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ON THE WEB

Gulf Currents That Turn Storms Into Monsters

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A month ago, Kerry Emanuel, an atmospheric scientist who has spent decades studying how hurricanes reach their peak strength, "had this terrible feeling of dread" when he saw that Hurricane Katrina's track in the Gulf of Mexico would carry it right over an oceanographic phenomenon known as the loop current.

Late Friday, Dr. Emanuel, from the Massachusetts Institute of Technology, felt the same dread when it seemed as if Hurricane Rita, fueled by the same current, was going to pass over a related warm eddy and grow even stronger.

To his relief, Rita did not, and that is one reason the storm weakened substantially before coming ashore.

In this stormy season, Dr. Emanuel and other storm experts have been fixated on the loop current, a great ribbon of hot water meandering through the Gulf of Mexico.

For a long time it has been little more than an oceanographic curiosity but, because of its role in energizing storms, it is now a centerpiece of hurricane forecasts.

The current is a conveyor belt of banked solar energy, typically with more than 100 times the flow of the Amazon. It gained notoriety after providing the fuel that helped transform Hurricanes Rita and Katrina from nondescript tropical storms into a rare single-season pair of Category 5 monsters.

In past decades, the current and swirling rings of warm water that it casts off have been tracked mainly for fishing fleets seeking the tuna and swordfish that congregate nearby, and oil companies worried that the roiling currents could rip their drill rigs out of the seabed.

Now, scientists are using satellites, buoys and air-dropped probes to study its ability to transform a nascent hurricane from a ragged pinwheel of rain and highway-speed winds into "a tornado the size of Georgia," as one Weather Channel meteorologist described Hurricane Rita late last week.

All other things being equal, its presence or absence appears to be essential for a hurricane in the region to achieve the rare state of the superstorm - one reaching the physical limits of power and size possible in earth's atmosphere.

Consequently "loop current" has become a familiar phrase on news broadcasts about this season's remarkable storms.

"It has everyone's attention now," said Kenneth J. Schaudt, a private oceanographer and meteorologist in Katy, Tex., who tracks the warm, deep waters for the oil and fishing industries and had to evacuate on Friday when it looked as if Rita was going to pass directly over his home.

Dr. Schaudt first became aware of the loop current's potential to nourish hurricanes in 1985, when he helped run a research project in which a small research vessel, the Pelican, was probing one of the warm eddies spun off by the loop south of Louisiana.

"As the boat surveyed the eddy, Hurricane Juan formed up essentially over the boat," he said. The crew members ended up having to lash themselves to the boat to avoid be swept away, he said.

The current carries warm water from the Caribbean Sea around the western horn of Cuba into the cul-de-sac of the gulf.

Finding no outlet, it generally curls up toward Louisiana and then exits between Florida and Cuba, turning north parallel to the Eastern Seaboard and helping to form the appropriately named Gulf Stream.

Hurricanes feed on the energy from warm water. But while the gulf is often uniformly hot at the surface, that layer is so thin that it offers limited energy to hurricanes, which can stifle themselves as they churn along and draw up cooler waters from below.

But when such a storm passes over the loop current or one of its eddies, the water can be 79 degrees as much as 300 feet deep, meaning that no matter how much a passing hurricane stirs things up, it never exhausts its fuel supply. The eddies can break into even smaller whorls of warm deep water that can drift independently in the gulf for months before dissipating.

Oceanographers who monitor all of this for the oil and gas industry have taken to naming the spinning, circular currents. The one that nurtured Hurricane Juan was Fast Eddy. Other eddies have been called Murphy and Nelson. (A list of eddies is online: www.horizonmarine.com/namedlces.html.)

Satellite sensors that can measure the elevation of the ocean surface to within an inch have allowed scientists to map the general location of the current by exploiting the fact that water expands when warm and thus lumps up where it's warm beneath the surface. There is so much heat banked in the depths of the loop current that the sea surface bulges as much as half a yard, said Gustavo Jorge Goni, an oceanographer at the Commerce Department's Atlantic Oceanographic and Meteorological Laboratory in Miami.

Together with Joaquin Triñanes of the University of Miami, Dr. Goni has been using satellite data to generate global maps of what is called "tropical cyclone heat potential," essentially a mix of measurements that describes how much energy a particular patch of ocean can provide to a passing hurricane.

To become a catastrophic storm, a hurricane needs a host of conditions to be met.

There must be no shear in the atmosphere, no disconnect between the speeds of successively higher layers of air, a condition that can dismantle an expanding storm before it organizes into the trademark bull's-eye of a potent cyclone.

The storm must encounter no pools of dry air. Hurricanes thrive only when there is moisture in the atmosphere, drawn from the sea.

And it must have an unclogged exhaust pipe, with cold air aloft allowing the hot, moist air to vault skyward.

Even if all these conditions are met, though, it now seems clear that a perfectly forming storm must have no energy limits in the ocean below.

There are seven regions where oceanic hot spots are big enough and deep enough to allow hurricanes to reach their peak, Dr. Goni said, including several places south of Japan and east of Indonesia. Along the coasts of the Gulf of Mexico and the Atlantic, the source of energy for major storms is the great flow of waters generated in the Caribbean.