Climate closure:
Game over for climate skeptics

Réchauffement anthropique:
La fin de la récréation

Evidence for warming
The “hockey stick”
Mann, Bradley, Hughes 1998

Industrial epoch warming
The Preindustrial versus industrial epoch

Temperature (°C) over time since the start of the series.
Ranking of temperatures from hottest to coldest
The Arctic
(melting of sea ice)

Over 2 million square km of sea ice lost over 35 years
1. The models are unreliable they have not been tested, they aren’t valid.
   predictions of warming doesn’t depend on the models

2. Pre 2004: “Heat Island effect”: warm biases due to urbanization?
   - The effect is very small

3. 1995-2005: Satellite temperatures versus surface measurements ...
   4 errors discovered (now there is agreement).

2006: “Because of the complexity of the problem, environmental skepticism was once tenable. No longer. It is time to flip from skepticism to activism.”

-Michael Shermer, editor of the Skeptical Inquirer
Anthropogenic Theory
CO$_2$: The last 350,000 yrs

The theory of anthropogenic warming: the “Greenhouse effect”
Anthropogenic warming: Pre-GCM era

1896
Nobel prize winner Svante Arrhenius: CO₂ doubling: 5 – 6°C of warming, “climate sensitivity”

1938
Callender estimated the warming as 2°C

1957
Keeling started his celebrated CO₂ measurements at Mauna Loa and at the south Pole
GCM era (post 1975)

GCM’s: for CO₂ doubling:

<table>
<thead>
<tr>
<th>Source</th>
<th>Year</th>
<th>Temperature Range (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US National Academy of Science</td>
<td>1979</td>
<td>1.5- 4.5°C</td>
</tr>
<tr>
<td>IPPC3</td>
<td>2002</td>
<td>1.5- 4.5°C</td>
</tr>
<tr>
<td>IPPC4</td>
<td>2007</td>
<td>2- 4.5°C</td>
</tr>
<tr>
<td>IPPC5</td>
<td>2013</td>
<td>1.5- 4.5°C</td>
</tr>
</tbody>
</table>

1998 climate models somewhat over-forecast the warming in the 2000’s

IPCC 5 (2013) extremely

IPCC 4 (2007) “it is likely that human influence has been the dominant cause of the observed warming since the mid-20th century”
Natural variability Theory
Accepting the warming:
Alternative theory - Natural variability (including solar)

1. The warming is due to natural variability.

2. The “pause”: the earth has stopped warming since 1998.

Implausible but not disproved until 2014...
Disproving Natural warming

Natural variability hypothesis was neglected by the scientific community
Increase in CO₂ since 1880

Concentration du CO₂

- 365 ppm
- 329 ppm
- 318 ppm
- 297 ppm
- 277 ppm

May, 2014: 400ppm Mauna Loa

Global temperatures: NASA – GISS data

T_{globe} (K)
CO$_2$ forcing as surrogate for all anthropogenic effects

Roughly: you double the global economy, you double the emissions, land use and other changes, you double the effects
Global temperatures: NASA - GISS data

Post war cooling

Prepause

Pause

1944

1976

1992

1998

2012
Global temperatures: NASA - GISS data

Slope gives (95% uncertainties)
Sensitivity to CO₂ doubling: 1.9-2.8°C

IPCC AR5 (2013): 1.5-4.5°C

1750 277 ppm
1880 290 ppm
1944 310 ppm
1976 331 ppm
1992 353 ppm
1998 363 ppm
2012 391 ppm

Post war cooling
Prepause
Pause

Energy/Time (CO₂ radiative forcing proxy)

$\text{Slope gives (95\% uncertainties)}$

$\text{Sensitivity to CO}_2\text{ doubling: 1.9-2.8}^\circ\text{C}$

$\text{IPCC AR5 (2013): 1.5-4.5}^\circ\text{C}$
Global temperatures:
NASA - GISS data

$T_{\text{globe}} (K)$

Anthropogenic "forcing"

Residual = Natural Variability

Anthropogenic ($\approx 1.0 \, ^\circ C$)
The graph shows temperature changes over time, with the y-axis labeled as $T(K)$. The x-axis represents years since the start. The data is divided into four periods:

- **1500-1624**
- **1625-1749**
- **1750-1874**
- **1880-2013**

The residuals are highlighted, with an average of 3 multiproxies. The graph indicates a noticeable increase in temperature over time.
Probabilities of extremes: Bell Curve, Black Swans

- Usual representation
- Representation showing extremes

≈ 5 standard deviations: one in a million chance

one in a thousand chance
The Pause

Geophysical Research Letters

RESEARCH LETTER
10.1002/2014GL060478

Return periods of global climate fluctuations and the pause

S. Lovejoy

1Physics, McGill, Montreal, Canada

Abstract An approach complementary to General Circulation Models (GCMs), using the anthropogenic CO2 radiative forcing as a linear surrogate for all anthropogenic forcings [Lovejoy, 2014], was recently developed for quantifying human impacts. Using preindustrial multiproxy series and scaling arguments, the probabilities of natural fluctuations at time lags up to 125 years were determined. The hypothesis that the industrial epoch warming was a giant natural fluctuation was rejected with 99.9% confidence. In this paper, this method is extended to the determination of event return times. Over the period 1880–2013, the largest 32 year event is expected to be 0.47 K, effectively explaining the postwar cooling (amplitude 0.42–0.47 K). Similarly, the “pause” since 1998 (0.28–0.37 K) has a return period of 20–50 years (not so unusual). It is nearly cancelled by the pre-pause warming event (1992–1998, return period 30–40 years); the pause is no more than natural variability.

Climate Change

Global warming slowdown just a ‘pause’

It can’t be used to prove that temperature changes not man-made, McGill prof says

Lord Christopher Monckton of Brenchley, who referred to Lovejoy’s work as an emanation “of the forces of darkness.” That was Lovejoy’s study which proved conclusively, he says, that there is such a tiny probability that what we are experiencing is natural warming — probably less than 0.1 per cent — that it can be dismissed. He has followed it up with a statistical analysis of average global temperatures be-
The Pause

Yellow is the NASA GISS global series (1900-2013 shown)

CMIP5 simulations

Santa Maria

Agung

El Chichon

Pinatubo

1961-1990 Mean Temperature (°C)

1920 1950 1980 2010

12.5 13.0 13.5 14.0 14.5 15.0 15.5
Global temperatures: NASA - GISS data

\[
\log_2 \left( \frac{\rho_{CO_2}(t)}{\rho_{CO_2,pre}} \right)
\]

\( T_{\text{globe}} \) (\(^\circ\)C)

- 1880: 290 ppm
- 1944: 310 ppm
- 1976: 331 ppm
- 1992: 353 ppm
- 1998: 363 ppm (391 ppm)
- 2012: 391 ppm

1750: 277 ppm

Post war cooling
Prepause
Pause

CO\(_2\) radiative forcing proxy
Residues (natural variability)

$T_{\text{nat}} \, (^{\circ}\text{C})$

- Post war cooling
- Prepause
- Pause

The pause with stochastic forecasts

Yellow is the NASA GISS global series (1900-2013 shown)
Friends of Science are also calling up the Chancellor of McGill University to retract the McGill press release and issue an apology for the use of Lovejoy's quote “This study will be a blow to any remaining climate-change deniers...”
Friends of Science
Rescuing TransCanada’s Energy East pipeline

On the TransCanada Hwy., near Anjou (since Nov. 19)

From the Facebook site of:
L’Association des communicateurs scientifiques du Québec
(Nov. 20, 2014)
The skeptics reaction (2)

"A mephitic ectoplasmic emanation of the forces of darkness"

- Viscount Lord Christopher Monckton of Brenchley evaluating on this work

Common reactions.. and misconceptions:

- Use of historical information
  
  Q: 800 years ago in medieval Europe *global* temperatures might have been warmer than today if so, doesn’t this contradict the analysis?
  
  A: Our conclusions are for *125 year periods* - there is nothing to prevent the same changes occurring much more slowly (i.e. over much longer periods).

- Use of unrepresentative paleo or instrumental sources, (the “Friends”):
  
  Q: The temperature change in central England from 1663-1762 was 0.90 °C, so such changes are not unusual.
  
  A. England is only 0.04% of the earth’s surface. The *global scale* temperature change was only 0.21±0.12 °C.
Impacts
Our simple method: doubling CO\(_2\): 3.08±0.58 °C

For 450 ppm: 2.2±0.4 °C (0.6±0.15 °C more than in 2013)

“Levels of CO\(_2\) in excess of only 350 ppm are not compatible with the planet on which civilization developed or to which life on earth is adapted”: Hansen et al 2008
What is to be done?
The challenge: Decarbonize the economy

Can we break the link between economic growth and CO₂ emissions?

Today: 80% of the world's energy comes from fossil fuels
The role of existent and new technologies

(IPCC scenarios, 2007; Stabilisation at 550ppm)

Economists’ magical thinking
No physical limits: if the price is right then technology can be conjured up to solve any problem...

In 2100, 90% of our energy must come from inexistent technology

NEW!

IPCC 2014 (working group 3 on mitigation and adaptation)
A major role for Carbon Capture and Storage technology that doesn’t exist...
Is continued quantitative economic growth possible?

Limits to Growth: Overshoot and collapse

According to the 1972 “Business as Usual” projection, the last 40 years have tracked well and collapse will start around 2015 (G. Turner, 2014)

Note: The nonlinear model is completely based on physical (not financial inputs and outputs).
Is continued quantitative growth desirable?

After - tax income, by family unit, Canada, 1976 – 2010
(2010 constant dollars, economic families)

Median after tax income economic families, 2010:
Quebec: $58,100
Canada: $65,500

Source: Statistics Canada
GDP versus GPI

GDP = Gross Domestic Product
GPI = Genuine Progress Indicator

The higher the GDP, the poorer we are!
What is to be done?

• Global Warming is a global problem requiring global scale cooperation.

• Saving the climate is incompatible with the current triumph of the unfettered market.
What is to be done?
Conclusions

1. It is much easier to disprove a theory (natural warming) that to prove one (anthropogenic warming).

2. The total anthropogenic warming since 1880 is about 1°C, for CO₂ doubling, 3.08±0.58°C.

3. The probability of the warming being natural is less than 0.1%.

4. The pause is a natural cooling event superposed on anthropogenic warming.

5. Decarbonizing is unlikely with continued global economic growth (“magical thinking”).

6. For many of us, continued economic growth is undesirable (lower GPI).