The Threat to the Planet*
Dark and Bright Sides Of Global Warming

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National Integrity in Science Conference
Ronald Reagan Building, Washington

*Any statements relating to policy are personal opinion
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 CO₂ < 350 ppm
   - Multiple Benefits of Solution
Basis of Understanding

1. Earth’s Paleoclimate History
2. On-Going Climate Changes
3. Climate Models
Temperature Change at Seasonal Resolution

Green Triangle = Volcano; Red Box = El Nino; Blue Semicircle= La Nina
Average of minima: 1365.476 ± 0.378 Wm^-2
Difference of minima to average: +0.059; +0.092; +0.082; -0.233 Wm^-2
Cycle amplitudes: 0.925 ± 0.019; 0.894 ± 0.020; 0.997 ± 0.017 Wm^-2
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
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 Sea Ice Extent (1979–2007)

Extent (million sq km)

September 2007
4.28 million km²

Mark Serreze, Julienne Stroeve, Walt Meier, Ted Scambos, Marika Holland, Jim Maslanik, Stephanie Renfrow, Matt Savoie
Arctic Sea Ice Extent
(Area of ocean with at least 15% sea ice)

Extent (millions of square kilometers)

- 2008
- 2007
- 1979–2000 Average

April May June July August
Arctic Sea Ice Criterion*

1. Restore Planetary Energy Balance
   → $\text{CO}_2$: 385 ppm → 325-355 ppm

2. Restore Sea Ice: Aim for -0.5 W/m$^2$
   $\text{CO}_2$: 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-$\text{CO}_2$ 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)
Discharge from major Greenland ice streams is accelerating markedly.

Source: Prof. Konrad Steffen, Univ. of Colorado
Greenland Mass Loss – From Gravity Satellite

-162 +/- 22 km³/yr
~0.4 +/- 0.1 mm/yr sea level rise

Velicogna and Wahr, 2005
Mass Balance of Greenland

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).

365 Gt/year = 1 mm SLR

Sources (corresponding to numbers on rectangles): 1 and 2 Krabill and others 200016 and 200417; 3 Thomas and others 200617; 4 Zwally and others 20055; 5 to 7 Rignot and Kanagaratnam 200818; 8 and 9 Velicogna and Wahr 2005[7 and 2008b; 11 Chen and others 2006]; 10 Ramillien and others 200832; 12 Luthke and others 200619
Sea Level Criterion*

1. Prior Interglacial Periods
   \[ \rightarrow \text{CO}_2 < \sim 300 \text{ ppm} \]

2. Cenozoic Era
   \[ \rightarrow \text{CO}_2 < \sim 300 \text{ ppm} \]

3. Ice Sheet Observations
   \[ \rightarrow \text{CO}_2 < 385 \text{ ppm} \]

*Assuming near-balance among non-CO$_2$ forcings
Pier on Lake Mead.
Fires Are Increasing World-Wide

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

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 $\text{CO}_2$

<table>
<thead>
<tr>
<th>Phenomenon</th>
<th>Target $\text{CO}_2$ (ppm)</th>
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</thead>
<tbody>
<tr>
<td>1. Arctic Sea Ice</td>
<td>300-325</td>
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<td>2. Ice Sheets/Sea Level</td>
<td>300-350</td>
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<td>3. Shifting Climatic Zones</td>
<td>300-350</td>
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<tr>
<td>4. Alpine Water Supplies</td>
<td>300-350</td>
</tr>
<tr>
<td>5. Avoid Ocean Acidification</td>
<td>300-350</td>
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</tbody>
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$\rightarrow$ Initial Target $\text{CO}_2 = 350^* \text{ ppm}$

*assumes $\text{CH}_4$, $\text{O}_3$, Black Soot decrease
Target CO$_2$: 

$< 350$ ppm

To preserve creation, the planet on which civilization developed
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

- Estimated Reserves
- Emissions to Date

(b) CO₂ Amount with Coal Phaseout by 2030

Observations
- EIA Reserves + Reserve Growth
- IPCC Oil & Gas Reserves

Forestry & Soil
- Oil/Gas/Biofuel
Initial Target CO₂: 350 ppm

Technically Feasible
(but not if business-as-usual continues)

Quick Coal Phase-Out Critical
(long lifetime of atmospheric CO₂)
(must halt construction of any new coal plants that do not capture & store CO₂)
Fossil Fuel CO$_2$ Emissions

(a) 2007 Annual Emissions  (b) 1751-2007 Cumulative Emissions

- **U.S.A. 19.3%**
- **China 20.6%**
- **Russia 5.0%**
- **India 5.0%**
- **Japan 4.0%**
- **Grm. 2.5%**
- **U.K. 1.8%**
- **Rest of Europe 11.8%**
- **Rest of World 21.7%**

- **China 8.5%**
- **U.S.A. 27.2%**
- **Russia 7.3%**
- **Germany 6.4%**
- **U.K. 5.9%**
- **CanAus 3.1%**
- **Ships/Air 5.2%**
- **Rest of Europe 17.9%**
- **Rest of World 13.3%**
Per Capita Fossil Fuel CO₂ Emissions

(a) 2007 Annual Emissions
(Tons Carbon/Year/Person)

(b) 1751-2007 Cumulative Emissions
(Tons Carbon/Person)
Source of Fossil Fuel CO₂

(a) 2007 Emissions

Coal: 40%
Oil: 41%
Gas: 19%

(b) In the Air Today

Coal: 50%
Oil: 37%
Gas: 13%
“Free Will” Alternative

1. Phase Out Coal CO₂ 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 CO₂ Sequestration
   - improved farming & forestry practices

4. Reduce non-CO₂ Forcings
   - reduce CH₄, O₃, 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
   - let marketplace choose winners
   - change profit motivation of utilities
   - watch U.S. modernize & emissions fall!
Key Elements in Transformation

Low-Loss Electric Grid
Clean Energy by 2020 (West) & 2030
Allows Renewable Energy Ascendancy

Carbon Tax and 100% Dividend
Tax at First Sale of Coal/Oil/Gas
Tax Can Rise & Spur Transformations
“100% or Fight! No Alligator-Shoes!”
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
   %CO₂ 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
Web Site

www.columbia.edu/~jeh1

includes

Letter to Prime Minister Fukuda

Global Warming Twenty Years Later: Tipping Points Near (today’s statement)

Target Atmospheric \( \text{CO}_2 \): Where Should Humanity Aim?