Recipe for a storm: The ingredients for more powerful Atlantic hurricanes

November 29 2007

This satellite image composite shows Hurricane Floyd off the Atlantic coast in 1999. UW-Madison researchers Jim Kossin and Dan Vimont have established a connection between an atmospheric circulation pattern known as the Atlantic Meridional Mode and the strength of Atlantic hurricanes. Image: courtesy Cooperative Institute of Meteorological Satellite Studies

As the world warms, the interaction between the Atlantic Ocean and atmosphere may be the recipe for stronger, more frequent hurricanes.

UW-Madison scientists have found that the Atlantic organizes the ingredients for a powerful hurricane season to create a situation where either everything is conducive to hurricane activity or nothing is — potentially making the Atlantic more vulnerable to climate change than

the world's other hurricane hot spots.

After the 2004 and 2005 hurricane seasons, many worry what Atlantic hurricane seasons will look like in a warmer world. Evidence indicates that higher ocean temperatures add a lot of fuel to these devastating storms.

In a paper published today, Nov. 29, in the "Bulletin of the American Meteorological Society," co-authors Jim Kossin and Dan Vimont caution against only looking at one piece of the puzzle. "Sea surface temperature is a bit overrated," says Kossin, an atmospheric scientist at UW-Madison's Cooperative Institute of Meteorological Satellite Studies. "It's part of a larger pattern."

Kossin and Vimont, a professor in the Department of Atmospheric and Oceanic Sciences, noticed that warmer water is just one part of a larger pattern indicating that the conditions are right for more frequent, stronger hurricanes in the Atlantic.

The atmosphere reacts to ocean conditions and the ocean reacts to the atmospheric situation, creating a distinct circulation pattern known as the Atlantic Meridional Mode (AMM). The AMM unifies the connections among the factors that influence hurricanes such as ocean temperature, characteristics of the wind and moisture in the atmosphere.

Finding that a basin-wide circulation pattern drives Atlantic hurricane activity helps explain evidence of significant differences in long-term hurricane trends among the world's basins.

In a study published last February, Kossin and his co-authors created a more consistent record of hurricane data that accounted for the significant improvement in storm detection that followed the advent of weather satellites. An analysis of this recalibrated data showed that

hurricanes have become stronger and more frequent in the Atlantic Ocean over the last two decades. The increasing trend, however, is harder to identify in the world's other oceans.

Kossin and Vimont wanted to determine why long-term trends in the Atlantic looked different from those in other basins, particularly in the Pacific, where the majority of the world's hurricane activity occurs. "The AMM helps us understand why hurricanes in the Atlantic react differently to climate changes than those in the Pacific," Vimont says.

According to Vimont, the other oceanic basins have their own modes of variability. Understanding how factors vary together provides a new framework from which to consider climate change and hurricanes. "Our study broadens the interpretation of the hurricane-climate relationship," Vimont says.

Looking at the larger set of varying conditions provides a more coherent understanding of how climate change affects hurricane activity. In the Atlantic, warmer water indicates that other conditions are also ideal for hurricane development.

However, in the Pacific, a hurricane-friendly environment goes along with cooler ocean temperatures in the area where the storms spend their lives. The inconsistent relationship with sea surface temperature leads Vimont and Kossin to conclude that the connection between hurricane activity and climate variability hinges on more than just changes in ocean temperatures.

"You can never isolate one factor on this planet," Kossin says. "Everything is interrelated."

Depending on the other conditions hurricanes care about, warmer oceans can mean different outcomes. Concentrating on how the atmosphere and

the ocean work together helps hurricane researchers see the bigger picture. Because higher sea surface temperatures in the Atlantic act in concert with the AMM, Vimont and Kossin suggest that Atlantic hurricanes will be more sensitive to climate changes than storms in other ocean basins.

In addition to helping researchers understand and predict the effects of climate change on hurricane activity, Vimont and Kossin can forecast the AMM up to a year in advance.

If the AMM is positive, all the conditions are right for hurricane development. If it is negative, those living on the coasts can generally expect a quieter hurricane season. Vimont and Kossin plan to further develop their AMM forecasts for use during the hurricane season.

The duo also hopes to continue to research the physical relationships that constitute the AMM as well as how future climate change will affect these modes of climate variability.

Source: UW-Madison, by Jennifer O'Leary