



平成22年度（第19回）ブループラネット賞  
受賞者記念講演会

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**2010 Blue Planet Prize  
Commemorative Lectures**

ジェームス・ハンセン博士 講演スライド集  
「人起源の気候変動：道徳的、政治的、法的課題」

ロバート・ワトソン博士 講演スライド集  
「オゾン層破壊、気候変動及び生物多様性の損失：  
食糧、水、人間の安全保障に関する意味合い」

Dr. James Hansen  
Slides for the Lecture  
“Human – Made Climate Change: A Moral, Political and Legal Issue”

Dr. Robert Watson  
Slides for the Lecture  
“Ozone Depletion, Climate Change and Loss of Biodiversity:  
Implications for Food, Water and Human Security”

ジェームス・ハンセン博士

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Dr. James Hansen

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“Human-Made Climate Change: A Moral, Political and Legal Issue”

# **Human-Made Climate Change:** **A Moral, Political and Legal Issue\***

**James Hansen**

**27 October 2010**

***Blue Planet Lecture***

**Tokyo, Japan**

\*Statements relating to policy are personal opinion

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## **Global Warming Status**

### **1. Knowledge Gap Between**

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

### **2. Planetary Emergency**

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

### **3. Bad News & Good News**

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

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# Climate Tipping Points

## 1. Ice Sheet Disintegration

- Ocean Warming → Ice Shelves Melt  
→ Ice Streams Surge → Disintegration

## 2. Species Extermination

- Shifting Climate Zones, Multiple Stresses, Species Interdependencies

## 3. Methane Hydrate 'frozen methane'

- In Tundra & On Continental Shelves
- Depends On Ocean & Ice Sheets

slide 3



First grandchild, Sophie – at age almost two years

slide 4

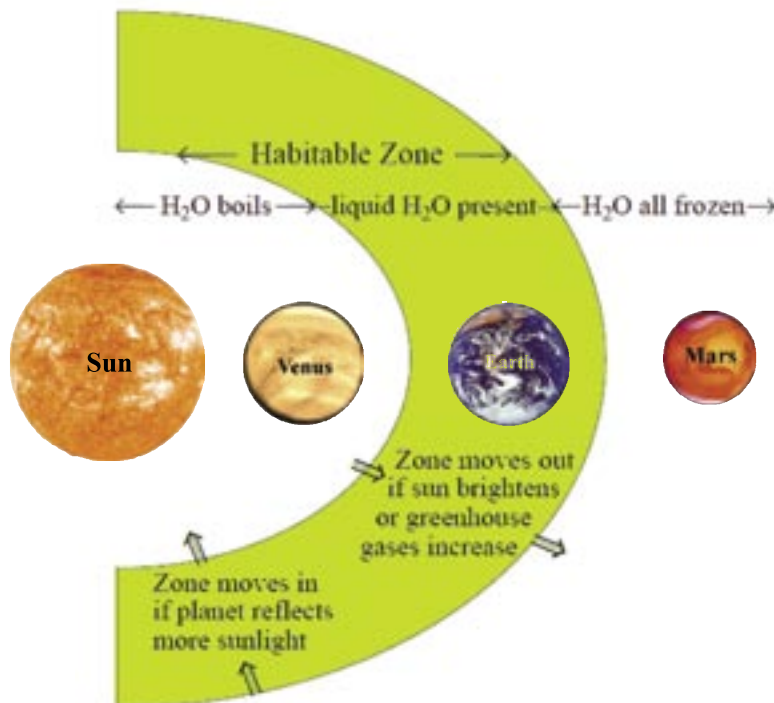
## GOLDBLOCKS PLANETS



<b>Temperature</b>	-50°C	+15°C	+450°C
<b>Greenhouse Effect</b>	a few degrees	~30°C	~470°C

Venus is closer to sun than Earth is, but cloud-covered Venus absorbs only 25% of incident sunlight, while Earth absorbs 70%. Venus is warmer because it has a thick carbon dioxide atmosphere causing a greenhouse effect of several hundred degrees.

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When the solar system formed, the sun was 30% dimmer than today and Venus had an ocean. As the sun brightened, a runaway greenhouse effect caused the Venus ocean to boil away.

At times when Earth was younger, the sun brighter, and atmospheric CO<sub>2</sub> less, Earth froze over ("snowball Earth").

Earth is in the sweet spot today.

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## **Basis of Understanding**

- 1. Earth's Paleoclimate History**
- 2. On-Going Global Observations**
- 3. Climate Models/Theory**

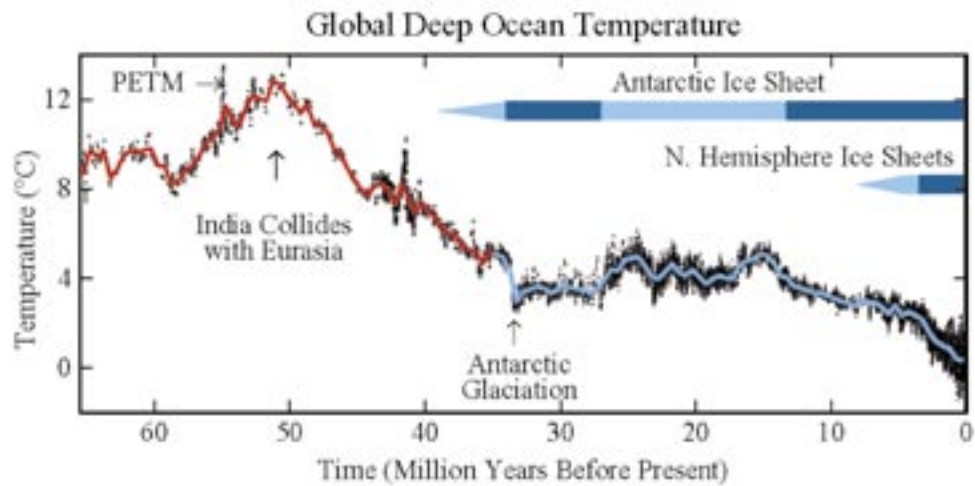
slide 7

## **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.

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**50 million years ago (50 MYA) Earth was ice-free.**

**Atmospheric CO<sub>2</sub> amount was of the order of 1000 ppm 50 MYA.**

**Atmospheric CO<sub>2</sub> imbalance due to plate tectonics ~ 10<sup>-4</sup> ppm per year.**

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## Cenozoic Era



End of Cretaceous (65 My BP)



Present Day

### Global Climate Forcings

External (solar irradiance): +1 W/m<sup>2</sup>

Surface (continent locations): ~1 W/m<sup>2</sup>

Atmosphere (CO<sub>2</sub> changes): > 10 W/m<sup>2</sup>

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## 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

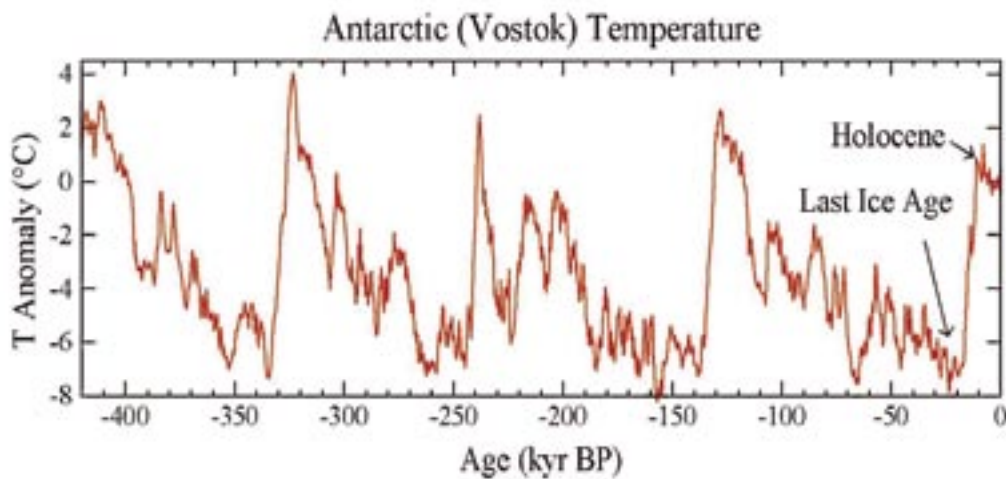
Humans Overwhelm Slow Geologic Changes

### 2. Climate Sensitivity High

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

Humans Could Produce “A Different Planet”

slide 11

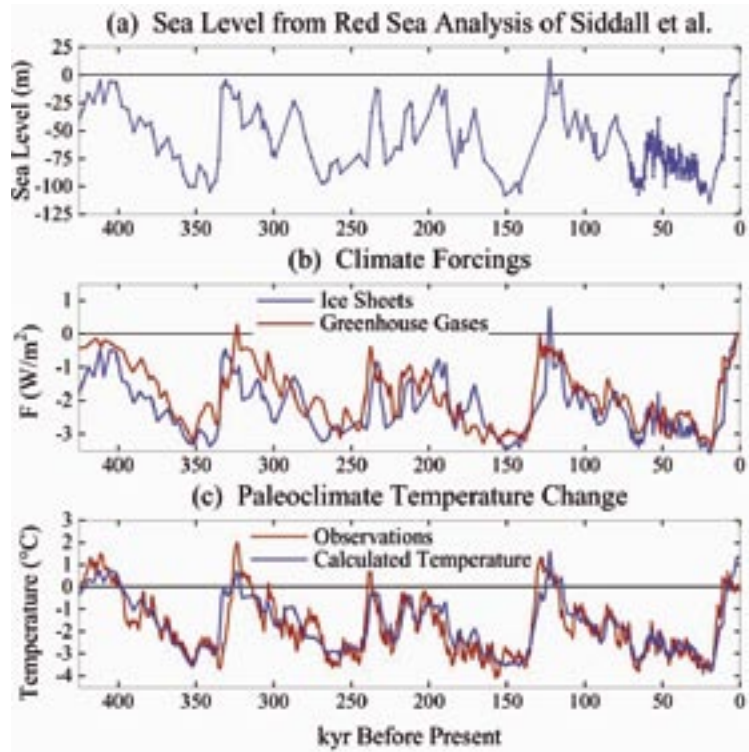


Earth's history provides important information on global warming.

Recorded human history occurs within the Holocene warm period.

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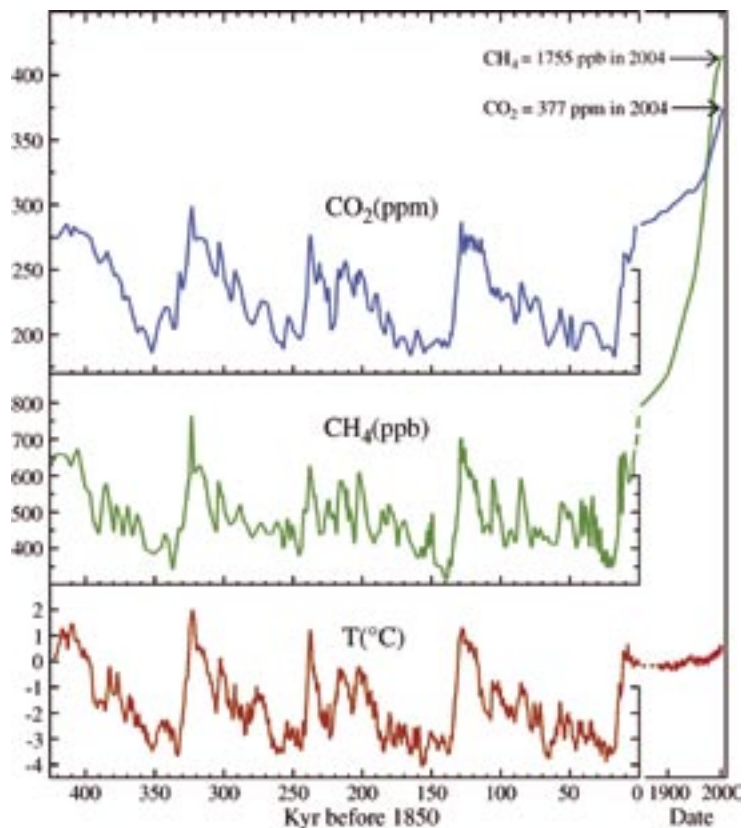




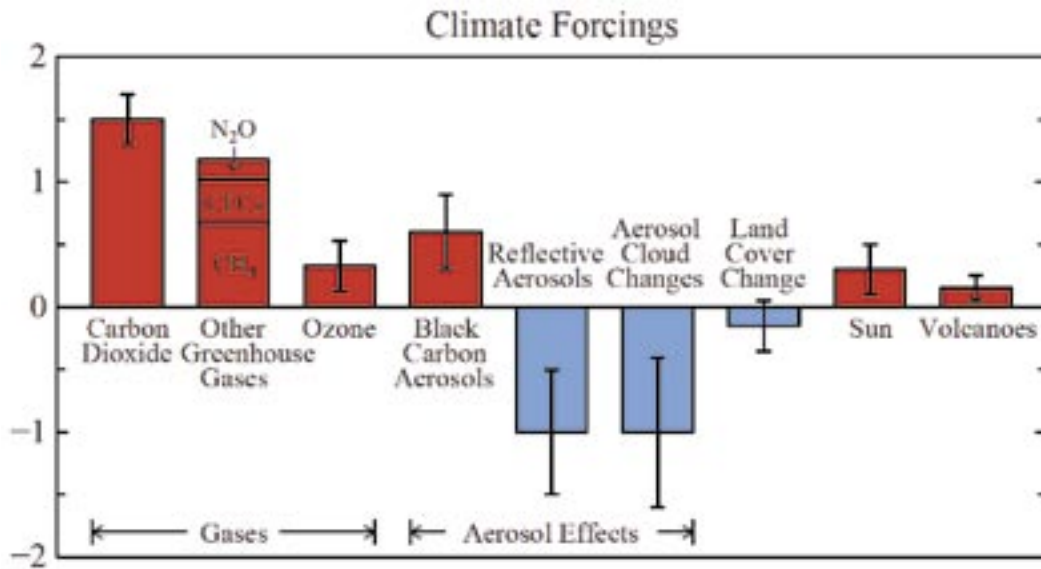
slide 13

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.



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Change of climate forcings in  $W/m^2$  between 1750 and 2000.  
 [from Hansen et al. "Efficacy of Climate Forcings" *J. Geophys. Res.* (2005)]

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### Sophie explains 2 Watts of forcing to brother Connor



**Sophie Explains GH Warming:**  
**"It's 2  $W/m^2$  Forcing."**

**Connor only counts 1 Watt**



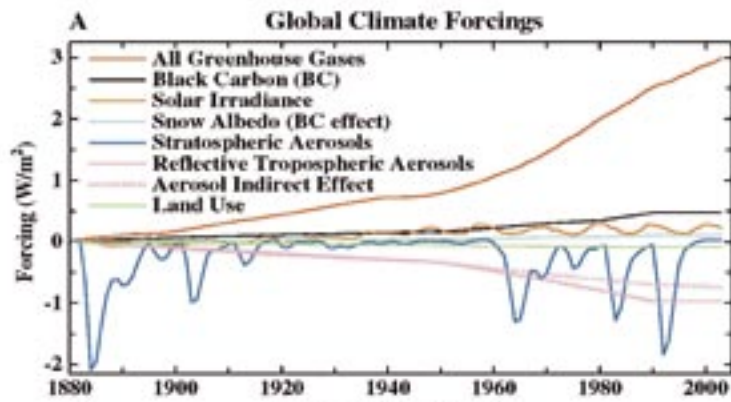
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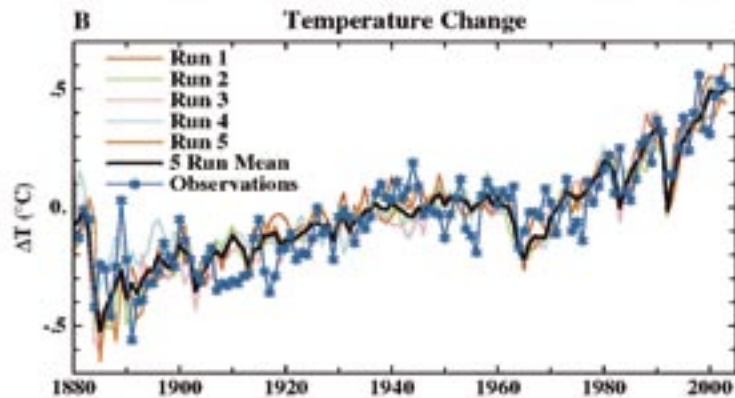
**Sophie and Connor at ages 9 and 4.**

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**(A) Forcings used to drive climate simulations.**

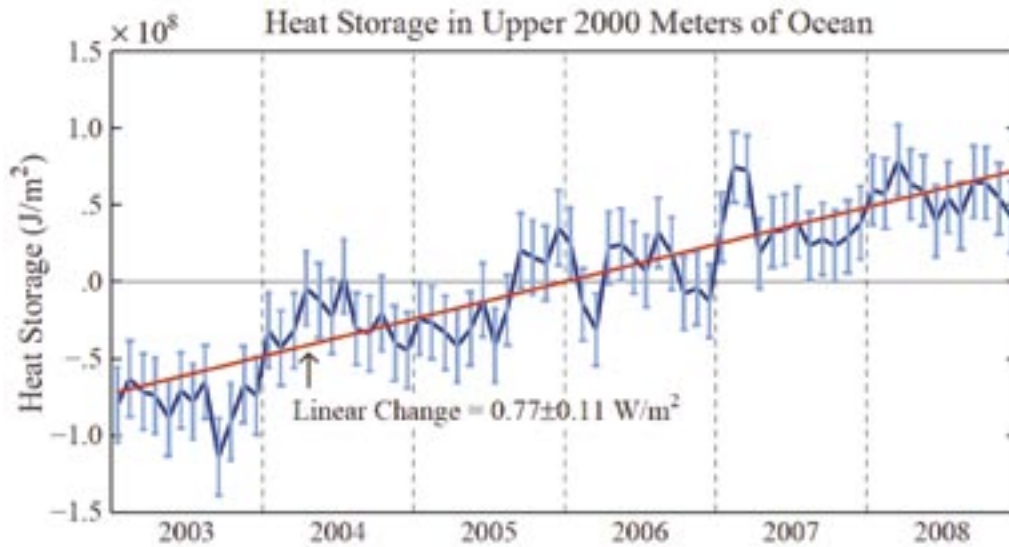


**(B) Simulated and observed surface temperature change.**



Source: Earth's energy imbalance: Confirmation and implications. *Science* 308, 1431, 2005.

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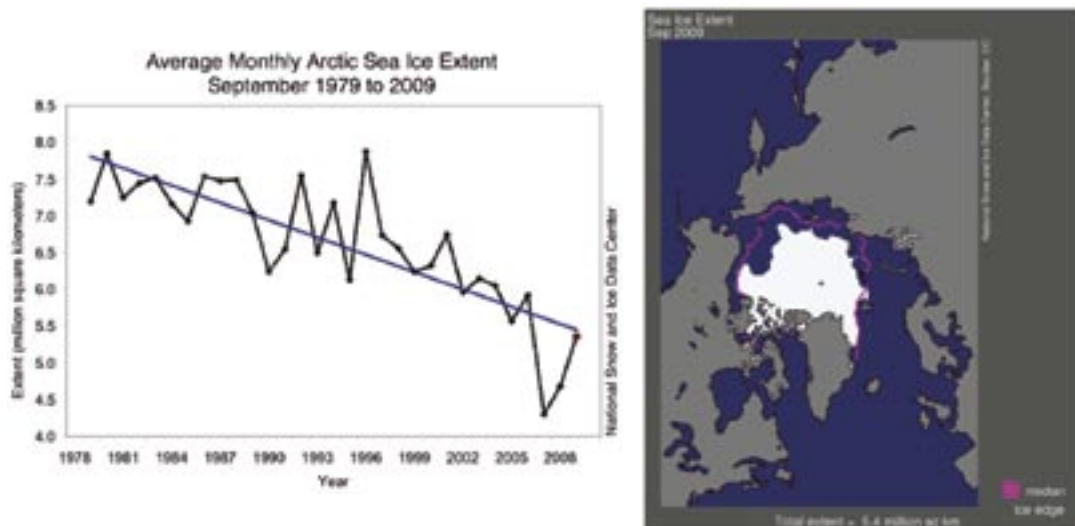


**Heat storage in upper 2000 meters of ocean during 2003-2008 based on ARGO data. Knowledge of Earth's energy imbalance is improving rapidly as ARGO data lengthens. Data must be averaged over a decade because of El Nino/La Nina and solar variability. Energy imbalance is smoking gun for human-made increasing greenhouse effect.**

Data source: von Schuckmann *et al. J. Geophys. Res.* **114**, C09007, 2009, doi:10.1029/2008JC005237.

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### Arctic sea ice area at warm season minimum.



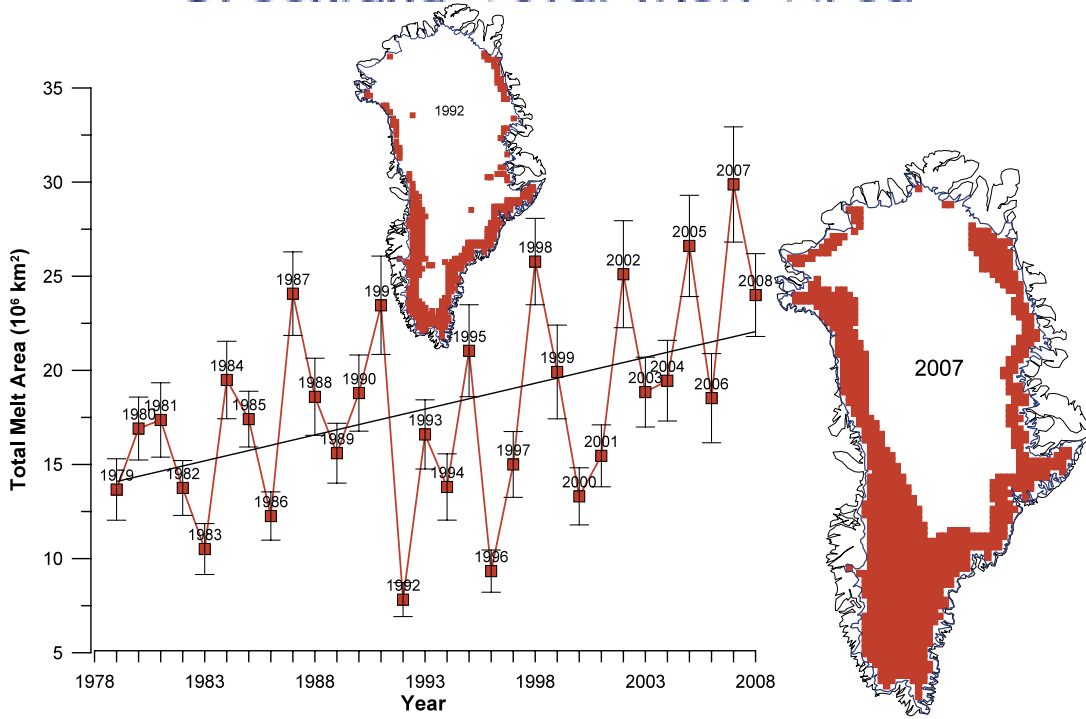
**September sea ice extent based on satellite microwave observations.**

Data source: National Snow and Ice Data Center

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# Greenland Total Melt Area



Area on Greenland with snowmelt.

Graph credit: Konrad Steffen, Univ. Colorado

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# 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)

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## Jakobshavn Ice Stream in Greenland

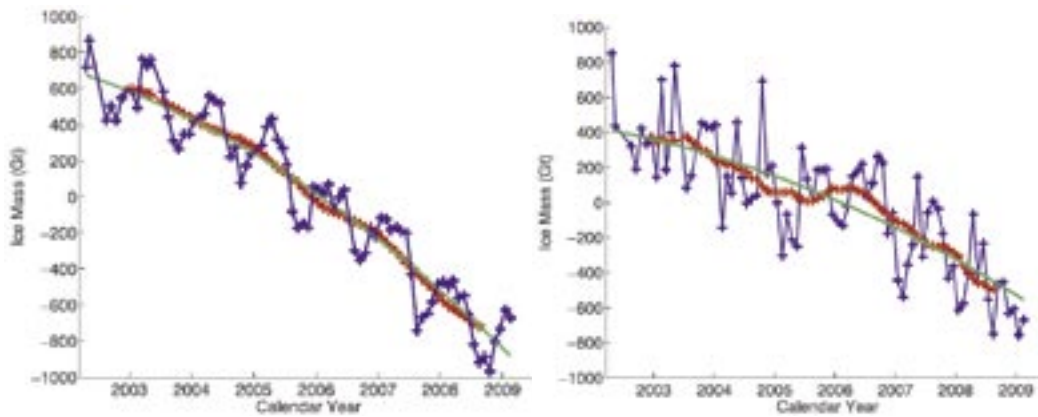
Discharge from major Greenland ice streams is accelerating markedly.



Source: Prof. Konrad Steffen,  
Univ. of Colorado

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## Gravity Satellite Ice Sheet Mass Measurements



**Greenland Ice Sheet**

**Antarctic Ice Sheet**

Source: Velicogna, I. *Geophys. Res. Lett.*, **36**, L19503, doi:10.1029/2009GL040222, 2009.

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### Pier on Lake Mead



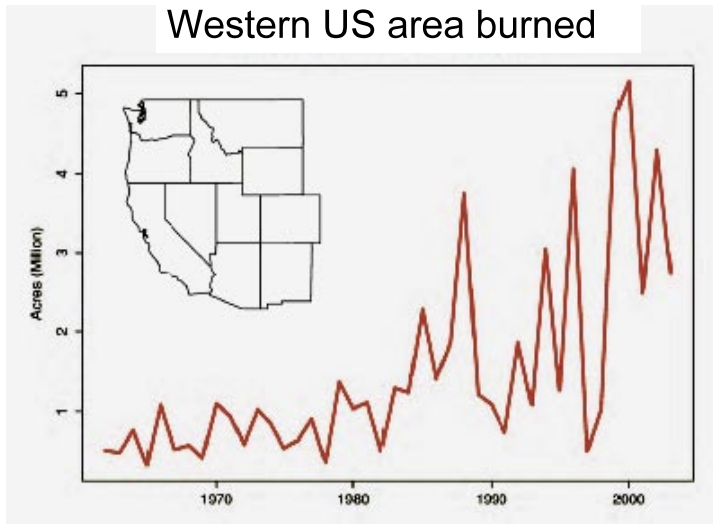
Subtropics are expected to expand with global warming.  
Observations show, on average, 4 degrees of latitude expansion.

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## 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

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## Himalayan (Rongbuk) Glacier



Rongbuk, the largest glacier on Mount Everest's northern slopes, in 1968 (top) and 2007. Glaciers are receding rapidly world-wide, including the Rockies, Andes, Alps, Himalayas. Glaciers provide freshwater to rivers throughout the dry season and reduce spring flooding.

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## Stresses on Coral Reefs



### **Coral Reef off Fiji**

(Photo credit: Kevin Roland)

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

<u>Phenomenon</u>	<u>Target CO<sub>2</sub> (ppm)</u>
1. Arctic Sea Ice	300-350
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

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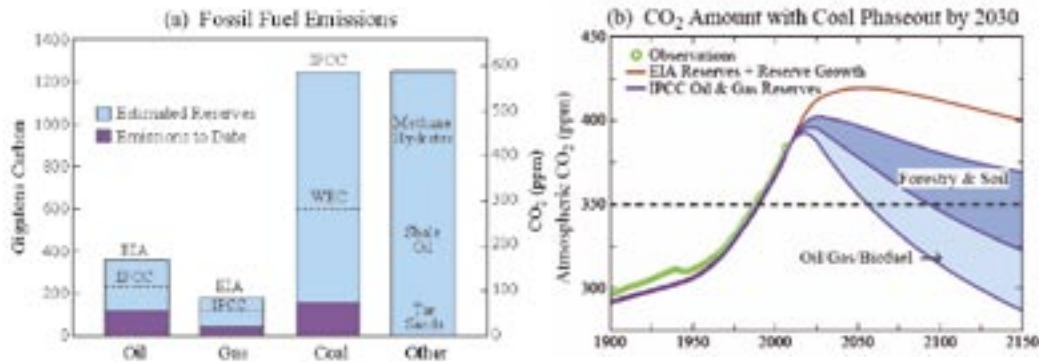
# Target CO<sub>2</sub>:

# < 350 ppm

To preserve creation, the planet  
on which civilization developed

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## Fossil Fuel Reservoirs & CO<sub>2</sub> Scenarios



Scenarios assume no “Other” = Tar Sands, Oil Shale, Methane Hydrates  
 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

Source: Hansen *et al.*, Target atmospheric CO<sub>2</sub>: where should humanity aim? *Open Atmos. Sci. J.*, 2, 217-231, 2008.

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## <350 ppm is Possible, But...

### Essential Requirements

1. **Quick Coal Phase-Out Necessary**  
All coal emissions halted in 20 years
2. **No Unconventional Fossil Fuels**  
Tar sands, Oil shale, Methane hydrates
3. **Don't Pursue Last Drops of Oil**  
Polar regions, Deep ocean, Pristine land

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## What's Really Happening

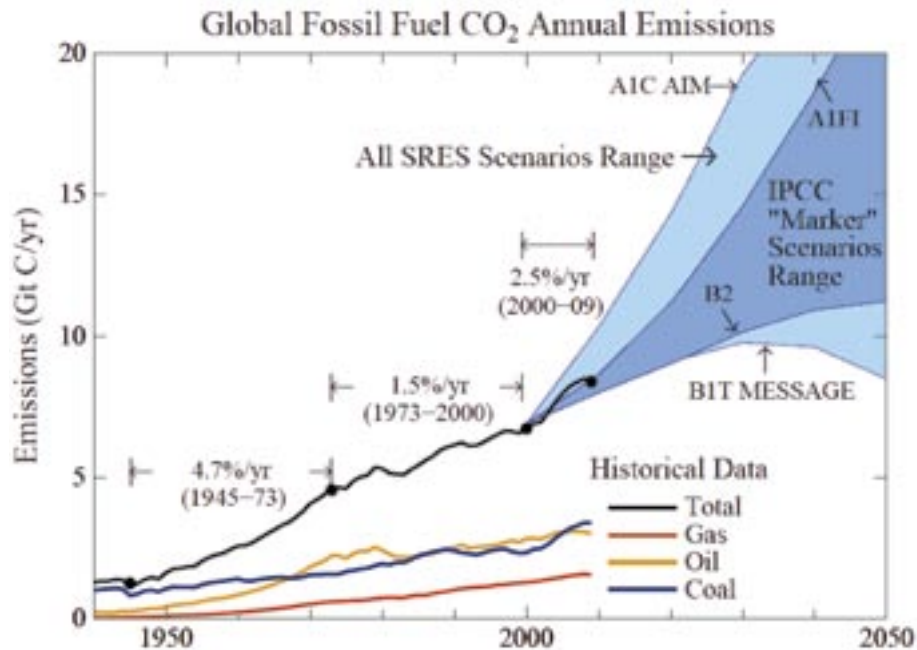
- 1. Tar Sands Agreement with Canada**  
Pipeline planned to transport oil
- 2. New Coal-fired Power Plants**  
Rationalized by 'Clean Coal' mirage
- 3. Mountaintop Removal Continues**  
Diminishes wind potential of mountains
- 4. Oil & Gas Extraction Expands**  
Arctic, offshore, public lands

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## Global Action Status

- 1. Huge Gap: Rhetoric & Reality**
  - Rhetoric: Planet in Peril
  - Policies: Small Perturbation to BAU
- 2. Greenwash/Disinformation Winning**
  - Appeasement of Fossil Interests
  - Still Waiting for a Winston Churchill
- 3. Kyoto & Copenhagen Failures**
  - Kyoto → accelerating emissions
  - Copenhagen → still "cap-&-trade"

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**Global fossil fuel carbon dioxide emissions accelerated after Kyoto Protocol.**

Date sources: Marland et al. (U.S. Dept. Energy, Oak Ridge and extended with BP Statistical Review of World Energy.)

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## Problem & Solution

### 1. Fossil Fuels are Cheapest Energy

- Subsidized & Do Not Pay Costs
- Solution: Rising Price on Carbon

### 2. Regulations also Required

- Efficiency of Vehicles, Buildings, e.g.
- Carbon Price Provides Enforcement

### 3. Technology Development Needed

- Driven by Certainty of Carbon Price
- Government Role Limited

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## Fee & Green Check (Dividend)

- 1. Fee Applied at First Sale/Port of Entry**  
Covers all Oil, Gas, Coal → No Leakage
- 2. Fee Specified: No Speculation, No Volatility**  
No Wall Street Millionaires at Public Expense
- 3. Other Merits**  
Only Potentially Global Approach  
Simple, Honest, Can be Implemented Quickly  
Market Chooses Technology Winners  
Most Efficient & Largest Carbon Reductions

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## Cap-and-Trade Flaws

- 1. Designed for Banks & Fossil Interests**  
Impossible to exclude big money
- 2. Price Volatility**  
Discourages clean energy investments
- 3. Ineffectual**  
Real carbon reductions small
- 4. Cannot be made global**  
China/India will not (& should not) accept caps

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# Fee & Green Check Addresses

## 1. **Economy: Stimulates It**

Puts Money in Public's Hands– A Lot!

## 2. **Energy: Fossil Fuel Addiction**

Stimulates Innovation – Fastest Route to Clean Energy Future

## 3. **Climate**

Only Internationally Viable Approach - -  
Zero Chance of China/India Accepting a Cap

Would Result in Most Coal & Unconventional Fossil Fuels, and some Oil, left in the Ground

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Lauren Emma (age 2½ days) and Jake (age 2½ years)



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Lauren Emma (age 2½ days) and Jake (age 2½ years)



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## Intergenerational Justice

**Jefferson to Madison:** ...self-evident that  
“Earth belongs in usufruct to the living”\*

**Native People:** obligation to 7<sup>th</sup> generation

**Most Religions:** duty to preserve creation

**Governments (with fossil interests):** we set  
emissions at whatever level we choose

**Public:** when will it become involved?

\* Legal right to use something belonging to another

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# Notes of Optimism

## 1. China

Enormous investments in carbon-free energy (solar, wind, nuclear power)

## 2. Legal Approach

Judicial branch less influenced by fossil fuel money (than executive and legislative branches)

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# Atmospheric Trust Litigation\*

## 1. Atmosphere is a public trust asset

Governments have fiduciary obligation to manage asset – it is not political discretion

## 2. Courts can enforce via injunction

Require carbon accounting, with schedule specified by science

## 3. Force governments at all levels

\* Wood, M., Atmospheric Trust Litigation, in *Adjudicating Climate Change: Sub-National, National, and Supra-National Approaches* (William C.G. Burns & Hari M. Osofsky, eds.) (2009, Cambridge University Press)

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## 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**

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