How strong is a hurricane? Just listen

April 10 2008

Knowing how powerful a hurricane is, before it hits land, can help to save lives or to avoid the enormous costs of an unnecessary evacuation. Some MIT researchers think there may be a better, cheaper way of getting that crucial information.

So far, there's only one surefire way of measuring the strength of a hurricane: Sending airplanes to fly right through the most intense winds and into the eye of the storm, carrying out wind-speed measurements as they go.

That's an expensive approach-the specialized planes used for hurricane monitoring cost about $100 million each, and a single flight costs about $50,000. Monitoring one approaching hurricane can easily require a dozen such flights, and so only storms that are approaching U.S. shores get such monitoring, even though the strongest storms occur in the Pacific basin (where they are known as tropical cyclones).

Nicholas Makris, associate professor of mechanical and ocean engineering and director of MIT's Laboratory for Undersea Remote Sensing, thinks there may be a better way. By placing hydrophones (underwater microphones) deep below the surface in the path of an oncoming hurricane, it's possible to measure wind power as a function of the intensity of the sound. The roiling action of the wind, churning up waves and turning the water into a bubble-filled froth, causes a rushing sound whose volume is a direct indicator of the storm's destructive power.

Makris has been doing theoretical work analyzing this potential method for years, triggered by a conversation he had with MIT professor and hurricane expert Kerry Emanuel. But now he has found the first piece of direct data that confirms his calculations. In a paper accepted for publication in Geophysical Research Letters, Makris and his former graduate student Joshua Wilson show that Hurricane Gert, in 1999, happened to pass nearly over a hydrophone anchored at 800 meters depth above the mid-Atlantic Ridge at about the latitude of Puerto Rico, and the same storm was monitored by airplanes within the next 24 hours.

The case produced exactly the results that had been predicted, providing the first experimental validation of the method, Makris says. “There was almost a perfect relationship between the power of the wind and the power of the wind-generated noise,” he says. There was less than 5 percent error-about the same as the errors you get from aircraft measurements.

Satellite monitoring is good at showing the track of a hurricane, Makris says, but not as reliable as aircraft in determining destructive power.

The current warning systems are estimated to save $2.5 billion a year in the United States, and improved systems could save even more, he says. And since many parts of the world that are subject to devastating cyclones cannot afford the cost of hurricane-monitoring aircraft, the potential for saving lives and preventing devastating damage is even greater elsewhere.

“You need to know, do you evacuate or not?” Makris explains. “Both ways, if you get it wrong, there can be big problems.”

To that end, Makris has been collaborating with the Mexican Navy's Directorate of Oceanography, Hydrography and Meteorology, using a meteorological station on the island of Socorro, off Mexico's west coast.

The island lies in one of the world's most hurricane-prone areas-an average of three cyclones pass over or near the island every year. The team installed a hydrophone in waters close to the island and are waiting for a storm to come by and provide further validation of the technique.

Makris and Wilson estimate that when there's a hurricane on its way toward shore, a line of acoustic sensors could be dropped from a small plane into the ocean ahead of the storm's path, while conditions are still safe, and could then provide detailed information on the storm's strength to aid in planning and decision-making about possible evacuations. The total cost for such a deployment would be a small fraction of the cost of even a single flight into the storm, they figure.

In addition, permanent lines of such sensors could be deployed offshore in storm-prone areas, such as the Sea of Bengal off India and Bangladesh. And such undersea monitors could have additional benefits besides warning of coming storms.

The hydrophones could be a very effective way of monitoring the amount of sea salt entering the atmosphere as a result of the churning of ocean waves. This sea salt, it turns out, has a major impact on global climate because it scatters solar radiation that regulates the formation of clouds. Direct measurements of this process could help climate modelers to make more accurate estimates of its effects.

Source: Massachusetts Institute of Technology