

## **Atlantic hurricanes and global warming**

Kevin Trenberth  
NCAR  
23 January 2008

How hurricanes change as the climate changes is a critical issue. The devastation caused by Katrina in August 2005 indicates what is at stake. However, the past record is troubled by inadequate observations, especially prior to about 1970 when satellites came along. There is large natural variability. Hurricanes are not simulated realistically in global climate models. And theoretical understanding is still developing.

The latest contribution to the scientific literature by Chunzai Wang and Sang-Ki Li, published in *Geophysical Research Letters* on Jan 23, 2008 rightly points out the global competition for where hurricanes occur. The Atlantic has only about 10% of the total number of tropical storms; most occur over the Northwest Pacific Ocean where they often threaten the Philippines, China, and Japan. In the northern hemisphere, the other main regions are the eastern Pacific off Mexico, and the Indian Ocean. But as more favorable conditions develop in one of these basins, it typically has an adverse effect on storms in other basins owing to related changes in the global tropical atmospheric circulation, and in particular the wind shear. Developing vortices in the atmosphere typically get blown apart before they can become strong storms if the low- and upper-level atmospheric winds are not in synch. Wind shear is the phenomenon where winds aloft are either different in direction or strength than those near the surface.

Other important factors include the sea surface temperatures and atmospheric water vapor, which are related to the sources of fuel for the hurricanes, in the regions where storms form. Hence when conditions are more favorable in the Pacific, such as during El Niño events, hurricane activity is suppressed in the Atlantic. This situation occurred in 2006 and 1997 (the most active year globally on record). Similarly, on the occasions where sea temperatures are high in the Indian Ocean and that region is favorable for convective activity, as happened in 2007 (witness cyclone Sidr that made landfall in Bangladesh as a devastating category 4 hurricane in November), hurricane activity is less in the Atlantic. In contrast, in 2005 the Atlantic Ocean reigned and brought with it a record breaking hurricane season.

With global warming, sea temperatures and water vapor are increasing and expected to increase further, generally making the environment more favorable for tropical storm activity. But how the expected increase in activity is manifested is less clear. Current understanding is that the intensity and perhaps the size will increase, but the number may actually decrease, as one powerful storm saps the energy from the ocean much more than several smaller storms. But the other key issue is where will the storms go? In particular will they make landfall?

Wang and his colleague weigh in on this by relating their statistics to land-falling storms. The trouble is that the latter are so few in number that they are not reliable indicators of activity. Considerable controversy on this topic, highlighted in work by Chris Landsea and countered by articles by Greg Holland and Michael Mann that point out why use of land-

falling storms is misleading. Unfortunately, several works related to these aspects are not accounted for by Wang and Lee, and their conclusions on this point are suspect. Their trends on wind shear are also highly suspect, again owing to changes in information as satellites became available in the 1970s that were not accounted for. Accordingly, Wang's conclusions do not account for the back-to-back record number of Atlantic land-falling storms in 2004 and 2005.

Nevertheless, Wang and Lee correctly recognize that the spatial distribution of warming matters, and they highlight an important issue both scientifically and for the potential effects on society.

For a discussion of tropical cyclones and climate change see

Trenberth, K. E., 2007: Warmer oceans, stronger hurricanes. *Scientific American*, July, 2007, pp 45–51.

<http://www.sciam.com/article.cfm?chanID=sa006&colID=1&articleID=26648CBA-E7F2-99DF-3CB0746D5B44B707>