STORM TRENDS ACROSS THE NORTH ATLANTIC OCEAN

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One of the projected consequences of CO_2-induced global warming is an increase in all types of extreme weather, including storms. A good test of the validity of this hypothesis comes from evaluating trends in storminess over the period of time when the Earth was recovering from the global chill of the Little Ice Age and transiting into the Current Warm Period, when the world's climate alarmists contend the planet experienced a warming that was *unprecedented over the prior one to two millennia*. In the present section, these claims are evaluated as they pertain to storms over of the North Atlantic Ocean.

Writing as background for their study, Bernhardt and DeGaetano (2012)[1] state that "East Coast Winter Storms (ECWS), commonly known as nor'easters, are among the most severe weather phenomena to impact the Northeastern United States," since "these storms may bring heavy precipitation (Frankoski and DeGaetano, 2011), strong winds, and flooding to coastal and interior areas of the eastern seaboard (Davis *et al*., 1993)." And with respect to their degree of "extremeness," they say that stronger storms generally move faster than weaker storms. However, they also write that "slow-moving storms can be especially problematic, as their extreme impacts may last longer, particularly in terms of storm surge and coastal flooding occurring over multiple tidal cycles." Therefore, it could validly be argued that either an increase or a decrease in the rate of a nor'easter's movement could be a sign of their becoming more extreme, which makes them the ideal type of storm for climate alarmists to use as an example of storms becoming more extreme in response to global warming; for the only way their claim could be refuted would be for the mean rate of movement of each year's set of nor'easters to be maintained - in the mean - over the long term.

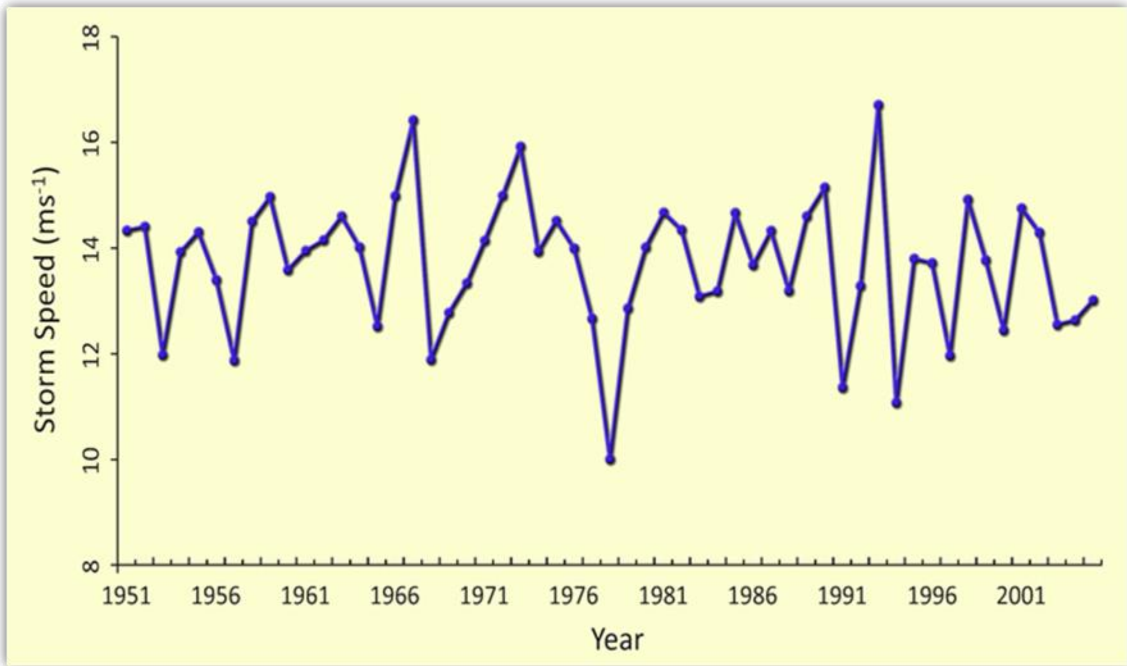
> *The global warming that occurred between 1951 and 2006 did not lead to an increasing trend in the extremeness of East Coast Winter Storms.*

Against this backdrop, Bernhardt and DeGaetano calculated the speeds of all ECWS over the 55-year period 1951-2006, using the criteria of Hirsch *et al*. (2001) to define "an ECWS as an area of low pressure with a closed circulation, moving in a general south-southwest to north-northeast direction and containing winds greater than 10.3 m/sec during at least one 6-hour period," which wind criterion was selected because "it represented a threshold for wave damage given by Thurman (1983)." In addition, the storms had to be located along the East Coast, in a box bounded at 30°N by 75 and 85°W and at 45°N by 65 and 70°W.

According to the two US researchers, their results indicated that "the speed of ECWS during their passage over or near the east coast of the United states varied substantially from storm to

[1] http://www.co2science.org/articles/V15/N36/C2.php.

storm, month to month, and season to season." *However*, as can be seen from the figure below, over the entire time period of their study, Bernhardt and DeGaetano rightly declare "there was no clear trend in ECWS speed," indicating that the global warming that occurred between 1951 and 2006 did not lead to an increasing trend in the extremeness of East Coast Winter Storms.



Average seasonal nor'easter storm speed. Adapted from Bernhardt and DeGaetano (2012).

Focusing on the past century, [Keim *et al*. (2004)][2] assessed the "temporal variability of coastal storms (both tropical and extratropical) and the wave climatology in the North Atlantic Basin (NAB), including the Gulf of Mexico." In doing so, the researchers report that "with both storm types, the empirical record shows decadal scale variability, but neither demonstrates highly significant trends that can be linked conclusively to natural or anthropogenic factors." And with respect to the wave climatology of the NAB, they say "the last two to three decades have been rougher at high latitudes than several decades prior, but this more recent sea state is similar to conditions from about 100 years ago."

In another study, based on surface pressure data for the period stretching from January 1874 to January 2008, which were obtained from eleven sites scattered throughout the northeast Atlantic region, [Wang *et al*. (2009)][3] computed -- and analyzed trends in -- the seasonality and regional differences of storm conditions characterized by 95th and 99th percentiles of geostrophic wind speeds, which they calculated from 3-hourly sea level pressure data over the period of time when the Earth recovered from the global chill of the Little Ice Age and transited into the Current Warm Period. Results of the analysis revealed that storminess conditions in the

[2] http://www.co2science.org/articles/V8/N15/C2.php.
[3] http://www.co2science.org/articles/V13/N13/C1.php.

study region "have undergone substantial decadal or longer time scale fluctuations, with considerable seasonal and regional differences." With respect to *annual* percentiles of geostrophic wind speeds for *the entire study region*, however, they state that "the Kendall test identifies a *downward* trend of at least 5% significance in both the 99th and 95th percentile series [italics added]."

Expanding the temporal domain of analysis a bit further back in time, Hanna *et al*. (2008)[4] employed the dp(abs)24 *pressure-variability index*, which is defined as "the absolute 24-hourly atmospheric surface pressure variation at a location," to study its temporal variability over the past 160 years via data obtained from "long-running meteorological stations in Denmark, the Faroe Islands, Greenland, Iceland, the United Kingdom, and Ireland," after first showing that the index is "significantly related to wind speed and is therefore a good measure of Atlantic and Northwest European storminess and climatic variation."

Hanna *et al*.'s results showed, as they describe it, "periods of relatively high dp(abs)24 and enhanced storminess around 1900 and the early to mid-1990s, and a relatively quiescent period from about 1930 to the early 1960s, in keeping with earlier studies." However, they report "there is little evidence that the mid- to late nineteenth century was less stormy than the present, and there is *no sign* [italics added] of a sustained enhanced storminess signal associated with 'global warming'." Such a finding, in the words of the researchers, "lends a cautionary note to those who suggest that anthropogenic greenhouse warming probably results in enhanced extratropical storminess, as this is indicated neither by our own nor existing published observational results for the northeast Atlantic for the last ~150 years."

Investigating the topic over a much longer time period, Dawson *et al*. (2003)[5] developed and analyzed relationships between temperature and storminess via Greenland ice-core $\delta^{18}O$ data (which

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4 http://www.co2science.org/articles/V12/N15/C1.php.
5 http://www.co2science.org/articles/V7/N42/C2.php.

correlate with temperature) and Na^+ (sea-salt) concentration data (which correlate with North Atlantic winter storminess) over the period AD 1000 to 1987. In doing so, Dawson *et al*. report that "it is extremely rare to find any year during the last thousand when high Na^+ concentrations coincided with extremely warm years," additionally noting that "the highest Na^+ values are associated with years that were exceptionally cold." They also report that "inspection of the data set for the Medieval Warm Period (here incorporating the time interval AD 1000-1400) indicates that there were very few winters during this period when high Na^+ concentrations are recorded." However, "as Mayewski *et al*. (1993) demonstrated," according to Dawson *et al*., "storm frequencies increased markedly after AD 1400."

In one final study, Trouet *et al*. (2012)[6] write that "an increasing number of high-resolution proxy records covering the last millennium have become available in recent years, providing an increasingly powerful reference frame for assessing current and future climate conditions." Thus, they proceed to search the scientific literature for evidence pertinent to their climate modeling concern, which also happens to be pertinent to the concern about global warming and what it does or does not imply about concurrent storminess. And what did their search reveal?

Among other things, the three researchers report that (1) "the content of marine-source ssNa aerosols in the GISP2 ice core record, a proxy for storminess over the adjacent ocean through the advection of salt spray [ss], is high during the LIA with a marked transition from reduced levels during the MCA [hereafter MWP] (Meeker and Mayewski, 2002; Dawson *et al*., 2007)," (2) "the onset of the LIA in NW Europe is notably marked by coastal dune development across western European coastlines linked to very strong winds during storms (Clarke and Rendell, 2009; Hansom and Hall, 2009)" and often inundating local settlements and therefore with supporting archival evidence (Lamb, 1995; Bailey *et al*., 2001)," (3) "a number of studies of Aeolian sand deposition records from western Denmark exist that have recorded a period of destabilization of coastal sand dunes and sand migration during the LIA and have ascribed it to a combination of increased storminess and sea-level fluctuations (Szkornik *et al*., 2008; Clemmensen *et al*., 2001; Aagard *et al*., 2007)," (4) "similar records and interpretations are available for the British Isles (Hansom and Hall, 2009) and Scotland (Gilbertson *et al*., 1999; Wilson, 2002)," (5) "in an analysis of Royal Navy ships' log books from the English Channel and southwestern approaches covering the period between 1685 and 1750 CE, Wheeler *et al*. (2010) note a markedly enhanced gale frequency during one of the coldest episodes of the LIA ... towards the end of the Maunder Minimum [MM]," (6) "this late phase of the MM is also registered by the deflation of sand into the ombrotrophic peat bogs of Storemosse and Undarmosse in southwest Sweden (De Jong *et al*., 2006)," (7) "more evidence for increased storm severity during the

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[6] http://www.co2science.org/articles/V15/N36/C3.php.

MM is provided by an archive-based reconstruction of storminess over the Northwest Atlantic and the North Sea (Lamb and Frydendahl, 1991)," (8) "increased storm activity during the LIA was not restricted to northwestern Europe, but was also recorded further south along the Atlantic coast in The Netherlands (Jelgersma *et al*., 1995) and northern (Sorrel *et al*., 2009) and southwestern France (Clarke *et al*., 2002)," and (9) "sedimentary records of LIA coastal dune accretion have also been found further south on the French Mediterranean coast (Dezileau *et al*., 2011) and in the western Iberian Peninsula (Borja *et al*., 1999; Zazo *et al*., 2005; Clarke and Rendell, 2006)."

Given the findings noted by Trouet *et al*., as well as those reported by other researchers that are described in this summary and for this particular portion of the planet, it is clear that relative *coolness*, as opposed to relative warmth, typically leads to more extreme storms, which is just the *opposite* of what the world's climate alarmists continue to contend.

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