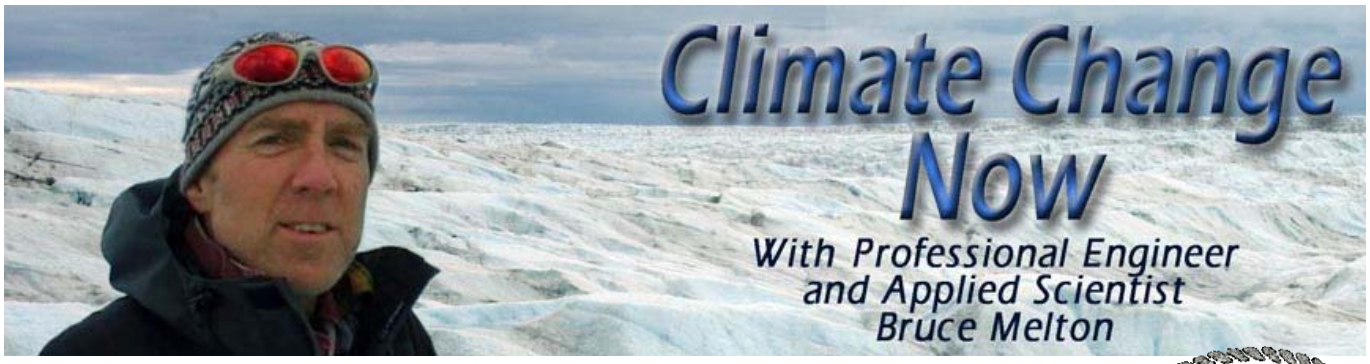

How Will We Know When Our Climate Has Changed Dangerously?

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Just exactly how will we know when our climate has changed dangerously? Well, how will you know when smoking kills you? Like smoking, it will not be difficult to tell when our climate has changed dangerously. Simple? So why is it that we continue to smoke? Do we think the Surgeon General is kidding? Do we think the IPCC is kidding? Or is it that the IPCC has not defined dangerous climate change well enough?

"Ah-hah" says the frustrated scientist who has beat his head against the wall trying to impress upon the public the implications of climate change; "Maybe they don't understand the definition of dangerous climate change?"

Let me then define dangerous climate change. Dangerous climate change starts thirty or fifty years ahead of time in the usual way. Our lives in developed nations are comfortable because of cheap energy. The warnings about CO2 emissions are impersonal and nothing that bad could really happen, not to me, not to us, it never has before. The atmospheric carcinogens build up for decades. The body of the planet is able to function without problems until, after a long, long time, the atmospheric pollutants that normally are not present in such quantities suddenly overwhelm the planet's ability to function. It happens quickly, in less than a decade, in a year or two.

Ecosystems that have evolved in a stable climate over thousands of years are suddenly thrust into an environment where they cannot survive. I am not talking about massive desertification – not right away. This is about a change of just a few degrees, on average. This is all it takes to push an ecosystem over the edge. It is happening right now in forests all across the Rocky Mountains. Insects and disease are having profound effects on virtually all of the forests in the West. Temperatures there have changed twice as much as global average temperatures, and that's enough. Fifty two million acres of trees are dead from one beetle infestation alone and there are dozens of different insect and diseases affecting a majority of the major species. Eighteen million acres were killed or significantly impacted in just 2008. This one major beetle infestation is twenty times larger than the last "biggest beetle infestation" to ever occur. The last "biggest" infestation ended in Alaska at about the turn of the 21st century. Three million acres of trees were killed then. The outbreak lasted ten years.

Coral reefs of the Caribbean are almost all dead. They are not *going* to die on a warmer planet. They are already dead. Eighty percent of all coral reefs in the Caribbean have had major species die-offs and

structural collapse. Waters have warmed just a degree, but this is enough. Add a few extreme bleaching events and the stresses become too high. The reefs did not evolve in a climate with these extremes. They were pushed over the edge like was projected for some point in the future, only it has already happened.

Nine of Canada's eleven caribou herds have collapsed. The Bluenose West herd in the Northwest Territories had a population of 80,000 at the turn of the century; it was under 20,000 animals in 2006. Northwest Territory biologists say that the Bathurst herd of the central barrens had fallen from over 120,000 animals in 2006 to 32,000. This is a loss of nearly 90,000 caribou in three years. An aerial survey could not even find enough of the Beverely herd to get statistically valid data for a cow/calf count. This herd of 280,000 in 1995 has almost completely disappeared.

Caribou herds have collapsed in the past, but now, temperatures in some parts of the Arctic have warmed five degrees in the last thirty years. The most dire foreshadowing of this academic journal article however is that the collapse of Earth's Caribou herds is only one of the first of many. The report warns (and this is quite uncharacteristic of a peer-reviewed academic journal article) that the Arctic, because of the polar amplification effect, leads the rest of the world in the impacts of climate change. What occurs in the Arctic today can be expected to occur across the rest of the planet in the future.

Arctic sea ice coverage has collapsed. We have all heard of the great loss of sea ice for the last several years. Five of the last five years have been the five lowest sea ice coverage records of all time. The latest research shows that Arctic sea ice has not been absent in the summer in 14 million years. Scientists studying ice-rafted sand grains in Arctic Ocean sediments have found that sand grains, too large to be transported by wind, were routinely rafted in shore ice that had broken away from shore. The sand grains fell from their ice rafts as they melted and formed a record in the ocean sediments below. Up until 14 million years ago there was evidence of this ice rafting in the Arctic Ocean.

Carbon dioxide is higher today than at any time in the last 15 million years. This new study looked at the boron/calcium and magnesium/calcium relationship of the tiny shells they found in their sediment cores. From the results, the oceanographers were able to determine the pH or acidity of the ocean water at the time the sea creatures died. There is a direct relationship between ocean acidity and atmospheric concentration of CO2, so the rest of the study was easy (sort-of). Interestingly, the time period between 15 and twenty million years ago saw CO2 levels only slightly higher than today. To exceed them significantly we have to look back 45 million years.

In another interesting note, that is again uncharacteristic of a peer reviewed academic journal article, the scientists mention that the last time that CO2 was as high as it is on our planet today, sea level was 80 to 130 feet higher.

On that note, sea level rise today has skyrocketed. Between 1950 and 1990, sea level rise was 1.2 mm to 1.5 mm per year. Between 1990 and 2000, sea level rise increased to about 2.0 mm per year. Between 2000 and 2006 it rose to 3.4 mm per year and by 2008 it was 3.7 mm per year. The latest analyses from the new super sensitive gravity satellites in 2009 show that sea level rise is accelerating 25 times faster today than it was for most of the 20th century, and increasing faster.

The U.S. Environmental Protection Agency (EPA), in collaboration with the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA), have a new mega report that looks at impacts from climate change. Their analysis of sea level rise shows that for low slope coastal areas (like most of the U.S.), the barrier islands and coastal wetlands will begin to disintegrate and disappear when sea level rise reaches 7 mm per year. The acceleration analysis done by Velicogna and her team shows that we will cross this threshold by 2014 to 2015,

There are 405 barrier islands on the Atlantic and Gulf Coasts of the U.S. totaling over 3,000 miles in length. There are 5.3 million acres of coastal wetlands. We are beginning to see the impacts from sea level rise happening now. Our beaches are almost gone and it is not just subsidence, storm erosion and beach starvation from inland dams.

All of this has happened with less than two degrees of warming (F). The climate scientists say that our CO2 emissions in the last several years have accelerated to worse than the worse case scenario, and that the worst-case scenario sees eleven or more degrees of warming by the end of the 21st century.

Is this dangerous climate change? Well it certainly is dangerous for the forests life forms, coastal life, wetlands, beaches, coral reefs and the caribou. But no, not really, this is not dangerous climate change - yet. It can get a lot worse, really quickly. Ecosystem collapse is a non-linear thing in general. That means that it happens in a hurry, like a population explosion. Ecological systems can absorb a tremendous amount of abuse for a long time. This is called assimilation – sort of like an alien society assimilating Earth's human population in a horror sci-fi flick. But, this is real. After pollutants in an ecosystem build and build they can suddenly reach a point where they can no longer be assimilated. Sort-of like that point where the skillet is left on the stove and the hot grease is just about to catch fire. The skyrocketing population explosion hits a wall – poof! The skillet catches on fire! The house burns down and the biosphere collapses. It happens all the time.

This is the major way that natural systems change. They cross a threshold and suddenly collapse. One moment it's water, the next, it's ice. Forests burn. Hurricanes strike. Volcanoes explode. Earthquakes collapse.

It is invisible until it happens and unlike a skillet on the stove, we don't know when our biosphere is about to collapse because our scientists have not yet found discovered these particular secrets. We know what dangerous climate change is, but we don not have a clue about when it will happen, what form it will take or how fast it will be. We do not understand the thresholds that will be crossed. How irreversible is irreversible? Will the planet's climate explode into the Venus Syndrome? Is there a warm climate state that is warmer than the one we are in right now? We just do not know. There is no evidence in the past (that we know of yet) that says that, given the increased solar irradiance and the continental configuration and present ocean circulation with two world oceans, that there is a warmer climate state than our climate today.

It is quickly becoming evident with the latest scientific discoveries that CO2 concentrations in the previous ancient warm climate states were not nearly as high as we thought they were in the 20th century. And since 2000, we have seen super computer model projection after supercomputer model projection fall one after another. The timelines are beat by decades, generations and even a century in the case of the beginning of Antarctic melt.

So the definition of dangerous climate change is this: It is that point at which our climate spirals out of control into biosphere collapse. It is the point beyond which there is no return. It happens quickly, there is no warning and it is final.

References:

Just a few degrees of change is all it takes to push an ecosystem over the edge… *Thresholds of climate change in ecosystems, U.S. Geological Survey, National Oceanic and Atmospheric Administration, National Science Foundation, U.S. Department of Agriculture, U.S. Forest Service, U.S. Department of Energy and the U.S. Environmental Protection Agency, U.S. Climate Change Science Program, January 2009.*

Fifty two million acres of beetle kill in the Rockies in 2008…
http://meltonengineering.com/North Americas mountain pine beetle pandemic 101708.pdf

Eighty percent of the coral reefs of the Caribbean are dead…
Paddack, et. al., Recent Region-wide Declines in Caribbean Reef Fish Abundance, Current Biology, April 2009.

Arctic sea ice coverage, 14 million years…
Loss of Sea Ice in the Arctic, US Army Engineering Research Center Cold Regions Research and Engineering, 2009
http://arjournals.annualreviews.org/doi/full/10.1146/annurev.marine.010908.163805

Canada's caribou herds collapse…
Vors and Boyce, Global declines of caribou and reindeer, Global Change Biology, May 2009
Post, et. al., Ecological dynamics across the Arctic associated with recent climate change, Science, September 2009.

CO2 higher than at any time in the last 15 million years… *Tripati, et. al., Coupling of CO2 and Ice Sheet Stability Over Major Climate Transitions of the Last 20 million years, Science Express ,October 8, 2009.*

Sea level rise and the 7 mm per year barrier island collapse threshold… *Velicogna, Increasing rates of ice mass loss from the Greenland and Antarctic ice sheets revealed b y GRACE, Geophysical Research Letters, October 2009.*
Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region, U.S. Environmental Protection Agency (EPA), in collaboration with the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA), 2009.

Worse than the worst-case scenario… *Intergovernmental Panel on Climate Change, Fourth Assessment Report, Working Group I, The Physical Science Basis, Summary for Policy Makers, 2007.*

Is there a stable climate state warmer than the one we are in when will the planet's climate runaway into the Venus Syndrome? *James Hansen, Bjerknes Lecture, American Geophysical Union Annual Meeting, San Francisco, December 2008.* http://www.columbia.edu/~jeh1/presentations.shtml

CO2 concentrations in previous ancient warm states were not nearly as high as we thought in the 20th century… *Pagini et. al., High Earth-system climate system sensitivity from Pliocene carbon dioxide concentrations, Nature Geoscience, January 2010.*

Antarctic ice melting 100 years ahead of projections… *Velicogna, Increasing rates of ice mass loss from the Greenland and Antarctic ice sheets revealed b y GRACE, Geophysical Research Letters, October 2009.*