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A day in the life of Doppler-on-wheels

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Eye-to-eye with a storm: the Doppler-on-Wheels (DOW) stands tall against the elements. Credit: NSSL/NOAA

'Tis the season ... for snow. Thundersnow.

Rare anywhere, thundersnow is sometimes heard during the lake-effect snowstorms of the Great Lakes. The interaction of clouds and ice pellets inside these storms generates a charge, with lightning and thunder the result.

How to catch thundersnow in action? This winter, a stalwart veteran of tornadoes, hurricanes and other severe storms will be waiting.

Enter the Doppler-on-Wheels

It's called the Doppler-on-Wheels (DOW), a National Science

Foundation (NSF) national facility used by NSF-supported and other researchers.

In rain, sleet or snow, like the postman, it always delivers ... storm data.

The DOW looks more like the dish of a radio telescope than a sophisticated weather instrument. It's mounted on the back of a flat-bed truck. DOW-on-board, the truck becomes an odd configuration of generator, equipment and operator cabin.

Ungainly as it may appear, it's ideally suited to providing detailed information on the inner workings of tornadoes, hurricanes and snowstorms, says Josh Wurman, Director of the Center for Severe Weather Research (CSWR) in Boulder, Colorado.

Wurman should know. He and colleagues developed the first DOW, now one of three, in 1995.

The DOW uses Doppler radar to produce velocity data about objects (such as tornadoes and other severe storms) at a distance.

For the last two springs (May and June, 2009 and 2010), Wurman and a posse of 120 other atmospheric scientists and students from universities and labs across the country--and the DOWs--went on the road from Texas to the Dakotas, Wyoming to Iowa.

In a project called VORTEX2, they tracked tornadoes across tens of thousands of miles, learning more about how these swirling funnels form and how we might better predict them.

"The critical contribution of the DOW is that scientists can collect more data with better precision," says Steve Nelson, program director in NSF's Division of Atmospheric and Geospace Sciences, which funds the

DOW, and funded VORTEX2 along with NOAA.

"Storms rarely move into the paths of ideally spaced instruments. Since we can't move the storms, we have to move the instruments."

Often that takes the DOW smack into the path of danger.

The stories it could tell. Like the time it measured a world-record wind speed of 301 miles per hour just above ground level in an Oklahoma tornado. Or the time it was the only "scientific team" to successfully brave Hurricane Ike's knock-down winds in Galveston, Texas.

"Current tornado warnings have only a 13-minute average lead time, and a 70 percent false alarm rate," says Brad Smull, program director in NSF's Division of Atmospheric and Geospace Sciences. "Can we issue reliable warnings as much as 30, 45 or even 60 minutes ahead of tornado touchdown?"

The DOW may hold the key to more accurate forecasts of tornadoes, hurricanes, snowstorms--whatever severe weather Earth's atmosphere can throw our way.

On the road again

Is it a weekend? Not in the DOW hangar. On May 1, 2009, Wurman and the DOW crew got ready to head into VORTEX2. "Preparations were going on at a frenetic pace," he says. "Everyone was here from 0800 to 2300, every single day."

Before scientists face a storm, the challenges are many. For example, the fuel was (legally) drained from the heaviest DOW truck so it could pass initial registration. It had to come in at 25,999 pounds or less. "The truck squeaked by," says Wurman, "at 25,940."

The next day, three radars, four mobile weather vehicles with 12 tornado pods (hard-shelled weather instruments placed directly in front of tornadoes), and countless support vehicles rumbled across the Great Plains.

Among the first things the DOW crew did was ... eat a real lunch. "For a group that was scarfing down snacks in a hanger for two weeks, it was a real treat," Wurman remembers.

Then the glamour, such as it was, was over.

It all led up to what scientists call an interception--and not on a football field. The VORTEX2 fleet, including the DOW, re-wrote tornado science history in June, 2009, when it "made contact" (via instruments only) with what's called a tornadic supercell.

Mobile radars; sticknets (tripod-mounted weather stations); disdrometers (lasers that measure raindrops and hail); mobile mesonets (vehicles with roof-mounted weather equipment); photogrammetry teams who document storms visually; and tornado pods marched across the landscape like soldiers sent into battle.

Data were collected by these "robots" from about 20 minutes before the huge tornado formed, through its birth, and almost until it died. Never before, says Wurman, had a tornado been studied in such detail through its entire lifetime.

Morning has broken ... the skies open

It began in Sterling, Colo., on a sunny June day. The VORTEX2 gang left the hotel--the last of countless hotels in the 2009 half of the VORTEX2 project--at about 11:30 a.m. local time.

The scientists made their way north into Wyoming near the edge of Nebraska, where they tracked changes in the atmosphere that indicate storms on the horizon--storms with winds that might spawn tornadoes.

"The environmental conditions were conducive to supercell development: there was enough wind shear and moisture present," says Karen Kosiba, a scientist at CSWR.

Once it became apparent that the storm was likely to spin off a tornado, the VORTEX2 crew deployed its instruments. Radars circled into position. Probe vehicles set up for mesonet transects. Disdrometer teams scouted out locations for good deployment sites.

Large bluffs blocked a clear view, however, so the radars had to find high terrain from which to scan. To follow the storm, their beams could not be interrupted.

The scientists got the job done. Not a moment too soon.

Snaking silently toward them was a very large tornado that lasted--on the ground--for more than 40 minutes. Stationed along and west of US-85, they watched in awe.

It was a cliché scene from a movie, says Rachel Humphrey, a graduate student at the University of Colorado. "All the practice we'd been doing, all the pseudo-deployments carried out in non-severe conditions, paid off. Once the tornado appeared, we watched from a safe distance. It came near--and crossed over, in some cases--our instruments."

After the tornado roped out, as they say in the trade, the DOW and its compatriots were on the road again, down US-85 to connect with I-80. Their intention? To call it a day and head to Nebraska for the night, right? Nope. They were trying to catch up to a storm again.

Nightfall ... but no rest for the weary

Nightfall was on its way, but tornadoes were still forming.

While the scientists drove along, a storm cell reinvigorated the Wyoming tornado. At times, the group reported, it looked like the entire funnel extended to the ground.

Along I-80, the DOW--and the scientists of VORTEX2--were surrounded on three sides by storms with tornado warnings. "It made for a very slow, very intense, but very exciting ride back to Nebraska that night," says Humphrey. "No, let me make it that morning. By the time we arrived, it was dawn."

And, on a usual VORTEX2 day, time for what the group called "the super-secret PI [principal investigator] meeting." There the day's plans were reviewed, locations for instrument deployments discussed, weather forecasts tracked--and locations of fast-food restaurants noted.

Day after day, night after night, in May and June 2009 and 2010, the scene was repeated. Seldom, however, did the nomads of VORTEX2 glimpse a tornado like that on the Nebraska-Wyoming line.

At the center of it all were the DOWs.
By the end of VORTEX2, scientists had collected dozens of terabytes of data from more than 80 different scientific instruments in two dozen tornadoes.

"With unprecedented data from storms that formed tornadoes--and storms that didn't--we'll soon know a lot more about why and when tornadoes form," says Wurman.

Tornado on the horizon: just where the DOW and its crew hope to be stationed. Credit: Josh Wurman

Still no rest for the weary ... on the road again, to meet Old Man Winter

The DOW is on the road again. This time to the eastern U.S. rather than the midwest. And in winter snows instead of spring rains.

In January and February, 2011, the DOW will face down the gales of Lakes Erie and Ontario.

Oswego, New York, and the nearby hills of the Tug Plateau might be nature's bulls-eye for winter snowstorms: the proximity of the Great Lakes whips their winds into high gear. They blow across New York State, burying cities and towns in snowdrifts several feet high.

But this winter, something will stand in their way. The DOW will be waiting, the face of its radar dish frozen with icicles rather than lashed by hail.

Scientists inside its heated truck will again track storms, this time to learn what drives long lake-axis-parallel (LLAP) bands of snow.

These snowbands are more intense than those of other snow squalls. LLAP storms produce some of the highest snowfall rates and amounts in the world, says atmospheric scientist Scott Steiger of the State University of New York at Oswego.

"The mobility of the DOW," Steiger says, "is ideal for following lake-effect storms. The DOW will allow us to witness these storms as they form and cross the lakes, which other weather radars can't do."

LLAP storms are known to produce thundersnows.

The citizens of western New York may be surprised to hear thunder in winter, scientists may scramble to understand it, but the DOW has been there before.

From the factors that lead to a tornado, to why a hurricane keeps spinning, to what fuels Old Man Winter, the DOW is ready to tackle another season of interceptions.

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