The Current State of Our Climate

by Bruce Melton, P.E.

Mr. Melton has been a professional civil and environmental engineer for 23 years, has done nearly a million dollars in EPA Clean Water Act research and has concentrated his engineering work in the Earth science areas of the development industry. In the last decade, Mr. Melton has become increasingly involved in climate change outreach, culminating in two trips to the Arctic this year and the preparation of a documentary concerning the current impacts of climate change on our planet.

***Preface*: Over 15,000 scientists attend the American Geophysical Union annual meeting in San Francisco this week, December 11, 2007. The buzz concerns the very real possibility that our climate has shifted into high gear and is now in a new state where change comes much, much more rapidly. Evidence is mounting that our current climate models may be 10 times or even 50 times slower and less aggressive than the ways in which our climate may actually be changing right now. This is not alarmism. This is an alarm.**

If the United States had a Chief Climatologists, it would be Dr. James Hansen, Director of the NASA Goddard Institute for Space Studies. This is the Federal organization that runs the U.S. climate modeling program and supplies climate modeling support to academics around the world. Dr. Hansen says that our climate may change fifty times faster than mainstream science is predicting. This is an extremely astounding statement that has huge implications and I will describe the effects that the US de-facto Chief Climatologist talks about later in this article. Right now I need to tell you why Dr. Hansen believes we have come to this situation where our future is likely to be so vastly different than mainstream society believes.

In December 2005 James Hansen blew the whistle on George Bush's campaign to censor climate scientists. In 1982, on the hottest day of the hottest year ever recorded up until that date, in front of the House of Representatives, James Hansen testified that global warming was real, that mankind was to blame, that global warming was proceeding faster than predicted, that the public would be difficult to convince and that we needed to do something about it fast.

Now jump ahead to the present, 25 years later - In May of 2007, Dr. Hansen published a summary document of the current state of climate science in the academic journal Environmental Research Letters. Knowing what I know about Dr. Hansen, when I read this letter, I about peed my pants.

I went to the Arctic to find out for myself, after all, my new career is in scientific outreach. I need to absolutely understand what it is that I am doing before I can truly be effective. I new that I must talk to the scientists in the field, the locals in their homes and that I must see with my own eyes what is happening because of climate change. Webster's calls an engineer, an "applied scientist". What I am doing is applying the science of climate change to our everyday lives. My dad was a chemical engineer. Chemists discovered how to make plastic. My dad brought us the plastic milk jug. Earth

scientists (and many others) have discovered how our climate works. I am bringing us the milk jugs of climate science.

Reticence – Broad Scale Scientific Conservatism

When I arrived in the Arctic, what I found made me feel like I had just read Dr. Hansen's article for the first time. It's not that I am incontinent or anything, it's just that this climate change business is really reaching its stride. I was just not prepared for what I saw.

Dr. Hansen's paper is entitled *Scientific Reticence and Sea Level Rise.* The Scientific Reticence part first: If climate change is so important, and if scientist are so certain that it is happening and the consequences are so dire, why isn't there a little more fuss about it? Well, I don't want to say that scientists are a fickled lot. They are not. They are no different than you and me; well maybe their vocabulary is different. Other than that, they have challenges and problems and they find solutions and go home to their families. Then they publish their papers in scholarly journals refereed by a jury of their peers.

Now, let me define "scholarly journal refereed by a jury of their peers": This is what scientists do for a living, this is how they feed their children. This is how they keep a roof over their heads. They do research, and then publish their findings. Before being published, a paper must first be accepted for consideration by a scholarly journal such as the Journal of Geophysical Research Letters. After being accepted for consideration the paper goes to a review board where it is reviewed by several or more expert scientists. These are the peers, and the review board is the jury. The review results in comments that must be addressed by the research scientist submitting the paper or it will not be published.

This is where the saying "publish or perish" comes from. If the researcher cannot address the comments from a jury of his or her peers – top their satisfaction - then he or she is not published by that journal. A researcher that does not publish does not remain a researcher long, at least not a tenured one. So to feed his or her family, publishing is imperative.

What James Hansen relates in his paper about publishing and reticence concerns the importance of not being too aggressive in publishing findings. The successful scientist does not push the envelope any more than required. The scientific community does not like aggressive science. It the science moves too fast, there is not enough time to adequately and thoroughly understand every facet of an issue. Hansen has a great example of what happens to scientist that push the envelope:

> In 1982, shortly after Hansen testified in Congress about the robustness of the science concerning the increased pace of climate change, the Department of Energy abruptly pulled funding for one of Hansen's research projects. They specifically cited an article published by Hansen in 1981 that was the basis for the 1982 Congressional testimony.

Hansen was pushing the envelope and lost funding because his funding source was conservative. Hansen believes this conservatism is a part of the industry of science. He believes that it is easier to get a project funded or a paper published if a scientist has a hypothesis that is not overly aggressive.

Now the second reason: If a researcher gets his paper published, and we find out later that there are inaccuracies in his paper – his colleagues can no longer trust his word. He looses his credibility. Without credibility, a scientists tenure is a stake. Without tenure, a scientists earnings fail. To a scientist, credibility and tenure are similar to our performance reviews. Without them our future is in doubt. A scientist must maintain his credibility and a senior scientist must be tenured. So scientists, by the force of industry are conservative. The have to protect the shirt on their backs and the family beneath their shirttails.

This conservatism has led to inaccurate computer modeling. Is this what the contrarians have been telling us? Well, it fits the philosophy that the science is immature and cannot yet produce a good model, but science can produce a good model – of our past climate. This is quite well understood. We have excellent records of ancient climate from many different sources using many different techniques. They all align to define the same climate for hundreds of thousands and even millions of years. But over the last several years we have been seeing changes in the climate – surprises, that are happening unexpectedly at a rate that is faster than the models predict.

There is a basic fundamental criteria in the climate models known as climate sensitivity. This sensitivity has been calibrated to work well with our past climate. So when the models are started hundreds of thousands of years ago, they reproduce our ancient climate well. But change the basic fundamental of climate sensitivity and it can greatly affect the predictions for our future climate.

Climate Change Acceleration

In Greenland, late this summer I was amazed at what I saw and understood as extreme melting. One place I visited, at the edge of the ice cap near a place called Kangerlussuaq, on the west coast of Greenland, had seen a melt of over 100 vertical feet in just three melt seasons. The scientist I talked with spoke of accelerated melting in the last three melt seasons. The place where I saw the first example of this extreme melting had been stable for decades, and probably even a hundred years or more. There was a road that led up onto the ice cap that Volkswagon had built in 2001, for a winter proving grounds. The road had been useable by the tourist industry to access the ice cap until 2004. Now the road is 100 feet above the ice, perched on what is called a terminal moraine. This terminal moraine is a giant pile of glacial debris piled up by the conveyor-like ice sheet as it moved downhill and melted at roughly the same place it had been melting for a hundred years.

The tour guides that I talked to told me this, and then I confirmed it through discussions with the scientist and review of academic papers. I was astounded. Why was this information not forthcoming in the media?

My next stop was a place called Ilulissat – also on the west coast of Greenland. Ilulissat is home to one of the Northern Hemisphere's most productive glaciers. In 1997 it was moving at about 4 miles per year, and by 2006 it had increased it's speed to nearly 8 miles per year. During the last melt season the discharge of the glacier increased by another third. This ice flow drains about 6% of Greenland and dumps more ice into the north Atlantic every day than, if melted, would be used by London in a year. This glacier is called the Jakobshvn Isbrae, or Jakobshavn Glacier. Recent academic literature tells of how the total quantity of ice from the discharge glaciers of Greenland has increased between two and three times between 2000 and 2006.

Another big surprise happened in the last couple of years in Antarctica. It has long been understood that the Antarctic Ice Sheet would be stable or actual increase in volume for the next 100 years. Worldwide it has been understood that the Antarctic ice mass and planetary configuration would be very resistant to impacts from climate change. The IPCC even states this in their most recent report - that Antarctica will not be a source of sea level rise until after 2100. Here's the surprise: numerous recent studies have now shown that Antarctica has started to lose more ice than it gains every year.

These recent findings are partly in dispute as to the actual impacts that Antarctica is having right now on sea level rise. But what is not in controversy is the fact that Antarctica has changed from a positive mass balance to a negative mass balance, and that this change was not supposed to happen for 100 years.

Unexpected, Surprising and Never Before Seen

This kind of thing has been unexpectedly happening more often lately. Another good example is that the amount of CO2 that is being naturally absorbed by our Earth's environment is decreasing faster than expected. One study shows decrease in the southern ocean surrounding Antarctica. Another shows decrease in the North Atlantic. The explanation of these decreases is complicated, and still needs further study, but the underlying assumption is still clear. Our oceans and terrestrial environments are losing their ability to absorb CO2 faster than the models predict.

Another unexpected and quite significant thing that is happening is that the emissions of CO2 across the planet are increasing faster than the models predict. This time, it's three times faster. The main reason is that we as a society are using more energy per person than the scientists assumed we would use when they built their climate models.

And still another unexpected, significant, and even alarming thing that is happening concerns the energy efficiency of our planet. One would expect, in this day and age, that our energy efficiency, the way we use fuel, is increasing. That is – we are getting more out of a unit of fuel today than we did last year, or the year before. But alarmingly, we are not. From 1970 until the year 2000, the planet as a whole was increasing its fuel efficiency by about 1.3% per year. Since 2000 our efficiency has been decreasing by about 0.3% per year. This is not at all what the scientists had anticipated when constructing their climate models.

Arctic sea ice melt was of course the big media show of late summer this year. On September 16, Arctic sea ice reached a new record low level. In the words of the National Snow and Ice Data Center, a program supported by NASA, NOAA and the National Science Foundation; "Arctic Sea ice during the 2007 season plummeted to its lowest level since satellite measurement began in 1979… shattering the previous record set for the month in 2005, by 23%".

Older historic records of sea ice extent are not as all encompassing as satellite measurements, but due to significant exploration in the Arctic, are fairly reliable back to nearly the beginning of the 17th century. In a large part of the Arctic, that area north between Greenland, Norway and Russia, we have pretty good records of ice extent from fishermen – 400 years. There is a significant consensus among scientist that our summer sea-ice today is significantly lower than at any time in this period.

Between 400 years ago and 1,000 years ago was a time called the Medieval Warm Period. Climate change contrarians repeat over and over that, not only was the Medieval Warm period warmer than today, but so was the 1920s and 30s. They have good reason to suspect so; well they did once upon a time. The current understanding of historic and prehistoric climate data show that our current period is definitely the warmest in 6,000 to 8,000 years. Today's multiple climate records in ice, sediment and other proxy technologies just do not support previous assumptions about global temperature.

You have to go back 6,000 to 8,000 years to reach a time that was warmer in the Arctic than it is now. And that time was not warmer on average across the globe. Polar amplification made it warmer in the Arctic during a period called the climate optimum – that point that was as warm as any time in the preceding 100,000 years before now. It was maybe 4 degrees F warmer in the Arctic then and sea-ice may very well have been lower than today, but there is one huge difference between then and now. Then CO2 levels in the atmosphere were 280 parts per million then, not 385 like they are today. The rate of increase back then was little to none. Today, CO2 concentrations are a good 33% higher, but most importantly – concentrations are rising rapidly and predicted to rise even more rapidly.

One more thing; it's just a little thing. The IPCC predicts that sea levels should be rising today at 1.28 mm per year. Two new satellites show that sea level is actually rising at 2.2 mm per year, more than 70% more – nearly double what the IPCC estimated. This new system, it is called GRACE - Gravity Recovery And Climate Experiment, is 10 to 50 times more accurate than previous technologies and it's researchers estimate that it has increased gravitational knowledge 100 times in its 5-year mission so far. The computer models associated with the satellite were not released until 2004, so the first scientific analyses have really just come out.

Sea level is rising about 1 mm per year more than expected, big deal. In 25.4 years this means an extra 1-inch of sea level rise? Nope, it doesn't work that way.

Dangerous Climate Change

What is happening is that the Arctic, which has seen a temperature increase of 4 to 7 degrees F in the last half of the 20th century (which is much higher than the world average because of polar amplification) has leapt into an accelerated mode of melting. An environmental threshold has been crossed and a new climate state is under operation. This is the first of the major feeback mechanisms that will be triggered by man-mad, or anthropogenic climate change.

The reason? Much of the reason for this feedback mechanism is because ice reflects up to 90% of the incoming energy from the sun and water absorbs 80% to 90% of the incoming energy from the sun. The energy that is reflected by ice is mostly lost back into space; because our atmosphere does not absorb energy directly form the sun. It has to be converted into heat energy first. Being absorbed by land or water converts the sun's energy into heat. This heat energy is then more easily absorbed by the atmosphere, where it helps through the greenhouse effect, warm the planet.

If there is more open water, more energy is changed into heat, which can melt more ice. This is called a positive feedback and it grows upon itself. The same thing happens on the ice sheets – snow that is wet from melting absorbs a lot more energy than dry snow reflects, and the positive feedback creates even more melt.

This feedback mechanism is something that the climate models do predict, but the unexpected thing that is happening is that we are reaching the levels of melt far in advance of what the models predict. In the case of the Arctic sea-ice melt, the models predict that the levels of melt that we saw last year were not supposed to happen until the middle of the 21st century.

Climate Sensitivity and Scientific Conservatism

So why are all of these unexpected things happening, and why is the melt so much more than the models have predicted? It's this reticence thing that James Hansen talks about. The conservative nature of the scientific process does not allow for or discourages this type of aggressive process, because it so far out of the normal realm of thinking. Just remember, how long it took for the world's society to be convinced that the Earth was round. This is the same thing. There are many comparisons, ice age theory for one. It took well over a hundred years for ice age theories to become established; others are microbial theory, infectious disease, and slavery. It is against human nature to be radical in ways that go against long established convention. So it takes time for radical ideas to be accepted by society.

Even the Intergovernmental Panel on Climate Change (IPCC) is guilty. They, as the largest body of scientists ever to be assembled, are surprised at the rate that the climate is now changing. Their final report of the fourth reporting period – each period a six-year process – states that Arctic sea-ice should not be in the condition that we found it this summer until about the year 2050.

So, why are the climate models wrong? The IPCC, like the scientific industry, is a huge bureaucracy of consensus. Researchers are discouraged from publishing information that is contrary to the consensus. It is becoming fairly obvious in academia in the last several years that our climate is significantly more sensitive than has been accepted in the past. This means that the climate reacts faster, with larger results.

The IPCC has another handicap. They basically stop taking papers nearly two years before they publish their final report of the session so that this huge body of scientists can reach their consensus about the state of our climate. The predictions that their models make are skewed today because of this. The latest scientific information about climate sensitivity cannot possibly be evaluated in the context of the great consensus that must take place to publish the IPCC reports.

> **Definition: Climate Sensitivity** – the way our climate reacts to outside forcing. Forcing is what increased CO2 levels do to our climate – they force it to change. Higher CO2 levels makes it warmer of course, but in the process there is more melt which creates positive feedbacks that increase the warmth trapped on the planet. This, and many other feedbacks are the wild cards. They define the sensitivity. Scientific knowledge in general, today, cannot accurately gauge the level to which these feedback effects work, and there are many, many different feedback effects, not just Arctic sea ice and wet/dry snow.

To predict our climate today using the increased feedback effects would have required for much more aggressive climate sensitivity to be accepted by the consensus. Because our recent climate science did not identify aggressive climate sensitivity as being a highly probably event, the models reflected less melt, or less warmth, over longer periods of time. And what makes the assumptions even more

complicated is, that there is just no way to know exactly how sensitive our climate is under our current atmospheric conditions because we have not encountered the amount of rapid greenhouse gas increases that we are seeing today in our climate history. If things today were more like they were 1,000, 10,000 or 100,000 years ago, the job would be easier, but our atmosphere is much different than anything that we have record of.

Planet Earth: Imminent Peril (title from one of Dr. Hansen's papers)

One of the most senior of the Greenland ice scientists that I met in Ilulissat (Dr. Konrad Steffen) recently stated publicly that he saw the climate models being used by the IPCC, the most robust (most advanced) climate models in the world, as being an order of magnitude conservative. That is – our climate is changing ten times faster or ten times more than the models predict.

Dr. Hansen's paper – *Scientific Reticence and Sea Level Rise*, Environmental Research Letters, May 2006, has some astounding things to say about our climate today and our climate in the near future. Hansen talks about the great accuracy of our climate models today. These models can accurate predict our past climate when started hundreds of thousand of years in the past, but they are having trouble with the climate today.

Carbon dioxide concentrations today are likely higher than at any time in the last one million years, and could be higher than at any time in the last three million years. The rate at which CO2 concentrations are rising today is likewise possibly as high as has been in three million years. Three million years is significant because it was about that time long ago that the isthmus of Panama isolated the Atlantic Ocean From the Pacific. This created a Climate system very unique to the one that it replaced. So the models, that are based on our past climate history have no way of knowing how sensitive our climate is today with CO2 levels where they are today. These models are based on sensitivity observed in history. Without knowing the sensitivity, assumptions based on convention must be made.

Dr. Hansen believes it is the responsibility of the scientist to make the assumptions that are required to get the job done. He, along with many of the rest of us, can see that the current crop of climate models is not getting the job done. But there are other methods of determining our future climate.
Dr. Hansen is now looking out the window.

Dr, Hansen believes that instead seeing increases in sea level of up to 22 inches by the end of the century as the IPCC suggests, we may see levels 25 meters +/- 10 meters (that's 15 to 35 meters) by the end of the century. This astounding suggestion is 32 to 114 feet! And remember, this statement is coming form the de-facto United States Chief Climatologist! His reasoning? The last time that temperatures were as warm as the IPCC is estimating, this is how high sea level was.

The IPCC states repeatedly in their most recent report that their sea level increase does not – it absolutely does not include what they call "increases in sea level caused by dynamical ice sheet processes". These dynamical ice sheet processes cannot be modeled today because we just don't understand how they work. So reticence, or scientific conservatives allows the IPCC (wrongly) to ignores these issues.

Even though we can't tell you why it happens, We have detected what we believe to be dynamical changes taking place right now in our climate, in ice sheets, in tundra, and in artic sea-ice coverage.

ICEQUAKE!

A paper published in early this year describes a new icequake that has been found mostly in Greenland. These icequakes are much larger than their traditional icequake brothers, coming in at magnitudes between 4.6 and 5.1 on the Richter scale. They are unlike traditional icequkes in that their magnitude is much large and their times scales are between 35 and 150 seconds. Traditional icequakes have a magnitude of no greater than 2.7 and last only one second or less. These icequakes were discovered in a summary of global seismic data and pinpointed to outlet glaciers in Greenland in 2003. The recent report describes "a dramatic increase in the number of these icequakes since 2002", and a doubling of their numbers in 2005 above any single year prior to 2003.

These icequakes are probably caused by meltwater draining down to the bottom of the ice sheet through cracks. The ice basically lubricates the ice and lets it flow more quickly. Satellite observations have shown the ice actually rising – floating on this film of water, up to two feet during the highest melt periods. This allows the ice to unstick from the bedrock and slip frictionlessly downhill. When the ice grinds to a halt against the bedrock it creates the icequakes.

Dr. Robert Correl, the Chairman of the Arctic Impact Assessment talks of sections of the outlet glaciers 10 kilometers long slipping towards the sea in 90 minutes.

Antarctica

The final unexpected twist in this apparent abrupt acceleration that we are seeing comes from Antarctica. The IPCC today, and most scientist up until a few years ago agreed that Antarctica would not see a negative balance, that is - a time when more ice was coming off of Antarctica than was piling up on top - to take place until after the year 2100. But recent, new highly accurate gravitational measurements from satellites have shown in multiple studies that Antarctica has indeed already transitioned to a negative balance.