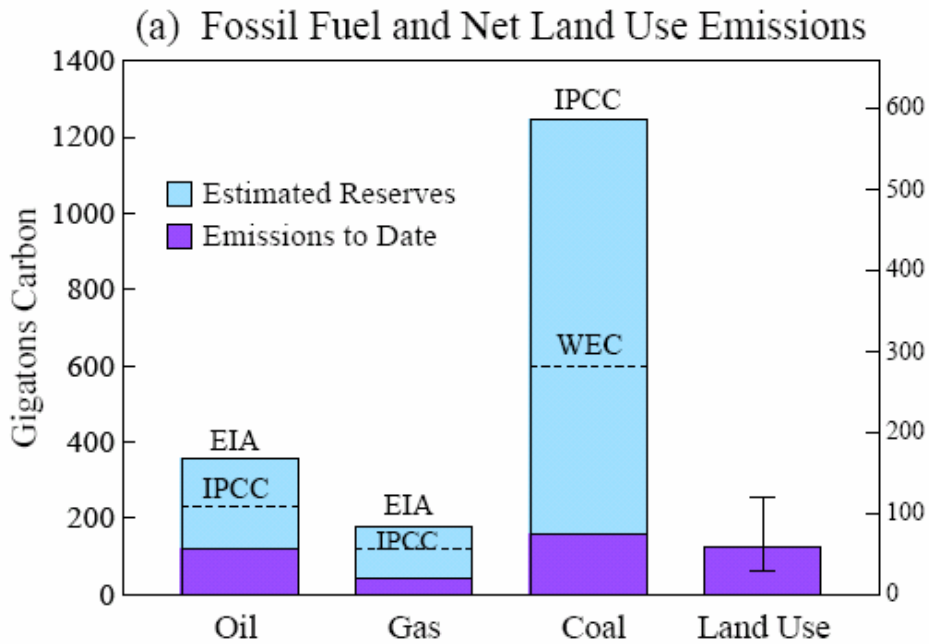
**< 350 ppm**

**To preserve creation, the planet  
on which civilization developed**

## Decay of Fossil Fuel CO<sub>2</sub> Emission



The fraction of CO<sub>2</sub> 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).



**Coal phase-out by 2030 → peak CO<sub>2</sub> ~400-425 ppm, depending on oil/gas**  
**Faster return below 350 ppm requires additional actions**

# **Initial Target CO<sub>2</sub>: 350 ppm**

## **Technically Feasible**

**(but not if business-as-usual continues)**

## **Quick Coal Phase-Out Critical**

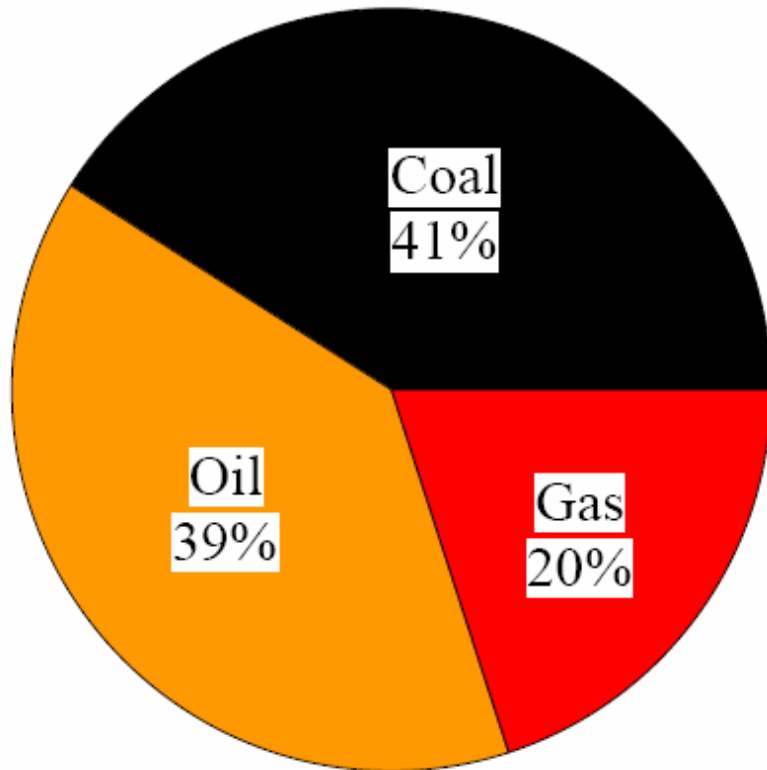
**(long lifetime of atmospheric CO<sub>2</sub>)**

**(must halt construction of any new coal plants that do not capture & store CO<sub>2</sub>)**

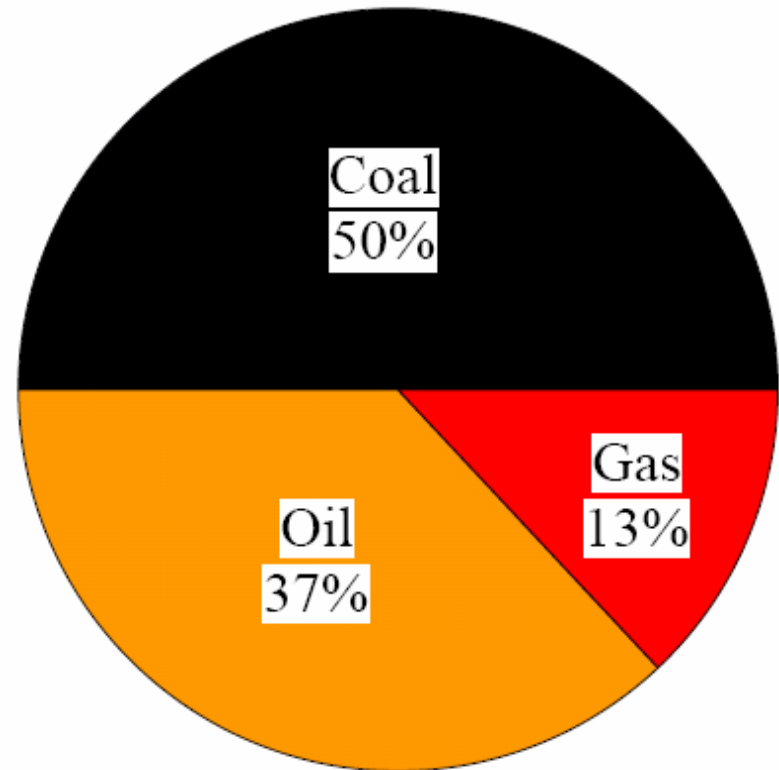


## Source of Fossil Fuel CO<sub>2</sub>

(a) 2007 Emissions



(b) Integrated Emissions

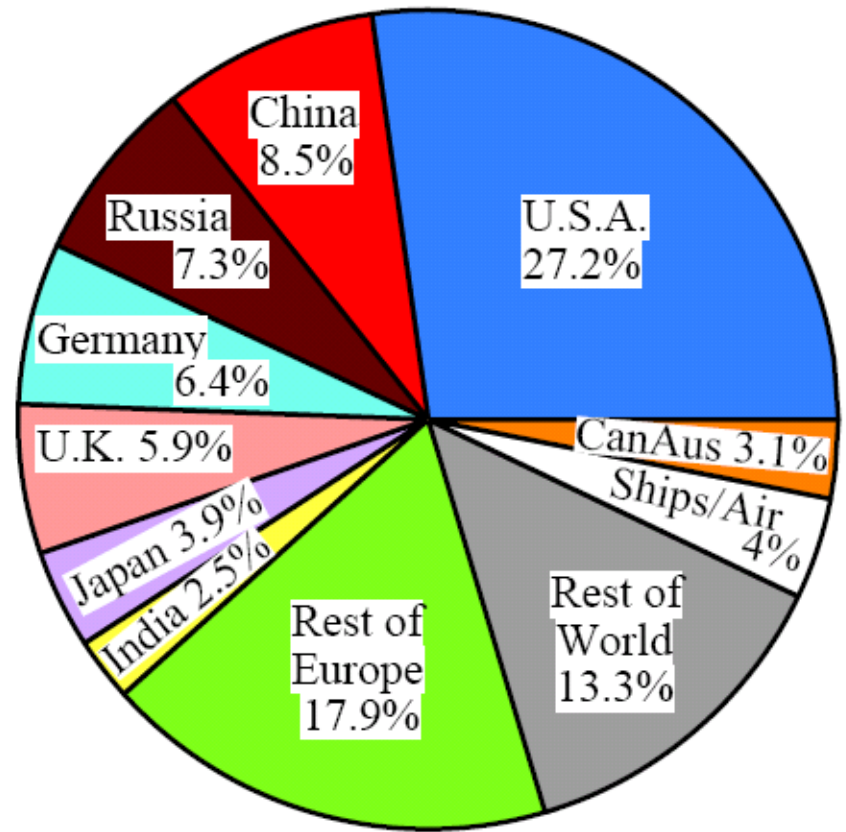
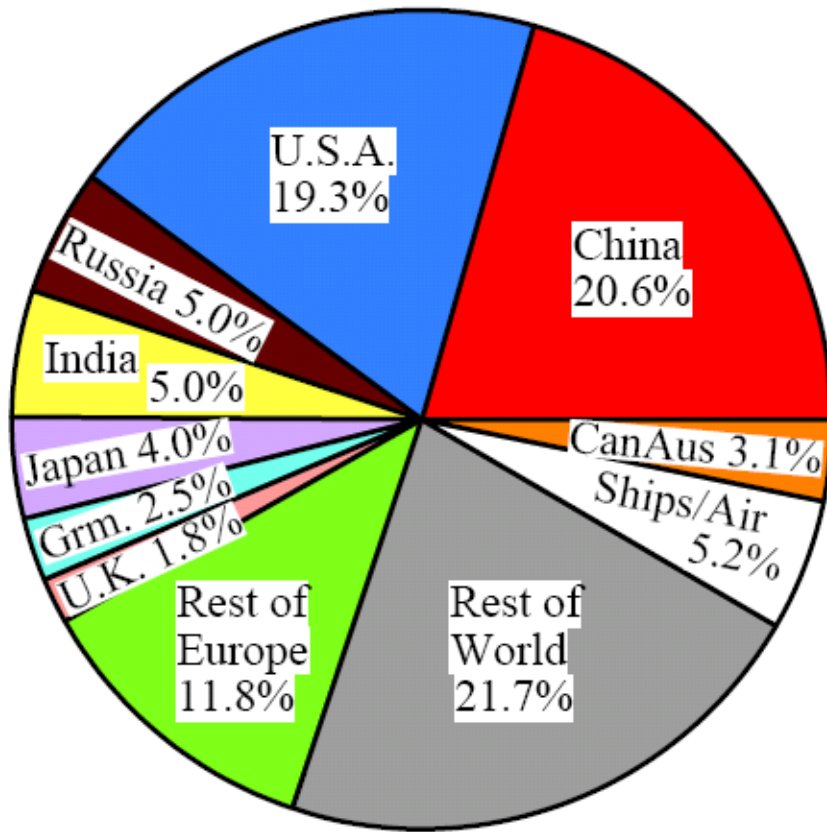


**Half of the fossil fuel CO<sub>2</sub> in the air today is from coal.  
On the long run, coal is likely to be even more dominant.**

# Fossil Fuel CO<sub>2</sub> Emissions

(a) 2007 Annual Emissions

(b) 1751-2007 Cumulative Emissions



**China passed the U.S. in current emissions. Because of the long CO<sub>2</sub> lifetime, the U.S. will be most responsible for airborne CO<sub>2</sub> for decades.**

# “Free Will” Alternative

## 1. Phase Out Coal CO<sub>2</sub> 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<sub>2</sub> Sequestration

- improved farming & forestry practices

## 4. Reduce non-CO<sub>2</sub> Forcings

- reduce CH<sub>4</sub>, O<sub>3</sub>, trace gases, black soot

# 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?**

# What's the Problem?\*

- 1. No Strategic Approach**  
**%CO<sub>2</sub> Reduction Approach Doomed**
- 2. No Leadership for Planet & Life**  
**Businesses Rule in Capitals**
- 3. Greenwash Replaces Strategy**

\*Just my opinions, of course

# What's the Solution?\*

(Not Carbon Cap or % Target!!!)

- 1. Coal Emissions Phase-Out**  
**UK, US, Germany Should Lead**
- 2. Carbon Price & 100% Dividend**  
**For Transformations, Avoid UFF**

\*Just my opinions, of course



# Intergenerational Conflict

**Intergenerational inequity** and injustice is the result, affecting the young and unborn.

**'Did not know' defense** of prior generations no longer viable.

**Ethical and legal liability** questions raised by actions that deceived the public.

**Continued failure** of political process (not even available to young and unborn) may cause increasing public protests.

# Climate Change Protest at Kingsnorth Power Station



Greenpeace activists on the painted chimney  
October 8 2008. Photograph: Will Rose/Greenpeace

## Kingsnorth Six: Not Guilty



**Huw Williams, Kevin Drake, Ben Stewart, Tim Hewke, Emily Hall and Will Rose  
outside Maidstone Crown Court.**

Photograph: Jiri Rezac/Greenpeace

# Web Site

[www.columbia.edu/~jeh1](http://www.columbia.edu/~jeh1)

includes

**Target Atmospheric CO<sub>2</sub>: Where Should  
Humanity Aim?**

**Global Warming Twenty Years Later:  
Tipping Points Near**

**In Defence of Kingsnorth Six**