Propaganda about Climate Change: Is anyone really unbiased?

Mark J. McCready
Professor and Chair of Chemical and Biomolecular Engineering
Why is this lecture topic on the schedule?

- And why did you come?
What we thought the temperature was (circa 1990)

Figure 3: World Climate History According to IPCC in 1990.
What we **now** think the average atmospheric temperature is?

![Graph showing temperature anomalies](image)

**Northern Hemisphere anomaly (°C)** relative to 1961-1990

- Instrumental data (AD 1902 - 1999)
- Reconstruction (AD 1000 - 1980)
- Reconstruction (40 year smoothed)

**1998 Instrumental value**
What could you read about the climate?

- [http://www.sciencedaily.com/releases/2008/04/080407132120.htm](http://www.sciencedaily.com/releases/2008/04/080407132120.htm)
- [http://www.edf.org/page.cfm?tagid=1368&source=ggad0802gw1368&gclid=CI7R6P6kzZMCFQ0MlgodhSkJfg](http://www.edf.org/page.cfm?tagid=1368&source=ggad0802gw1368&gclid=CI7R6P6kzZMCFQ0MlgodhSkJfg)
- [http://www.opinionjournal.com/extra/?id=110008220](http://www.opinionjournal.com/extra/?id=110008220)
Outline of Talk

- Key “facts” and hopefully understanding about the Earth’s Climate
- Uncertainties, that limit our understanding
- Within this uncertainty, why various people take “positions”
- A rational path of action for people who wish to consider the future as well as their present lives
Climate Science Background

- It is not an unreasonable analogy to look at climate science as we look at health of a single human
  - We know a lot about detailed biomolecular and cellular processes, but we can’t explain why while you can remember in great detail everything about your last “eagle”, ---
  - but can’t find your car keys!
- Further we can’t just do “experiments” on you or other people to find out exactly what we want to know
  - (no one will eat 10 pounds of cyclamates each day to see if he gets cancer) (recall “Fresca”!)

mjm@nd.edu
Climate Science Background

- Climate Science is not a laboratory science and hence we have to get our understanding from observations of what has already happened in response to uncontrolled forcings (solar changes, variations in orbit or changes in carbon dioxide levels).

- On the global scale, we can’t do experiments in which such forcings are controlled.
Climate Science Background

- Because we don’t understand humans as an overall system, we can’t predict for sure if you will have a bad response to Vioxx or if it simply won’t work…
  - And another 10,000 rats are not going to get us there!
- While we understand radiative heat transfer, convection, and chemistry of the environment, we don’t understand the climate system
- Hence can’t predict the future “climate” with absolute certainty.
- Climate scientists should just be straightforward about this.
  - But of course the political “climate” has to allow such honesty.
Climate Science Background

- However, just as we must take a prudent path to drug approval, in the face of uncertainty…
- We should do likewise for the climate
  - Use the best scientific methods we can
  - Allow experts to debate the methods and results openly
  - Ask for their best consensus
  - Make policies that take this information as well as political, social, economic factors into consideration.
  - Review these policies as new science (or other information) becomes available.
What definitive things can be said about the climate?

- Carbon dioxide (CO2) levels have increased substantially since the late 1800’s
- Carbon Dioxide is a “greenhouse” gas, as it is an efficient absorber of infra-red radiation.
- In this role, increases in CO2 concentration exert a “warming forcing” on the temperature of the atmosphere.
- While the sensitivity of additional CO2 on the this forcing is not certain, the effect has not yet reached saturation -- so that more CO2 will cause additional forcing on the temperature.
Last Millennium CO2

LAW DOME, ANTARCTICA ICE CORES

Source: Etheridge et al. (CSIRO)
Recent CO2 changes
More radiation can be absorbed by CO2

Theoretical (black body) radiation vs. actual observations (measured by satellite over Guam where surface temperature is 27 °C)

Note absorption of energy at these wavelengths by “greenhouse gases”

Effective emissivity is ratio of area under observed curve to area under theoretical curve – depends strongly on CO₂ concentration
What direct effect of CO2 increase can be seen?

Forcing from increased CO2

- There is no doubt increased forcing from CO2
  - Methane Also
- More warming would lead to more water vapor in the atmosphere
- Both CO2 and Water have highly utilized IR bands so the forcing is less than linear
  - People use logarithmic
What do temperature measurements look like?
Tulsa, OK


![Graph showing temperature trends over years with actual temperature, average temperature, and trend lines.](image_url)
St. Louis, MO

Global Temperature Trends

<table>
<thead>
<tr>
<th>Period</th>
<th>Rate °C per decade</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0.177±0.052</td>
</tr>
<tr>
<td>50</td>
<td>0.128±0.026</td>
</tr>
<tr>
<td>100</td>
<td>0.074±0.018</td>
</tr>
<tr>
<td>150</td>
<td>0.045±0.012</td>
</tr>
</tbody>
</table>
Changes in Greenhouse Gases from Ice Core and Modern Data

(a) Carbon Dioxide (ppm)
(b) Methane (ppb)
(c) Radiative Forcing (W/m²)
(d) Nitrous Oxide (ppb)

Radiative Forcing (W/m²)

Rate of Change (10⁻³ Wm⁻² yr⁻¹)

Time (before 2005)

mjm@nd.edu
Now it’s a Scythe!

Oh, don’t mind me... I’m a little early.
Just go about your business... pretend I’m not here.
Temperature map of US
what is “1 degree”?
Major factors on climate

Radiative Forcing Components

<table>
<thead>
<tr>
<th>RF Terms</th>
<th>RF values (W m⁻²)</th>
<th>Spatial scale</th>
<th>LOSU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-lived greenhouse gases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO₂</td>
<td>1.66 [1.49 to 1.83]</td>
<td>Global</td>
<td>High</td>
</tr>
<tr>
<td>N₂O</td>
<td>0.48 [0.43 to 0.53]</td>
<td>Global</td>
<td>High</td>
</tr>
<tr>
<td>CH₄</td>
<td>0.16 [0.14 to 0.18]</td>
<td>Global</td>
<td>High</td>
</tr>
<tr>
<td>Halocarbons</td>
<td>0.34 [0.31 to 0.37]</td>
<td>Global</td>
<td>High</td>
</tr>
<tr>
<td>Ozone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stratospheric</td>
<td>-0.05 [-0.15 to 0.05]</td>
<td>Continental</td>
<td>Med</td>
</tr>
<tr>
<td>Tropospheric</td>
<td>0.35 [0.25 to 0.65]</td>
<td>Continental</td>
<td>Low</td>
</tr>
<tr>
<td>Stratospheric water vapour from CH₄</td>
<td>0.07 [0.02 to 0.12]</td>
<td>Global</td>
<td>Low</td>
</tr>
<tr>
<td>Surface albedo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land use</td>
<td>-0.2 [-0.4 to 0.0]</td>
<td>Local to</td>
<td>Med</td>
</tr>
<tr>
<td>Black carbon on snow</td>
<td>0.1 [0.0 to 0.2]</td>
<td>continental</td>
<td>Low</td>
</tr>
<tr>
<td>Total Aerosol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct effect</td>
<td>-0.5 [-0.9 to -0.1]</td>
<td>Continental</td>
<td>Med</td>
</tr>
<tr>
<td>Cloud albedo effect</td>
<td>-0.7 [-1.8 to -0.3]</td>
<td>Continental</td>
<td>Low</td>
</tr>
<tr>
<td>Linear contrails</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar irradiance</td>
<td>0.01 [0.003 to 0.03]</td>
<td>Continental</td>
<td>Low</td>
</tr>
<tr>
<td>Total net anthropogenic</td>
<td>1.8 [0.6 to 2.4]</td>
<td>Global</td>
<td>Low</td>
</tr>
</tbody>
</table>
Temperature predictions

SRES Mean Surface Warming Projections

Global surface warming (°C)

Year

2000
2100
2200
2300

1900

-1.0
0.0
1.0
2.0
3.0
4.0

A2
A1B
B1
Constant composition commitment
20th century

23
21
17
21
17
16
12
10

mjm@nd.edu
“Predictions”

- The CO2 and methane increase will cause some degree of “warming” forcing on the climate
  - How much is uncertain -- models don’t include fundamental cloud physics, changes in ocean currents and are generally limited by the spatial resolution.

- It is impossible to confidently predict things such as:
  - Numbers strengths of future storms
  - Overall changes in precipitation
  - “Local” changes in temperature
  - “Local” changes in precipitation
A comparison of tropical temperature trends with model predictions

David H. Douglass, a* John R. Christy, b Benjamin D. Pearson a† and S. Fred Singer c,d

a Department of Physics and Astronomy, University of Rochester, Rochester, NY 14627, USA
b Department of Atmospheric Science and Earth System Science Center, University of Alabama in Huntsville, Huntsville, AL 35899, USA
c Science and Environmental Policy Project, Arlington, VA 22202, USA
d University of Virginia, Charlottesville, VA 22903, USA

ABSTRACT: We examine tropospheric temperature trends of 67 runs from 22 ‘Climate of the 20th Century’ model simulations and try to reconcile them with the best available updated observations (in the tropics during the satellite era). Model results and observed temperature trends are in disagreement in most of the tropical troposphere, being separated by more than twice the uncertainty of the model mean. In layers near 5 km, the modelled trend is 100 to 300% higher than observed, and, above 8 km, modelled and observed trends have opposite signs. These conclusions contrast strongly with those of recent publications based on essentially the same data. Copyright © 2007 Royal Meteorological Society
Do the “models” work

Uncertainties in the climate mean state of global observations, reanalyses, and the GFDL climate model

Thomas Reichler and Junsu Kim

Received 13 August 2007; revised 15 November 2007; accepted 12 December 2007; published 5 March 2008.

[1] Climate research relies on realistic atmospheric data over long periods of time. Global reanalyses or observations are commonly used for this type of work. However, the many problems associated with both the reanalyses and observations cast doubts on the reliability of such data for climate applications, and users often need to know how large the errors and uncertainties associated with the different data sets are. This paper is a systematic assessment of the errors and uncertainties contained in the time mean (1979–1999) of many different climate quantities taken from a variety of global data sets, including four popular reanalyses, the output of the climate model developed at the Geophysical Fluid Dynamics Laboratory (GFDL), and a wide range of observations. We find that the ability of reanalyses to reproduce the observed climate mean state varies widely, with radiative quantities exhibiting the largest discrepancies. The different reanalysis products share many common errors, but overall the European Centre for Medium-Range Weather Forecasts 40-year reanalysis (ERA-40) matches best the observations. Interestingly, the climate model reproduces the observed climate mean state of certain quantities more faithfully than the reanalyses. This indicates that modern models have reached a high level of realism in their mean state and that care must be taken.
Will there be more strong storms?

Can We Detect Trends in Extreme Tropical Cyclones?

Christopher W. Landsea, Bruce A. Harper, Karl Hoarau, John A. Knaff

Recent studies have found a large, sudden increase in observed tropical cyclone intensities, linked to warming sea surface temperatures that may be associated with global warming (1–3). Yet modeling and theoretical studies suggest only small anthropogenic changes to tropical cyclone intensity several decades into the future [an increase on the order of ~5% near the end of the 21st century (4, 5)]. Several comments and replies (6–10) have been published regarding the new results, but one key question remains: Are the global tropical cyclone databases sufficiently reliable to ascertain long-term trends in tropical cyclone intensity, particularly in the frequency of extreme tropical cyclones (categories 4 and 5 on the Saffir-Simpson Hurricane Scale)?

Tropical cyclone intensity is defined by the maximum sustained surface wind, which occurs in the eyewall of a tropical cyclone over an area of just a few dozen square kilometers. The main method globally for estimating tropical cyclone intensity derives from a satellite-based pattern recognition scheme known as the Dvorak Technique (11–13). The Atlantic basin has had routine aircraft reconnaissance since the 1940s, but even here, satellite images are heavily relied upon for intensity estimates, because aircraft can monitor only about half of the basin and are not available continuously. However, the Dvorak Technique does not directly measure maximum sustained surface wind. Even today, application of this technique is subjective, and it is common for different forecasters and agencies to estimate significantly different intensities on the basis of identical information.

The Dvorak Technique was invented in 1972 and was soon used by U.S. forecast offices, but the rest of the world did not use it routinely until the early 1980s (11, 13). Until then, there was no systematic way to estimate the maximum sustained surface wind for most tropical cyclones. The Dvorak Technique was first developed for visible imagery (11), which precluded obtaining tropical cyclone intensity estimates at night and limited the sampling of maximum sustained surface wind. In 1984, a quantitative infrared method (12) was published, based on the observation that the temperature contrast between the warm eye of the cyclone and the cold cloud tops of the eyewall was a reasonable proxy for the maximum sustained surface wind.

In 1975, two geostationary satellites were available for global monitoring, both with 9-km resolution for infrared imagery. Today, eight...
Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment

P. J. Webster,¹ G. J. Holland,² J. A. Curry,¹ H.-R. Chang¹

We examined the number of tropical cyclones and cyclone days as well as tropical cyclone intensity over the past 35 years, in an environment of increasing sea surface temperature. A large increase was seen in the number and proportion of hurricanes reaching categories 4 and 5. The largest increase occurred in the North Pacific, Indian, and Southwest Pacific Oceans, and the smallest percentage increase occurred in the North Atlantic Ocean. These increases have taken place while the number of cyclones and cyclone days has decreased in all basins except the North Atlantic during the past decade.
Increasing destructiveness of tropical cyclones over the past 30 years

Kerry Emanuel

Theory and modelling predict that hurricane intensity should increase with increasing global mean temperatures, but work on the detection of trends in hurricane activity has focused mostly on their frequency and shows no trend. Here I define an index of the potential destructiveness of hurricanes based on the total dissipation of power, integrated over the lifetime of the cyclone, and show that this index has increased markedly since the mid-1970s. This trend is due to both longer storm lifetimes and greater storm intensities. I find that the record of net hurricane power dissipation is highly correlated with tropical sea surface temperature, reflecting well-documented climate signals, including multi-decadal oscillations in the North Atlantic and North Pacific, and global warming. My results suggest that future warming may lead to an upward trend in tropical cyclone destructive potential, and—taking into account an increasing coastal population—a substantial increase in hurricane-related losses in the twenty-first century.

More controversial, with little guidance from existing theory. Global climate model predictions of the influence of global warming on storm frequency are highly inconsistent, and there is no detectable trend in the global annual frequency of tropical cyclones in historical tropical cyclone data.

Although the frequency of tropical cyclones is an important scientific issue, it is not by itself an optimal measure of tropical cyclone threat. The actual monetary loss in wind storms rises roughly as the cube of the wind speed as does the total power dissipation (PD; ref. 15), which, integrated over the surface area affected by a storm and over its lifetime is given by:

\[ PD = 2\pi \int_0^\tau \int_0^r C_D \rho |V|^3 r dr dt \]  

where \( C_D \) is the surface drag coefficient, \( \rho \) is the surface air density, \( |V| \) is the magnitude of the surface wind, and the integral is over radius to an outer storm limit given by \( r_0 \) and over \( \tau \), the lifetime of
Trends in global tropical cyclone activity over the past twenty years (1986–2005)

Philip J. Klotzbach

Received 3 February 2006; revised 2 March 2006; accepted 18 April 2006; published 20 May 2006.

[1] The recent destructive Atlantic hurricane seasons and several recent publications have sparked debate over whether warming tropical sea surface temperatures (SSTs) are causing more intense, longer-lived tropical cyclones. This paper investigates worldwide tropical cyclone frequency and intensity to determine trends in activity over the past twenty years during which there has been an approximate 0.2°–0.4°C warming of SSTs. The data indicate a large increasing trend in tropical cyclone intensity and longevity for the North Atlantic basin and a considerable decreasing trend for the Northeast Pacific. All other basins showed small trends, and there has been no significant change in global net tropical cyclone activity. There has been a small increase in global Category 4–5 hurricanes from the period 1986–1995 to the period 1996–2005. Most of this increase is likely due to improved observational technology. These findings indicate that other important factors govern intensity and frequency of tropical cyclones besides SSTs. Citation: Klotzbach, P. J. (2006), improved technology has allowed the technique to be applied to both infrared and visible imagery [Dvorak, 1984], and more accurate estimates of real-time intensity have become available. In addition, the quality and resolution of satellite imagery has continued to improve over time, and with this improved imagery, operational forecasters can be more confident of their satellite-derived intensity estimates. The elimination of aircraft reconnaissance in the Northwest Pacific in 1987 raised the importance of satellite-based intensity estimates even more. Also, the Joint Typhoon Warning Center urges caution in utilizing data prior to 1985 [Chu et al., 2002]. Because of these earlier period limitations and the desire to obtain a near-homogeneous data set, only the past twenty years (1986–2005) are examined in this paper. If the trends shown by Emanuel [2005] and Webster et al. [2005] are to be accepted, then one should also find a similar increasing trend in global TC data sets over the last 20 years.
What are the built in biases?

- Scientist
  - Previous work constitutes “reputation” -- hard to go against previous claims
  - Needs to get funding for research
  - Can he/she really separate political leanings from her/his research given the way the world views the issue?
What are the built in biases?

- Politician
  - The “right” and the “left” have strongly stated positions on the issue of global warming
    - Rush Limbaugh says there is no warming
    - Al Gore says there is
  - Needs to balance party affiliation with needs and concerns of his/her local constituency
  - What access to “truth” is available?
    - All of the staff have similar party affiliation and are ambitious
    - Scientific “debate” is not easy to decipher.

mjm@nd.edu
WHAT ARE THE BIASES?

- “Media” People
  - Limited access to real knowledge on the issue
    - Staffs probably don’t have engineering or science degrees
  - Probably do not understand science
  - Need to “sell” the show or newscast
    - Debate is “won” based on sound-bites
    - Entertainment as important as “truth”

- Salt water can burn!
  - http://www.youtube.com/watch?v=aGg0ATfoBgo
Path forward

- We cannot be sure that increasing carbon dioxide will not alter atmospheric temperatures or that such potential increases would not have deleterious effects
  - In fact there is a reasonable likelihood of warming.
- Responsible citizenship suggests a proactive approach
Path forward

- Cut down use of fossil fuels
  - Everybody knows the standard things to do…
    - At some point, reduction in gasoline consumption will impact prices
- **Wise** investment in more efficient energy systems from appliances to buildings to cities
- Encourage “point of source” sustainable energy technologies
  - Solar, Wind, (and efficiencies: heat pumps)
  - Find ways that these can be economical
- Need rational and *technologically* enlightened discourse about the entire nuclear power issue
Path forward

- Need to use best technologies for power generation to get the most energy for every molecule of CO2 that is emitted
  - Political “will” must be found
  - A IGCC power plant was proposed for St. Joseph county IN. It was rejected for unsubstantiated reasons…. And will be built closer to Gary IN where there is a lot more pollution sources…
Path forward

- What ever your personal views are on this subject, you need to help “people” and “society to hear and understand the scientific and technological realities of energy rather than letting decisions be made based on “hype”, politics or irrational fears!