

Human-Made Climate Change: **A Scientific, Moral and Legal Issue***

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***Statements relating to policy are personal opinion**

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 CO₂ < 350 ppm
- Multiple Benefits of Solution

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

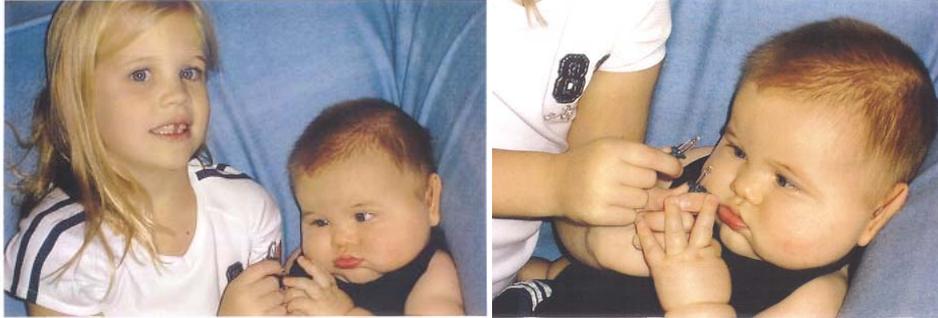
3. Methane Hydrate 'frozen methane'

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



First grandchild, Sophie – at age almost two years

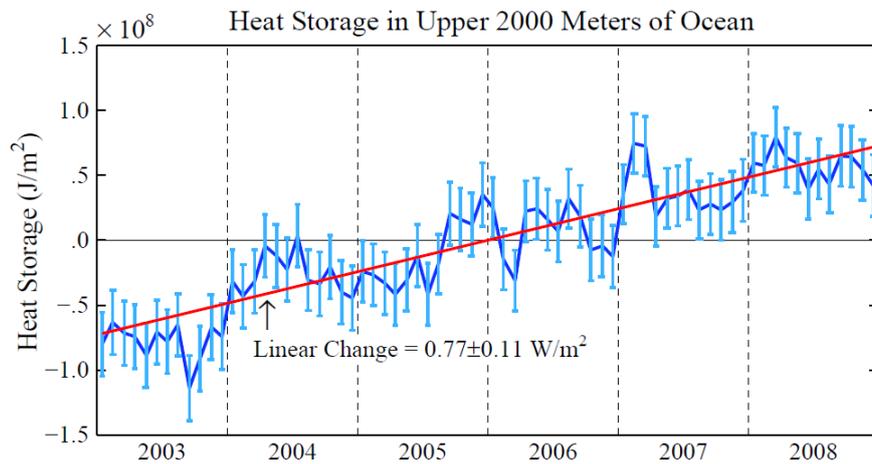
Sophie explains 2 Watts of forcing to brother Connor



Sophie Explains GH Warming:

Connor only counts 1 Watt

"It's 2 W/m² Forcing."



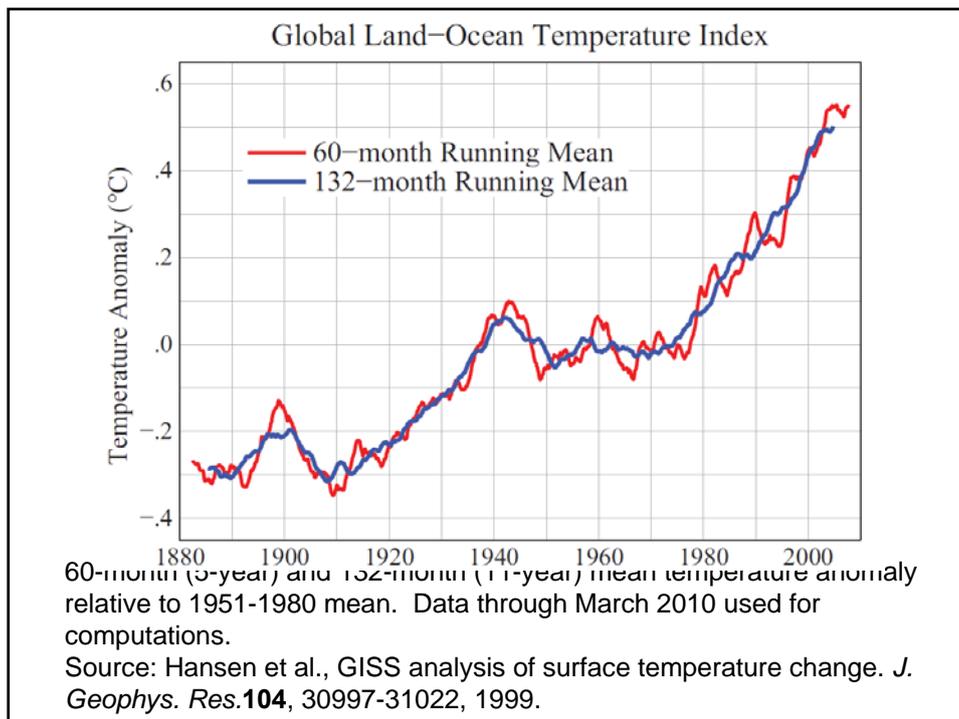
Heat storage in upper 2000 meters of ocean during 2003-2008 based on ARGO data.

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.

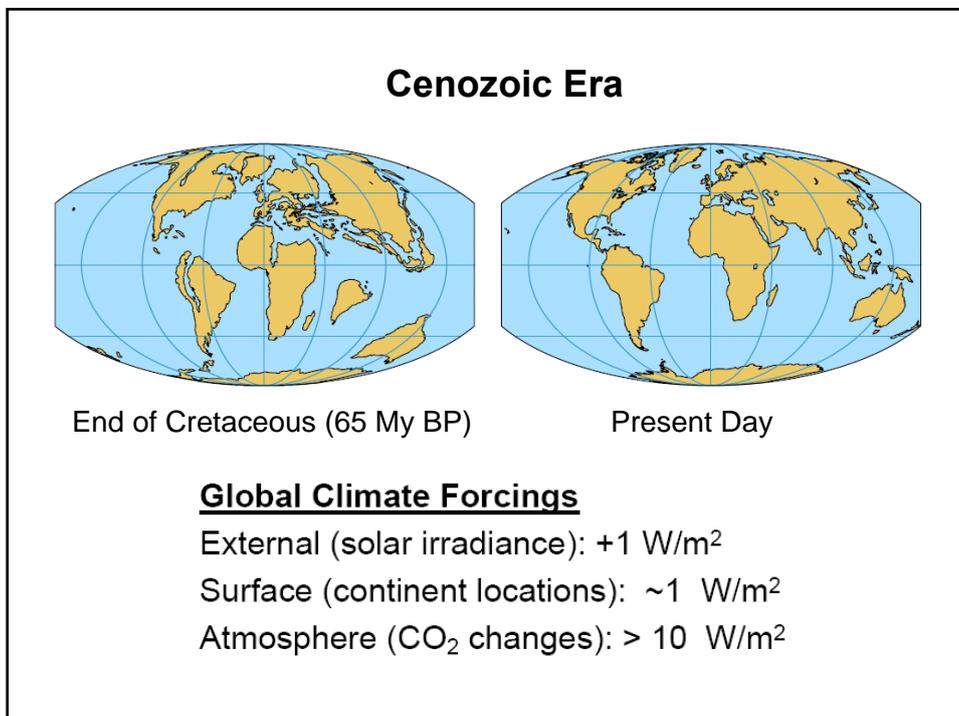
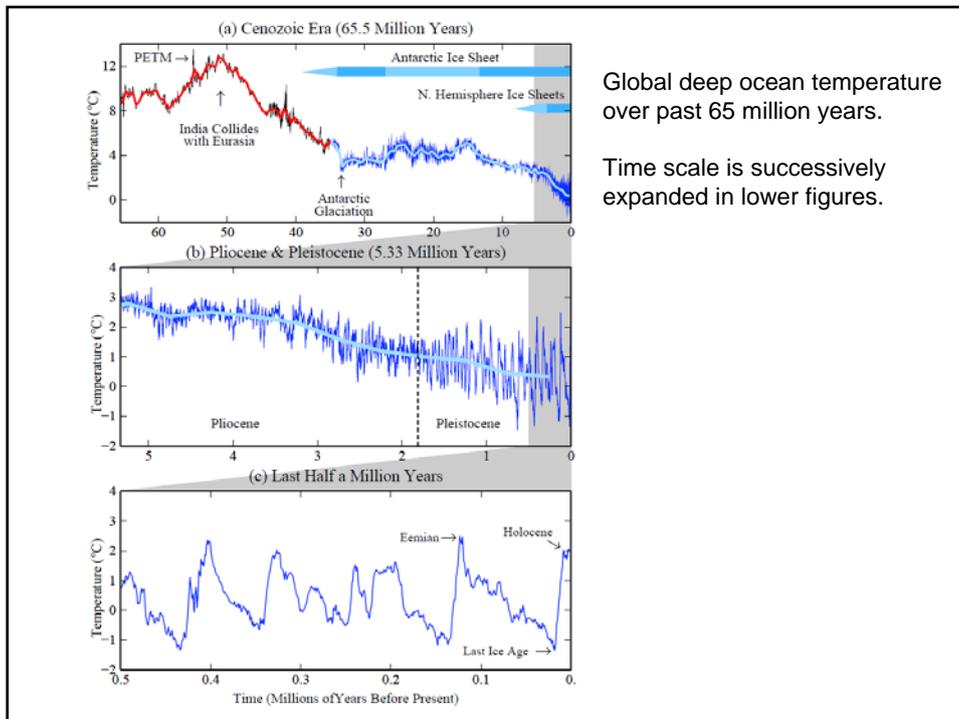
Energy imbalance is smoking gun for human-made increasing greenhouse effect.

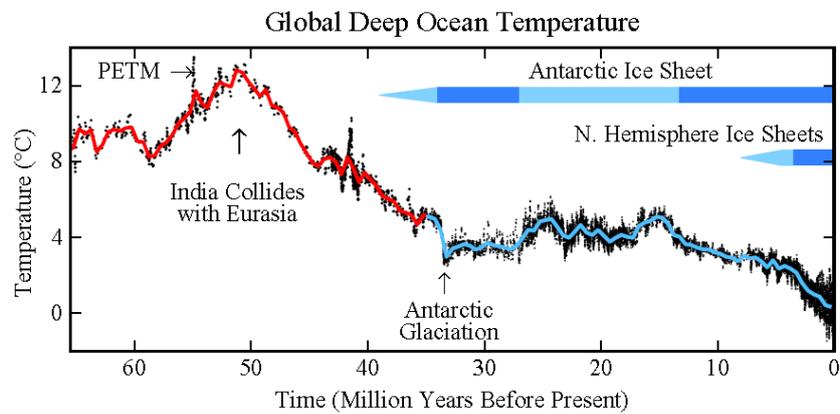
Data source: von Schuckmann *et al. J. Geophys. Res.* **114**, C09007, 2009, doi:10.1029/2008JC005237.



Basis of Understanding

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





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

Atmospheric CO₂ amount was of the order of 1000 ppm 50 MYA.

Atmospheric CO₂ imbalance due to plate tectonics ~ 10⁻⁴ ppm per year.

Summary: Cenozoic Era

1. Dominant Forcing: Natural ΔCO₂

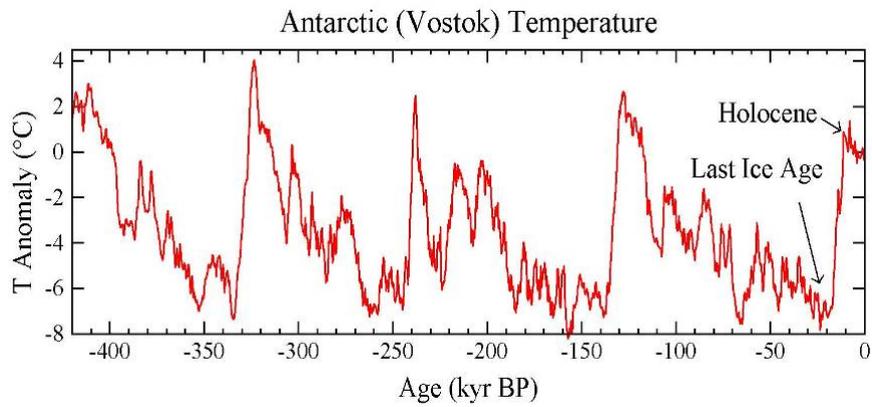
- Rate ~100 ppm/My (0.0001 ppm/year)
- Human-made rate today: ~2 ppm/year

Humans Overwhelm Slow Geologic Changes

2. Climate Sensitivity High

- Antarctic ice forms if CO₂ < ~450 ppm
- Ice sheet formation reversible

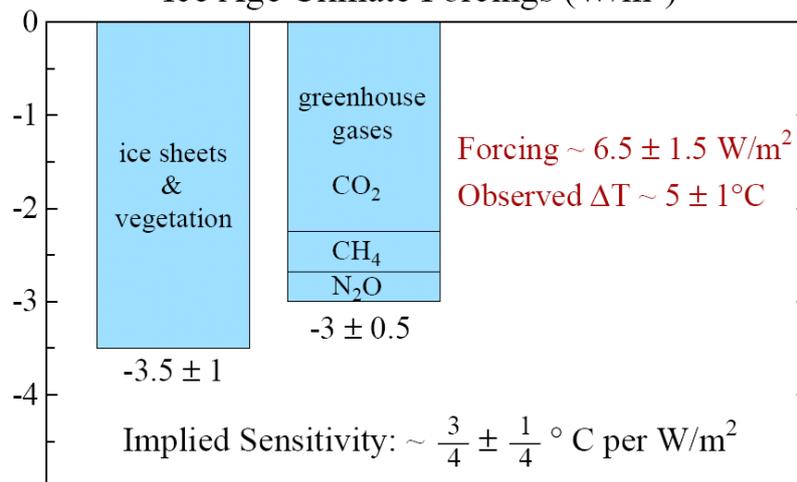
Humans Could Produce "A Different Planet"



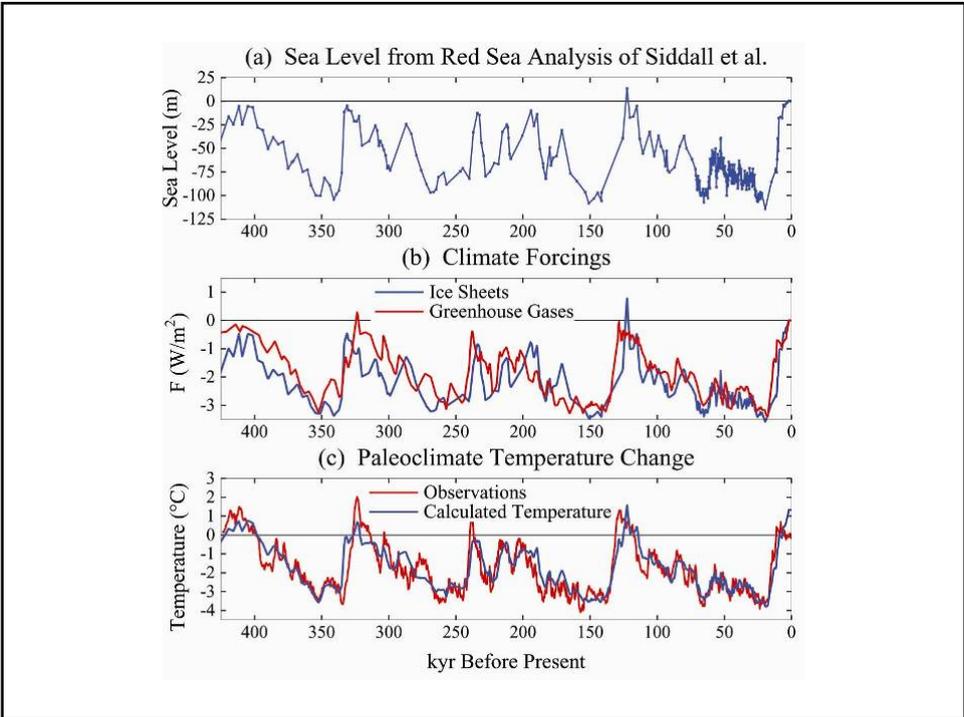
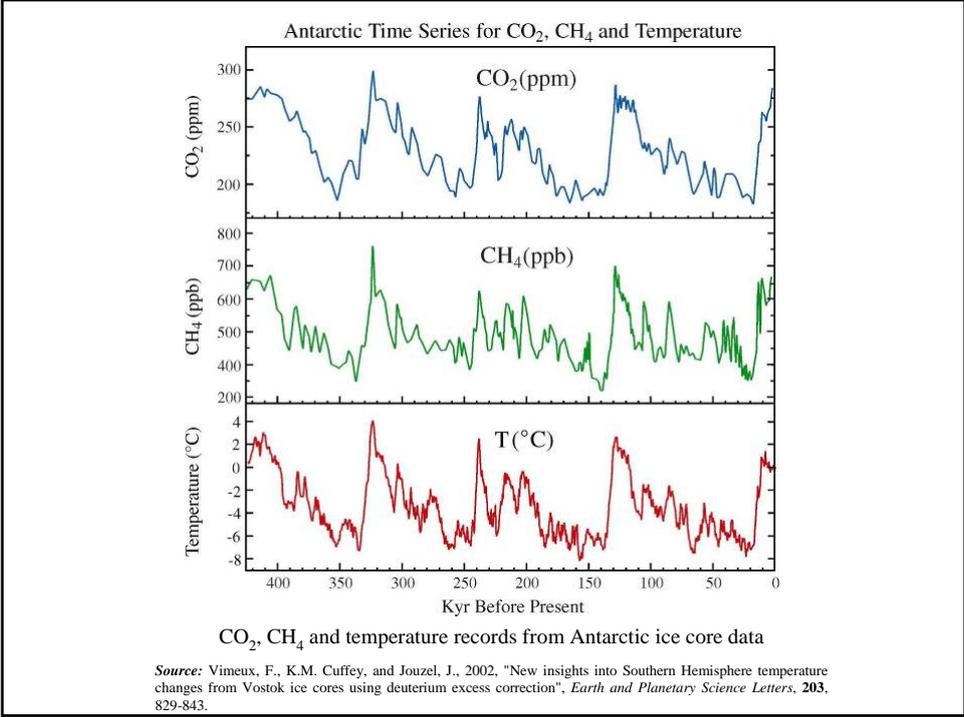
Earth's history provides important information on global warming.

Recorded human history occurs within the Holocene warm period.

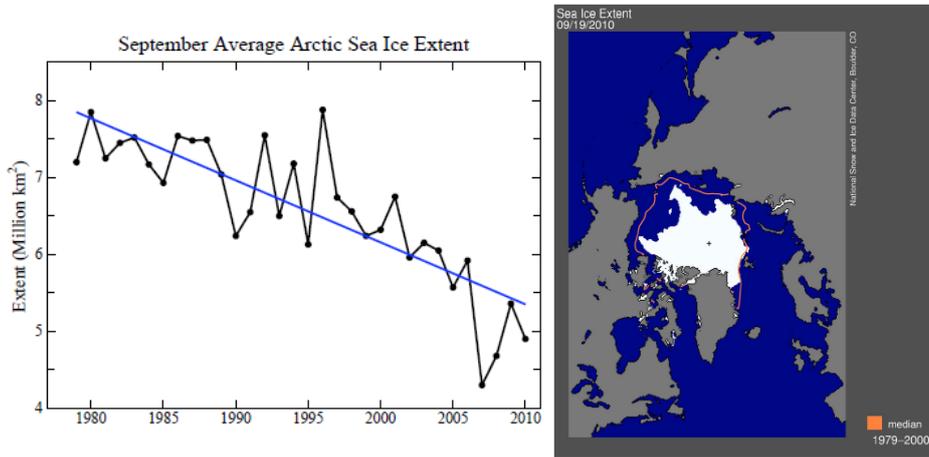
Ice Age Climate Forcings (W/m^2)



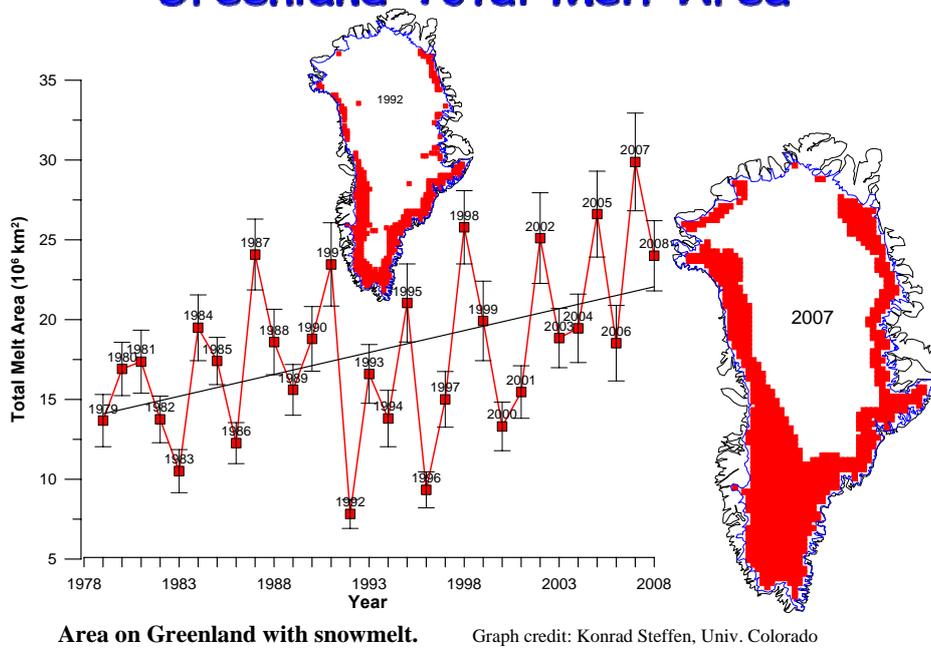
Climate forcings during ice age 20 ky BP, relative to the present (pre-industrial) interglacial period.



Arctic sea ice area at summer minimum.



Greenland Total Melt Area



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)

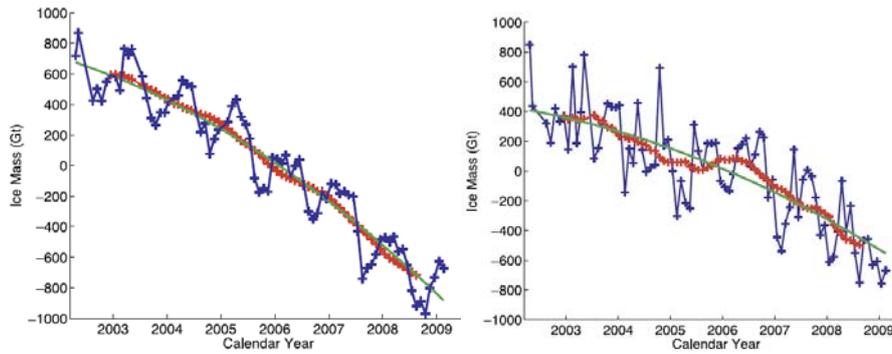
Jakobshavn Ice Stream in Greenland

Discharge from major Greenland ice streams is accelerating markedly.



Source: Prof. Konrad Steffen,
Univ. of Colorado

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.

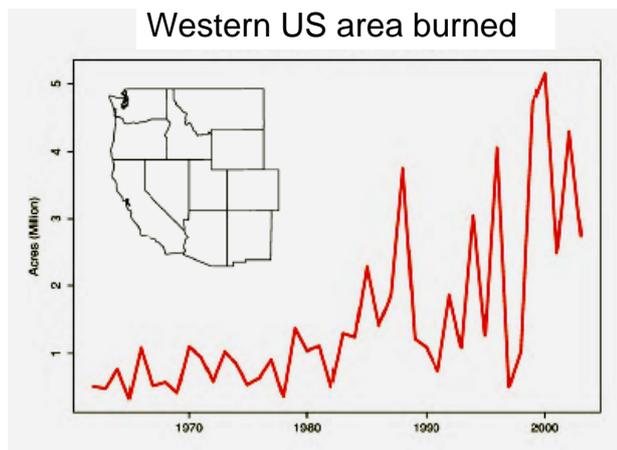
Pier on Lake Mead



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

Fires Are Increasing World-Wide

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



Source: Westerling et al. 2006

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.

Stresses on Coral Reefs



Coral Reef off Fiji

(Photo credit: Kevin Roland)

Assessment of Target CO₂

<u>Phenomenon</u>	<u>Target CO₂ (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 CO₂ = 350* ppm

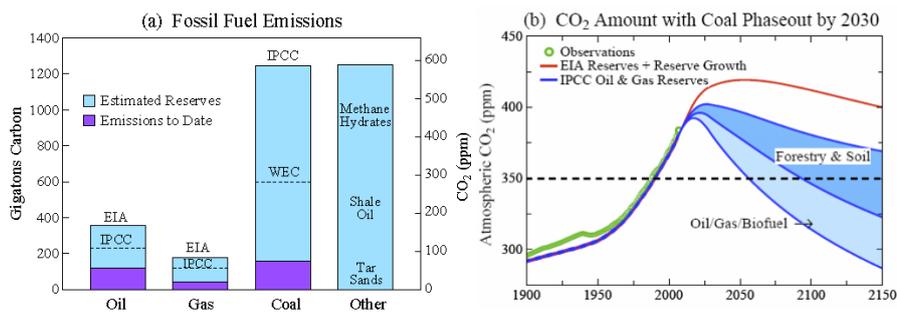
*assumes CH₄, O₃, Black Soot decrease

Target CO₂:

< 350 ppm

To preserve creation, the planet on which civilization developed

Fossil Fuel Reservoirs & CO₂ Scenarios



Scenarios assume no "Other" = Tar Sands, Oil Shale, Methane Hydrates
Coal phase-out by 2030 → peak CO₂ ~400-425 ppm, depending on oil/gas.
Faster return below 350 ppm requires additional actions

Source: Hansen *et al.*, Target atmospheric CO₂: where should humanity aim? *Open Atmos. Sci. J.*, 2, 217-231, 2008.

<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

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

Global Action Status

1. Huge Gap: Rhetoric & Reality

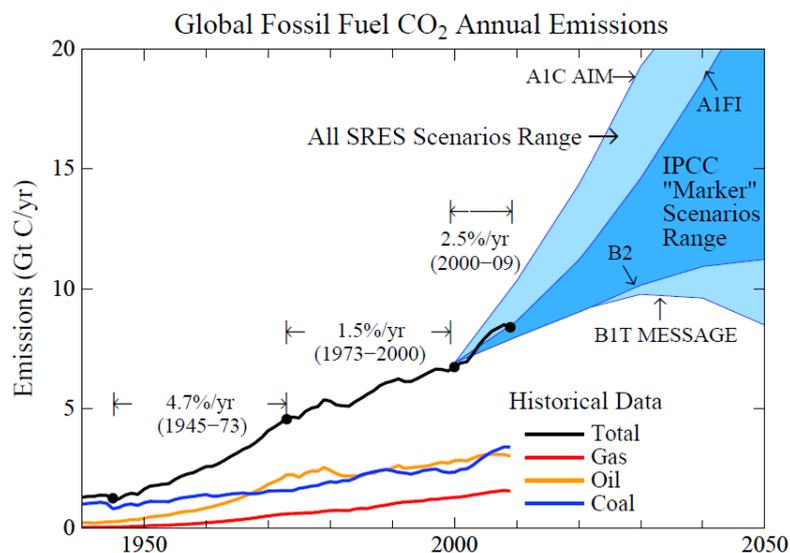
- Rhetoric: Planet in Peril
- Policies: Small Perturbation to BAU

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”



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.)

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

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

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

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

Intergenerational Justice

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

Native People: obligation to 7th 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

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



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



Sophie writing letter to President Obama



Opa reads the letter to President Obama.



Sophie, Opa and Connor celebrate good letter.

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)

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

Web Site

www.columbia.edu/~jeh1

includes

**Target Atmospheric CO₂: Where Should
Humanity Aim?**

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

In Defence of Kingsnorth Six