Facing Down

OU LAUNCHES HORUS, THE WORLD'S MOST ADVANCED, REVOLUTIONARY WEATHER RADAR.

BY ANNE BARAJAS HARP | PHOTOGRAPHY BY SHEVAUN WILLIAMS

IMAGINE HAVING AN EXTRA, precious 30 minutes to reach shelter with your family before a monster tornado obliterates everything in its path.

What would it mean if local meteorologists could tell you 10 times faster that your car is in danger of being hammered by softball-sized hail or flooded on city streets?

These are realities unfolding in the new era of Horus, the world's most advanced and flexible radar system—envisioned, designed and built by scientists and engineers at the University of Oklahoma's Advanced Radar Research Center (ARRC).

Horus, which was developed with the support of NOAA's National Severe Storms Laboratory and publicly launched in October, is the first fully digital polarimetric phased array weather radar. Its revolutionary technology captures highly detailed storm images that flow like a movie and produces data at a speed and volume never realized.

Horus represents radar's "holy grail," says ARRC Executive Director Robert Palmer.

"We're seeing data that are amazing," shares Palmer, who also is OU's associate vice president of research and partnerships. "Horus is fulfilling all of our dreams of what a fully digital array would do when applied to weather."

n the Storm

Advanced Radar Research Center Executive Director Robert Palmer, seen in one of the center's anechoic chambers, says Horus represents radar's "holy grail."

Clockwise from left: David Schvartzman and Matt McCord. Lead Engineer Matthew Herndon controls the Horus digital phased array via laptop computer from the radar truck's cab.

HORUS COMBINES TWO technologies. Dual polarization, also used in NEXRAD radars, provides detailed information distinguishing rain from snow or ice. Digital phased array technology, like that used by some advanced military systems, provides broad, rapid scans of the skies and atmosphere that can capture terabytes of data in only minutes. It explains why Horus is named for the Egyptian sky god with an "all-seeing eye."

"Currently, radar works by mechanically moving a big radar dish and pointing it at different parts of a storm," says David Schvartzman, an OU assistant professor of meteorology and active ARRC member who serves as the lead scientist for Horus field research.

"That's like pointing a narrow flashlight beam. But Horus operates like a digital camera. It takes a picture of a whole region in one instant, as if hundreds of flashlight beams were illuminating a storm all at the same time."

Horus—a mobile unit of up to 1,600 antenna elements on a flat array that rises 20 feet into the air—provides data updates 10 times faster than current radar systems, Schvartzman says. "Right now, data are updated maybe every three to five minutes. With Horus' technology, updates are 15 to 30 seconds."

This means meteorologists and people tracking storms on their phone's radar apps will see images "that look like watching an actual movie of the storm," he adds.

Capturing every moment of developing storms could revolutionize weather prediction, says Palmer, OU's Tommy C. Craighead Chair in the School of Meteorology.

"Tornadoes can change tremendously in just 5 minutes," he says, explaining that Horus' ability to "steer" electronically means it can scan storms in totally different ways with a simple computer command. The radar system also is future proof because it can be reconfigured and updated endlessly through software changes to handle everything from detecting wildfires to measuring ground precipitation and ash during volcanic eruptions.

OU Vice President for Research and Partnerships Tomás Díaz de la Rubia feels Horus' impact may extend well beyond Oklahoma and the nation's borders. He believes it will be instrumental as the globe confronts a changing climate.

"We as a society and a planet face severe, dire challenges going forward because of the continuous increase in frequency and severity of extreme weather events around the world, which are causing tremendous loss of life and massive disruptions to economies," Díaz de la Rubia says.

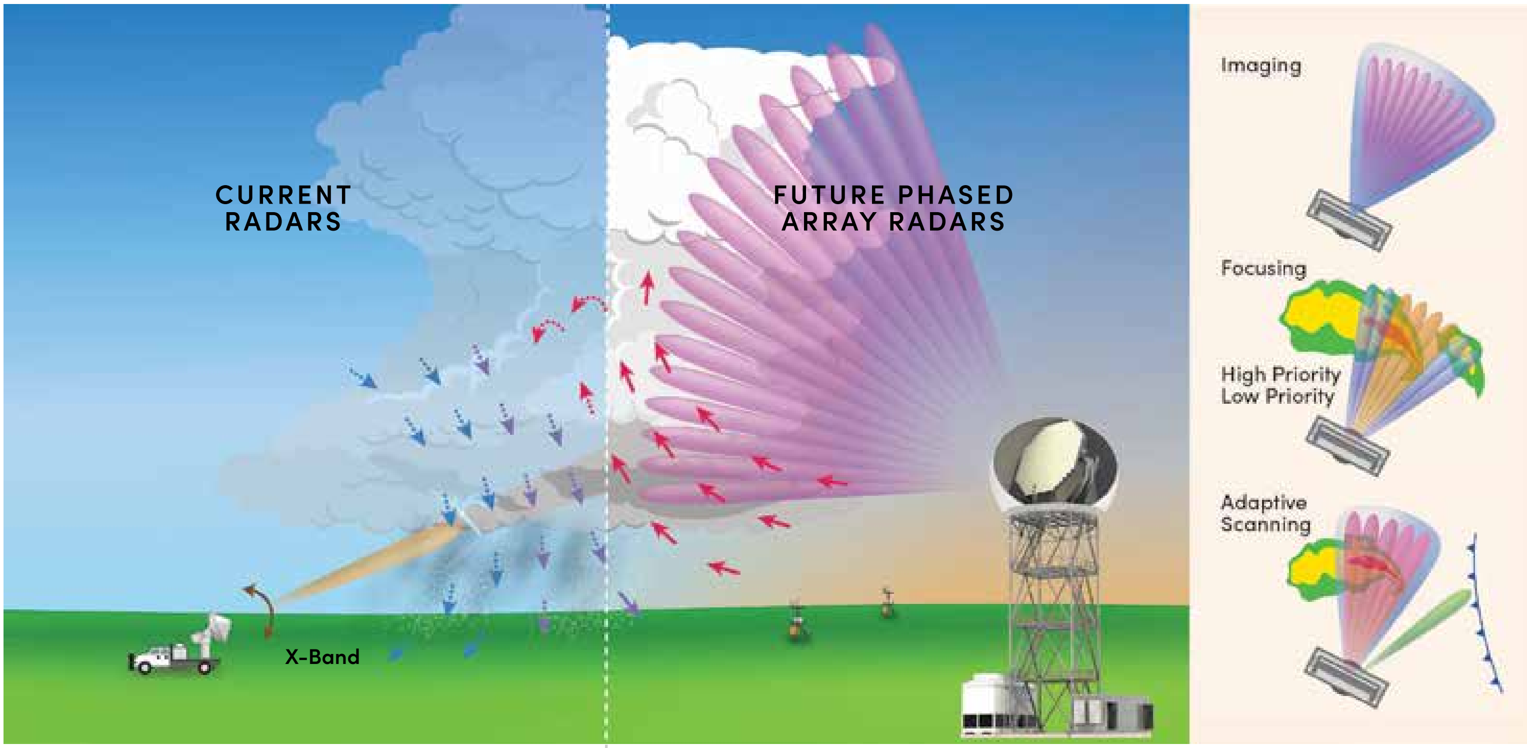
Such challenges have very human costs. Since 2016, NOAA has documented over $1 trillion in damage from climate and weather disasters, and the U.S. Census Bureau estimates that in 2022 alone, more than 3.4 million Americans were displaced from their homes by extreme weather disasters.

"Horus is the most advanced technical solution to creating a future generation of weather radars that will help predict and prepare for extreme and severe weather events here and around the world," he says, citing examples of devastation from monsoons and typhoons in areas of the Pacific Islands and Indian subcontinent. "Horus will help save lives. We are creating a global-impact solution."

Horus has been deployed for experimentation during a range of weather

"HORUS WILL HELP SAVE LIVES. WE ARE CREATING A GLOBAL-IMPACT SOLUTION."

ARRC lead engineers Redmond Kelley, left, David Schvartzman and Matt McCord with Horus.



BOONLENG CHEONG

- Poor Temporal Resolution
- Poor Vertical Sampling

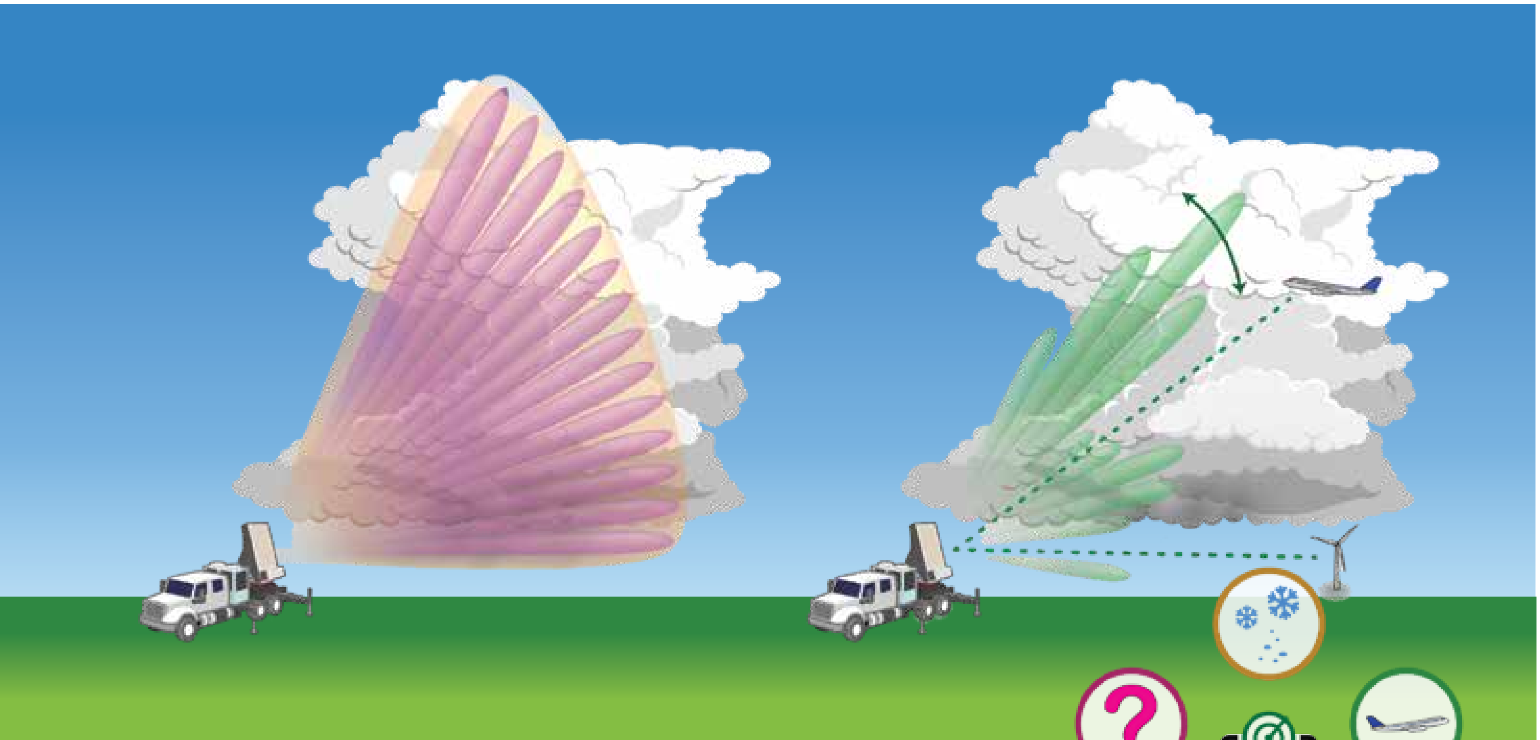
- 1D Radial Wind
- Severe Attenuation
- Cannot Observe Turbulence

VS.

- Superior Temporal Resolution
- Excellent Vertical Sampling

- 3D Wind Vectors
- Minimal Attenuation
- Excellent Turbulent Scattering

Below, Redmond Kelley debugs an issue on a printed circuit board. Kelley and his fellow ARRC engineers designed all the electronics that operate Horus. Right, the mascot of the Horus radar system, the Egyptian sky god with an "all-seeing eye."



BOONLENG CHEONG

Artist's depiction of example capabilities of a fully digital phased array weather radar. Above left, dense vertical sampling using imaging in a range-height-indicator mode. Above right, adaptive nulling for interference mitigation, including non-stationary clutter. Right, a symbolic depiction of software reconfigurability for future requirements/missions.

events, and the results surprised even those who dreamt up the system. "The quantity of data is tremendous; it's hundreds, if not thousands, of times bigger than what current radars produce," Palmer says.

Schvartzman recalls the moment he realized that Horus had captured a previously undocumented phenomenon—dozens of "lightning channels," the natural path of lightning strikes.

"Lightning happens on a scale of maybe a few dozen milliseconds," he says. "Conventional dish radars are too slow to catch it, but Horus can see a lightning bolt coming down from the top of the cloud to the ground.

"It was an unprecedented observation that can advance our understanding of storm electrification processes," Schvartzman says. "I was in awe of the high-quality data Horus was producing; it made me proud to be a part of the Horus team, the ARRC and OU. I'm excited about the discoveries we will make."

Palmer wagers that Horus may help to inform the replacement of NEXRAD, the "gold standard" network established in 1988 by the National Weather Service and featuring roughly 160 radars across the nation. "That," he says, "would be the pinnacle of my career."

Palmer can see a day in the not-so-distant future when OU develops a patent for Horus' technology, followed by a network of Horus digital phased array radars being deployed nationwide. The first example could be a large, stationary phased array built and tested within miles of OU.

"Horus is the most sophisticated, advanced and capable weather radar in the world," he says, adding that the system will likely have a lifespan of 30 to 40 years. "We have to take advantage of this technology to help the country. It's too important."

Horus' potential impact has led NOAA and the Office of Naval Research to invest tens of millions of dollars into the radar's development over the past decade. Future federal Horus projects include extensive field experiments with the Defense Advanced Research Projects Agency, the same U.S. Department of Defense unit that created the Internet.

Not even the nation's top radar manufacturers, known as "big primes," have developed comparable technology, Palmer says. This fact hugely benefits more than 80 OU graduate students who are working alongside two dozen of the nation's top radar engineers at ARRC. OU undergraduates also are gaining hands-on experience assembling and testing the panels that make up the Horus array.

"Students wouldn't have this chance anywhere else in the world. When they interview for careers in the radar industry and tell them what they've been doing, jaws are going to drop," he says.

"I love that we're training students who are getting access to the most advanced type of radar in the world, who will graduate and be ready to go to work," Palmer says. "I think we'll have a massive impact on the future of our country's radar and weather industries."

Díaz de la Rubia can only agree.

"In the ARRC, OU has the world's top scientists and engineers training the best students in advanced radar technology and its applications to extreme and severe weather prediction and response," he says.

"It's a shining example of how a top-tier public research university can excel." S

Anne Barajas Harp is editor of Sooner Magazine.