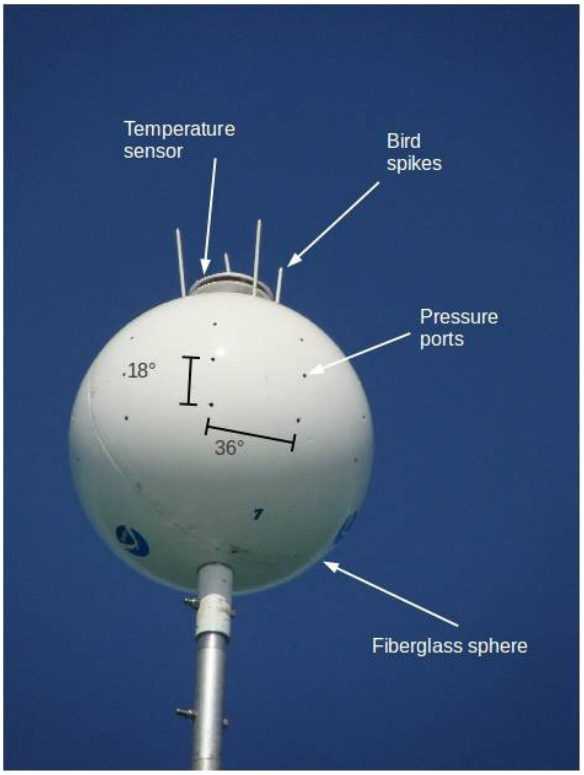
Air Resources Laboratory
Extreme Turbulence Probe

What It Is

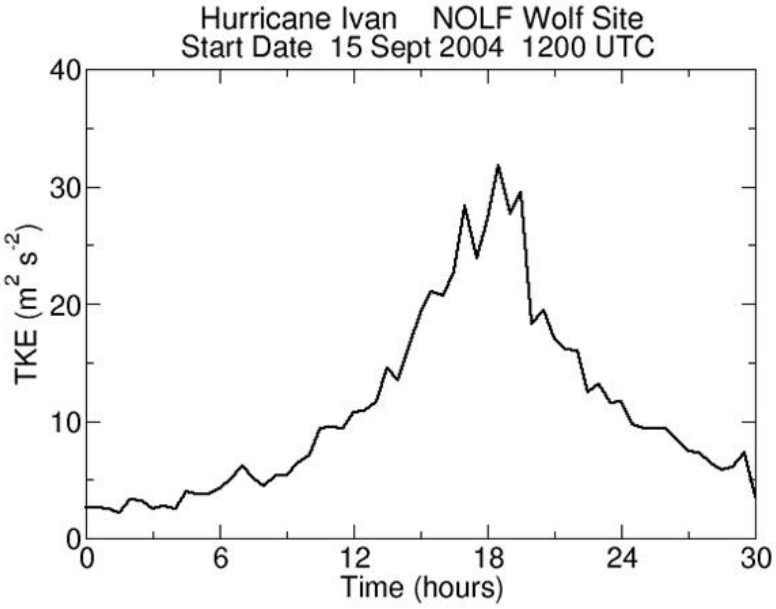
The Extreme Turbulence (ET) probe is an innovative wind sensor that is specifically designed to operate in hurricane conditions. It is based on the same technology used for aircraft gust probes. ARL has worked with aircraft gust probes since the 1980s and modified the technology for use at a stationary location in high winds. The 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, which can interfere with measurements in high winds. 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.



A closeup of the ET probe. Image: NOAA

What It Is Used For

The ET probe is designed to operate in extreme maritime environments with hurricane-strength winds, rain, and spray. Standard turbulence sensors work poorly or fail under these conditions. During initial development, probes were deployed near the coast as hurricanes made landfall. The primary purpose of these early deployments was to demonstrate 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 near the U.S. coast for Hurricanes Francis and Ivan. During these deployments, the probes only needed to operate for a few days at a time as the hurricanes came onshore. They successfully collected turbulence and flux data while exposed to heavy rain and winds up to 50 m/s. 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.



Since 2009, the ET probe research has focused on measuring vertical surface fluxes over

the sea surface as part of NOAA's Hurricane Forecast Improvement Project (HFIP). Of particular interest is the vertical momentum flux over the sea, which is often represented as a drag coefficient. To observe these fluxes, the probes are being deployed on over-water platforms for several months during the hurricane season. These longer deployments have required significant modifications to the probe design. In the 2009 season, one probe was deployed on a long pier on the North Carolina coast, and a second one was deployed on a navigation light in the Florida Keys. In 2010, two probes were deployed on platforms in the Florida Keys. The photo below 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., so the only high-wind events were associated with extratropical cyclones affecting the North Carolina site in 2009.

Why It Is Important

Turbulent transfers of momentum and energy between the ocean surface and the atmosphere are major factors in the development and decay of tropical cyclones. Hurricane forecast models must use parameterizations for these surface fluxes. Because wave action and spray increase with wind speed, the values of these fluxes are poorly understood in hurricane conditions. Most models use parameterizations that are extrapolations based on observations taken in wind speeds under 20 m/s. There is accumulating evidence that such extrapolations are inaccurate in hurricane winds.

The probes have other potential applications. Turbulent gusts during hurricanes are a significant factor in the damage patterns observed from the storms. Because the probes can measure wind fluctuations at 50 Hz, they can provide useful information related to wind loading on structures. The probes have potential applications beyond hurricane measurements. Extratropical cyclones also produce high wind and spray environments, and the probes could be used to provide high-frequency wind observations in these environments. Large wind turbines are now being deployed offshore. The ET probes may be useful for measuring extreme wind loads that could damage these turbines.

Photo: NOAA

For More Information:

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