A Review of Global Warming Science

By Daniel Simmons

Across the country people are saying that it is time to "take action" against climate change. As a result, this year more than 350 bills were in state legislatures that either regulated greenhouse gases or laid the groundwork to regulate greenhouse gases. This is a five-fold increase in legislative activity on this subject from last year. Efforts to regulate greenhouse gases are afoot at the federal level as well. Before we rush off half-cocked and institute measures which will increase the price of energy, and thereby increase the costs of all goods and services, we should understand some important issues on climate change science.

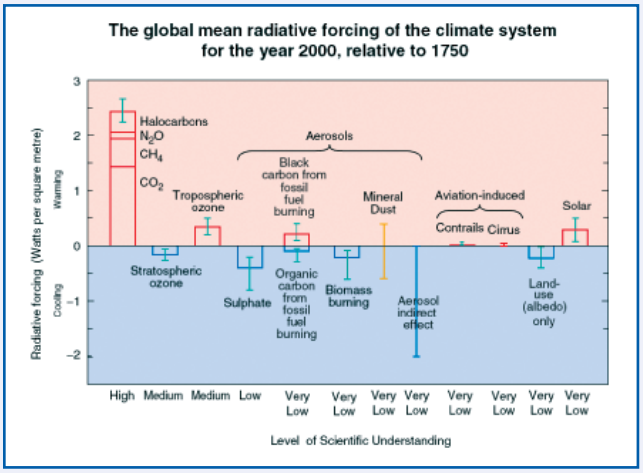
What Do We Know about Climate Change?

The earth's climate is variable. It was variable before humans were the dominant species on the earth. During the last Ice Age, glaciers covered almost all of Canada and into the northern United States. During the Jurassic period, when dinosaurs roamed the earth, it was much warmer. Neither of these changes was caused by humans.

In the more recent past, the earth was in period known as the Little Ice Age. This ended in the late 1800s and the earth has warmed since that time. Also since the 1800s we created the industrial revolution and our burning of fossil fuels has caused carbon dioxide levels to increase in the atmosphere.

Carbon dioxide is a greenhouse gas, and if everything else remained constant, the increase of carbon dioxide should lead to some warming of climate, but everything else has not remained constant. In other words, human activities are likely responsible for part of the warming we have experienced since the end of the Little Ice Age. The real question is how much of the warming is attributable to human activities? We know that at the local level humans are definitely causing warming because of "urban heat islands." Our self-constructed environment of concrete, pavement, and other surfaces retains heat more than vegetation. But on a global level the only way we can access man's impact on the environment is through computer models.

Figure 1



Computer Models

Despite claims that show that humans are impacting climate, climate models cannot accurately model climate. For example, if you took the exact climactic condition on the earth in January 1, 1980 and fed it into a climate model, the model cannot even come close to describing the climate of today. Even the authors of the U.N. Intergovernmental Panel on Climate Change (IPCC) admit to this. As Kevin Trenbeth, a lead author on the IPCC report, has written:

> None of the models used by IPCC are initialized to the observed state and none of the climate states in the models correspond even remotely to the current observed climate. In particular, the state of the oceans, sea ice, and soil moisture has no relationship to the observed state at any recent time in any of the IPCC models.

In other words, climate models cannot recreate the climactic changes we have seen in the past. As such, we know they cannot skillfully predict the future. While Kevin Trenbeth acknowledges limitations in the global climate models, he believes that the models provide good, general information about climate. But even they have to be questioned because of the inability of the models to recreate earth's climactic conditions.

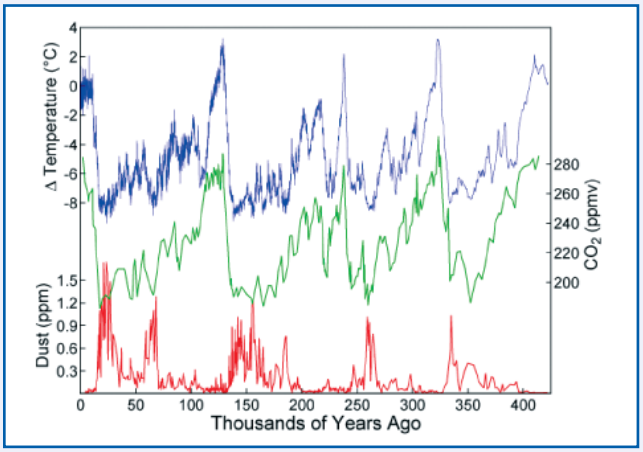
Besides not being able to predict the future with any skill, climate models cannot predict the regional climate and the problem at the regional level. The American Association of State Climatologists has stated, "climate predictions have not demonstrated skill in projecting future variability and changes in such important climate conditions as growing season, drought, flood-producing rainfall, heat waves, tropical cyclones and winter storms." In other words, climate models cannot predict with any accuracy any of the things that matter most about climate. When we hear claims that climate change will lead to droughts, less snow pack, etc., it is important to understand that these claims are not supported by models because the models cannot predict these claims with any degree of accuracy.

One of the reasons climate models cannot be used to predict future climate accurately is because we do not understand all of the climate "forcings" very well. Climate forcings are the ways in which factors such as the sun and the chemical makeup of the atmosphere cause the climate to change. We think we understand how greenhouse gases force temperatures, but we don't have a good understanding of ozone's impact, aerosols, or solar activity. Figure 1 is from the International Panel on Climate Change. It shows that we think we understand how greenhouse gases, on the left, affect climate, but that we have a relatively low understanding of important cooling factors such as aerosols and a low understanding of changes in how the sun affects earth's climate.

Some of the latest scientific papers show that the cooling effect of aerosols is greater than previously understood. An August 2006 article in *Science* stated, "the authors estimate that anthropogenic aerosols [create]…a forcing on climate that is larger than, and of opposite sign to, that of greenhouse gases." Popular belief with respect to climate change states that the sun's changes do not impact earth's climate much, but this is changing as scientific knowledge progresses. A recent paper in *Geophysical Research Letters* found that the sun contributed as much as 45–50 percent of the 1900–2000 global warming, and 25–35 percent of the 1980–2000 global warming." According to this paper, "the solar impact on climate change during the same period is significantly stronger than what some theoretical models have predicted."

As noted earlier, carbon dioxide levels in the atmosphere are increasing. If everything else remained the same, this should cause some warming. But everything else does not remain constant. Humans release aerosols which decrease the temperature and changes in the sun's radiance increase

Figure 2



the earth's temperature. The earth's climate is a complex system and it is very difficult to model such a complex system when we do not understand everything that affects climate.

Carbon Dioxide and Temperature

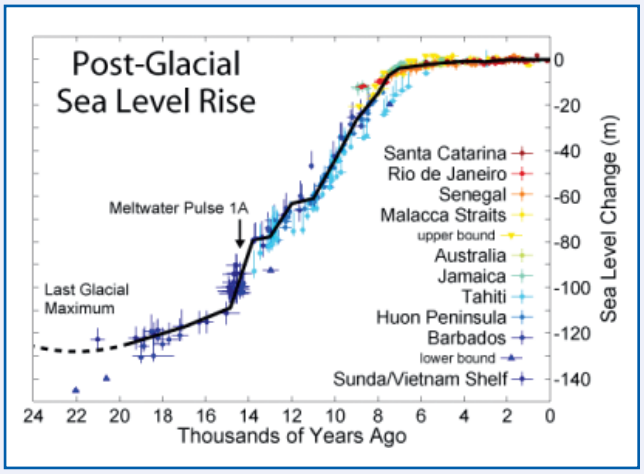
But some people, such as Al Gore, argue that we know plenty about climate and that there is one factor above all that changes temperature—carbon dioxide. In his movie, *An Inconvenient Truth*, Al Gore displays a large chart that shows temperature changes over time and carbon dioxide changes over time. The chart he shows is similar to Figure 2. The top line shows the temperature over time, the middle line shows the carbon dioxide concentrations, and the bottom line shows the amount of dust.

In *An Inconvenient Truth* Al Gore says that the relationship between temperature and carbon dioxide is "complex" and implies that carbon dioxide changes drive temperature changes. The problem with this theory is that there are numerous papers that show that temperature increases *precede* carbon dioxide increases. If carbon dioxide rises after temperature, then it is obvious from the examples in the past that carbon dioxide was not the driver of temperature.

Specific Claims about Global Warming

People who are concerned about global warming trot out a few examples of how humans are harming the earth. These people say that human activities are causing the retreat of glaciers, causing sea levels to rise, and making hurricanes more frequent and stronger.

Figure 3



Retreat of Glaciers

Many glaciers around the world are retreating, but that does not necessarily mean that humans are causing the retreat. A perfect example of this is the retreat of the glaciers on Mount Kilimanjaro in Africa. Many people, including Al Gore, cite this as evidence of human-included global warming. But according to the latest science, the retreat of the glacier is not caused by human-induced global warming. The authors of an article published in the July–August edition of *American Scientist*, state that "global warming has nothing to do with the decline of Kilimanjaro's ice, and using the mountain in northern Tanzania as a 'poster child' for climate change is simply inaccurate." The Kilimanjaro glaciers are retreating, not because of warmer climate (in fact the temperature is always substantially below zero), but because there has been a drying of the surrounding air, which means less snowfall to build up the glaciers.

But what about the glaciers in the rest of the world? First, it should come as no surprise that many glaciers are in retreat. The Little Ice Age, which lasted from the 1600s through the mid 1800s, was a period of colder climate than today. Glaciers grew when the earth was cooler and they are now retreating in today's warmer climate.

If carbon dioxide increases were driving the melting of glaciers then the decline in the size of glaciers should be increasing. But they are not. In fact, the rate of glacier melt is not increasing. In other words, while many glaciers are decreasing in size, they are losing smaller amounts every year.

Sea Level Rise

Sea levels are rising. But sea level rise is not a new phenomenon. Sea levels have been rising for the last 10,000 years—since the end of the last ice age. When glaciers covered much of the Northern Hemisphere so much water was locked up in the ice that it lowered sea levels. As the earth's climate warmed and the glaciers melted, the water returned to the sea, increasing the sea level. Figure 3 shows how sea level has risen over the past 20 thousand years.

In more recent times the rate of sea level rise has decreased. Sea level is still increasing, but not as much as in the past. But this is the opposite one would expect if carbon dioxide increases were driving sea level rise.

If increasing levels of carbon dioxide were leading to sea level rise, then the rate of sea level rise should be increasing, but it is not. Figure 4 shows sea-level rise from 1904–2003. The graph shows that sea levels have continued to rise, but that the rise slightly slowed during the second half of the 20th century. In the first half of the 20th century sea level rose by 1.91±0.14 mm/yr compared to 1.43±0.14 mm/yr during the second half of the 20th century.

Sea level is indeed rising. Sea level rise is partially a result of global warming, but that global warming started 20,000 years ago—far before humans could impact climate in any way.

Global Warming and Hurricanes

In Al Gore's movie, *An Inconvenient Truth,* he prominently featured the aftermath of Hurricane Katrina to create the impression that global warming will lead to more intense hurricanes. But his view is not supported by science. In November 2006, the World Meteorological Association released a consensus statement that read, "Though there is evidence both for and against the existence of a detectable anthropogenic signal in the tropical cyclones (hurricanes) climate record to date, no firm conclusions can be made on this point." Even the U.N.'s Intergovernmental Panel on Climate Change recently stated that while there is some evidence of increased hurricane intensity, "there is no clear trend in the annual numbers of tropical cyclones."

In its recent consensus statement on hurricanes, the World Meteorological Association also stated that "No individual tropical cyclones can be directly attributed to climate change." This means that it is incorrect to say that Hurricane Katrina was caused by global warming, because it was a one-time event, just like the abnormally calm 2006 hurricane season. Which is a better example of the results of global warming—Hurricane Katrina or the fact that no hurricanes made landfall in the U.S. in 2006?

All Bad News, But No Good News

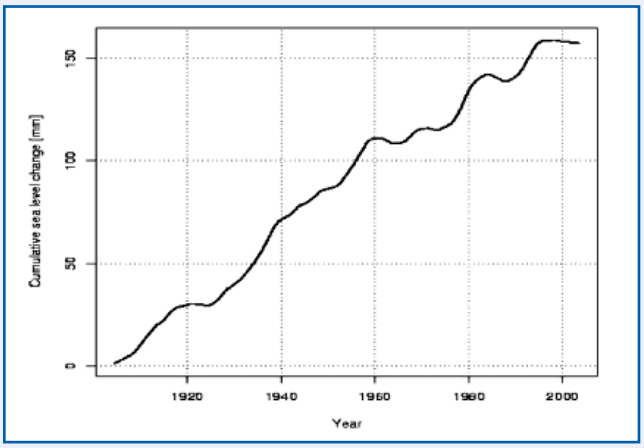
Every time we hear something about climate change all we hear are claims that climate change is causing bad things to happen. Global warming is causing more hurricanes, it is causing sea level to rise, it is causing too much rain and flood, it is causing too little rain and drought. It cannot possibly be the case that all of the results of climate change are universally bad. Yale Professor Robert Mendehlson testified before the Senate in 2000 and explained that in net, climate change will likely be beneficial for the United States:

> Climate change is likely to result in small net benefits for the United States over the next century. The primary sector that will benefit is agriculture. The large gains in this sector will more than compensate for damages expected in the coastal, energy, and water sectors, unless warming is unexpectedly severe. Forestry is also expected to enjoy small gains. Added together, the United States will likely enjoy small benefits of between $14 and $23 billion a year and will only suffer damages in the neighborhood of $13 billion if warming reaches 5°C over the next century. Recent predictions of warming by 2100 suggest temperature increases of between 1.5°C and 4°C, suggesting that impacts are likely to be beneficial in the U.S.

Conclusion

Climate change is a very important issue for all of us. As we consider policy regarding climate change we should understand one of the most important principles in statistics—correlation is not causation—just because two things happen together, such as carbon dioxide increases and temperature increases, does not mean that carbon dioxide is driving temperature increases. We must remain humble about our climate models and understand that they cannot predict the future, or anything close to it.

Figure 4



Climate science is ever-improving, but there is still a lot we do not understand. Before we understand more about what is driving climate change, we should be careful about the legislation we enact to "combat climate change." Most plans, such as capping carbon dioxide emissions, will be very, very expensive for Americans. Not only will it increase the costs of all goods and services, but it will put us at a competitive disadvantage to all of the developing countries of the world. Instead of enacting harmful programs with climate change legislation, we should "first, do no harm."

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