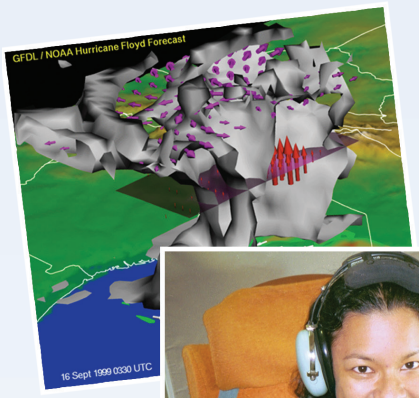
# Hurricanes: Improved Track and Intensity Predictions

**Track forecast improvements up to 20 percent are possible using dropsonde data. A 20 percent reduction in track errors should reduce the average warning area by at least 10 percent (34 miles), saving the public more than $45 million over 5 years.**



**The 10-year Hurricane Forecasting Improvement Project (HFIP) recently proposed to Congress will address "rapid intensification" as the number one problem of hurricane forecasting.**

Where a hurricane tracks, if it will intensify, and ultimately how hard it will hit are main concerns of NOAA hurricane forecasters and researchers. OAR models, data collection, and analyses contribute to the National Weather Service's improved average hurricane track forecasts. In fact, today's average 5-day track forecast is as good as the 3-day track forecast was ten years ago.

*Impact*

**More timely and reliable forecasts for improved community outcomes**

NOAA's hurricane forecast accuracy is tied to improvements in computer-based numerical weather prediction models. The National Hurricane Center uses many models, including those developed by OAR's Geophysical Fluid Dynamics Laboratory (GFDL) and the Atlantic Oceanographic and Meteorological Laboratory (AOML).

AOML researchers on NOAA "Hurricane Hunter" aircraft fly into the eye of these dangerous storms to collect and analyze data. Global Positioning System (GPS) dropsondes, an innovative technology developed by AOML, provide key data in real time to the National Hurricane Center and are crucial for studying the wind structure in the eyewall region of hurricanes.

During the 2007 Hurricane Season, AOML and NASA successfully flew an Aerosonde® Unmanned Aircraft System (UAS) through hurricane-force winds and at record low altitudes into Tropical Cyclone Noel. Using UAS to monitor tropical storms and hurricanes is important because UAS thermodynamic and wind observations can be obtained at altitudes unsafe for manned aircraft. In NOAA, the UAS program is managed by OAR's Earth System Research Laboratory (ESRL).

In spite of this progress, rapid intensification remains the number one challenge of hurricane forecasting. The 10-year Hurricane Forecast Improvement Project (HFIP), managed by OAR and the National Weather Service, will improve hurricane forecasts so emergency management officials can make informed decisions in advance of storms with more confidence. HFIP planning began after the 2005 hurricane season – the most active on record – which produced several monster storms, including Hurricane Katrina. OAR research efforts in the next decade will target HFIP objectives to reduce track and intensity errors by 50 percent, and improve prediction of rapid intensification events.

*Images, top to bottom: Three-dimensional depiction of GFDL Hurricane model; OAR hurricane research scientist Shirley Murillo; National Hurricane Center's 3-day forecast for Hurricane Katrina, Aug. 26, 2005.*

**Learn More:**

www.aoml.noaa.gov/themes/Hurricanes/hurricanes.html

uas.noaa.gov

# Tornadoes: Heroic Technology Advances Weather Forecasting

## *Impact*

**Four-fold increase in tornado warning lead times saves lives**

When killer tornadoes tore through Oklahoma and Kansas in May 1999, NOAA's Norman, OK, Weather Forecast Office issued warnings up to one hour in advance of some of the twisters. The office credited the NEXRAD (NEXt generation weather RADar) system and the Advanced Weather Interactive Processing System (AWIPS) for helping the team quickly and accurately assess the weather conditions and get out life-saving warnings. In fact, after this event, national media deemed NEXRAD a "hero." Together, with emergency managers and the media who helped disseminate NOAA warnings, an estimated 600 lives and countless dollars were saved. Both NEXRAD and AWIPS were developed by OAR researchers.

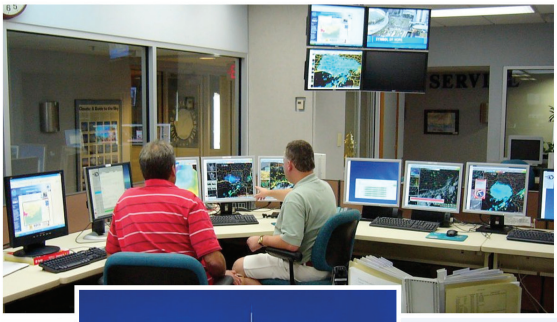
**"Technology has bought a precious 15-20 minutes in life-saving and property-saving time. The hero: a lowly radar called the 88-D …. mark[s] an unambiguous case indeed of government improving lives – by saving them."**
*USA Today,* May 6, 1999

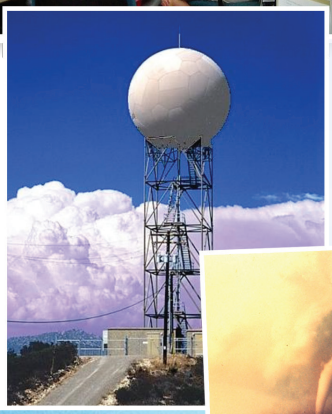
Three decades ago, successful tests of Doppler radar led by OAR's National Severe Storms Laboratory (NSSL), the National Weather Service, the Federal Aviation Administration, and the Air Force's Air Weather Service led to NEXRAD in the 1990s, a national network of 158 Doppler radars.

The AWIPS workstation, developed by a predecessor of OAR's Earth System Research Laboratory (ESRL) with the NWS and contractor PRC, fundamentally changed how NWS forecasters access radar, satellite, model outputs and other weather data streams. Without AWIPS, forecasters accessed radar via one computer, satellite imagery on another, and had no capability to overlay different streams of data on a single visual. With continuous improvements in AWIPS, forecasters have tremendous flexibility to manipulate information, develop a forecast and use automated tools to rapidly communicate warnings to tailored geographic areas.

Looking to improve warning times even further, NSSL and its partners are investigating how the U.S. Navy's AEGIS phased array radar system may be applied to tornado detection, forecasts, and warnings in a multi-use environment. Multi-function Phased Array Radar (MPAR) could extend average warning lead times significantly. A single network of MPAR units could theoretically replace seven single-function conventional radar networks that currently serve aviation, defense, homeland security, and weather forecasting needs.

**A 2005 external evaluation calculated storm-related injuries were down by 40 percent and fatalities by 45 percent after NOAA implemented NEXRAD.**





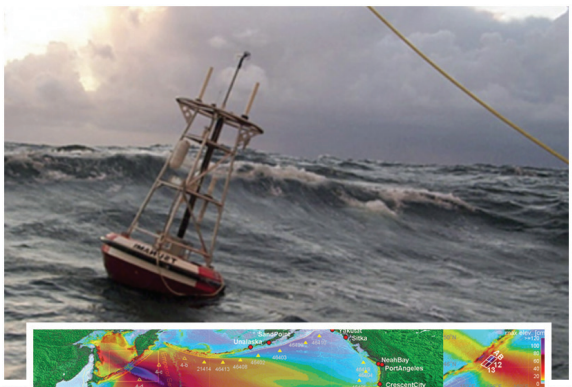
*Images, top to bottom: Advanced Weather Interactive Processing System; NEXRAD Doppler radar; tornado and tornado damage.*

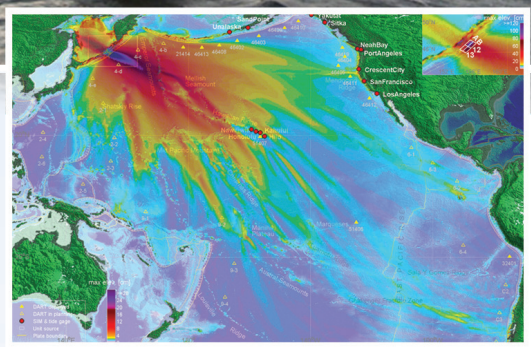
**Today, tornado warning times average 15 minutes. Only a three-minute warning was possible 20 years ago.**



**Learn More:** www.nssl.noaa.gov

**NOAA's DART® patent is licensed to a private company. Chile and Australia have purchased DART® systems.**





**For his groundbreaking work on tsunami warning, Dr. Eddie Bernard, Director of OAR's Pacific Marine Environmental Laboratory (PMEL), earned the 2008 Service to America Homeland Security Medal from the Partnership for Public Service.**

# Tsunamis: Getting Beyond "If the ground shakes, if the water recedes, or if you hear a loud roar"

"How could we detect a tsunami, tell you how big it's going to be in advance, and tell you what to expect when it arrives?" These were the questions Dr. Eddie Bernard, Director of OAR's Pacific Marine Environmental Laboratory (PMEL), and his team had been asking for 25-plus years. They had to build an instrument that could detect a tsunami in the open ocean, get the data fed into a numerical model which would generate the prediction, and find a way to relay the data back to a warning center within minutes. In 1995, their research gave birth to DART®, the Deep-Ocean Assessment and Reporting of Tsunami system, the first operational tsunami detection system in the world.

*Impacts*

**Tsunami detection and warnings save lives and property, while decreasing unnecessary false alarms**

Tsunamis are caused by earthquakes or land slides on the ocean floor. Seismic alerts are broadcast, but are no guarantee of a tsunami. What had frustrated people like Bernard for years was the 75 percent false alarm rate caused by a system built on tide gauges and seismometers. Waves with tsunami potential are sneaky. They can be subtle and incredibly difficult to detect. This is what makes DART® such an ingenious invention. Its exceptionally sensitive pressure recorder anchored miles below the surface on the ocean floor is capable of detecting a half-inch wave. Data are transmitted to a surface buoy then relayed to PMEL and the NOAA Tsunami Warning Centers in Alaska and Hawaii via satellite.

**In 1986, Hawaii spent $40 million on a needless evacuation due to a false alarm. In 2003, a false alarm was cancelled saving an estimated $68 million.**

The Indian Ocean tsunami disaster in December 2004 brought a real urgency to implementing DART® throughout waters surrounding the United States and in other places around the globe. Thirty-nine second-generation DART® systems with two-way communication for remote maintenance are now at work in the Pacific, Indian, and Atlantic Oceans, the Caribbean Sea, and Gulf of Mexico.

Bernard has been as passionate about public education as developing this life-saving system. He saw the public's heightened awareness of the 2004 tragedy as an opportunity for enhanced tsunami preparedness education. "It didn't take much because the visuals that were coming in from Thailand, and India. All you had to do was just remind people that this can happen to them when they are on the beach."

*Images, top to bottom: NOAA DART® II buoy; NOAA animation of the December 2004 Indian Ocean tsunami; Dr. Eddie Bernard, DART® creator.*

**Learn More:** nctr.pmel.noaa.gov