Researchers take tips from 'Twister' to chase elusive storm data

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Yvette Richardson, professor of meteorology and associate dean for undergraduate education, Penn State College of Earth and Mineral Sciences launches meteorology probe into storm. The probe is supported by two helium filled balloons that lift it into the air until one balloon is separated from the package so the probe can drift in the storm sending back temperature and humidity data. Credit: Penn State

Some great ideas are born out of years of painstaking research. Others are gleaned from the plotline of the movie "Twister."

The latter is how Paul Markowski, professor of meteorology, and Yvette Richardson, professor of meteorology and associate dean for undergraduate education, Penn State College of Earth and Mineral Sciences, set a course to create and launch probes into storms to, as they put it, "revolutionize our understanding of how tornadoes form."

In "Twister," probes are launched into a storm by using cruise control to drive a truck filled with sensors into a tornado. Penn State researchers, seeking to fill a void in thermodynamic data captured in and around storms, began seeking ways to devise something similar.

Using a pair of helium balloons, Scott Richardson, senior research associate in meteorology and atmospheric science, devised a low-cost delivery system for commercially available probes. The 13-gram probe uses two balloons to achieve altitude before one balloon is remotely jettisoned, allowing the probe, carried by the remaining balloon, to drift with the winds.

Each device is capable of measuring temperature, humidity, pressure and GPS location in real time. Researchers are able to track as many as 34 probes, although that number increases to hundreds in the newest probe prototype.

"In 'Twister,' probes were levitated by a tornado," Markowski said. "We just float the probes above the ground and the storm's internal wind field draws them in. If you have the right kind of storm and launch from a sensible area, it's hard to miss."

In May, Markowski and Yvette Richardson, armed with dozens of probes and three 175-pound tanks of helium strapped to the floor of a passenger van, spent a week traveling 2,200 miles, chasing storms in the

Great Plains to test the devices. There, they had several successful launches into supercell storms—the most likely precursor to a tornado—including launches near Mannsville, Oklahoma, and Gove City, Kansas,, where more than 20 probes drifted through each of the storms for about 90 minutes, collecting data that had previously only been estimated using computer modeling.

"We would have loved to have flown more but that's how many we could inflate in that time period," Markowski said. "We were lucky that the storm was moving slowly."

As Markowski and Yvette Richardson hurriedly filled and tied balloons to probes at about three minutes a clip, amid rain and strong winds in a field, they had one recurring thought as the devices lifted skyward: Will this even work?

"Although we'd planned ahead as much as possible, there was a risk that it wouldn't work," said Yvette Richardson.

But it did work. Calculations to determine the best launch points, done at Penn State by Shawn Murdzek, an undergraduate researcher, proved effective and the probes efficiently and evenly dispersed.

With radar, meteorologists have a broad view of the windfield of a storm but know little about how forces associated with temperature and pressure can change that wind. This research aims to explain why the winds evolve and what causes tornadoes to form.

"The radars are giving us what the winds are doing and these probes tell us what the ttemperature pattern looks like in relation to the wind," Yvette Richardson said.

The next step will be to link the newfound temperature data with the radar wind data to begin searching for patterns. Knowing this relationship could help forecasters better predict if a supercell storm will turn into a tornado.

"Knowing the thermodynamics within a storm helps us evaluate our theories for how tornadoes form," Yvette Richardson said. "Right now, they're all based on our assumptions of what those look like from either numerical models or from observations we have from cars that drive around underneath a storm. We know how temperature varies along the ground but not above that. This research adds that missing link."

Now that they know it works, the next step is to up the ante.

The researchers are working with a company that is developing a prototype that is much lighter, which will cut down on the size of the balloons, reducing filling times and increasing the likelihood they'll be sucked in by a storm. Other options, such as balloons that can be inflated in advance, are also being pursued.

Soon Markowski and Yvette Richardson will return to the Great Plains with more hands and the updated probes.

"We really want to get our students out there. It would be great for them and also give us more sets of hands," Markowski said. "I think you're going to be hearing a lot about this in the next five years. We like the trends. Lighter, smaller, more probes being able to be tracked. Really all the stars are aligning to make gains in our understanding of storms and tornadoes."

Early on, Markowski and Yvette Richardson dreamed of efforts to deliver probes to storms. In the early stages of the endeavor, they teamed up with Jack Langelaan, associate professor of aerospace engineering, and aerospace engineering doctoral student John Bird, to use rockets to release parachuted probes that could be drawn into storms. The team also included Mike Hickner, who was tasked with improving the biodegradability of the probes, lessening the environmental impact.

In their quest for this high-tech delivery system, Markowski and Yvette Richardson began looking for options that might get their research off the ground. After years of brainstorming, the two-balloon approach emerged as the most field-ready solution. However, many of the goals of the original collaboration, such as creating biodegradable devices at low cost, remain.

"Ultimately, understanding is needed to make warnings to the public better," said Markowski. "To improve warnings, you need either an improvement in technology, an improvement in basic understanding, or both. Scientists are usually in the business of improving understanding rather than improving technology, but this project involving both scientists and engineers gave us a chance to do both."

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