Science

» **Green**

Keep up with the latest environmental news at Green, a special online section at **washingtonpost.com/green**.

Tornado-Chasing Project Aims to Improve Forecasts

By KARI LYDERSEN
Washington Post Staff Writer

When a tornado is about to cut a devastating swath through an American town, those in its path get a warning lead time of 13 minutes on average to try to reach shelter.

"If you live in a trailer community, is 13 minutes enough to wake your family and get them bundled up and outside?" asks tornado researcher Joshua Wurman, head of the nonprofit Center for Severe Weather Research. And "if you are elderly or handicapped, you're going to have a hard time getting to a shelter in 13 minutes," he said.

And that's the average; many times people are warned about six or seven minutes earlier. That is because although scientists know that certain kinds of "supercell" thunderclouds can spin off tornadoes, they know very little about the exact conditions that indicate a tornado will occur and whether it will be a mild twister or a violent killer.

In the mid-1990s, a two-year study called Vortex had a phalanx of scientists chasing tornadoes around the Great Plains, inspiring much public fascination, daredevil amateur tornado-chasers and the 1996 movie "Twister."

Vortex (which stands for Verification of the Origins of Rotation in Tornadoes Experiment) resulted in significant advances, including the revelation that tornadoes can occur on smaller time and space scales than previously thought and that sometimes they do not show up on radar. Knowledge gained from the study led to an increase in average warning times, but it did not unlock the secrets of exactly when and why tornadoes form.

As a result, predictions about tornado occurrence are successful only about a quarter of the time.

"Sometimes people will choose not to take shelter even if they're told to," said Yvette P. Richardson, a meteorology professor at Pennsylvania State University. "In general, the more we can reduce the false-alarm rate, the more seriously the public will take warnings."

PHOTO COURTESY OF THE CENTER FOR SEVERE WEATHER RESEARCH

Mobile Doppler radar scans a tornado in 2004.

Now comes Vortex2, a five-week tornado-chasing project beginning next month that scientists hope will finally provide the knowledge to accurately predict when and where a tornado will develop.

"Ultimately we'd like to get to the point where we can put sufficient data into our models so we know when a tornado will happen," said Stephan P. Nelson, a program director in the atmospheric sciences division of the National Science Foundation, which, along with the National Oceanic and Atmospheric Administration, provided the $12 million funding for Vortex2. "Then you can get first responders to be better prepared — police, fire, medical personnel, even power companies. Now, that's not even remotely possible."

As part of Vortex2, about 80 veteran scientists and graduate students will chase storms across a wide swath from South Dakota to Texas and from eastern Colorado to Iowa and Minnesota, with their nerve center in Norman, Okla.

They will be armed with a host of tools, including lasers that measure raindrops, Doppler radar mounted on trucks, high-tech balloons, unmanned aircraft and instruments on tripods anchored in the tornadoes' path.

"We're throwing everything but the kitchen sink at it," said Wurman, who has chased 141 tornadoes over 14 years. "We'll have a whole potpourri of instruments surrounding the storm, all measuring different things in different ways."

The technology available this time is far superior. The inaugural Vortex used Doppler radar on planes, which would pass over a tornado at about five-minute intervals. Now radar mounted on trucks, which can get within two miles of a tornado, will provide uninterrupted data.

"We will be able to distinguish between rain, hail, dust, debris, flying cows," said Howard Bluestein, a meteorology professor at the University of Oklahoma and member of the Vortex2 steering committee.

Two ingredients are necessary to form the supercell thunderstorms that spawn tornadoes: a source of buoyant energy, namely warm and moist air near the ground, and a rotational force generated by winds at the surface blowing at a different speed or direction than winds high in the atmosphere.

A typical thundercloud develops as warm air rises into colder air masses above, then usually dissipates quickly once rain falls. Supercell thunderstorms, by contrast, can last for hours and can move rapidly, tracking over 100 miles. Supercell thunderstorms may also create "mesocyclones," swirling winds embedded within the larger thunderhead that can be as much as six miles in diameter.

About five to 10 percent of these storms actually spin off tornadoes, which are typically about 500 feet in diameter. Scientists know what forms a mesocyclone, but they are largely lost when it comes to understanding which ones will spawn tornadoes and how violent they will be.

"A number of things have to happen sequentially and at the same time and in the right order," said John Monteverdi, a meteorologist at San Francisco State University who has been chasing tornadoes for 24 years. "You have to start knocking the dominos down to find out what happens in that last stage. I think we're getting close, and this project should help."

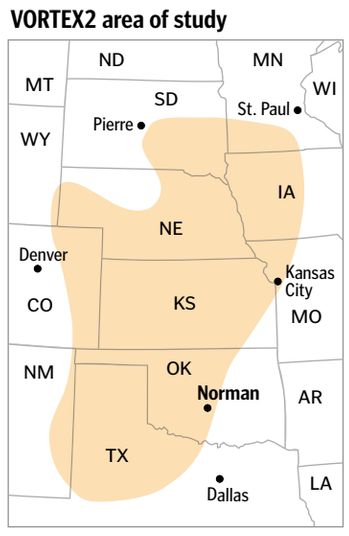
Risky though it appears, members of the project note that their crews have never logged a death or severe injury. But they say amateur tornado-chasers who follow scientists around with video cameras are endangering themselves and others. Not only do these adrenalin junkies put themselves in harm's way, the scientists say, they often speed and park their cars in the middle of the road, endangering other motorists and distracting highway patrol officers.

Scientists warn that it is only a matter of time before a major tornado sweeps through a densely populated urban area and causes horrific damage and loss of life.

Chicago, Atlanta, Dallas and Houston, in particular, are in regions prone to violent tornadoes. Wurman said in a 2007 study that a tornado cutting through Chicago could kill 13,000 to 45,000 people and cause tens of billions of dollars in damage.

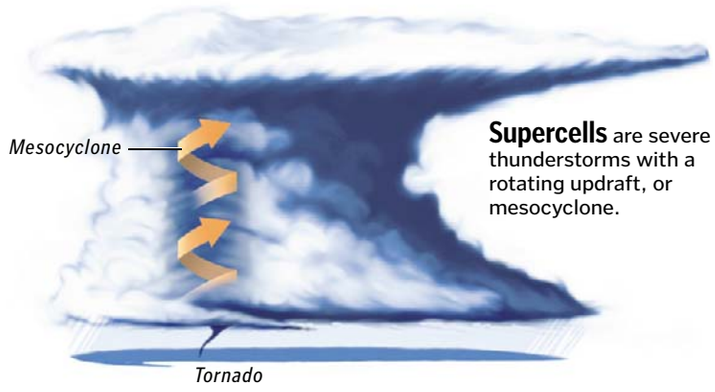
"Tornadoes have a great beauty to them sometimes," Wurman said. "There's a great elegance to the vortex itself. But when you see it going toward a town or city, there's a quick change in your impression, and it's like a tiger: Something beautiful becomes deadly."

VORTEX2 area of study



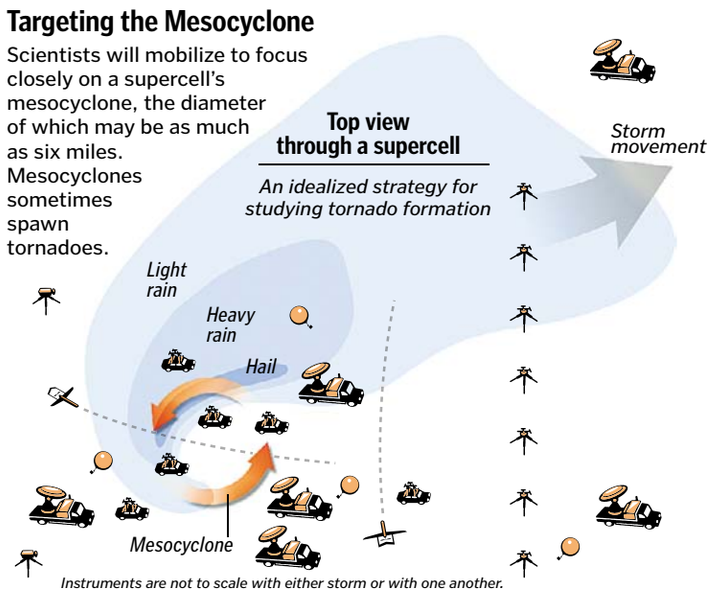
Sampling Storms

In May and June, a nomadic team of scientists, using a wide variety of instruments, will chase tornado-forming storms across the Central Plains.



Targeting the Mesocyclone

Scientists will mobilize to focus closely on a supercell's mesocyclone, the diameter of which may be as much as six miles. Mesocyclones sometimes spawn tornadoes.



Instruments are not to scale with either storm or with one another.

An arsenal of sensors

- **Sticknet:** Measures temperature, humidity, barometric pressure, wind speed and direction, rainfall and hail.
- **Mobile mesonet:** A sticknet on wheels; GPS device allows accurate wind measurements while driving.
- **Mobile radar:** Several types of radar, including rapid-scanning Doppler, mounted on different trucks.
- **Photography**
- **Rawinsonde:** Balloon-borne radio that measures the wind aloft.
- **Unmanned aerial vehicle:** A 12-pound plane that measures temperature, pressure, humidity and wind velocity; can remain aloft for as long as an hour.

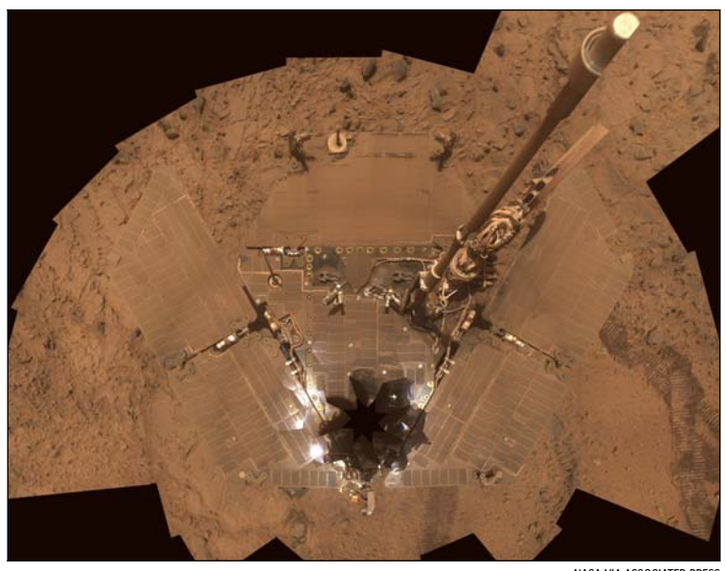
SOURCES: National Oceanic and Atmospheric Administration, Center for Severe Weather Research

BY PATTERSON CLARK — THE WASHINGTON POST

Spirit Is Ailing But Still Running

Scientists Unsure How Rover's Stint On Mars Will End

By JOEL ACHENBACH
Washington Post Staff Writer



NASA VIA ASSOCIATED PRESS

This 2007 image shows the deck of Spirit encased in dust. The Mars rover, more than five years old, is operating at about 30 percent of normal power.

The old rover was supposed to work for only 90 days, enough time to crawl two-thirds of a mile across the Martian desert. More than five years later, Spirit has put five miles on its odometer and is still rolling along — but getting mighty cranky.

The rover, one of two NASA vehicles operating on Mars, has a broken right wheel. It has dust on its solar panels. It's operating at about 30 percent of normal power. Various sensors and software programs have gone screwy.

Then, on April 9, Spirit refused to wake up. The rover is designed to sleep at night, when there is no sunlight hitting the solar panels. But Spirit snoozed right through its wake-up call. It happened three times in succession. Finally a backup timer got Spirit up and moving again after a 27-hour slumber.

John Callas, project manager for the Mars rovers at the Jet Propulsion Laboratory in Pasadena, Calif., said he doesn't have an explanation for what ailed Spirit. Nor can he explain why the rover repeatedly rebooted itself when engineers at the JPL tried to send it commands. The engineers found a fix — they relayed commands via a spacecraft that orbits Mars — but the incidents suggest that Spirit is getting erratic. Or maybe just old.

By any measure, Spirit and its sister rover, Opportunity, which is a good bit healthier, have been triumphs of the civilian space program. Spirit may yet operate for several more years, or it may be on its last legs. In any event, it is providing a tutorial on how even the most exquisitely designed machines eventually die.

"I don't think anyone can tell you how these rovers will eventually end on Mars," Callas said. "Will they gradually degrade until their mechanical functionality goes or will they have a catastrophic end, where something inside the rover breaks?"

When the rovers were designed, the presumption was that dust would blanket the solar panels within a few months of being on Mars and that the rovers would grind to a halt. Martian winds blew to the rescue, cleaning the panels periodically and letting the rovers extend their missions.

Spirit is now driving around a plateau called Home Plate in a valley known as the Inner Basin. Opportunity, on the other side of Mars, has left Victoria Crater and is rambling toward a large crater named Endeavour.

Day-to-day life on Mars can be rocky. The temperature can swing 150 degrees Fahrenheit between night and day because of the thin atmosphere. That heating and cooling cycle puts stress on metal.

"Metal parts and glass parts expand and contract as the temperature changes," said John Casani, who has worked on robotic space missions for decades at the JPL. "If you take a piece of metal and keep bending it back and forth, pretty soon it's going to break."

Casani said spacecraft — the ones that stick to space and don't try to land on a planet or some such feat — exist in a much more stable environment. Thus the JPL is still getting data from the two Voyager craft launched in 1977. According to the JPL, the oldest functioning spacecraft is Voyager 2 (launched slightly earlier, strangely enough, than Voyager 1), which is zipping toward interstellar space far beyond Neptune's orbit.

There's not much to see out there, and, in any event, no operational camera to see it with, as the spacecraft's batteries, powered by radioisotope decay, slowly become enfeebled. But a few instruments still function, and scientists have rebuffed efforts to shut down the Voyager program.

Spacecraft can also be sent to their deaths. Casani was the project manager on Galileo, a probe to the Jupiter system. When Galileo ran low on propellant, engineers knew that eventually it would lose attitude control and start tumbling. That raised the fear that Galileo would crash into one of Jupiter's moons, which potentially harbor life and might be contaminated by stowaway Earth microbes. So Casani and his colleagues used the last bit of propellant to send Galileo into Jupiter, where it burned up in the thick atmosphere.

When things go wrong, scientists and engineers often have a workaround. Sometimes they just get lucky, which is what happened when Spirit's right front wheel broke three years ago.

The other five wheels on the rover were functional and were capable of dragging the broken wheel across the surface. The inoperative wheel, locked, gouged a trench as it went along. By examining that trench, Spirit was able to detect a certain kind of silica that offered evidence of ancient hot springs on Mars.

"When life hands you lemons, you make lemonade," Callas said.

So that's not really a broken wheel on Spirit — it's a scientific instrument.