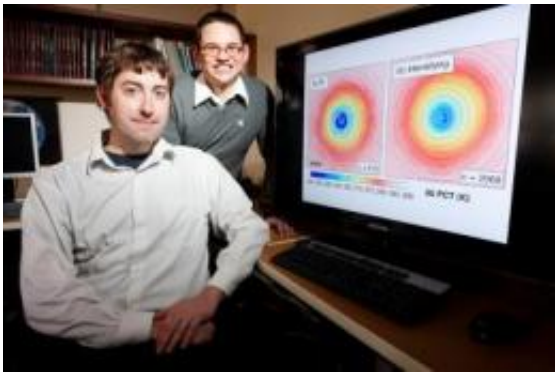


# Ring around the hurricanes: Satellites can predict storm intensity

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University of Illinois atmospheric sciences professor Stephen Nesbitt, left, and graduate student Daniel Harnos analyzed passive microwave satellite data to identify telltale structural rings in tropical storms that are about to intensify into hurricanes. Credit: L. Brian Stauffer

Coastal residents and oil-rig workers may soon have longer warning when a storm headed in their direction is becoming a hurricane, thanks to a University of Illinois study demonstrating how to use existing satellites to monitor tropical storm dynamics and predict sudden surges in strength.

"It's a really critical piece of information that's really going to help society in coastal areas, not only in the U.S., but also globally," said atmospheric sciences professor Stephen Nesbitt. Nesbitt and graduate student Daniel Harnos published their findings in the journal

## [Geophysical Research Letters.](#)

Meteorologists have seen large advances in forecasting technology to track the potential path of [tropical storms](#) and hurricanes, but they've had little success in predicting [storm](#) intensity. One of the biggest forecast problems facing the tropical meteorology community is determining rapid intensification, when storms suddenly transform into much stronger cyclones or hurricanes.

"Rapid intensification means a moderate-strength tropical storm, something that may affect a region but not have a severe impact, blowing up in less than 24 hours to a category 2 or 3 hurricane," Harnos said. "This big, strong storm appears that wasn't anticipated, and the effects are going to be very negative. If you don't have the evacuations in place, people can't prepare for something of the magnitude that's going to come ashore."

For example, Hurricane Charlie, which hit southern Florida in 2004, was initially forecast as a category 1 storm. However, when it made landfall less than 24 hours later, it had strengthened to a category 4, causing major damage.

Rapid intensification is so hard to predict in part because it's driven by internal processes within the storm system, rather than the better-predicted, large-scale winds that determine the direction of the storms. The [satellite imagery](#) most commonly used for meteorology only looks at the clouds at the top of the storms, giving little insight as to what's going on inside the system.

Harnos and Nesbitt focused their study on passive microwave satellite imagery. Such satellites are used commonly for estimating precipitation, surface temperature and other data. The Illinois researchers were the first to use them systematically to observe hurricane structure and

intensity changes.

"What makes it ideal for what we are doing is that it's transparent to clouds. It senses the amount of ice within the clouds, which tells us the strength of convection or the overturn of the atmosphere within the hurricane," Nesbitt said. "It's somewhat like trying to diagnose somebody with a broken arm by taking a picture of the arm, versus being able to X-ray it."

The researchers scoured data from passive microwave satellites from 1987 to 2008 to see how hurricanes behaved in the 24 hours before a storm underwent rapid intensification. Such a big-picture approach, in contrast to the case studies atmospheric scientists often perform, revealed clear patterns in storm dynamics. They found that, consistently, low-shear storm systems formed a symmetrical ring of thunderstorms around the center of the system about six hours before intensification began. As the system strengthened into a hurricane, the thunderstorms deepened and the ring became even more well-defined.

The study also looked at high-shear storms, a less common phenomenon involving atmospheric winds hanging with height.

Such storms showed a different structure when intensifying: They form a large, bull's-eye thunderstorm in the center of the system, rather than a ring around the center.

"Now we have an observational tool that uses existing data that can set off a red flag for forecasters, so that when they see this convective ring feature, there's a high probability that a storm may undergo rapid intensification," Nesbitt said. "This is really the first way that we can do this in real time rather than guessing with models or statistical predictions."

Since passive microwave satellites orbit every three to six hours, meteorologists can use them to track tropical storms and watch for the telltale rings to give forecasters about a 30-hour window before a storm hits its maximum strength.

Next, the researchers hope to even further increase their forecasting ability by modeling the internal dynamics of the storm systems as they intensify to pinpoint the causes of the structural changes they observed and find out what drives the intensification process.

"The satellite gives up as snapshot of what's taking place," Harnos said. "We know what's going on, but not how those changes are occurring to end up in the pattern that we're seeing. So what we're working on now is some computer modeling of hurricanes, both real storms and idealized storms, to see dynamically, structurally, what's taking place and what changes are occurring to produce these patterns that we see in the satellite data."

**More information:** [DOI: 10.1029/2011GL047010](https://doi.org/10.1029/2011GL047010)

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