

Update on Climate Change Debate

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I would like to bring you up to date on the climate debate post-Copenhagen and “Climate Gate”, the name for the climate misinformation that has surfaced over the past 6 months. It is clear that there is some climate fatigue out there but I assure you that it is not going to go away and will play an important part in our business over time. Prior to Copenhagen there were proposals in some shipping circles to provide a \$ 25.00 levy per ton of ship fuel to create a climate adaptation fund for developing nations – so it is important to keep a watch on this space.

I am an ocean scientist and it is important to recognize that the climate system relies a great deal on the ocean, which is the main, moveable heat of the planet. When we talk about weather we focus on the atmosphere. With climate, we focus on the ocean and its interaction with the atmosphere. There is as much stored heat in the top meter of the ocean than in the whole of the atmosphere (average depth of the ocean is 4000 m).

I believe that the only way out of the present climate situation is a business strategy. I think we need Governments to level the playing field for a price for carbon that accurately reflects the cost of either not putting it into the environment or putting it away. I believe, perhaps naively that if this were to happen, technologists, scientists, engineers and businessmen will get together and find ways to make this a reality. I don't think that there is an altruistic solution to the climate problem. No one will solve this for free.

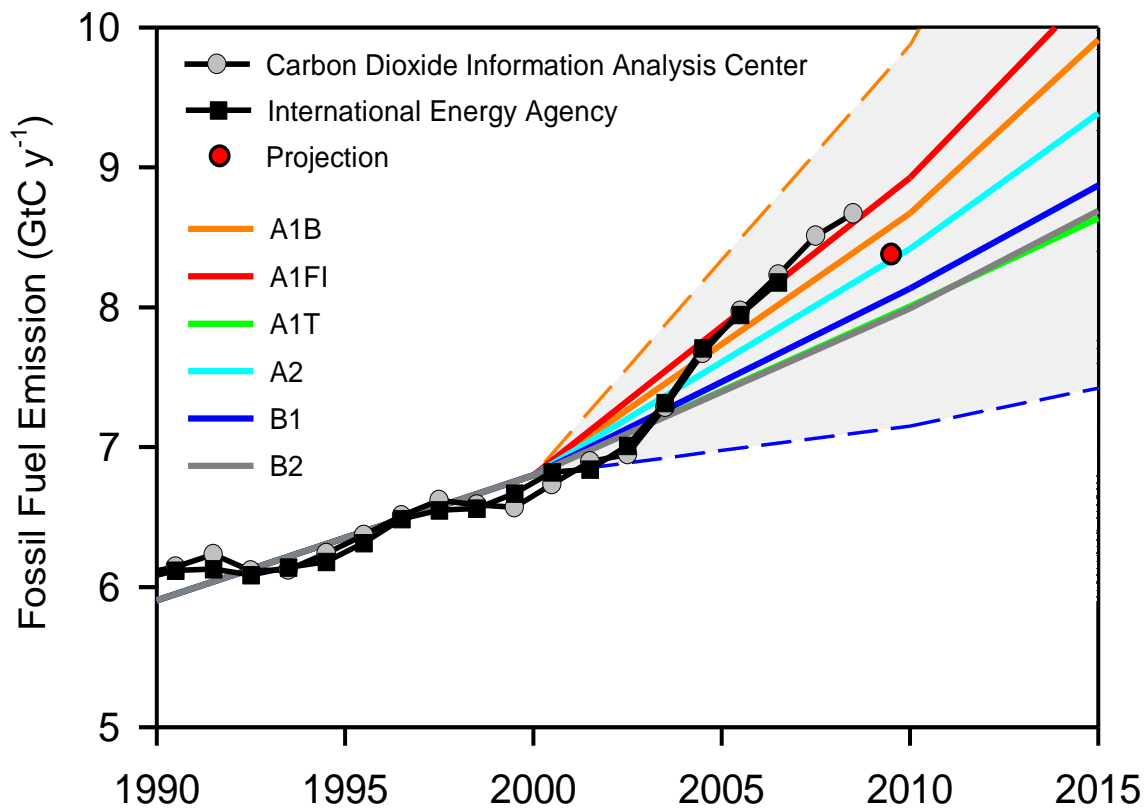
The International Panel for Climate Change (IPCC) has been charged with being the brain trust for climate for the governments of the world. It is made up of over 2000 earnest scientists and economists who mean well. Unfortunately, very recently a few of the IPCC's leading scientists made some very serious mistakes and I will highlight these in this talk.

Overall, climate change – or a better term climate instability is real and hopefully I will be able to convince you that this is the case without showing you one graph with temperature. Global warming was a media term and made famous by Vice President Gore – and perhaps not that representative of the problem. As the mean temperature of the earth changes – it will be warmer in some areas, cooler in others, dryer in some and wetter in others. I have been in Europe a few times recently and even in Moscow in minus 26 degree C everyone was hoping for a bit of global warming. Only a few months ago, in Vancouver they were trucking snow to the Olympics and dealing with very mild temperatures and rain – so where it was cold in parts of the US and Europe due to a very negative state of the North Atlantic Oscillation (-2.22), it was warm in other parts of the world.

First of all coal has now exceeded oil as the source of carbon with coal responsible for 42% and oil 36%. The total of man induced carbon is now 8.7 petagrams (billion tons) per year, 30 times the body weight of all the humans in the planet per year. The growth rate in carbon has been increasing in the atmosphere from 2 % per year until 3 years ago to now 3.4 %. Most of the carbon resides in the ocean and deep ocean sediments but recent data suggest that the sinks, or the capacity for the ocean and land to absorb carbon is decreasing. This means unless we stimulate the oceans and land to take up more carbon, more will end up in the atmosphere exacerbating the problem – more warming more instability.

About 12 years ago the IPCC came up with a few different scenarios about CO2 emissions related them to 2 -6 degrees C warming. We are right now ahead of the worst-case scenario. We must not forget that it was only 5 degrees C cooler during the last ice age.

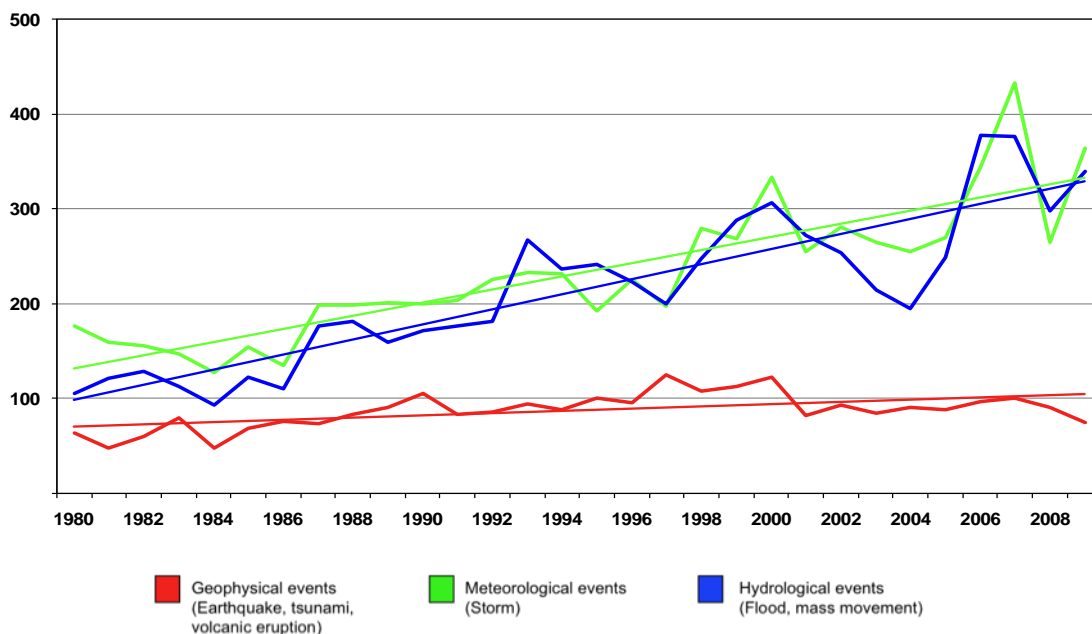
Projections of CO2 emissions to atmosphere in Billion tons per year as carbon



Over the last 6 months coupled with the colder winter in parts of North America and Europe a few well-placed scientists who were part of the IPCC process made a few mistakes in the very disciplined field of science. They suggested that all the Himalaya glaciers would melt by 2035. There was also the suggestion that Africa would be in drought by 2020 – not peer

review data - in fact the latest data suggest that rainforests seem to be more resilient to drought than first thought. They ignored a paper suggesting that there was no upward trend in natural disasters. However, Munich Re think differently and have shown increases in floods and storms over the years so this criticism has not been substantiated. But worst of all a few would not share their data with other including potential critics which negates the scientific process of peer review.

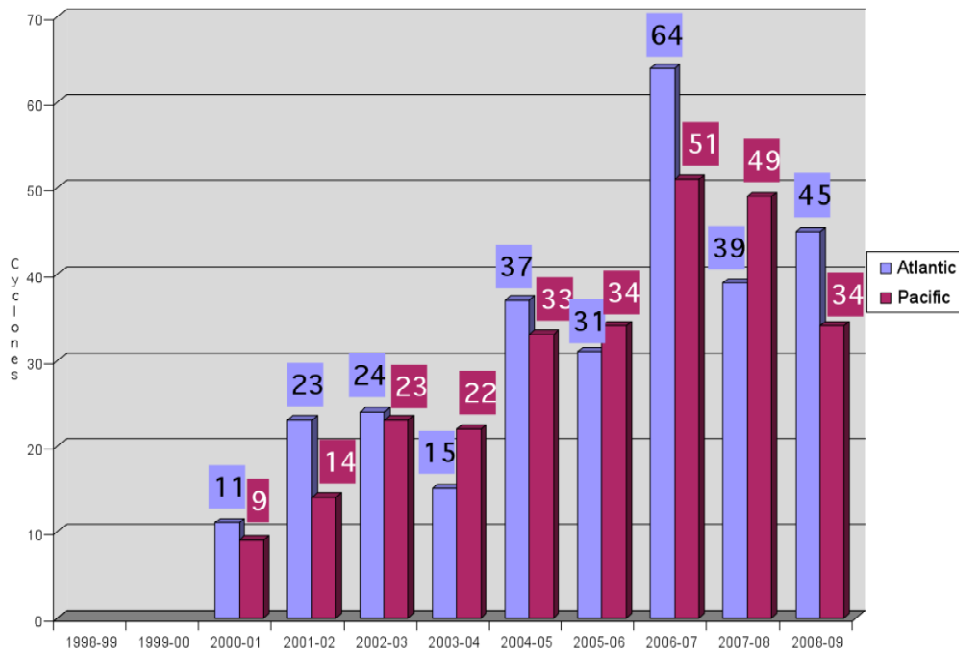
Increasing Trends of Annual Number of Geophysical, Meteorological and Hydrological Events, 1980-2009 (Munich Re)



Over the past few years we have seen a change in the saltiness of the ocean in the mid-latitudes and the equator with the poles getting fresher (less salty). As increasing temperature evaporates seawater and the earth has to thermodynamically

balance it rains more in the poles. In the Atlantic, the heat is moved poleward by the ocean and atmosphere there is the possibility that if the heat is not moved by the ocean – the atmosphere takes over. There are two major modes of poleward heat transport – winter storms and hurricanes. Hurricanes are very efficient tools to transfer heat. Satellites such as Quikskat are recording more powerful winter storms over time – it will only take time to determine whether increased storms over 60 knots as recorded by Quikskat in the Atlantic or Pacific are due to increasing observational skill or genuine changes in poleward heat transport. In Bermuda in 2010, we have seen a very rough ocean – and the degree of mixing in the ocean due to storminess has been greater than we have seen since we started collecting data some 55 years ago.

Quikskat Satellite derived storms over 60 knots in the Atlantic and Pacific Winters. Trend may still be due to better detection but time will tell.



Along with the transport of heat is the transport of water vapor. The humidity of at least the North Atlantic atmosphere has been changing due to increasing temperature and this translates into more rain per storm and increased potential for more powerful storms. Xynthia the winter storm that hit France a few months ago was an intense storm and initial results suggest that because SST's were warmer than normal, atmospheric humidity was high, this generated a more powerful storm. For insurers it hit during an unusual high tide and much of the damage was due to water and waves rather than wind – covered by the French Government. However, increased rainfall – per storm or downfalls – will be part of the future. I feel sorry for the operator of the Thames Barrier in London as he will become a schizophrenic, not knowing whether to raise the barrier to prevent water coming in due to storm surge or letting the barrier down to let the rainwater out!

Although “Climate Gate” has cast doubts on the temperature records of the world, we are seeing unprecedented changes in the chemistry of the ocean. As the CO₂ migrates into the ocean over time, this has changed the pH or acidity of the ocean due to increased carbonic acid concentration. This is really the smoking gun of mans impact on the planet as we never would have expected this occurring. Concerns are for all the areas of the world where calcification affects the biology of ocean organisms. In Bermuda, we believe that over the past few decades we have seen a change in the calcification rate of corals. For insurers who hold policies for island nations and countries such as Australia where coral reefs build a natural barriers to storms, the ability of these biological systems to repel sea level is decreasing. The reality of this issue globally is that we need to put CO₂ in the deep ocean- or in deep bore holes, but we need to do it without acidifying the oceans – a real challenge for technology. Trees alone will not solve the

problem as when they die the CO₂ is re-admitted to the atmosphere.

Where we are seeing an interesting trend is in global sea-level rise. Since the last ice age about 11,000 years ago the ocean sea-level has increased. Due to poor global coverage of sea-level measurements we are only beginning to see or understand the impact. I was unconvinced about SLR being an important indicator of change until a few years ago. We have gone from an average change of 1.4 mm per year, to 1.8 mm per year and in the last 6 years or so to 3.2 mm per year. This is a very small amount but as it is accretional it is very important. Small changes in the mean, have a large effect on extremes. In Fremantle, Australia a one in 5 year flooding event has now become a one in 2 year event due to sea-level rise. It surprises most that half of sea-level rise is attributed to changes in the expansion of the ocean between 0 and 750 meters depth. Recently we have seen warming in the ocean to 2000 meters so I believe that overall sea-level due to ocean expansion will be increasing very significantly over time. In fact where the sea-level models have failed is in the prediction of the effect of the changes in the earth's albedo (the reflectiveness of the earth surface). As one melts ice in the Arctic one creates a blue ocean and brown earth which now absorb rather than reflect sunlight due to the brightness of the snow. The positive feedback for melting increases rapidly. The IPCC suggested a sea-level rise of 40 to 60cm by the end of the century. New models suggest 1.2 to 1.4 m instead making hurricane prone areas such as Florida and the gulf coast a bit more vulnerable.

Florida with 1 Meter sealevel indicated in red.

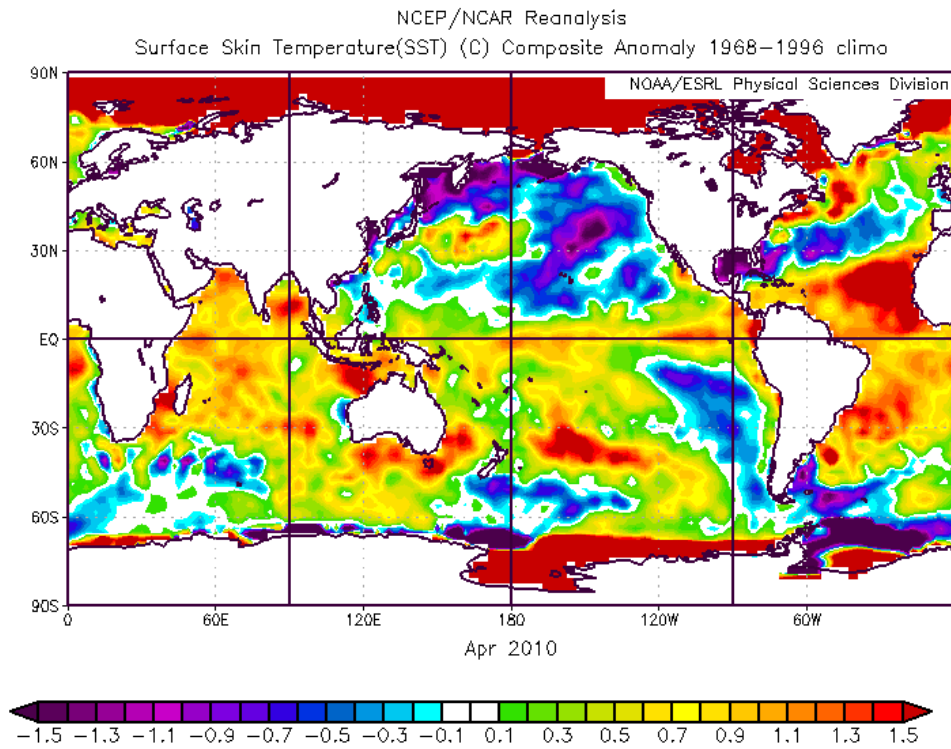


What are the concerns for the insurance industry? According to the Association of British Insurers, the cost of natural hazards to the industry under an enhanced climate scenario will increase the need for more capital. A study by the ABI a few years ago, suggest that under high emissions scenarios, we will need double the risk capital per storm. We may now be considering perhaps fewer in number but more powerful storms in the Atlantic. Increasing solar irradiation will increase the thickening of warm pools in the Atlantic, Pacific and Gulf of Mexico. Two recent papers, well reviewed have suggested that overall tropical cyclone numbers may decrease, but Cat 4 and 5

storms will increase by a factor of two – over time. No one knows what that time may be or whether the experts are correct but the issue of hypercanes should be a concern.

Certainly this season is predicted to be a strong hurricane season. The main development area in the Atlantic off Africa is warmer than ever recorded. The anomaly – or abnormal Sea Surface Temperature (SST) is 1.46 °C. The three years that it was close to this were 1969 with 5 intense storms, 2005 with 7 intense storms and 1958 with 5 intense storms giving an average of these three years of 15 named storms, 11 hurricanes and 6 intense. An average season is 10, 6 and 2 respectively. Whether this holds out over the season will be interesting but should it happen I would predict a lot of airborne oil in the Gulf of Mexico.

Main development area sea surface temperatures. Note the deep red off Africa.



In conclusion, I believe that global climate change is still a huge issue that we as a society are going to be faced with soon. If you don't believe me, this last slide is definitely pointing to a trend and can't be ignored.