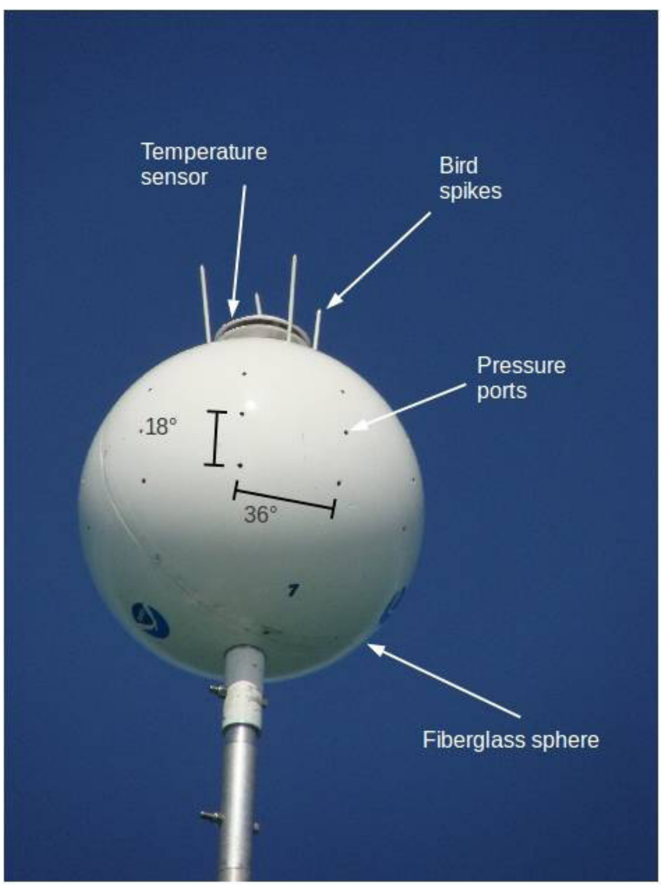
Air Resources Laboratory

Extreme Turbulence Probe

Providing Marine Atmospheric Boundary Layer Turbulence Data for Improving Hurricane Forecasts

Image of Hurricane Ivan in 2004. Source NOAA

The danger and cost of hurricanes continue to be demonstrated with each hurricane season. A hurricane builds energy as it moves across the ocean, feeding on warm, moist tropical air near the surface. Both the intensification and eventual decline of these storms are linked to turbulent exchanges of heat, water vapor, and momentum between the lower part of the atmosphere and the underlying water and land surfaces. Yet, these exchanges are poorly understood because turbulence measurements in hurricane conditions are difficult to acquire. Most turbulence instruments can not handle hurricane force winds and intense rain. Better turbulence observations in hurricane conditions would allow researchers to develop improved representations of air-surface exchanges in models, increasing the accuracy of hurricane forecasts.

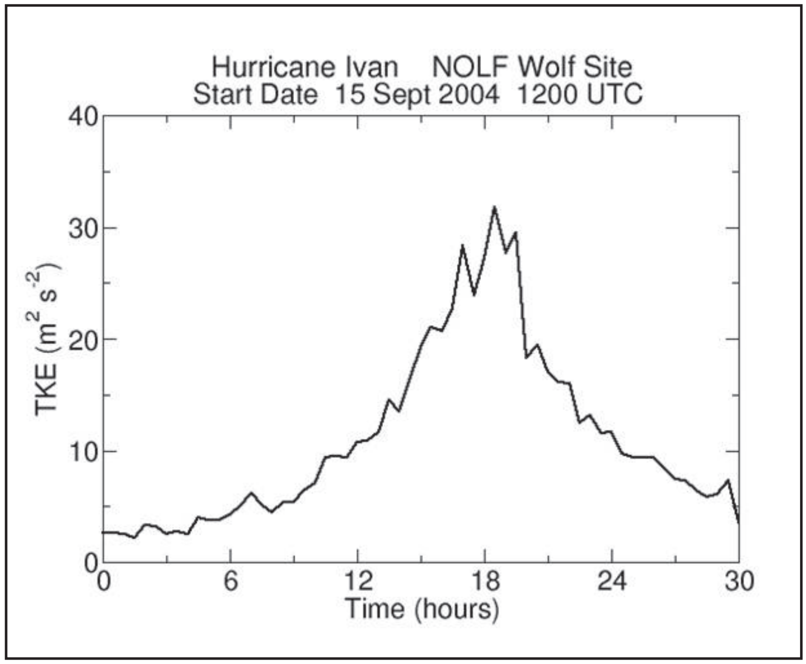


A closeup of the ET probe. Image: NOAA

The Air Resources Laboratory (ARL) has developed the Extreme Turbulence (ET) probe, an innovative wind sensor specifically designed to work in hurricane conditions. The probe's development is based on the same technology used in aircraft gust probes, such as ARL's Best Aircraft Turbulence probe, but it is deployed on a stationary tower or buoy instead. The ET probe uses a 43 cm diameter fiberglass sphere with three horizontal rows of pressure ports. Each port is connected to pressure sensors mounted on circuit boards inside the sphere. The size of the ports and the orientation of the internal tubing are designed to minimize the effects of rain and spray. A fast-response temperature sensor is located in a housing on top of the sphere. The probe measures all three vector components of the wind at 50 Hz, providing turbulence statistics and estimates of vertical surface fluxes in addition to mean winds.

During initial development, ET probes were deployed near the coast as hurricanes made landfall. The early deployments demonstrated that the probe design would work in real hurricane conditions without water fouling the pressure ports or other problems.

In 2004, the probes were deployed for a few days near the U.S. coast for Hurricanes Francis and Ivan. They successfully collected data while exposed to heavy rain and winds up to 50 meters per second. The plot to the left, for example, shows the turbulent kinetic energy (TKE) over a 30 hour period during the Gulf Coast landfall of Hurricane Ivan.



In recent years, ARL has focused its ET probe research on measuring vertical surface momentum and energy fluxes over the sea surface for longer periods of time. This research is part of NOAA's Hurricane Forecast Improvement Project. To observe these fluxes, the probes were deployed on over-water platforms for several months during the 2009 hurricane season. In preparation for longer deployments, ARL made significant modifications to the probe design. One probe was deployed at the end of a 560 meter pier jutting out over the water on the North Carolina coast. A second probe was deployed on a navigation light in the Florida Keys. In 2010, two probes were deployed on over-water platforms in the Florida Keys. The photo on left shows a probe deployed on the Tennessee Reef navigation light near Long Key, FL. Both 2009 and 2010 ended up being quiet years for hurricanes affecting the U.S. The only high-wind events were associated with extratropical cyclones affecting the North Carolina site in 2009.

Photo: NOAA

The ET probe may be useful for other applications beyond hurricane measurements. Because turbulent gusts are a significant factor in the damage patterns observed from hurricanes and other large storms, the probes could provide useful information related to wind loading on structures. For example, since large wind turbines are now being deployed offshore, probes may be useful for measuring extreme wind loads that could damage the turbines.

For More Information:

Field Research Division
www.noaa.inel.gov/
Air Resources Laboratory
www.arl.noaa.gov

NOAA/ARL
Field Research Division
1750 Foote Dr.
Idaho Falls, ID 83402
Phone: (208) 526-2329
Fax: (208) 526-2549

Last Updated April, 2012