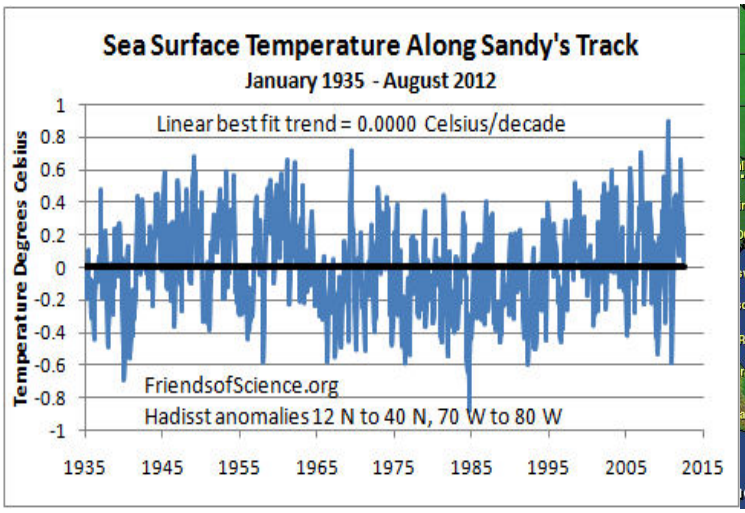
November 7, 2012 **Ken Gregory**

Carbon Dioxide Emissions Don't Cause More Severe Storms

Numerous stories have recently appeared in the media blaming human-caused carbon dioxide emissions on the super-storm "Sandy" without providing any empirical evidence to support the claim. Tropical hurricanes are powered by the sea surface temperature with the surrounding air uniformly warm and humid. Conventional storms outside of the tropics are powered by the temperature difference between colliding warm fronts and cold fronts. Sandy became a category 1 hurricane on October 24. It moved northward and encounters a high-pressure cold front from the north, which causes the storm to morph into a conventional but powerful storm. It turns northwest near noon on October 29 due to the cold front, was downgraded to a post-tropical storm and came ashore near Atlantic City, New Jersey. The storm caused over 70 deaths in the Caribbean and over 100 deaths in the USA. See here. By comparison, the Galveston category 4 hurricane killed about 8000 people.

The sea surface temperature anomalies from January 1935 to August 2012 in the region of the hurricane path are shown at below left. The data is from here. The storm track (from here) is shown at below right.



The sea surface temperature anomalies are from the Hadley Centre's Hadisst dataset in the region 12 N to 30 N, 70 W to 80 W, which encompasses the storm path. I used the same area as used by Bob Tisdale here, who first reported the lack of sea surface temperature change. The thick solid horizontal line is the linear best fit of the temperature series. It shows no warming trend since January 1935. The hurricane was not made more intense by a warming ocean. There was no warming. The August 2012 sea surface temperature was an insignificant 0.2 degrees Celsius (^{o}C) warmer than the long term average. The post-tropical storm size and intensity was caused largely by the intense cold front from Canada. Cold air can't be blamed on global warming.

The greenhouse effect is defined as the difference in temperature between the surface and the effective temperature of the upper atmosphere that results in outgoing radiation to space. An increase in

greenhouse gases from carbon dioxide emissions is theorized to cause an increase in this temperature difference resulting in global warming. The National Oceanic and Atmospheric Administration database shows an upper atmosphere temperature rise of 0.33 ^{o}C from January 1980 in the same region of Sandy's path as determined from the outgoing radiation measured by satellites. This is slightly less than the sea surface temperature rise of 0.37 ^{o}C over the same period. There has been no significant increase in the greenhouse effect (0.04 ^{o}C) in the area of Sandy's path since 1979 based on the best available satellite data.

Have storms become more intense on the USA east coast in recent decades? Researchers from Cornell University have studied the wind speed of northeastern storms from 1951 through 2006. The scientists, Bernhardt and DeGaetano, 2012, found, "There was no clear trend in speed during the time period, although considerable season-to-season variability was present." See here.

What about in Europe? The longest climate records in the world are in Europe. A study of European climate records by Reinhard Bohm, Vienna, Austria, in 2012 shows that the temperature and precipitation records of the last three decades were less variable than in earlier decades. See here and here.

A team of five scientists from Germany's Hamburg University evaluated measures of extra-tropical cyclone intensity from 1957 and they report "no significant trend could be found in [any] of the cyclones quantities". In their conclusions section, they note "The absence of a significant trend in the cyclone parameters for the whole North Atlantic is consistent with the findings of" other scientists who have explored the same issue.

Two scientists, Wallace and Anderson, from Rice University, Houston, Texas, collected 37 sediment cores within a lagoon on the Texas coast. The measured grain size and used radio-carbon dated to create a detailed history of hurricane events from 5300 to 900 years ago. Intense storms produce large grain sediments. They note during this period there was significant variation in climate. They write, "there has been no notable variation in intense storm impacts across the northwestern Gulf of Mexico coast during this time interval, implying no direct link between these changing climate conditions and annual hurricane impact probability. In addition, there have been no significant differences in the landfall probabilities of storms between the eastern and western Gulf of Mexico during the late Holocene, suggesting that storm steering mechanisms have not varied during this time."

The data shows that significant climate changes do not cause detectable changes in either the number of hurricane events or their intensity in the Gulf of Mexico. See here, here (World Climate Report).

This is consistent with the global and North American accumulated cyclone energy (ACE) index, a measure of the 2-year cumulative hurricane intensity and longevity, as determined by Dr. Ryan Maue, Florida State University. The current global and North American ACE are near the 30-year low and are about 58% of the 1993 values. See here.

What about storms further north? A team of five scientists from the East Carolina University studied sediment cores and ground penetrating radar data from the Outer Banks Barrier Islands, North Carolina.

They report, “the Medieval Warm Period and Little Ice Age were both characterized by elevated storm conditions as indicated by much greater inlet activity relative to today," and that in recent decades there has been "a general decrease in storminess at mid-latitudes in the North Atlantic," reflecting "more stable climate conditions, fewer storm impacts (both hurricane and nor'easter), and a decrease in the average wind intensity". See here.

Two researchers from the United Kingdom, Clarke and Rendell (2009), examined evidence of storm activity in the North Atlantic region, primarily from storm related sand movements. They found that the most intense storms occurred during the cold periods. The authors write, “There is evidence of periods of increased storminess during the Little Ice Age (AD 1570–1990).” They also state, "the Holocene record of sand drift in western Europe includes episodes of movement corresponding to periods of Northern Hemisphere cooling, particularly at 8.2 ka [thousand years ago], and provides the additional evidence that these periods, like the Little Ice Age, were also stormy." See here and here.

Three researches in 2012 reviewed a large number of recently available proxy records of North Atlantic storm activity over the last millennium, including sea salt in Greenland ice cores, sand movements, sedimentary records and Royal Navy ships' log books. They report that evidence of intense storm activity during the Little Ice Age and reduced storm activity during the Medieval Warm Period. Evidence of enhanced storm activity during the Little Ice Age was found from Northern Europe to the western Iberian Peninsula. See here and here.

How about tornadoes? Tornadoes develop from thunderstorms with very strong wind shear due to colliding warm and cold fronts. Most of the 20th century warming occurred in the high northern latitudes. Very little warming has occurred in the tropics because additional heat energy there is converted into ocean evaporation. So we would expect a warmer Arctic would result in fewer and less intense tornadoes due to the reduced temperature gradient. Indeed, the historical record shows a decline in the annual number of strong to violet tornadoes from 1950 to 2011. See here.

Of the 25 deadliest tornadoes in the USA, only one happened since 1955. See here. Of the 25 deadliest hurricanes in the USA, only two happened since 1955. See here.

The scientific evidence shows that there is currently less storminess than in cooler times, and that we should expect fewer and less intense storms with global warming. We are very lucky to be living at a time of relative warmth with mild storms.