An Independent, Objective Assessment of the Human-Caused Global Warming Issue

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The Right Climate Stuff Research Team

- Volunteer group of primarily retired NASA scientists and engineers - veterans of the Apollo Program.

- Formed in February 2012 as an independent, objective, research team with no funding.

  - INITIAL GOAL: Determine the extent to which burning fossil fuels can cause harmful global warming.

- The Bottom Line – We are going to run out of fossil fuels before atmospheric CO2 can rise to levels that could cause harmful warming of the planet.
The Right Climate Stuff Research Team

We aren’t climate scientists

We do have education, training, and experience in the same scientific disciplines that climate scientists use

We have expertise in identifying and mitigating Threats from exploring the unknowns of manned space flight

- We define Problems in terms of a deviation from “Normal”
- Global temperatures are not deviating from Normal limits of the last 10,000 years!

We have bounded the warming that atmospheric CO2 and other GHG can have

- Not a serious nor immediate Threat requiring Global Action
• CONCLUSIONS: Due to world-wide rising energy demand and rising fossil fuel prices, as fossil fuel reserves are consumed,

➢ A market-driven transition to alternative fuels will be required before any climate problems can occur

➢ A USA national energy plan is needed to ensure our energy future

➢ Climate alarmism is causing irrational energy-related decisions

➢ Climate alarmism results from complex climate simulation models; not from data!

  o Models are not sufficiently accurate to guide public policy decision-making regarding CO2 emissions

  o Models are not validated!
Current Climate Models Not Validated

Fig. from John Christy, Univ. of Alabama-Huntsville, Dec 2013 Testimony to US House of Representatives
IPCC Metrics for GHG Climate Sensitivity

**Equilibrium Climate Sensitivity (ECS)**

- Loosely defined as global average temp rise that will eventually result from doubling CO2 level in the atmosphere
- Computed by complex, un-validated computer model simulations for what happens after 1000 years!

**Mainstream Climate Science (IPCC) Position**

- $1.5 < \text{ECS} < 4.5 \text{ deg C}$ (IPCC 2013 AR5 Report)
- Uncertainty range has not changed in 35 years and $billions spent on “study” of this issue!
- Was reduction of uncertainty range ever the research goal?
**IPCC Metrics for GHG Climate Sensitivity**

**Transient Climate Response (TCR)**

- Climate model simulation of Global Warming that would result from
  - Increasing atmospheric CO2 levels at a rate of 1% per year until doubled CO2 level is reached
  - Current rate of increase is about 0.5% per year

- TCR climate model simulation more realistic than an ECS simulation
  - But still hypothetical!!
Transient Climate Sensitivity (TCS)

- To obtain a verifiable GHG climate sensitivity metric, our research team defined a new metric:
  
  - **Transient Climate Sensitivity (TCS)** – The rise in global average surface temperature due to the actual gradual rise of CO2 in our atmosphere until CO2 levels are doubled
  
  - Effects of all GHG are approx. $= 1.5 \times (CO2$-only effects)

- TCS is a verifiable quantity using actual data
  
  - We determined conservative value of TCS from climate data based on
    - 40 percent rise in atmospheric CO2 since 1850
    - $< 0.8K$ rise in Global Average Temperature since 1850

- TCS = 1.2K, K = deg. Kelvin
CO2 Level In Atmosphere

TRCS

**CO2 Atmospheric Concentration, PPM**

- **Navy Sub Limit**
- **Space Station Limit**
- **Plant Growth Requirement = 150 ppm**
- **Doubled CO2**

YEAR

1750 1800 1850 1900 1950 2000 2050 2100
CO2 TRENDS IN ATMOSPHERE

CO2 ATMOSPHERIC CONCENTRATION, PPM

YEAR
CO2, ppm

Law Dome Data
Mauna Loa Data
CO2 Estimated
Earth Surface Energy Balance

Conservation of Energy

\[ e(W, C, G)\sigma T^4 = (1 - a)S - Q \]

\( W, C \) and \( G \) are atm. concentrations of water vapor, \( CO_2 \) and other GHG, respectively.
A Simple Model For Temperature Changes

Using calculus to form a differential of the Earth Surface Energy Balance Equation

\[
\left[ (\frac{\partial e}{\partial W} \frac{\partial W}{\partial C} + \frac{\partial e}{\partial C}) dC + (\frac{\partial e}{\partial W} \frac{\partial W}{\partial G} + \frac{\partial e}{\partial G}) dG \right] \sigma T^4 + 4e(W, C, G) \sigma T^3 dT = (1-a)dS - Sda - dQ
\]

For \( T = 288K \) and \( e = 238.5/(\sigma T^4) = 0.611 \), \( 4e\sigma T^3 = 1/0.302 \)

\[ dT = [0.302] \{ - [\text{changes in } e(W, C, G)] \sigma T^4 + (1-a)dS - Sda - dQ \} \]

[changes in \( e(W, C, G)\)]\( \sigma T^4 \) are called Radiative Forcing from GHG including water vapor (W) feedback effects
A Simple Model For Temperature Changes

Radiative Forcing changes from CO2 concentration in atmosphere relative to the 284.7 ppm concentration in 1850 can be modeled as:

\[
\left[ \frac{\partial e}{\partial C} dC(\text{year}) \right] \sigma T^4 = 3.71 \{ \text{LOG}[C(\text{year})/284.7]/\text{LOG}[2] \} \text{ W/m}^2
\]

Radiative Forcing changes from other GHG concentration rise in atmosphere relative to 1850 can be modeled as a fraction, \( \beta \), of CO2 radiative forcing

\[
\left[ \frac{\partial e}{\partial G} dG(\text{year}) \right] \sigma T^4 = (\beta)3.71 \{ \text{LOG}[C(\text{year})/284.7]/\text{LOG}[2] \} \text{ W/m}^2
\]
A Simple Model For Temperature Changes

Surface Emissivity changes due to water vapor feedback effects can be modeled as a fraction, \( w \), of CO2 and other GHG warming

\[
\Delta T(\text{year}) = 0.302 \left( (1+w)(1+b) \left( 3.71 \right) \frac{\log[C(\text{year})/284.7]}{\log[2]} \right) - Sd_a - dQ
\]

Using our expressions for radiative force changes since 1850 due to CO2, other GHG and water vapor feedback

\[
\Delta T(\text{year}) = 0.302 \left( (1+w)(1+b) \left( 3.71 \right) \frac{\log[C(\text{year})/284.7]}{\log[2]} \right) + (1-a)dS - Sd_a - dQ
\]

Using our definition for TCS = \(0.302(1+w)3.71\) deg K

\[
\Delta T(\text{year}) = \text{TCS}(1+b) \frac{\log[C(\text{year})/284.7]}{\log[2]} + 0.302((1-a)dS - Sd_a - dQ)
\]

Note: In definition of TCS, \( w \) accounts for water vapor feedback and all other feedbacks to CO2, other GHG and aerosol radiative forcing
Recent Global Average Temp Variation

HADCRUT4 GLOBAL YEARLY AVG TEMPERATURE
Functions Used In Temperature Data Fit

TRCS

HadCRUT4 Temp(Year) = (1850 value)

+ (TCS)(1+\beta)\{\log[\text{CO2(year)}/284.7]/\log[2]\}
+ 0.021(\text{year} - 1850)/155

+ A_L \sin[2\pi(\text{Year}-1850)/1000 \text{ yr.}]

+ A_S \sin[2\pi(\text{Year}-1988)/62 \text{ yr.}]

\text{TCS}(1+\beta) \text{ is a constant determined from function fit to Temp time history data; Nominal value of } \beta = 0.5 \text{ used to determine TCS}
CASE 1: Transient Climate Sensitivity (TCS) = 1.0 deg K
- 1000 Year Temp Cycle Amplitude = 0 deg K
- 62 Year Temp Cycle Amplitude = 0.15 deg K
- Lower bound curve is 0.45 deg K lower than upper bound curve
With 1000 Year Climate Cycle – TCS = 0.75K

**HadCRUT4 GLOBAL AVERAGE TEMPERATURE ANOMALY**

CASE 2: With 1000 Year Temp Cycle and TCS = 0.75K

\[ T(\text{year}) = -0.15 + \text{TCS}(1.5) \frac{\log[C(\text{year})/284.7]}{\log[2]} + 0.021(\text{year-1850})/155 + 0.2 \sin[2\pi(\text{year-1850})/1000] + 0.15 \sin[2\pi(\text{year-1988})/62] \]

**CASE 2:** Transient Climate Sensitivity (TCS) = 0.75 deg K
- 1000 Year Climate Cycle Amplitude = 0.2 deg K
- 62 Year Climate Cycle Amplitude = 0.15 deg K
- Lower bound curve is 0.45 deg K lower than the upper bound curve

**TCS = 0.75K + 1000 Year Cycle**

0.8 deg K
Extracting Most Conservative TCS Value

TRCS

Determining A Conservative Value For Transient Climate Sensitivity (TCS)

\[ T(\text{year}) = -0.22 + \text{TCS}(1.5) \log \left( \frac{C(\text{year})}{284.7} \right) / \log[2] + 0.021(\text{year}-1850)/155 \]

- \( \text{TCS}(1+\beta) = \text{TCS}(1.5) = 1.8K \)
- \( \text{TCS} = 1.4K \)
- \( \text{TCS} = 1.2K \)
- \( \text{TCS} = 1.0K \)
Bounding Future Warming

BOUNDING MAX POSSIBLE AGW TEMPERATURE RISE

- Temp w/ TCS = 1.0K
- HadCRUT4 Data
- Temp w/ TCS = 1.07K
- Alt. Bound TCS = 1.2K
- CO2 PPM

Max Temp Rise Before All Fossil Fuel Reserves Are Burned = 1.2K
Our ECS Compared to Recent Research

TRCS (2014)

TRCS

Lewis and Curry (2014)
Conclusions

• Climate models are not sufficiently accurate for use in critical public policy decision-making regarding AGW

• AGW can be bounded using available data
  ➢ Should expect a modest amount of continued warming
  ➢ Maximum expected warming may be beneficial, not necessarily harmful
  ➢ More CO2 in the atmosphere is definitely beneficial as a powerful plant fertilizer

• Current AGW “pause” should continue for about 20 years

• United Nations’ IPCC recommendation for world-wide CO2 emission controls is not supported by available physical data.