

A GLIMPSE INSIDE THE GLOBAL WARMING
CONTROVERSY

Why You Need to Consider Both Sides

by

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A Glimpse Inside the Global Warming Controversy

Why You Need to Consider Both Sides

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“When the facts change, I change my mind? What do you do, sir?”

Lord Keynes (British Economist)

“Do you believe in Global Warming?” I have often been asked this question by people with little or no scientific background. It seems like a simple question that demands a “yes” or “no” answer. But in reality it is a complex question that cannot be reduced to an unqualified “yea” or “nay”. The intent of this paper is not to resolve this question by rallying evidence for or against Global Warming (as if that can be done in a few pages!), but rather to lay bare the complexity of the climate change issue. Those who come to appreciate this fact will likely agree that simple answers are not only bad education, but can lead to bad policies.

The controversy surrounding global warming is not centered so much on the increase in global temperature over the last 150 years, but on the primary *cause* of this increase—natural, human, or a combination of the two. The theory in question is called Anthropogenic Global Warming (AGW).

There is actually more than one AGW theory, and they vary considerably as to the causes and extent of human induced climate change. The most prevalent model is based on projections from the United Nations Intergovernmental Panel on Climate Change (IPCC). It is this version of the AGW hypothesis that has become the focus of so much controversy.

According to the IPCC model, solar radiation that is absorbed by the earth’s surface is reradiated and absorbed by atmospheric CO₂ (and other trace greenhouse gases). This produces a slight warming in the troposphere which sets into motion a chain of events that will cause global temperature to rise by 2-6 degrees Celsius by the year 2100. Such an increase could have disastrous regional and even global effects (extreme heat, glacial melt, sea level rises, droughts, floods, powerful storms, etc.). In order to mitigate this potential danger, the emission of CO₂ by industry and consumers must be vastly reduced by limiting the use of fossil fuels and/or sequestering CO₂.

The IPCC’s AGW hypothesis has not gone unchallenged in scientific journals. There are at least eight major issues where the data and/or the conclusions are being disputed in the scientific community with increasing frequency:

1. **Reconstructing the Past:** One of the challenges of climate science is to understand the causes of past climate change in order to isolate the fingerprint of CO₂ warming. To do this, we must construct a reliable record of historical temperatures prior to the extensive use of fossil fuels. Since instrumental measurements were not widespread until c. 1850, climate scientists must use “proxies”, such as tree rings, ice cores, and corals, to determine temperature. Unfortunately, proxies are not always precise. Some do not show a linear

response to temperature change and many are sensitive to other factors in the environment (e.g., rainfall) which can lead to interpretive errors. Major disagreements surround the reconstruction of the medieval warm period, including the assertion by some scientists that recent temperatures are the highest they have been in thousands of years (the so-called “hockey stick” controversy).

It may come as a surprise to some that even the instrumental temperature record of the last 150 years is skewed. Though showing a general upward trend, *part* of the recorded increase in land based temperatures may be more apparent than real—caused by poor siting of climate stations and the growth of cities (“urban heat islands”). Adjusting the raw data to compensate for these artifacts is not an exact science, as shown by the differences in land based global temperature reported each month by the major data centers.

Since 1979, the use of satellite data has provided a more reliable and accurate determination of global temperatures. Unlike land based instruments, satellite temperatures include data from the world's oceans as well as from remote areas that were previously inaccessible. But at least two more decades of satellite data are needed to establish long term climate trends.

2. **Climate Sensitivity:** Most scientists agree that if CO₂ is doubled by the end of the century, it can only account for a .3 to 1.2 degree C rise in temperature, acting alone. The rest depends on whether the climate amplifies (+ feedback) or diminishes (– feedback) this forcing. Therein lies the real dispute and that's where the hypothesis starts to run thin. Climate sensitivity is based on many complex interactions that are not fully understood. A number of these interactions are discussed in the paragraphs which follow.

3. **Water Vapor:** This is actually the largest greenhouse gas by far, and will ultimately determine whether the atmosphere amplifies or diminishes CO₂ radiative forcing. Unfortunately, it is also one of the least understood components. The extent, type, opacity, *and* height of cloud cover that develops in response to CO₂ forcing can make or break the IPCC's AGW hypothesis (e.g., a 1% error in cloud cover equals 5 million square kilometers of clouds over the earth's surface). Some clouds enhance warming by trapping heat, others prevent warming by blocking sunshine. There are no physical equations for predicting this as of yet.

As research scientist Roy Spencer has pointed out, there are still open questions about cause and effect. According to the IPCC, changes in cloud cover will amplify CO₂ radiative forcing (+ feedback). But there are many other factors, unrelated to CO₂ forcing, which can influence cloud formation (e.g., ocean temperature fluctuations). It may be that these unrelated changes in cloud cover are actually a primary cause of warming and not an effect of CO₂ forcing. By erroneously attributing changes in cloud cover to CO₂ forcing, the climate system will appear more sensitive than it really is. More research is needed to untangle this problem.

4. **The Oceans:** Our understanding of the ocean-climate connection is still emerging. Studies have intensified, thanks in part to this controversy. We now know that oceans undergo decadal and multi-decadal oscillations due to salinity and temperature gradients (and, perhaps, solar and gravitational cycles). There is a high degree of correlation between these oscillations and global temperature. According to climate specialist Joseph D'Aleo, this correlation has been known for years, but it is largely ignored by IPCC climate models.

Since water has a much higher specific heat than air (4x), some scientists suggest that global temperature cannot be measured by surface stations alone, but must include the enormous heat capacity of the oceans. Recent cooling in the upper layers of the ocean (Pacific Decadal Oscillation) implies a loss of heat in the climate system rather than an increase. Computer climate models have not yet caught up to this science. In the end we may discover that the oceans, not CO₂, are the real climate drivers.

5. The Role of CO₂: IPCC climate models assume that an increase in CO₂ will be followed by a rise in global temperature. This assumption is based on a well known physical constant: the absorption of energy at different wavelengths by CO₂. But the cause and effect relationship of CO₂ to the climate system may not be that simple. The IPCC acknowledges that, based on ice core samples over the past 420,000 years, CO₂ increases *followed* temperature increases by centuries (other paleoclimate studies have confirmed this relationship elsewhere). As the oceans (and soil) warm, CO₂ escapes (outgassing) much like the gas escaping from soda pop left on the kitchen counter. This may explain why fluctuations in CO₂ levels occurred even prior to the industrial era.

The current increase in average global temperature since the mid nineteenth century began decades before CO₂ levels started to rise dramatically due to industrialization (around 1940). During the twentieth century, global temperatures fell from the 1940's to the 1970's, as CO₂ continued to rise. Some scientists speculate that this negative correlation to temperature may have been caused by sulfur emissions (sulfur crystals reflect sunlight). But it may also suggest that the relationship of CO₂ to climate change is more complex than climate modelers assume. Temperatures have been flat, even slightly down, over the last decade as CO₂ levels continue to rise.

Finally, there are disagreements surrounding the residence time of CO₂—i.e., how long it remains in the atmosphere before being absorbed. Does it continue to accumulate for centuries as some scientists contend, or is it absorbed more rapidly by “sinks” such as vegetation (which thrive on increased CO₂ levels) and oceans as suggested by some data?

6. The Sun: Temperatures have been slowly rising since the end of the Little Ice Age which ran from ~1600 to ~1850. This cold period was marked by a quiet sun with very low sunspot counts (Maunder Minimum and Dalton Minimum). A number of solar scientists believe that even slight fluctuations in the sun's irradiance can precipitate significant climate changes even though the mechanisms involved are not well understood. Attempts to correlate solar irradiance to climate change are being proposed and tested at different levels, including its influence on the ozone layer and the possible role of cosmic rays in cloud nucleation (CERN's CLOUD Project).

The IPCC has thus far rejected the use of solar correlation because the physics are not well understood. But, do you have to understand the complexities of atmospheric pressure in order to use a barometer? There is no doubt that solar fluctuations have played a role in past climate changes and will continue to do so. Some solar scientists are now suggesting that the sun may be entering another minimum which could bring about a protracted stagnation or decrease in global temperatures.

7. Falsifiability: Skeptics of the IPCC's AGW hypothesis claim that proponents of the theory have failed to adequately separate natural and manmade climate signals. Consequently global warming is cited as a cause for phenomena that may lie within the envelope of natural variability (e.g., glacial melt, hurricanes, even heavy snows!, etc.). What changes in climate would falsify the IPCC's AGW theory? Do we have to wait until the end of the century? All climate scientists agree that the recent flattening and decline in global temperature over the last decade is due to natural variability. Though this decline was not anticipated by climate models, IPCC supporters are confident that warming will resume in the next decade or so.

But, as climate scientist Roger Pielke Sr. has observed, it seems that no matter what changes take place in weather or climate—i.e., extreme heat or extreme cold—they are said to verify the IPCC's hypothesis. Consequently there can be no falsifying evidence against it, at least not on a decadal scale. Scientists like Pielke (who believes that humans are altering climate, but not primarily through CO₂) are asking for specific, quantitative criteria that will allow us to prove or falsify the theory on a decadal scale rather than pushing this question into the indefinite future. Part of the urgency stems from the influence the IPCC is having on public policy. Policymakers need reliable information, especially when billions of dollars are at stake.

8. Computer Modeling: There are two basic modeling systems for climate prediction: Dynamical and Statistical. The latter bases predictions on long-term statistical trends and historical analogs (i.e., pattern repetition). The former calculates atmospheric parameters at different grid points around the globe using physical equations. Essentially it is a 3D mathematical model of the atmosphere. Some models use a combination of these methods. IPCC projections of global warming are based almost entirely on dynamical modeling.

The main dispute centers on the shortcomings of these dynamical models. AGW is so complex—intertwining ocean and land temperatures, ocean currents and oscillations, changes in the cryosphere, biosphere, solar irradiance, aerosols, cloud formation, CO₂ levels, etc.—that some statisticians and climate scientists believe the level of confidence with which the IPCC puts forth its projections (90-95%) are entirely unjustified. There are no physical equations for some of the key parameters (e.g., extent and type cloud formation) and the models do not take into account oceanic and solar oscillations (though this is being improved). Indeed, many aspects of climate sensitivity are not derived as an *output* from the model's physical equations. Rather, they are an *input* by the modelers and represent their best guess (parameterization). The model's projections, then, will reflect the bias of the modeler (typically tilted toward higher sensitivity). Though computer modeling appears promising at first glance, the skill of such models in projecting global and regional climate over decades may be worthless, if not misleading.

Some critics of the dynamical modeling approach also point out that in operational meteorology, dynamic models (used by the National Weather Service to make our daily forecasts) break down in less than 10 days even though they are “initialized” using thousands of current observations at every level of the atmosphere. As Edward Lorenz (1963) and F. Giorgi (2005) concluded regarding complex, non-linear systems, it is not possible to reliably model even simple parameters over a long period of time, in an open, chaotic system like the atmosphere.

Finally, there is the larger methodological question about the way computer models are used in climate science. The notion, held by some climate scientists, that computer simulations can test the validity of a hypothesis is not scientifically sound. The computer simulation *IS* the hypothesis, and it must be validated against real world data. Without adequate data input, the use of such models constitutes circular reasoning.

Conclusions

Many proponents of the IPCC's AGW hypothesis consider the evidence for their theory incontrovertible and view it as "settled science." They reject all skepticism as mere denial, and appeal to the consensus of the climate science community against the "deniers." There are, of course, crackpots on both sides of the issue who receive frequent attention from the media. However, the "skeptics" are by no means without credentials. They are former NASA scientists, university professors, physicists, climatologists, and National Academy of Science researchers, who are highly respected in their fields.

The media coverage of this issue might lead one to believe that the debate is over. But, papers and articles continue to be published by recognized scientists and authors like Roy Spencer, Roger Pielke Sr., Richard Lindzen, Douglas Hoyt, William Cotton, Robert Carter, and Willie Soon. These scientists maintain that (1) many of the projections put forth by the IPCC lack adequate scientific support; (2) too much emphasis has been placed upon the role of CO₂; (3) the level of confidence in computer modeling is misplaced; and (4) the IPCC has overemphasized the anthropogenic contribution to climate change by underrating natural fluctuations in climate, some of which are not yet fully understood.

Scientists who disagree with the IPCC's science do not necessarily rule out an anthropogenic contribution to climate change. What they do oppose, however, is reducing a complex problem like climate change to one primary forcing agent, namely, CO₂. According to the National Academy of Science, other types of human activity such as land use changes (e.g., deforestation, urbanization) and aerosol pollution (e.g., soot, sulfur, etc.) may contribute significantly to human induced climate change, especially on a regional basis. The IPCC has largely ignored these factors. There is a wide range of opinions on the long distance effects of such regional forcings (teleconnections), and how much overall impact they have on global climate. Much more data would be needed in order to answer these questions. Nevertheless, these types of human activity demand *very different intervention strategies* than we are pursuing at present, with the reduction and sequestration of CO₂ emissions.

In my view, the IPCC's AGW hypothesis provides a foundation upon which a more complex model of climate change can be built. In the meantime, we should be cautious about placing our faith in climate models that vastly oversimplify the actual climate system. Supporting evidence for the IPCC's projections does not warrant the high level (90%-95%) of confidence exhibited by its authors. Much less should these projections be used, at this point, for making public policy decisions. Though the latest IPCC report (2007) concludes that global warming, due to increased CO₂, is a virtual certainty, the authors themselves raise fundamental doubts about our scientific understanding of radiative forcing agents and climate change, both past and present.

Why this confidence, then, in the IPCC's AGW hypothesis? Just as many IPCC defenders accuse skeptics of receiving funding from big oil, so skeptics assert that the rush to go public was driven by scientists and administrators who are either committed to environmentalist ideologies or have direct ties to environmental groups. Consequently, the power of the IPCC's projections to influence public policy has, in turn, energized and funded environmentalism. This funding includes large government and corporate grants on AGW research, and enormous spending on the reduction of carbon emissions.

Regardless of motives or incentives on either side, it is clear that crucial aspects of the anthropogenic global warming theory are still in a state of flux. Someone sounded the alarm too soon and policy has outrun scientific certitude. Those who question the IPCC hypothesis may be in a minority (albeit a growing minority), but science is not a democracy. Controversies are settled by facts, not by votes. As the history of science has shown, the majority are not always right.

In the mean time, the media will continue to hype this issue, focusing on the most sensational statements and events. Apocalyptic views, like those of Al Gore and James Hansen (NASA), have dominated the public discussion and classroom education. Yet, these views do not even represent the IPCC's projections, which are far more conservative and a lot less theatrical. Of course, alternate models of climate change are not even considered. This one sidedness only proves how desperately good education is needed on this issue.



BIO

**My background: I worked as a weather forecaster and instructor in the US Navy, and as a Meteorological Technician for the National Weather Service (Dulles) and Central Weather Service (Chicago). More recently I have served as head of the science department for St Nicholas Orthodox School (Cuyahoga Falls, OH) which closed in 2006. I continue to write science curriculum, conduct summer science camps, and volunteer as a trained storm spotter.*



WEB RESOURCES

In defense of the IPCC AGW Model

ipcc-wg1.ucar.edu/wg1/wg1_home.html (the official IPCC report)

www.climatechange.gov (the U.S. climate change science program)

www.realclimate.org (ongoing articles and commentary by climate scientists)

climatechangeeducation.org/science/index.html (educational resources)

www.ncar.ucar.edu/research/climate (National Center for Atmospheric Research)

www.ncdc.noaa.gov/paleo/perspectives.html (paleoclimatology resources)

www.aip.org/history/climate/ (history and resources on climate change science)

In criticism of the IPCC AGW Model

icecap.us (features daily articles gathered from numerous sources)

www.weatherquestions.com/Roy-Spencer-on-global-warming.htm (research scientist at the University of Alabama in Huntsville)

scienceandpublicpolicy.org (Science and Public Policy Institute)

wattsupwiththat.com & www.surfacestations.org (survey and commentary on anomalies in U.S. climate stations)

www.climateaudit.org (audit and commentary on official climate statistics)

www.worldclimatereport.com (review and commentary on current news and research)

petitionproject.org (a declaration against catastrophic warming signed by 31,000 scientists)

Other Perspectives and Alternative Models

climatesci.org (a broader view of climate change by Roger Pielke Sr., research scientist at the University of Colorado)

books.nap.edu/openbook.php?isbn=0309095069 (report by the National Research Council of the National Academy of Science)

climatedebatedaily.com (an ongoing presentation of both sides of the issue)

globalwarmingclearinghouse.blogspot.com (reports, articles, papers, and Blogs referencing the latest information)

