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Hurricane Highway

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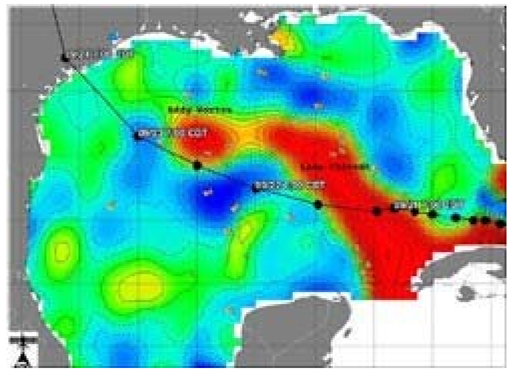
Tropical Storm Alberto came and went without achieving hurricane status, but Beryl, Chris, Debby, Ernesto, and friends are waiting in the wings. Getting ready for these uninvited summer guests requires advance preparation, and residents of the U.S. East Coast need all the lead time they can get. Meteorologists and oceanographers, using a combination of real-world data and computer modeling, are refining their ability to predict hurricanes. Their goal is to avoid human misery and property destruction of the sort inflicted by Hurricanes Katrina and Rita in 2005.



Sea surface height in the Gulf of Mexico for Sep. 21, 2005.
High-standing Loop Current extension shown in red. Black line shows the path of Hurricane Rita. Image credit: NASA/JPL/University of Colorado.

Just in time for this year's hurricane season, Researchers at the University of Rhode Island (URI) and the National Oceanic and Atmospheric Administration (NOAA) have incorporated effects of the Loop Current into the hurricane prediction model used by the National Hurricane Center. The Loop Current runs between the Gulf of Mexico and the Caribbean Sea, and its northward extension has been blamed for intensifying Katrina and Rita to category 5, the highest intensity on the Saffir-Simpson Hurricane Scale.

Only three hurricanes made landfall as category 5 storms in the United States between 1935 and 2004. Last year was the first on record in which four category 5 hurricanes—Emily, Katrina, and Rita, and Wilma—developed in the Atlantic basin. Emily and Wilma reached their maximum strength over the ocean, but Katrina and Rita destroyed lives and property along the U.S. Gulf Coast.

In a *Newswise* press release, URI professor Isaac Ginis explained that the temperatures of the surface layers in the Gulf of Mexico and the Caribbean Sea are quite similar, but the surface layer is much deeper in the Caribbean. Thus, category 5 hurricanes are much more common in the Caribbean. When the Loop Current moves northward into the Gulf of Mexico, it carries this warm Caribbean water along with it. Hurricanes that follow the Loop Current into the Gulf are intensified by the warm water.

The Loop Current moves northward about once every nine months, coinciding with hurricane-producing atmospheric conditions every few years. Hurricane Camille, a 1969 category 5 hurricane, was probably the product of such a coincidence, according to Ginis. His group modeled the ocean's effect on hurricanes, including the location of the Loop Current. They coupled this model with an atmospheric model created by NOAA's Geophysical Fluid Dynamics Laboratory.

Ginis was the first to demonstrate the ocean's role in forming and steering hurricanes, and his group's model is the first to include the effects of the Loop Current. The model also factors in friction between the air and the ocean's surface, which exerts a drag effect on a hurricane. Contrary to their expectations, the research group found that even though stronger winds produce higher waves, there is not a corresponding increase in drag. "When winds reach about 75 miles per hour and higher, the hurricane seems to just skim across the top of the waves and isn't impacted by the surface roughness of the waves," Ginis said in the *Newswise* release.

The URI model is supported by observational data, provided in part by the Marine Meteorology and Atmospheric Effects group of the Office of Naval Research. This group is now focusing on studies of the Pacific Ocean, but in previous years, the ONR group focused on data collection in the Atlantic and Gulf regions via its Coupled Boundary Layers/Air–Sea Transfer (CBLAST) program. The Navy was particularly interested in protecting its ships in port from storm surge damage. Advance warning of the path and strength of a hurricane would be valuable in making the decision whether to remain in port or set out to sea.

In 2003, the CBLAST program deployed more than 20 buoys in the Caribbean, where they rode in the path of Hurricanes Fabian and Isabel. The 53rd Weather Reconnaissance Squadron of the Air Force Reserves flew the buoys into the path of the storms and dropped them into the ocean at the optimum time and place under the oversight of NOAA's Hurricane Research Division. The buoys measured water temperature, sea surface height, rainfall, and wind speed.

More measurements were collected during Hurricanes Frances, Ivan, and Jeanne in 2004, again with the help of the 53rd Weather Reconnaissance Squadron. As a part of this study, programmable floats measured water temperature, salinity, dissolved gases, and velocity as they traveled back and forth between the ocean's surface and a depth of 200 meters.

One float was deployed in the eye of the hurricane, another about 50 km north of the eye, and a third about 100 km north. The floats provided a valuable addition to satellite data, which only penetrates the first few mm of the ocean's surface. The floats were provided by the University of Washington's Applied Physics Lab and the Scripps Institution of Oceanography. They transmitted their data to the Iridium cell phone satellites after the storms had passed. The Scripps team also provided drifters that remained on the surface, collecting and transmitting data on air pressure, wind speed and direction, and sea surface temperature.

Data collected during these studies have been built into NOAA's hurricane prediction models in the hopes that these models will yield more accurate predictions and a greater understanding of how hurricanes travel and gain intensity.