Atlantic Basin Hurricane Response to Increases in Temperature

Does global warming lead to either more frequent or more intense Atlantic basin hurricanes?

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ATLANTIC BASIN HURRICANE RESPONSE TO INCREASES IN TEMPERATURE

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How does the frequency of occurrence of Atlantic basin hurricanes respond to increases in temperature?

In exploring this question within the context of the warming that occurs in going from cooler La Niña conditions to warmer El Niño conditions, Wilson (1999)[1] analyzed data from the last half of the 20th century, finding that the probability of having three or more intense hurricanes was only 14% during a (relatively) warm El Niño year, but fully 53% during a (relatively) cool La Niña year. Two years later, Muller and Stone (2001)[2] conducted a similar study of tropical storm and hurricane strikes along the southeast U.S. coast from South Padre Island (Texas) to Cape Hatteras (North Carolina), using data from the entire past century. For tropical storms and hurricanes together, they found an average of 3.3 strikes per La Niña season, 2.6 strikes per neutral season, and 1.7 strikes per El Niño season, while for hurricanes alone the average rate of strike occurrence ranged from 1.7 per La Niña season to 0.5 per El Niño season, which represents a frequency-of-occurrence decline of fully 70% in going from cooler La Niña conditions to warmer El Niño conditions. Likewise, Elsner *et al.* (2001)[3] -- who also worked with data from the entire past century -- found that when there are below-normal sea surface temperatures in the equatorial Pacific, "the probability of a U.S. hurricane increases."

For tropical storms and hurricanes together, they found … a frequency-of-occurrence decline of fully 70% in going from cooler La Niña conditions to warmer El Niño conditions.

Lyons (2004)[4] also conducted a number of analyses of U.S. landfalling tropical storms and hurricanes, dividing them into three different groupings: the 10 highest storm and hurricane landfall years, the 9 lowest such years, and all other years. These groupings revealed, in Lyons' words, that "La Niña conditions occurred 19% more often during high U.S. landfall years than during remaining years," and that "El Niño conditions occurred 10% more often during low U.S. landfall years than during remaining years." In addition, it was determined that "La Niña (El Niño) conditions were 18% (25%) more frequent during high (low) U.S. landfall years than during low (high) U.S. landfall years."

1 http://www.co2science.org/articles/V3/N3/C3.php.
2 http://www.co2science.org/articles/V5/N6/C1.php.
3 http://www.co2science.org/articles/V5/N14/C1.php.
4 http://www.co2science.org/articles/V7/N31/C2.php.

An analogous approach was used by Pielke and Landsea (1999)[5] to study the effect of warming on the intensity of Atlantic basin hurricanes, using data from the period 1925 to 1997. In their analysis, they first determined that 22 years of this period were El Niño years, 22 were La Niña years, and 29 were neither El Niño nor La Niña years. Then, they compared the average hurricane wind speed of the cooler La Niña years with that of the warmer El Niño years, finding that in going from the cooler climatic state to the warmer climatic state, average hurricane wind speed dropped by about 6 meters per second.

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Independent confirmation of these findings was provided by Pielke and Landsea's assessment of concurrent hurricane damage in the United States: El Niño years experienced only half the damage of La Niña years. And in a ten-year study of a Mediterranean waterbird (Cory's Shearwater) carried out on the other side of the Atlantic, Brichetti *et al.* (2000)[6] determined -- contrary to their own expectation -- that survival rates during warmer El Niño years were actually greater than during cooler La Niña years.

In another pertinent study, Landsea *et al.* (1998)[7] analyzed the meteorological circumstances associated with the development of the 1995 Atlantic hurricane season, which was characterized by near-record tropical storm and hurricane activity after four years (1991-94) that had exhibited the lowest such activity since the keeping of reliable records began. They determined that the most important factor behind this dramatic transition from extreme low to extreme high tropical storm and hurricane activity was what they called the "dramatic transition from the prolonged late 1991-early 1995 warm episode (El Niño) to cold episode (La Niña) conditions."

A few years later, Elsner *et al.* (2004)[8] found in a 20th-century changepoint analysis of time series of major North Atlantic and U.S. annual hurricane counts -- which in the words of its authors, "quantitatively identifies temporal shifts in the mean value of the observations" -- that "El Niño events tend to suppress hurricane activity along the entire coast with the most pronounced effects over Florida."

As for why North Atlantic hurricane activity is suppressed under warmer El Niño conditions, Donnelly and Woodruff (2007) opined that it was "due primarily to increased vertical wind shear in strong El Niño years hindering hurricane development." Such a conclusion is supported

[5] http://www.co2science.org/articles/V2/N20/C3.php.
[6] http://www.co2science.org/articles/V4/N10/C2.php.
[7] http://www.co2science.org/articles/V5/N20/C1.php.
[8] http://www.co2science.org/articles/V7/N33/C1.php.

by the results of two analyses conducted by Klotzbach. In his first paper, Klotzbach (2011a)[9] examined Caribbean tropical cyclone activity over the period 1900-2008, looking for impacts from the El Niño-Southern Oscillation (ENSO) and the Atlantic Multidecadal Oscillation (AMO); and in doing so, he found that "the probability of one or more hurricanes and major hurricanes tracking through the Caribbean increases dramatically from 39% and 26% in the 10 warmest ENSO years to 92% and 63% in the 10 coldest ENSO years, respectively," in harmony with the similar findings of Tartaglione *et al*. (2003), who additionally demonstrated that this cooling-induced response was likely due to "reductions in vertical wind shear and increases in low-level vorticity" in La Niña conditions. This connection was also demonstrated by Klotzbach, who determined that "for the 10 warmest events since 1948, the average 200-850-mb zonal wind shear in the Caribbean was 7 m/s compared with only 3 m/s in the 10 coldest events since 1948."

The Colorado State University researcher also determined that "the impacts of ENSO are reduced slightly when the AMO is positive," and he found that "a negative AMO phase and El Niño combine to provide large-scale climate features that are especially hostile for tropical cyclones." He reports, for example, that "29 hurricanes tracked into the Caribbean in the 10 strongest La Niña years in a positive AMO period compared with only two hurricanes tracking through the Caribbean in the 10 strongest El Niño years in a negative Atlantic multidecadal oscillation period." Similar findings were reported in Klotzbach's second paper (2011b[10]), which expanded his analysis beyond the Caribbean and throughout the Atlantic basin.

In addition to the growing body of empirical evidence that indicates global warming has little to no impact on the intensity of hurricanes, there exists model-based evidence for the same conclusion.

In addition to the growing body of *empirical* evidence that indicates global warming has little to no impact on the intensity of hurricanes, there exists *model*-based evidence for the same conclusion. Vecchi and Soden (2007)[11], for example, explored "21st Century projected changes in VS [vertical wind shear] over the tropical Atlantic and its ties to the Pacific Walker circulation, using a suite of coupled ocean-atmosphere models forced by emissions Scenario A1B (atmospheric CO_2 stabilization at 720 ppm by year 2100) for the Intergovernmental Panel on Climate Change 4th Assessment Report (IPCC-AR4)," where VS was defined as "the magnitude of the vector difference between monthly-mean winds at 850 hPa and 200 hPa," and where "changes are computed between two 20-year periods: 2001-2020 and 2081-2100."

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[9] http://www.co2science.org/articles/V14/N19/C1.php.
[10] http://www.co2science.org/articles/V14/N19/C2.php.
[11] http://www.co2science.org/articles/V10/N28/C2.php.

Results of the model-based analysis revealed that the 18-model ensemble-mean projected change in VS over the 21st Century is "a prominent increase in VS over the topical Atlantic and East Pacific (10°N-25°N)." Noting that "the relative amplitude of the shear increase in these models is comparable to or larger than model-projected changes in other large-scale parameters related to tropical cyclone activity," they state that the projected changes "would not suggest a strong anthropogenic increase in tropical Atlantic or Pacific hurricane activity during the 21st Century," and that "in addition to impacting cyclogenesis, the increase in SER [shear enhancement region] shear could act to inhibit the intensification of tropical cyclones as they traverse from the MDR [main development region] to the Caribbean and North America."

Global warming does not lead to either more frequent or more intense Atlantic basin hurricanes. In fact, it generally does just the opposite.

In light of these several findings, the obvious conclusion to be drawn from the results of these several studies is that global warming does not lead to either more frequent or more intense Atlantic basin hurricanes. In fact, it generally does just the opposite.

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Cover photo of Hurricane Dennis passing over Florida
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