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The #Frankenstorm in Climate Context

By ANDREW C. REVKIN - October 28, 2012

As communities from the Carolinas to Maine brace for high storm surges, winds and downpours, there's a growing climate discussion building around #Frankenstorm, which is the favored Twitter handle for the extraordinarily vast and potent nor'easter that is evolving as Hurricane Sandy, already a killer, collides with an Arctic cold front.

You can track specific developments in and around New York here and follow the details of the storm's track and impacts via Jeff Masters, the Capital Weather Gang and Weather.gov.

But what is the role, if any, of greenhouse-drive global warming in this kind of rare system?

It's easy to say, as some climatologists have, that "climate change is present in every single meteorological event." As you'll hear below, some climate scientists are telling me this event is precisely what you'd expect following a summer in which much of the Arctic Ocean was open water.

But there remains far too much natural variability in the frequency and potency of rare and powerful storms — on time scales from decades to centuries – to go beyond pointing to this event being consistent with what's projected on a human-heated planet.

[*At the bottom of the post, I've appended an excerpt from a highly relevant 2002 Nature paper.] [*Adam Frank posted a great piece on the NPR blog on other factors complicating this question.]

While the echo of Frankenstein in that Twitter moniker can imply this is a human-created meteorological monster, it's just not that simple.

There are several areas in which greenhouse-driven warming is thought to be a potential influence. The first is in the buildup of heat in southern surface waters. A paper published earlier this month in the Proceedings of the National Academy of Sciences was the latest to draw this conclusion, in this case through detailed analysis of storm surges recorded by Atlantic coast tide gauges:

> We find that warm years in general were more active in all cyclone size ranges than cold years. The largest cyclones are most affected by warmer conditions and we detect a statistically significant trend in the frequency of large surge events (roughly corresponding to tropical storm size) since 1923.

But on longer time scales, the situation is murky because so many factors shape the formation and growth of tropical cyclones. I wrote in 2007 about a Nature paper by Jeff Donnelly of the Woods Hole Oceanographic Institution and others. Here's the core conclusion:

> Over the last 5,000 years, the eastern Caribbean has experienced several periods, lasting centuries, in which strong hurricanes occurred frequently even though ocean temperatures were cooler than those measured today, according to a new study.

That's the Caribbean, of course.

What about the Northeast? Here's Hurricane Sandy. Last year was Hurricane Irene and then there was Hurricane Floyd in 1999. But when you look back in time in this region, big questions arise about just what constitutes a superstorm.

As I've written before, the great tropical storm and floods that devastated Vermont in November 1927 (and after Irene) appear to have been minor compared to repeated past hill-scouring superfloods, according to an important study of lake-bed sediments revealing storm patterns and intensities in recent millenniums.

Here's the lede from my story on that paper, published one decade ago:

> Four times since the last ice age, at intervals roughly 3,000 years apart, the Northeast has been struck by cycles of storms far more powerful than any in recent times, according to a new study. The region appears to have entered a fifth era in which such superstorms are more likely, the researchers say.

The other questions related to human-driven climate change are focused on the impact of reduced Arctic sea ice on Northern Hemisphere weather patterns. Jennifer Francis of Rutgers and Judith Curry of the Georgia Institute of Technology are among researchers who've reported evidence of links between open Arctic waters in summer and more turbulent winters (although both say it's still uncertain where around the Northern Hemisphere the rougher weather will be focused after an ice-reduced summer).

I've sent a query to a batch of meteorologists and climate scientists focused on various aspects of the connection between broader climate conditions and

extremely powerful Atlantic Ocean storms. Francis was the first to weigh in, on the sea ice connection and the questions raised by the 2002 paper on past periods of storminess:

> The jet stream pattern — particularly the strongly negative NAO [North Atlantic Oscillation] and associated blocking — that has been in place for the last 2 weeks and is projected to be with us into next week is exactly the sort of highly amplified (i.e., wavy) pattern that I'd expect to see more of in response to ice loss and enhanced Arctic warming. Blocking happens naturally, of course, but it's very possible that this block may have been boosted in intensity and/or duration by the record-breaking ice loss this summer. Late-season hurricanes are not unheard of either, but Sandy just happened to come along during this anomalous jet-stream pattern, as well as during an autumn with record-breaking warm sea-surface temperatures off the US east coast. It could very well be that general warming along with high sea-surface temperatures have lengthened the tropical storm season, making it more likely that a Sandy could form, travel so far north, and have an opportunity to interact with a deep jet-stream trough associated with the strong block, which is steering it westward into the mid-Atlantic. While it's impossible to say how this scenario might have unfolded if sea-ice had been as extensive as it was in the 1980s, the situation at hand is completely consistent with what I'd expect to see happen more often as a result of unabated warming and especially the amplification of that warming in the Arctic.
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> I haven't read the entire Noren paper yet, but it does not surprise me that severe flooding in the northeast could be linked with periods of negative AO [Arctic Oscillation]. When the AO is negative, the jet stream tends to be wavier, just like the situation we're in now, which favors slow-moving weather systems that can cause floods. Losing ice, reducing the poleward temperature gradient, and warming the entire climate system should contribute to increasing the likelihood of anomalous storms.

I'll be adding more perspectives as they come in.

Martin Hoerling, a meteorologist at the National Oceanic and Atmospheric Administration focused on the forces influencing extreme weather, sent this note:

> Great events can have little causes. In this case, the immediate cause is most likely little more that the coincidental alignment of a tropical storm with an extratropical storm. Both frequent the west Atlantic in October…nothing unusual with that. On rare occasions their timing is such as to result in an interaction which can lead to

> an extreme event along the eastern seaboard. As to underlying causes, neither the frequency of tropical or extratropical cyclones over the North Atlantic are projected to appreciably change due to climate change, nor have there been indications of a change in their statistical behavior over this region in recent decades (see IPCC 2012 SREX report).
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> So, while it will rain like “black cats and Frankenweenies” over the midatlantic, this is not some spell conjured upon us by great external forces….unless you believe in the monster flicks of Universal Stuidios fame!

Kevin Trenberth of the National Center for Atmospheric Research offered these thoughts (I’m adding links to explain some of the acronyms):

> The sea surface temperatures along the coast are 5 degrees F. or more above average and 1 degree F. is from global warming. Stronger storm and more precipitation results.
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> But with respect to the Arctic connection, I don’t believe it. Yes the NAO and NAM have gone negative: the NAO since about the middle of October, and it is projected to go back to close to zero in a week or so: heading to more positive now. The NAO and NAM (or AO as some call it) are natural modes of variability. They occur in models with no external forcings and just climo SSTs. The SAM in the Southern Hemisphere is similar in that regard and the SAM has been affected by the ozone hole and perhaps CO2 to make for a more positive sign. This is clear. So the natural mode can be influenced by externalities. There are several possibilities in the Northern Hemisphere. One may be the Arctic sea ice melt, another might be ozone depletion and certainly events in the stratosphere (including solar effects). To the extent that cooling in the Southern Hemisphere makes for a more positive phase of SAM, one might argue that warming in the Northern Hemisphere works the other way, but it is far from clear. NAO and NAM can do this all by itself. How less sea ice does anything is not clear. It does mean air is apt to be warmer and moister and with prospects for more snow on nearby land in the Fall. But the actual heating of the atmosphere is very small to cause it to do anything.
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> The studies published on this report associations that, to me, do not tell us cause and effect.It is true that hurricanes normally recurve and head east, especially at this time of year. So we do have a negative NAO and some blocking anticyclone in place, but the null hypothesis has to be that this is just “weather” and natural

> variability. The more definitive study on effects is by Balmaseda et al in QJRMS last year. [*There's more from Trenberth here.]

Here's a thought from Patrick J. Michaels, the climatologist best known for his work for the libertarian Cato Institute:

> By any standard, this is an impressive cyclone for our latitude. You might want to check Ludlum's "Early American Hurricanes" for the Snow Hurricane of 1804, which was earlier and a bit further north — but NYC showed a pretty similar barometric pressure. Are you familiar with his great series of books on pre-1900 weather?

Alluding to my line about variability excluding any global warming link beyond saying the storm is consistent with projections, Michaels wrote this:

> It's also consistent with a planet with colder temperatures as well as one with warmer ones. More important, events like this are inevitable on a planet that has an ocean with the geography of the Atlantic (meaning a Gulf Stream-like feature), a large north-south continent on its western margin without a transverse mountain range to inhibit the merger of tropical warmth with polar cold, and four seasons in the temperate latitudes. And I predict confidently that we will survive Sandy, which should not be a tropical cyclone at landfall.

This is an excerpt from "Millennial-scale storminess variability in the northeastern United States during the Holocene epoch," the 2002 paper using lake-bed sediment cores from around the Northeast to generate a Holocene history of storminess:

> Climate models suggest that human activities, specifically the emission of atmospheric greenhouse gases, may lead to increases in the frequency of severe storms in certain regions of the Northern Hemisphere. However, the existence of natural variability in storminess confounds reliable detection of anthropogenic effects.
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> During the past ~600 years, New England storminess appears to have been increasing naturally. This rhythm in storm frequency may explain some of the recently observed increases in extreme precipitation events. If the pattern of millennial-scale variability that we documented through the Holocene persists into the future, New England storminess would continue to increase for the next ~900 years. Because climate synopses compiled from instrumental records cannot distinguish underlying natural increases in storminess from anthropogenic effects, detected increases in

> contemporary storminess may not be a reliable indicator of human-induced climate change.

In the meantime, don't forget there's an upside in all of this, as USA Today is reporting in this article: "Hurricane stocks to watch as Sandy roars up coast." [When written on Sunday, this was intended as a gentle jab at such reporting, but I realize it can be interpreted as non-ironic.] As we wait for the power to go out here in the Hudson Valley, I don't find it easy to focus on the bright side.

[*Material above that's marked with an asterisk was added after publication.]

Here's a closing view of the storm, highlighting its water vapor content:

http://www.youtube.com/watch?v=5FCsOTwR1xE&feature=player_embedded