What Have We Done?

Sometime after the beginning of the twenty first century, our climate crossed a threshold. It moved into a new phase of change, one that is much faster, stronger and enormously more important than the climate change we have become accustomed too. Our climate has now made a move similar to many it has made in the past, only much more troubling because mankind, nearly seven billion strong, is an occupant of this planet.

Arctic sea ice has shattered its previous coverage record 40 to 70 years ahead of schedule. This is not something that the super computer models consider in their calculations of our future climate.

Our society has increased their carbon dioxide emission at such a rapid and unexpected rate that it is now equal to that which the scientists use for a worse case scenario – in the year 2100. Thirty seven million acres of trees have been killed in North America because of increased insect infestations on a warmer planet. This has happened in the last decade and using the math of the US Forest Service, somewhere near eighteen and a half billion trees are dead.

Methane emissions have accelerated rapidly. Methane is a greenhouse gas that is 21 time more potent than carbon dioxide, whose emissions, because of better agricultural practices across the world, stabilized about a decade ago. Now it is likely that the increasing and unexpected melting of Arctic and sub Arctic permafrost may have caused a new acceleration of methane emissions. The reason may also be frozen methane at the bottom of the continental shelf north of Siberia has started to melt.

Neither of these sources of methane has been include in the scientists' estimations of climate change.

The great southern ocean is now projected to see a mass extinction of primary productivity by the year 2030 - 40 to 60 years ahead of schedule. Primary productivity is the basis of the food chain that feeds almost everything in the ocean. It consists of plankton, algae and other single and multi celled plants and animals that are the food for the fishes in the sea. Carbon dioxide in the atmosphere dissolves in the ocean naturally and in the process adds acid to ocean waters. All of the extra carbon dioxide that mankind is generating today will make the ocean waters too acidic for much of primary productivity to survive. This is happening first in the polar regions where, like melting ice and permafrost, impacts are seen first on a warming planet.

Ocean acidity is actually rising faster than at any time since the age of the dinosaurs, 65 million years ago.

But the extinction of this primary productivity and the impacts on the animals that need these life forms for survival is only part of the story. Primary productivity is responsible for storing away a large amount of the carbon dioxide naturally stored by the oceans and it is also responsible for roughly half of the oxygen that goes into our atmosphere. The great southern ocean around Antarctica is not just the canary in the coalmine. It is one of the most productive ecosystems on the planet; it plays a natural role in keeping our carbon dioxide levels down and keeping our oxygen levels in the habitable zone.

Antarctica was once considered, by almost every single scientist on the planet, to be stable for at least another 100 years, maybe even start accumulating ice and reducing sea level rise. New gravity measuring satellites, 100 times more powerful than those used before have now found that not only is Antarctica melting and losing more ice than it is gaining as snow, but it has now caught up with Greenland. This is happening 100 or more years before the scientists predicted it would happen.

Atmospheric carbon dioxide has reached levels unprecedented in possibly the last 24 million years. Global temperature is higher than at any time in the last 160,000 years and possibly as high as or within 1.8 degrees Fahrenheit of anything this planet has

seen in the last three million years. Abrupt ecosystem changes are happening in the North Atlantic, North Pacific and Bering Seas, Alaskan spruce forests, permafrost woodlands of the sub Arctic, Arctic sea ice, the extensive forests of North America, semi-arid forests of the Southwest U.S.

Sea level rise has nearly tripled in the last decade and the complete demise of our beaches and coastal wetlands could happen within the next decade.

James Hansen, Director of the NASA Goddard Space institute - the foremost US Government climate modeling agency - gave a presentation at the American Geophysical Union annual meeting in San Francisco in December 2008 (16,000 earth scientists attended the annual meeting). He says that the rate of CO2 change today is 10,000 times faster than at any time in the known history and prehistory of the planet. Dr. Hansen says that the threat of the Venus syndrome is very real; runaway, irreversible climate change resulting in the loss of our atmosphere and oceans is very possible, maybe not within our lifetimes, but as soon as within that of our children. Impacts preceding the loss of our atmosphere would likely cause devastating changes to our society a bit sooner than the next generation.

"There may have been times in the Earth's history when CO2 was as high as 4000 ppm without causing a runaway greenhouse effect. But the solar irradiance was less at that time. What is different about the human-made forcing is the rapidity at which we are increasing it, on the time scale of a century or a few centuries. It does not provide enough time for negative feedbacks, such as changes in the weathering rate, to be a major factor. There is also a danger that humans could cause the release of methane hydrates, perhaps more rapidly than in some of the cases in the geologic record. In my opinion, if we burn all the coal, there is a good chance that we will initiate the runaway greenhouse effect. If we also burn the tar sands and tar shale (a.k.a. oil shale), I think it is a dead certainty."

These statements by Dr. Hansen are indeed extreme. Hansen is possibly the most important climate modeler in the world – he is the director of the US climate-modeling agency. His analysis is based on one of the most advanced climate models in the world. The audience to which these statements were made is dramatically prestigious. The

American Geophysical Union is the greatest group of Earth scientists to ever assemble, and it may be greatest single group of scientists to ever assemble. The importance of the venue; and the prestige and credibility of Dr. Hansen come together to create a professional and scientific statement whose gravity cannot be under-stated.

Why is This A Crisis?

To the average person, these times in our climate do not feel like, look like, or act like a crisis. The average global temperature has not even increased 2 degrees F. Why then, is climate change a crisis? What is so bad about it being a little warmer?

One of the reasons is called climate sensitivity. We humans, as a species are sensitive to climate, but we have learned how to cope with a varying climate. We can survive in a wide range of temperatures from oppressively hot to frighteningly cold. We have learned to wear clothes for warmth and take siestas in the heat of the afternoon. We have learned about air conditioning and indoor heating.

Some plants and animals on our planet can survive in a greatly varied environment. Birds migrate when it gets too cold. Caribou migrate when it warms up. The great masses of life on the Serengeti migrate when it gets too dry. Many animals hibernate when it gets too cold, or when it gets too warm or dry; by burying themselves in the snow, mud or sand. Fish migrate when they run out of food or the water temperature becomes unbearable. Plants shed their leaves when it gets too cold. But all these changes in life have limits. If it gets too cold, too hot, too wet or dry, things die.

This little bit of warming to us humans doesn't seem like much, but is greater than anything that has happened in the last 10,000 years and warming "in the pipeline" will see temperatures warmer than they have been in millions of years. Scientists are finding that our planet and her environments are more sensitive than they once understood. We are beginning to see the impacts and recent discoveries show that they are far more harmful than previous predictions.

So if this crisis is real, why are we not doing anything about it? Why isn't the alarmist media crying out in agony? The answers are not simple, but they are plain enough once understood. A thorough understanding is necessary in order for the true risks of the climate crisis to be understood. This is the topic of Chapter 2.

This chapter is just a summary of the big picture. Enormous momentum is building in the scientific community about the seriousness of climate change. Across the world a movement has been underway for nearly a decade to address this crisis. In the United States, we are finally beginning to cease the denial that has taken place that started with the Clinton Administration and moved into what may, in the future, be seen as nothing but criminal actions during the Bush Administration.

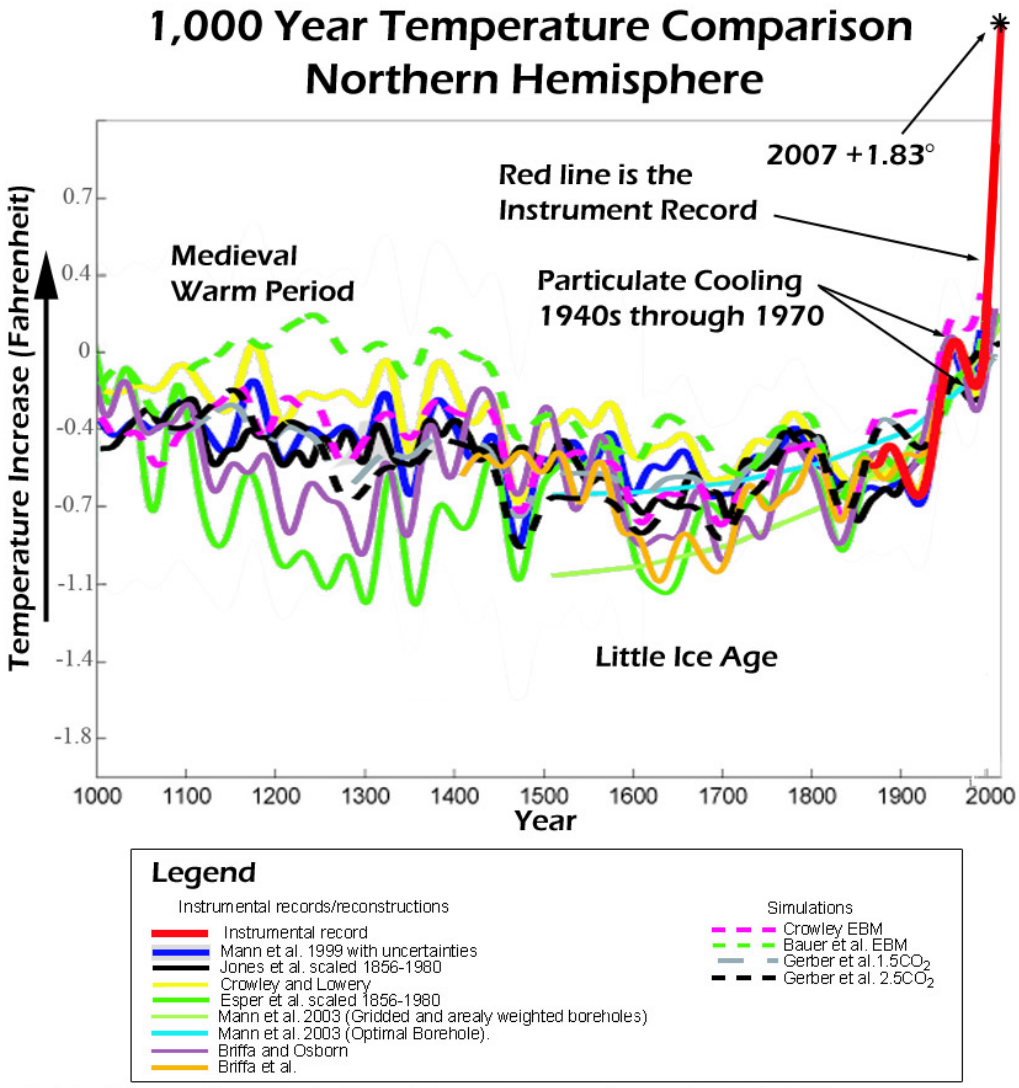
Today (March 2009), less than a year from the United Nations meeting in Copenhagen to finalize a follow-on agreement to the Kyoto Protocol, the worlds top climate scientists are meeting in Copenhagen to try and impress upon the world the newly discovered seriousness of the climate crisis.

New research presented at this conference shows even greater increases in CO2, ocean acidification, diminishment of ocean productivity, sea level rise and future increases in temperature. The research will be released this week at the Copenhagen Climate conference.

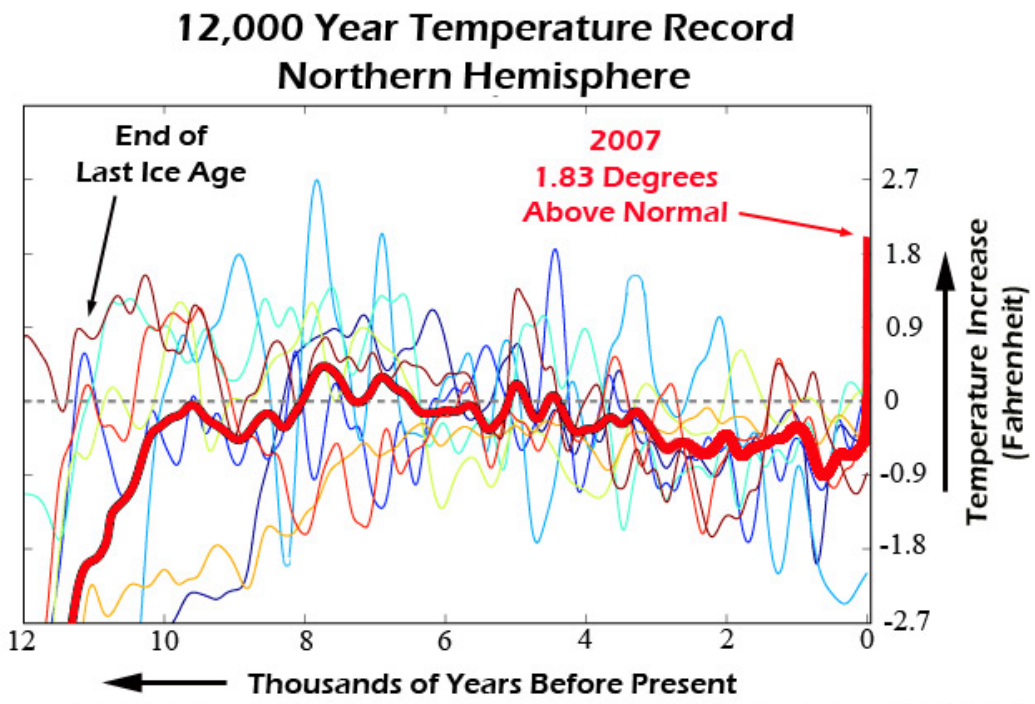
The best case scenario of CO2 reduction, where CO2 levels start falling by 3% per year by 2015, show that there is still a 50% chance that the earth will warm 3.6 to 5 degrees F. A 3.5 degree rise is an amount that is widely acknowledged to create major disruptions in society. In stark contrast to the "best case scenario" where CO2 levels decrease by 3% per year after 2015, CO2 levels on the planet today are ***increasing*** at 3% per year and this rate is increasing rapidly.

The latest temperature predictions for the path that the world will probably take regarding global warming and climate change (the most likely scenario from all of the climate models) now show an increase of 9 degrees F by the year 2100. This is a level of climate change that will have devastating consequences to the world as we know it.

The two images of temperature change for the last 1,000 years and the last 12,000 years show the scope of what a five or a ten-degree change in climate looks like compared to our natural climate variation.



Original Source: Jones et. al., On past temperatures and anomalous late-20th century warmth EOS, American Geophysical Union, July 2003 . The various colored lines represent various temperature reconstructions. The instrument record in red has been extended from 2003 to 2007 by the author.



Data Source: Jones and Mann, Climate over Past Millennia, Reviews of Geophysics, Vol. 42, No. 2 May 2005
Instrument record extended by the author to 2007.

Comparing our climate today to the last 10,000 years, it is easy to see how stable average temperatures have been compared to the last hundred years. The two previous images show historic and prehistoric temperature records that have been studied exhaustively for over a decade now. All of different colored lines are various interpretations from different parts of the world using different indicators of temperature and discussed. The bold red line is the average. (Earth's temperature is discussed in detail in Chapter 4.)

Some things have a very narrow window where life is possible. Poison dart rainforest frogs are a good example. Some species can live only at the tops of mountains where it is cool and wet enough for their survival. Extreme dryness is a death sentence for virtually any animal or plant. If it becomes too dry, even for a cactus, it will disappear. If large enough areas dry, animals cannot migrate far enough to find food. Some

circumstances are less obvious. Most caribou rely on the Arctic tundra to raise their young and build up enough strength to last through the winter.

Tundra in the Arctic is almost always underlain by permafrost. Summer temperatures in the Arctic allow a very narrow depth of soil to thaw, giving life to the tundra. As more permafrost melts, more pools of water are formed that drown the tundra, or the melt water drains away and the soil dries out because the permafrost no longer captures the melt water in the melt zone. The soil becomes too dry for the tundra to survive. The caribou can't migrate further north because of the Arctic Ocean, so they disappear.

Prolonged mega-droughts have been a common occurrence in the American West. Records of these mega-droughts come from lakes throughout the Great Basin in the American West. These lakes have no outlets and are an excellent place to see the balance in nature between rainfall runoff and evaporation. When rainfall is high, lake levels are high and when rainfall is low, lake levels are low. Analysis of tree stumps buried in sediment far below today's water surface shows that at times, droughts far greater than the dust bowl of the 1930s or the big drought of the 1950s occurred routinely in prehistoric times. The scientists, or anyone else for that matter, can tell that these trees grew where they found them because they are all upright with roots intact, buried in sediment up to a few feet from the original soil line and their tops are rotted off. What the study of these preserved stumps and rainfall runoff analysis shows is that a mega-drought lasts from several hundred to a dozen hundred years and rainfall can be only 25% of what we see today. In the West, this amount of rainfall is two to four times less than what it takes to make what we humans consider a big drought.

Our oceans and northern forests are two very large and not so obvious examples of the seriousness of the climate situation. These ecosystems are responsible for most of the carbon capture and most of the oxygen generation on this planet. These ecosystems are now in great peril from rapid, extensive and unparallel warming and CO2 concentration increases not seen since the age of the dinosaur.

One class of forest in particular is quite vulnerable. This is the great northern forest of the world. These forests cover about 15% of the Earth's land surface. The trees in these forests are generally spruce, fir, pines aspen and alder. They like it cold. They actually

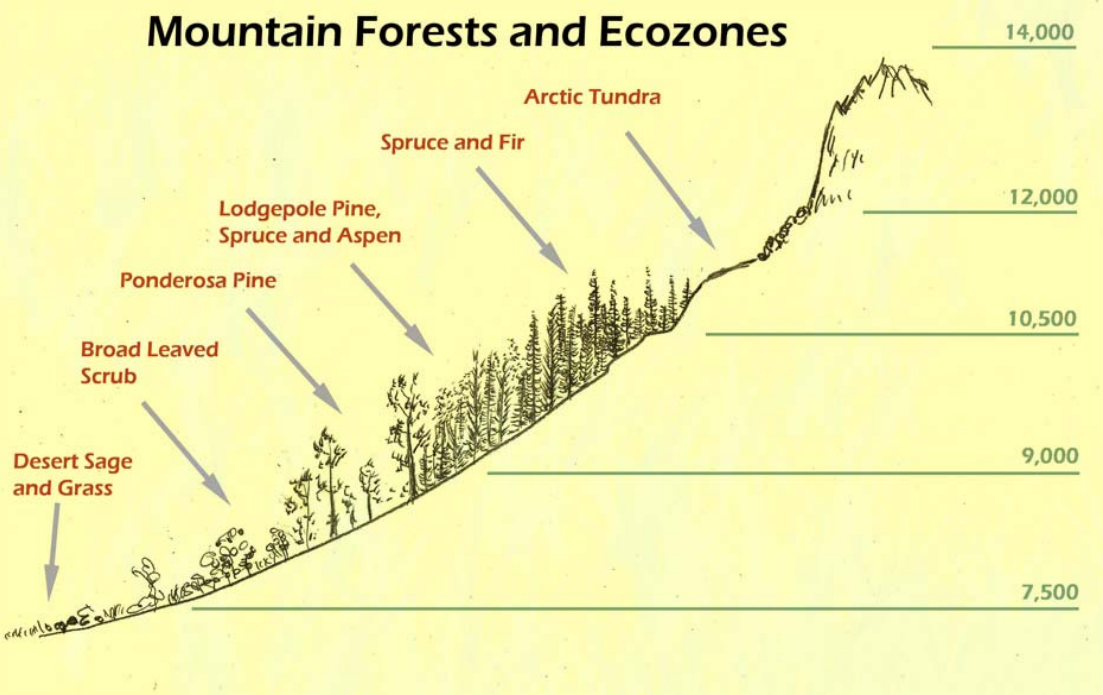
grow best when temperatures are less than 15 to 25 degrees above freezing. When it gets warmer than that, they suffer and don't grow as fast and become more likely to be infested by insects or disease.

The great mountain pine beetle pandemic in North America, responsible for the death of 37 million acres and 18.5 billion trees (according to the math of the US Forest Service Mountain Pine Beetle Incident Commander) since the mid 1990s, is a prime example of a warming forest ecosystem succumbing to insect infestation – in this case a great pandemic. Prominent drought in the North American West, and temperatures that are warming twice as fast as the planet's average (about 2.5 degrees F.) are responsible. With just this small amount of extra warming, and a very slight drought by prehistoric standards, we are seeing massive, unprecedented (in recorded history) die offs of forests. New studies have shown that the entire forest ecosystems of the world in northern latitudes have seen a doubling of tree death in the last decade or two.

When the details of the "tree death doubling" are seen, they don't seem so bad. The doubling is 1.5% death annually to 3% annually. But when one considers the long life of a tree and then realizes that as 3% die per year, every year, year after year, and that this rate is increasing, it becomes obvious fairly quickly that the average age of the forest, even without these completely devastating beetle pandemics, will be cut in half quite rapidly. This means a great deal for the forest ecosystem as a whole. But what means even more is *WHY* these trees are dieing.

Forest types vary markedly according to elevation. Air cools one degree F. for every 200 feet up the mountain. This explains why mountaintops retain their snow longer. It's not necessarily that the mountaintops get more snow, it is because more of the snow on them hangs around longer because it is colder.

The mountains themselves also help produce more snow and rain. As moisture rich air rises up a mountainside it can more easily be squeezed out for the clouds. So mountainsides are colder and wetter the higher up we go.



The individual distinct bands of vegetation can only grow where they grow because temperature and moisture conditions are exactly right for that mix of trees so that natural conditions allow them to grow there. They grow in environments with a difference of no more than one or two thousand feet in elevation. Because temperature changes one degree per 200 feet, there is no more than 10 degrees of temperature change where any one forest makes its home.

The Intergovernmental Panel on Climate Change (IPCC), the largest group of scientists in the world specifically studying climate change, projects a worse case scenario temperature change, on average across the planet, of 11.5 degrees by 2100. Polar areas and high altitude mountain areas will change more, if the response of the Rocky Mountains so far at double the world average holds true, then, like the Artic and Antarctic, we could see 20 degrees or more of temperature change in the Rockies by the year 2100. That is another 2 plus degrees every decade. These projections are based on various things, but one of the most important is carbon dioxide concentration in the

atmosphere. This most important of the greenhouse gasses plays a large part in determining what the average global temperature will be in the future.

The carbon dioxide concentration of our atmosphere today has unexpectedly skyrocketed to a 3% annual increase. This is higher than the all of the climate models worse case scenario. In reality this means that future warming will be even greater than the worse case climate model predictions.

The health of our forests today is beginning to show signs of temperature changes in a big way. If the temperatures change 10 degrees, complete forest will die and not be able to regrow because the temperature will just be too warm for them to survive. A ten degree warming will shift a forests habitat 2,000 feet up the side of the mountain. A 20 degree warming will shift the habitat up into space, somewhere above the top of the mountain. So in the future, things will likely be even worse that we understand that they are supposed to be.

Another compounding factor is mountain top ecosystems generally have very little soil and few places for forests to grow because of exposed rock and vertical terrain. Many of the forests of the world have no place to go on a warmer planet and they will simply vanish.

Feedbacks: Environmental Avalanches and Explosions

What most folks understand about climate today is that it is indeed changing and it will mean life is less than optimal at some point in the future. Very few people however know about climate feedbacks. Even scientists knew little about feedbacks a decade ago. Their existence was theorized but little had been published concerning “proof”. Today this assumption is a bit different. Scientists know a lot about some kinds of climate feedback, but not enough yet to include a whole lot about them in their supercomputer models. What they do is to state that these feedbacks are disregarded in their models. This, of course, limits the model’s results on the low side of reality, making them even more conservative.

These exclusions are necessary because the scientists cannot afford to be wrong. If they get too many things wrong, they lose their credibility; the academic journals quit publishing them and they perish (publish or perish is real).

The most famous of these exclusions is the IPCC discussions of "dynamical ice sheet changes" and future sea level. Dynamical ice sheet changes are things that we have never seen, but we know exist because scientific records show evidence of their existence. Sediment samples for the middle of the North Atlantic Ocean have sand and gravel in them transported from dry land that is far too heavy to have floated there. The only way for heavy particles to get out in the middle of the ocean is for them to hitch a rid on a melting iceberg. These layers repeat themselves occasionally and can be inches thick. This means that there were many times more icebergs in the North Atlantic than are imaginable under normal iceberg production that we see today. How did all of these icebergs come to be?

Vast iceberg armadas must have been released from the ice sheets in these "dynamical ice sheet changes". The smoking gun lies in what is called a marine ice sheet. A marine ice sheet is many thousands of feet thick and its bottom rests on rock below sea level. It is not an ice "shelf" where the whole ice mass is floating and the melting or disintegration of the ice shelf does not significantly affect sea level because 90 percent of the ice is submerged (like an ice cube in a glass of water).

In a marine ice sheet, many more times the volume of ice is above sea level than below. These ice sheets are very sensitive to sea level change and water temperature, much more so than ice shelves. It is theorized that they have been responsible for the fastest of the prehistoric sea level changes. The records of these extreme sea level rise events are found in ancient beaches across the planet, but the most reliably dateable occurrences are found in ancient corals.

Some corals can only grow within a few feet of sea level. When sea level changes rapidly enough, the growth of these corals cannot keep up and this can be seen in the coral growth records and these events can be dated. They have been found to match the dates when the great iceberg armadas created the layers of sand and gravel in the middle of the North Atlantic. The sea level rate change has been determined to be up

to 16 feet per century. But the finest resolution, or the greatest accuracy of the dating techniques, the smallest amount of time that researchers were able to ”see” in the coral records, is 100 years. The marine ice sheet disintegrations could have happened much faster.

There is one marine ice sheet left on the planet: the great West Antarctic Ice Sheet. It is now showing signs of instability. This could be an excellent example of a feedback explosion where an extremely dramatic unstoppable and irreversible world wide environment is changed in a very short period of time. Much more will be said about these implications later.

Ice discharged from Greenland, in the form of icebergs such as this one the size of a small town, has increased two to three times in about the last decade. This rate is increasing further and will not stabilize or decrease in the foreseeable future.

So what is this most famous instance of an explosive climate feedback being disregarded? The IPCC states no less than four times in their 2007 Assessment that

dynamical ice sheet discharges are not taken into consideration in their analysis of sea level rise.

There are many other areas where extraordinary impacts may be realized as feedback mechanisms kick in like the true catastrophic avalanches that they really are. But instead of seeing these ideas as precautionary and conservative, there are many voices in this world today that see this kind of discussion as destructive.

Wanton Disregard and Dangerous Intellect

Dissenting climate change voices often come from conservative or independent outlets that give little credence to issues related to environmental issues. They represent an extremely vocal and well moneyed minority. They take small pieces of real scientific data and skew them to meet their agendas. Whether this is done willfully or through ignorance and good intentions is disputed. I personally think that almost all of the dissension among those who do not see climate as a problem or threat is innocent and based on good intentions. But good intentions and $3.25 will only get you a fancy cup of coffee at Starbuck.

The US Senate Committee on Environment and Public Works has published a report that is an excellent example. Of course any report coming out of the Senate should be viewed as having authority. But in the climate change world, this is not the case. Very educated and respected persons have authority from the perspective of the general population. Weathermen should know about climate. Doctors of science, physicists, professors of evolutionary biology, all should know about climate science. And they do know – enough to be dangerous.

Climate science is the most complicated science ever known. It is a compilation of at least a dozen different major fields of science including physics, biology, geology, chemistry, oceanography, cryology, atmospheric physics, marine biology, sedimentology, botany, atmospheric chemistry, astronomy, paleo botany, plate tectonics and many, many obscure sciences like speleology - the study of caves or tempestology – the study of storms.

Climate scientists put all the puzzle pieces together. Findings are based on decades of work with other climate scientists concentrating on climate. Just because an educated person has the letters DR. before their name does not make them an appropriate reference for climate information. Meteorologists are an excellent example. Up until about five years ago there was very little global climate study required of

This terminal moraine is nearly 200 feet tall and several hundred years old. The ice cap should be towering over the moraine. But the Big Melt started and the ice cap began a very rapid retreat of greater than 30 vertical feet per year since about the end of the 20th century.

meteorologists in their college work. One of the most important maxims of climatology is that the weather is not climate. Climate is all weather averaged over very long periods of time. Climate discussions basically start at thirty-year averages. Weather discussions basically end at 30-day discussions. A common thread joins the two, but that common thread does not give a meteorologist any more knowledge about climate science than it gives a molecular biologist.

The study of weather fronts and the dynamics of low and high pressure and daily variation of continental wind patterns and temperature and precipitation just really have nothing to do with the climate of the planet, the one that we are talking about here.

Climate is the *results* of weather – lots of it over a long period of time. To a meteorologist, weather records are the results of weather. What a weatherperson cares about is today and the next week or month or the last time a weather record was broken. A climatologists is concerned about the last thirty years of all weather everywhere combined, at the minimum, and looks at the next thirty years as his or her forecast..

It is really important that this be understood. Some of the most revered authorities in the climate contrarian's tool bag are meteorologists. The differences between meteorology and climate cannot be emphasized enough. Of course there are more meteorologists out there that do indeed have decent knowledge of climate issues. But you will not find them arguing on the contrarian side of the issue.

The Senate Environment and Public Works Committee Report has 650 supporting scientists. Almost all of these scientists are not climate scientists. They might be smart, highly educated individuals, but their public comments show that they do not understand climate science, and they have published no academic papers about climate science almost across the board. Their academic credentials may be impeccable, but that just does not matter.

The hypotheses in the Senate Environment and Public Works Committee Report are created through impartial knowledge. They don't understand that they don't have the appropriate knowledge to be judging climate issues – they are dangerous intellects. They seem to have authority and they are using that apparent authority to persuade others. They have highly developed deductive resources and use these resources with bits and pieces of information to come up with plausible sounding but irrelevant assumptions about climate. Like my granddaddy used to say: "A good sounding idea is not always a good sound idea."

The standard discussion points, almost across the board for the climate contrarian just do not make sense when "real" climate science is used to evaluate the discussion points. It really takes very little research to find out why these hypotheses do not hold water. (There will be plenty of evaluation of these discussion points later on.)

As a good example: One of the popular anti-climate change blog that bases it's discussions on climate science, recently talked about the new data coming from Greenland's outlet glaciers. The data now show the recent increase in Greenland outlet glacier speed as a temporary trend that has now slowed. The trend is a part of a natural process that happens when a glacier surges. Surging has been common on glaciers since man started studying them but not to the extent that we are seeing in Greenland. The scientists who have made recent discoveries about glacial surge in Greenland are obviously spot-on in their findings; it is very difficult to get published if a scientist's findings are not understood according to known science.

These colossal icebergs are from the Jakobshavn Gletchier (glacier) in West Central Greenland. It is one of the fastest glaciers in the world with the highest ice discharge. From 1997 to 2004 the glacier doubled it's speed from 65 to 132 feet per day. Every year since 2004 the ice melt in Greenland has been higher than it was in 1997. All time record melts were set in 2005, 2007 and likely 2008.

Traditional science states that glaciers surge then return to their normal state until they surge again. This happens on glaciers everywhere. Because the glaciers in Greenland have slowed, this blog makes that information look like climate change is not responsible for the surge; that because the glacier's speed is still not increasing, climate

change could not possibly be responsible. This is a very compelling argument that does fall in line with accepted science - well not really.

What the blog then goes on to do is to vaguely fault the general assumptions of climate change science, vaguely deflate the validity of general climate change science and proclaim the agenda of the climate contrarian to be correct - that global warming, because of this new scientific finding is not a big factor in sea level rise (as was assumed by earlier studies) and is not caused by a warming planet.

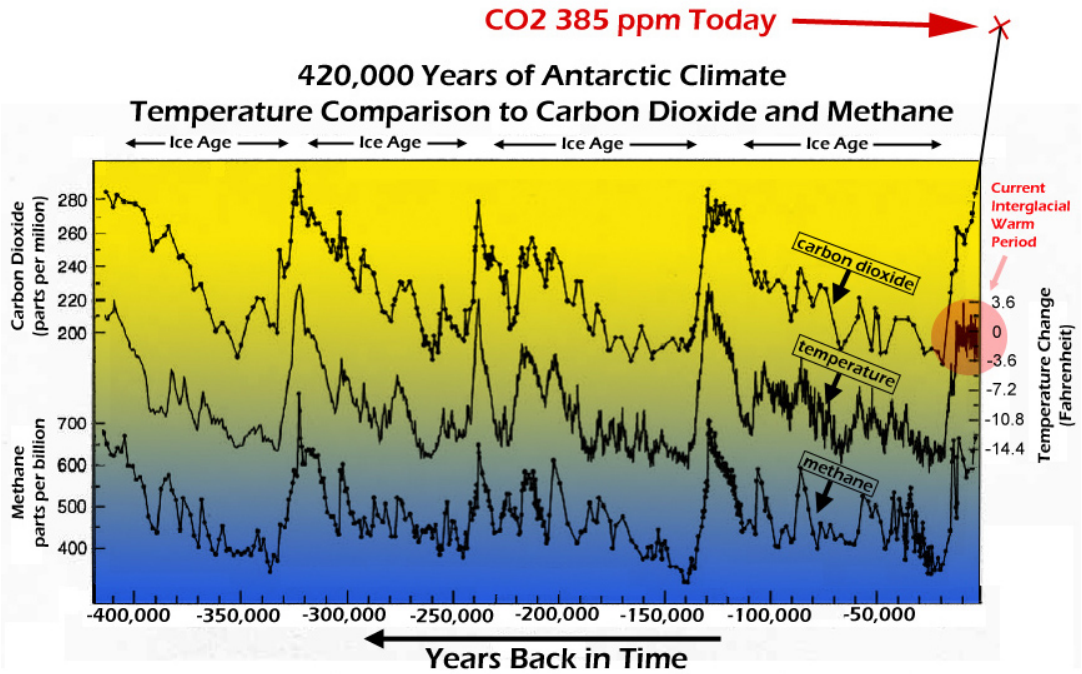
The paper says nothing about the magnitude of the recent glacial surges; about how big they are compared to known science (several glaciers were moving at 100 feet per day). It does not say why sea level is rising so rapidly and has not retreated to its pre-surge conditions like the Greenland Ice Cap glaciers have (and the Greenland glaciers have not retreated to their pre-surge rates, only slowed a bit). It says nothing about the possibility of these events happening more often in a warmer world, and it says nothing about the rapidly increasing rate of melting seen around the edges of the Greenland ice cap or the number of repetitive record melt years seen in Greenland in the last couple of decades and occurring more rapidly every year. To leave out the other pieces of the discussion is appropriate in scientific publishing, but misleading to the average consumer, not to mention, because of the public nature of the discussion, destructively suggestive of something that is not a reality. This is not a highly focused scientific report. It is supposed to be an all inclusive summary of climate science.

The Unbelievable Nature of the Beast

Massive changes in our climate have repeatedly happened in prehistory. Are they science fiction or science fact? No written records exist. The records that do exist are grounded in geology. They are the pages of prehistory in sediments and atmospheric deposition on ice and many other places where scientists can “read” the records from prehistory. These records are painstakingly extracted from every corner of the Earth by modern-day explorers.

They are looking at signs of our past climate as they were preserved in the ancient past. Chemistry is the basis for the understanding this history. Different amounts of this certain element or that can tell us about temperature or atmospheric gasses or ice volume on the planet. Dust in ice can tell us how windy it was which can be related to how cold it was. Rocks, gravel and heavy grains of sand, far out to sea, can tell us of great iceberg armadas unleashed into the oceans by other climate forces.

The slow, painstaking methodical industry of science "discovers" these things. The scientists who are conservative by nature - who perish professionally if they are wrong



Data Source: Petit, et.al., Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica, Nature Volume 399, June 1999, NOAA, National Climatic Data Center, Department of Commerce.

- these fundamental knowledge seekers, are the ones who tell us the unbelievable. They are the ones that tell us that temperature changes across the planet can be as great as 10 degrees F over a few decades or less and at the poles, three or four times that much.

The scientists are the ones who tell us things like: CO2 concentrations are far higher than they have been in a world similar to the one we live in today, and that they are rising far faster than at any time ever known.

These unbelievable things are trouble for some people (aye! most people!), they always have been. Society has a mental momentum that is difficult to overcome. This momentum is full of prejudices and preconceived notions based on past experiences. Many things in science have shown this momentum like microbial theory, relativity, ice age theory, the flat Earth… Our past is a driving force in our present and our future.

Authoritarian beliefs make the spread of new knowledge difficult at times because the beliefs of just a few leaders are conveyed to their followers because of trust. Those of faith understand that there is a divine overseer and do not understand how such extreme things could be allowed to happen to this world. Between 40% and 50% of US citizens believe in Creationism. How can world that is 10,000 years old be reconciled with 900,000 year old climate records? Pure ignorance can be blamed as well. New knowledge is a difficult thing to master. It often displaces prior knowledge in a way that is discomforting and unsettling. Common things are reassuring and new things can be difficult to place in to proper context. For some, anything from science is distrusted. Like an author I was recently reading said " I never learned how to read instructions." Some people just never learned how to understand science – any science. They turn off, disassociates, blink-out, their eyes glaze over the instant something science-like is said. There is also the negative propaganda. It exists. It happens because of greed and selfishness. It is easy for things to be unbelievable.

Climate Time Lag – The Thirty Year Plan

The "climate lag" is what the climate scientists refer to as "warming in the pipeline". Climate lags atmospheric gas changes by 30 years more or less. This means that our climate today, if we stopped emitting CO2 immediately, would still see big changes. We would likely see changes in temperature, that are as large as mankind has caused in the last several hundred years, continue for the next 30 years and likely even more. The most recent research shows that climate changes could persist for over a thousand

years. This happens because of the thermal inertia of the ocean and the slow and fast feedbacks that amplify small changes in climate (much more on these later). Most of the climate lag changes would happen fairly quickly within the 30-year time frame. But the most important thing to understand about our climate lag is that our planet today is operating on greenhouse gas concentrations form the 1970s (from 30-years ago). The climate we have today, because it reacts so slowly to because of the oceans and feedbacks, is just now catching up with the 70s.

Our planet has nearly doubled its population since the 70s and the average person today emits five times more CO2 than they did in the 70s. This means that green house gas emissions today, of just CO2, are ten times greater per year than they were in the 70s. Our climate has a lot of catching up to do in the next thirty years.

Every day many of us check the weather to see what to wear the following day. It is important on time scales that matter to us that we know to carry a coat, umbrella, wear a hat to block the sun, water the lawn, etc. On time scales important to climate, we as a society have very few things that matter. Business has even fewer – who ever heard of a 30-year balance sheet? Time frames of this length simply do not matter to the vast majority of our society. So there is simply no known mechanism to account for the climate lag.

Our scientists are telling us, but we do not know how to listen. Yet we plan for our children's college tuition 20 years ahead. We plan for our own retirements 30 or 40 years ahead. We plan for our transportation systems 30 years into the future, our water and wastewater utility systems, drinking water and electrical generation needs. But business has no thirty-year plan, and because climate doesn't matter to our coats, umbrellas, hats or lawns, there is no known mechanism for us individuals to plan for the climate lag.

The thirty-year balance sheet would exist in business if there were an incentive to plan that far in advance. But who can say what any given business model will look like in thirty years, and why? What is the financial incentive? Business today is by far driven by the financial incentive. With so many variables that change on yearly or at the most decade long cycles, how is a thirty year plan worked into the thought process?

The future value of money is just too low to have a "worth" today. The balance sheet says that the future value of money is relevant to the bottom line today. Business is driven by the bottom line. If the future value of an action is small, it carries a small value on the balance sheet. Priority is given to those items that have the greatest value today. Stock values and the public worth of an institution are present day considerations, or nearly so. If the future has a lower worth, it is not given as much value today and is treated with a lower priority than those things that are more "valuable".

If inflation says that a dollar today was only worth $0.32 thirty years ago, that dollar today has only one third of the value as a dollar did then and only one third of the priority because of the bottom line.

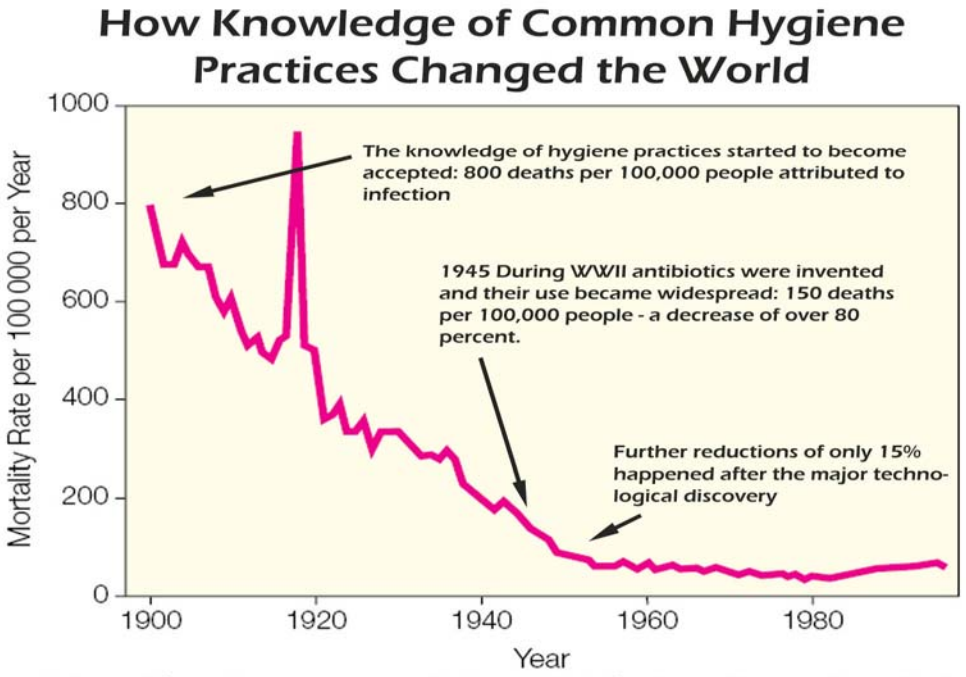
It hardly mattered what happened today, from a balance sheet bottom line standpoint in 1978, or what happens in 2038, from the same standpoint today. The value of planning for climate change has no meaning according to the normally functioning business balance sheet.

Germs, Tectonics and a Round Earth.

The unbelievable, no matter how true, is still unbelievable until understood. Why do people not believe unbelievable things that are true? When someone tells you that your neighbor's house just burned down you might say "No! You are kidding!" You do not believe your neighbor's house burned, even though it is true. Ignorance, propaganda, momentum, the things our trusted leaders tell us, what we saw with our own eyes just this morning, the way life has always been – all of these things are reasons not to believe something regardless of the factual nature of the thing being disbelieved. These unbelievable things are given less value, philosophically as well as monetarily. Science is full of examples of this happening.

Germ theory, plate tectonics, ice age theory, electricity, the telephone, the Internet – the examples are endless. In the mid 17th century, germ theory was first proposed. The theory stated that very small things, transmitted from an infected thing to an uninfected

thing, were the root cause for illness and disease. For centuries before this theory, the cause of disease was understood to be vapors or evil spirits. Doctors and physicians



Adapted from Armstrong, et. al., Trends in Infectious Disease Mortality in the United States in the 20th Century, Journal of the American Medical Association, January 1999.

treated their patients with this knowledge. They prescribed opening of windows, airing of bedding, religious practices, not frequenting or associating with places or persons known to associate with evil spirits and the purging of the body of evil spirits.

Patients were advised to seek better companionship, to go west to get pure air, to stay away from swamps and forests and dark places. Even 200 years after germ theory was proposed, these beliefs continued. After germs were proven to be infectious through direct contact in 1859, after being seen in the newly invented microscope, these beliefs persisted for 50 years. It was not until the turn of the twentieth century that hygiene practices were "discovered" to be methods for preventing disease. Hand washing, cleanliness in treating wounds, food storage practices and proper waste disposal all came into widespread use after 1900. Deaths from disease fell by 80% up until the

beginning of World War II. It was at this time that the first drugs were used to treat infection and antibiotics were invented. After World War II and the discovery of antibiotics, death from infection fell *only* another 15%. It was simple knowledge that changed the world.

Knowledge is the key

It might happen in the future, we know it has happened in the past – these abrupt climate changes. But how do we know it will happen in the future? How do we know what to believe?

Einstein's Theory of Relativity was published in 1905 and did not receive the Nobel Prize for 16 years. Lead, arsenic, blood letting, discharge of human waste and control of air pollution are just a few examples of things that we have learned about through science that we now understand much differently than we did before.

It took quite a while to see that lead, the most common element in paint for several hundred years, was a really bad thing to be putting into paint. It took several hundred years to learn that blood letting to fight disease was a total waste of time. How many years did it take for humankind to learn that the Earth was round, or that it was not the center of the universe? It took a long, long time, but these things were "discovered" fairly abruptly. Society "learning" them is what took so long.

We learned about ice age theory slowly. It took over 100 years for society to understand that giant ice sheets once covered vast parts of North America. We learned about ozone destruction very quickly however. The discovery of the ozone depleting reaction in 1974 prompted the US government to ban ozone depleting substances in aerosol cans in 1978. Then the ozone hole over the Antarctic was discovered in 1985. in 1987 the Montreal Protocol was adopted by 180 countries. It banned the vast majority of ozone depleting substances across the world. Today it appears that these bans might be working. Ozone destruction seems to have halted at about 30% of former concentrations and might be rising slightly. The Montreal protocol saved the ozone layer, but just barely.

Greenhouse gas poisoning of our atmosphere is a much bigger and much more complicated issue than ozone depletion. Impacts from greenhouse gas poisoning are at least as serious as from ozone depletion and much likely they are much more serious. Yet the alarm was first wrung in the late 1970s about greenhouses. Kyoto tried to get a good start towards resolving the greenhouse gas issues but was decimated by the US.

The reasons that knowledge takes a long time to be understood are numerous. Greenhouse gases have far more sources, and far more vested interests than ozone depleting substances. It was easy to control ozone depletion, both technically and politically. Carbon dioxide is completely different, more like the discovery of germ theory and the ensuing 300 years it took to invent antibiotics. Today's scientist know form the extraordinary number of new discoveries in science over the last half dozen years that our climate is now changing far faster than it was at the end of the 20th century.

Climate science is as difficult for society to understand today as germ theory or plate tectonics back in the day. So putting the new climate knowledge to work for society is taking some time as is usual. This would be acceptable if the new knowledge only meant that mankind would move forward be benefited by the science. The untreated impacts from manmade climate change however are far from being understood and even further from being acted upon. Further complicating things, the target is moving. It is getting further away, and the longer we wait to act, the further away it will get. Like ozone depletion, an atmospheric problem that was quickly acted upon, greenhouse gas poisoning of our atmosphere is an extremely bad thing to allow to continue.

Mega Reports

New knowledge in climate science is rapidly accumulating. New discoveries about our climate are being made today 1,000 times faster than they were being made in 1988. The pace is simply astonishing. Google Scholar lists 431,093 citations for "climate change" or " global warming" from 1964 through 2007. A citation is a reference to an individual academic report. The search was done for the exact words "climate change" or "global warming" in the *title* of the citation. The sources that Google Scholar uses

in its search are all scholarly; scientific journals, universities, government institutes and the like.

Google Scholar Citation Search 1964 through 2007		Citations per year
1964 through 2007	431,093	N/A
1964 through 1990	10,943	421
1991 through 2000	116,040	11,604
2001 through 2007	304,110	38,014

The Google Scholar search engine does return multiple listings per citation when those citations are listed separately at different institutions. So to give a references to these numbers, between 1993 and 2003, a search was done of the International Science Institute scientific clearing house database (Naomi Oreskes, 2004), that found nearly 1,000 individual papers with the words “global climate change” in the title. For the same period and same search, Google Scholar found 19,600 citations. The point of this exercise is not the number of scientific discoveries (although the numbers are staggering) it is the rate at which these discoveries are being made today as compared with the past.

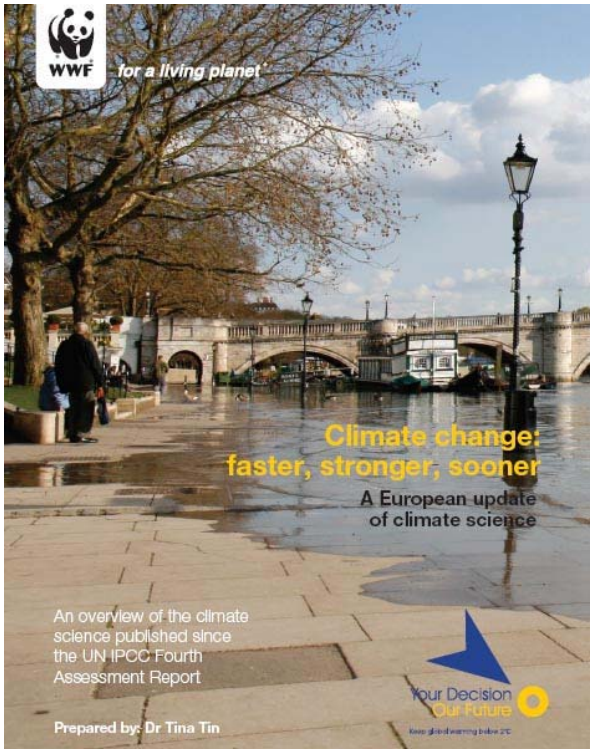
To get the approximate number of scientific papers divide by 20. So in 2007, there were almost 2,000 papers published with just the words “climate change” or “global warming in their titles. Now to give this number some scale, I checked the Table of Contents of the March 12, 2009 issue of Nature. I found 10 articles related to climate change and global warming. None of these articles had the words “climate change” or “global warming” in their titles. None of the articles even had any of the four individual words in their titles. The amount of research is simply staggering.

Another prime example of the amount of work being done on climate change is the International Polar Year that wraps up this month. The IPY focuses on the polar regions and climate change. Included under this massive polar science project are 459 projects from 63 countries totaling $2 billion. Each of the 459 projects will likely generate dozens of papers.

Complimenting the individual scientific papers are numerous mega-reports that summarize large numbers of papers about specific items dealing with climate change.

The following are examples of just six of these mega-reports:

- Intergovernmental Panel on Climate Change Fourth Assessment: (November 2007) 2500 expert reviewers (climate scientists), 800 contributing authors (climate scientists), 450 lead authors (climate scientists) from 130+ countries and 3,600 pages. This report summarizes virtually every single academic paper published on climate change from every country on Earth since the last report was published in 2001.

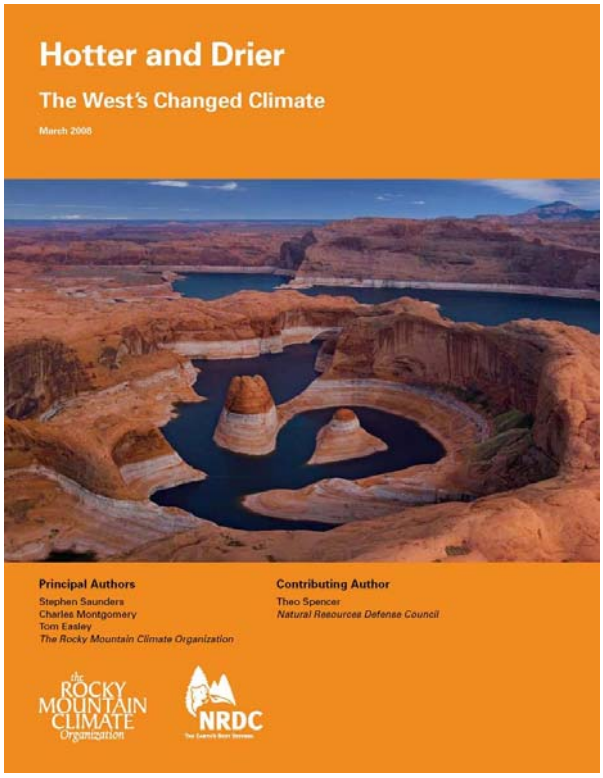


- Climate Change: Faster, Stronger, Sooner: World Wildlife Fund, (December 2007) – This study analyzed the relevant climate change publications, between 2006 and late 2007, that were made after the IPCC Assessment report stopped taking papers in 2006. Their findings were as stated in the title. The introduction to the report called the findings "sobering".

- Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region: (September 2008) U.S. Climate Change Science Program, US Geological Survey, (784 pages), finds that sea level rise of greater than 7 mm per year will result in loss of our barrier islands and coastal wetlands. Sea level rise today has rapidly risen through 3.3 mm per year from an average of 1.2 to 1.5 mm per year over the last 50 years.

- Arctic Climate Impact Science (ACIS): An update since the ACIA: (April 2008) This study finds that all Arctic ecosystems are changing. They are changing much faster and with greater impacts than previously found in the Arctic Climate Impact Assessment in 2005. Melting of Arctic Sea ice and the Greenland ice cap is accelerating severely and the report warns of these systems reaching irreversible and catastrophic tipping points.

- Hotter and Drier: (March 2008) A report by the Rocky Mountain Climate Organization, an group of 17 government agencies 17 private businesses and 11 non profits summarize the climate crisis in the American Rockies. In a sentence: all of the mature lodgelpole pine forests in the US Rockies, about 18% of the forests in the American West, will be dead in three to five years because of a climate change induced beetle infestation.



- Abrupt Climate Change: (October 2008) US Geological Survey, U.S. Climate Change Science Program (544 pages). Abrupt climate changes are likely to or very likely to happen or could already be occurring, especially if the climate models are correct. The report also acknowledges that the climate models are conservative.

- Past Climate Variability and Change in the Arctic and at High Latitudes: (October 2008) US Geological Survey, U.S. Climate Change Science Program (477 pages). Recent observations in the Arctic have identified large ongoing changes and

important climate feedback mechanisms that multiply the effects of global-scale climate changes.

This is not the Earth that Our Grandparents Grew Up With

Today our atmosphere is vastly different than from any time in the prehistoric past that matters. Before about three million years ago, the Isthmus of Panama did not exist and our planet had a different ocean circulation than it does today. The ocean is the great driver in Earth's climate. Consequently, because of the different ocean circulation, our climate was much different and behaved much differently than it does today. This was a time when there was only ice at the South Pole and then quite a bit less than there is today. The two mile thick Greenland Ice Cap simply did not exist - the climate was that much different then.

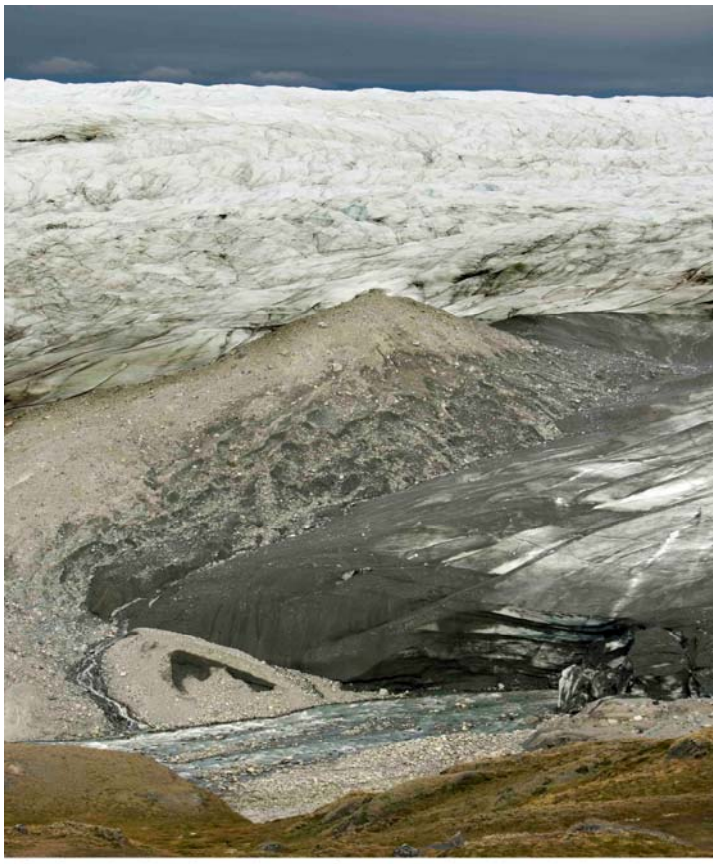
Once the Isthmus of Panama rose out of the ocean climate changed dramatically. The Pacific cooled and became less salty and Atlantic heated up and became saltier. We started having ice ages every 100,000 years based on astronomical cycles. The Earth's orbit changes ever so slightly around the sun during these cycles. This slight change in heat from the sun was enough to start feedback cycles that amplified climate changes that ranged from ice age cold to the interglacial warmth that we have today. These ice ages were peppered with abrupt climate changes of 10 degrees F or more averaged across the planet. In the last 100,000 years of the most detailed ice records collected, where annual climate changes can be clearly seen, there were at least 24 of these events, the largest of which happened in less than a decade and likely just a couple of years.

These abrupt climate changes meant extraordinary changes to Earth's climate, sea level and environmental living conditions across the globe. Changes of sea level of 16 feet per century have been recorded – devastating to a world today where one in ten is highly vulnerable to just 3 feet of sea level rise.

Ninety percent of an iceberg is underwater. Iceberg armadas may not be happening now, but they have occured repeatedly throughout prehistory. They happen when climate is changing the fastest. Today our climate is changing 100 times faster than ever seen before.

The industry of science is very conservative, and quite slow by what we as the public perceive as standards of technology. The aggressive technological swings that we see around us everywhere are the culmination of decades of work. Climate science is probably adjusting faster than any other known field of science because there is so much at stake, the risks are so high and the number of scientists working in the field is so vast, but results come from research slowly. Still the number of news climate discoveries is astounding. Communicating this much technologically advanced information to the public and our leaders is nearly impossible. The science is just too complicated and the "perceived" need or risk is too low.

Not too long ago, climate science was the domain of truly geeky scientists. Climate change was what we did in the winter when we escaped to Florida. What we did when we retired and escaped to Arizona or what we cursed when we had to ship the ice of the windshield before work in the morning.



The Greenland Ice Cap melts away from a centuries old terminal moraine. The river in the foreground is over 100 feet wide. This image was made at a place called Point 660 near Kangerlussuaq, on the west coast of Greenland, above the Arctic Circle.

Public perception has a huge blind spot. This blind spot is caused by several things. A poor understanding of basic climate science is part of the problem. Our scientists are wonderful scientists but they can not explain their scientific findings in normal language. Other reasons are these feedback mechanisms that are exploding unexpectedly all around us. The scientists were not ready for that. The public has even less knowledge than the scientists.

They were also not ready for our climate to be more sensitive than the scientists were assuming before, or maybe it is just the feedback mechanisms again. They weren't ready for their super computer climate models to be so conservative. Again – the feedbacks and climate sensitivity may be to blame. And the scientists were not ready for the political and business as usual propaganda of the climate contrarians.

This is all happening so fast that public discussion cannot keep up. You may have heard that some scientists are now saying that radically aggressive changes need to be completed by the year 2020 or 2030. We must be completely carbon emission free with our electrical generation or risk what the scientists call dangerous anthropogenic (man-caused) changes to our climate. Dangerous Anthropogenic Interference would be those irreversible, unstoppable unmentionables again. But just to be sure it is understood, Dangerous climate interference is something that will have significant global societal impacts. As-in life as we know it will never be the same.

References:

Read on for references. All of the topics covered above are discussed in greater detail in the balance of the book.