When Schwantes' team analyzed the plutonium, they discovered that it contained the isotope sodium-22, a byproduct of a secondary nuclear reaction within the bottle. "The sodium has a half life of two and a half years, which given the age of our sample, means it shouldn't have been there," Schwantes says. Separating the plutonium into the polypropylene bottles, it turns out, started a chemical reaction — the sodium began to form after the sample was poured into the plastic bottles. Further analysis also indicated the quantity of the original plutonium before the split, the team reported in the journal Analytical Chemistry.

The serendipitous splitting of the original bottle offered new methods and insights into nuclear forensics — the science of identifying the source, point of origin and transport routes of nuclear materials. "If this was an interdicted sample, the FBI would want to know if this was part of a larger batch of material or do we think we interdicted the entire material out there," Schwantes says. "We could also determine how long ago this material was separated from the larger batch."

The use of the sodium-22 was "one of the more clever aspects of the paper," says Ian Hutcheon, a physicist at Lawrence Livermore National Laboratory in Livermore, Calif., and co-author of the primary nuclear forensics reference book called "Nuclear Forensic Analysis." "People who aren't paying close attention might easily have overlooked the sodium." In addition, Hutcheon notes, the work with sodium-22 was the first time this technique had been used and now gives others in the field an additional tool.

Schwantes' work with an unclassified sample shows the power of nuclear forensics methods and acts as a warning to those who might try to deal in illicit materials, Hutcheon says. "The hope is that nuclear forensics acts as a deterrent, and if people come into possession of illicit nuclear material, they are going to know they are going to be caught."

David B. Williams

WEATHER MODEL PREDICTS HURRICANE INTENSITY

Scientists have made significant headway when it comes to predicting the path of a hurricane barreling toward land. But predicting what a deadly storm's intensity will be when it makes landfall is tougher — intensity often changes during a hurricane's journey. Now, a next-generation weather model is proving capable of simulating intensity variations, potentially allowing scientists to make better hurricane intensity predictions in the future.

Every hurricane consists of a center, or eye, surrounded by an eye wall, a zone of dense clouds in which wind speeds reach their maximum. But as a hurricane grows, this structure often changes; in more than half of strong hurricanes a secondary eye wall forms outside the first one and eventually displaces the initial eye wall. This formation and replacement process can increase the area over which strong winds prevail — an important factor with respect to the amount of damage that a hurricane can cause. But during this process, the intensity and structure of the hurricane change, and this change is "one of the most challenging forecast problems," says Bin Wang, a meteorologist at the University of Hawaii at Manoa.

During Hurricane Katrina, for example, at least one secondary eye wall formed and broadened the overall wind field, which was a major reason for the storm's destructiveness, says Michael Bell of the National Center for Atmospheric Research in Boulder, Colo. Katrina's most damaging effect was the storm surge, which was affected by how strong the winds were, how long they were sustained, and how large of an area they covered, Wang adds.

But changes in intensity and size due to eye wall formation and replacement like Katrina's are difficult to predict in real time. And size matters, Bell says. "Katrina was a Category-3 storm at landfall," which meant its peak wind speed was weaker than, for example, Hurricane Charlie, which struck the Florida coast in 2004, he says. "But because [Katrina] was much bigger, it affected a very broad stretch of the coastline."

NASA image courtesy of Jeff Schmaltz, MODIS Land Rapid Response Team at NASA GSFC

Hurricane Rita, which struck the Gulf Coast in 2005, may be an example of a type of hurricane characterized by a large eye and eye walls thicker than those of regular hurricanes.

Wang and Hawaii colleague Xiaqiong Zhou found that the high-resolution Weather Research and Forecasting (WRF) model — a model that has been around for a few years but has never been used for this aspect of hurricanes — could simulate the process well. WRF modeled the formation of a secondary eye wall, the replacement of the first one and the transformation into an annular hurricane — a type of hurricane characterized by a large eye and eye walls thicker than those of regular hurricanes — better than any previous weather model, they reported in Geophysical Research Letters. Annular hurricanes — 2005's Category-3 Hurricane Rita may have been one — sometimes form after secondary eye wall formation and replacement. The WRF model showed the formation of an annular hurricane within 24 hours of secondary eye wall formation and replacement, which is consistent with observations and indicates that the model appears to match reality, Wang says. By comparison, previously used models produced the formation of annular hurricanes only after several days and without eye wall replacement.

The findings are promising, Bell says. "We have made a lot of progress in track forecasting over the past 20 years, but the intensity problem has not made as much progress as we would have liked," he says. "These findings give us some hope that if a storm was threatening the United States' East Coast or the Gulf of Mexico, we could [use the model] to potentially simulate these types of structural changes in a real-time forecast."

Nicole Branan