Dropsondes—Work horses in hurricane forecasting

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(Phys.org)—Inside a cylinder that is about the size of a roll of paper towels lives a circuit board filled with sensors. It's called a dropsonde, or "sonde" for short. It's a work horse of hurricane forecasting, dropping out of "Hurricane Hunter" airplanes right into raging storms. As the sonde falls through the air, its sensors gather data about the atmosphere to help us better understand climate and other atmospheric conditions.

"Dropsondes have a huge impact on our understanding of hurricanes and our ability to predict hurricanes," explains electrical engineer Terry Hock at the Earth Observing Laboratory in the National Center for Atmospheric Research (NCAR), located in Boulder, Colo.

With support from the National Science Foundation (NSF), Hock and his colleagues at NCAR have been designing, building and improving dropsonde technology for more than 30 years. "Our most current development is a fully automated dropsonde system for NASA's unmanned Global Hawk aircraft," says Hock.

Compared to earlier models, today's sondes are lighter weight, relatively inexpensive and loaded with sensors.

"We have a lot of electronics and, on the back side, a battery pack to operate the sonde. We have a temperature and two humidity sensors, and we have a GPS receiver," explains Hock, as he points out the different circuit board components. "As the sonde moves, we're using that GPS receiver to track the sonde's movements very precisely, which is then

telling us the wind speed and wind direction. At the top of the sonde is a parachute which slows down the descent."

Electrical engineer Dean Lauritsen, a member of Hock's team, developed the system software on the aircraft, which controls the aircraft data system and process, and also displays dropsonde data during the sondes free fall to earth. There's such a system on the HIAPER, the NSF/NCAR Gulfstream V Research Aircraft, which uses sondes for scientific research, and a similar system used by the U.S. Air Force Reserve Hurricane Hunters in Biloxi, Miss., and the NOAA Hurricane Hunters in Tampa, Fla. On board each aircraft are a computer and a rack of electronic equipment to monitor and receive information from sondes. "The system is capable of tracking as many as eight dropsondes in the air at the same time. Each one of them is transmitting data on a separate frequency as it falls." says Lauritsen.

From the time the sonde leaves the aircraft, it is checking surroundings two times a second and sending information back to the aircraft, including pressure, temperature, humidity, wind speed, and wind direction. Future developments are expected to include sensors for chemicals such as ozone.

"We're taking vertical slices of the atmosphere constantly as the sonde falls," says Hock. "We're seeing very precise single measurements show up immediately on the computer screen."

Researchers process the information using NCAR-developed custom software, and then send it to weather forecasters and researchers around the world. In the case of the Hurricane Hunters, the information goes to the National Hurricane Center in Miami.

NCAR software engineer Charlie Martin develops custom software called ASPEN, which stands for Atmospheric Sounding Processing

Environment. ASPEN helps make sense of all the dropsonde data. "Once the dropsonde has fallen through the atmosphere and the data has come back to the aircraft, that raw data needs a little more treatment before we send it to weather services around the world," explains Martin.

Martin points to a map showing a compilation of dropsonde wind data collected in August 2011, as Hurricane Irene was churning its way toward the Florida coast. "The winds are in a circular pattern," says Martin, as he identifies small triangles on the map that represent the wind and wind direction. "The center of the hurricane is clearly depicted in the center of the circular pattern. The National Hurricane Center uses this data along with other data to classify the hurricane and assign a category to it."

Hock and his team also custom fit aircraft with launchers to deploy the sondes, including one system for helium-filled balloons. In 2010, American and French researchers deployed balloons over Antarctica that dropped 600 sondes over a four-month period to study atmospheric conditions and the shifting ozone layer. "There is now a very dense set of measurements that came out of this project that has mapped the Antarctic atmosphere like it has never been done before," notes Martin.

"Atmospheric conditions above the Antarctic continent are hard to study since only a handful of sounding stations are regularly maintained there," says Peter Milne, program manager for ocean and atmospheric sciences within NSF's Office of Polar Programs. "Fortunately, the Antarctic polar vortex, a huge cyclone that sets up above the entire continent, is like the NASCAR of long distance ballooning, with balloons sweeping around the continent for as long as they stay aloft. Using these drifting platforms provided a unique data set."

Such "inside information" is helping scientists learn more about climate and hurricanes. Data from dropsondes is also giving scientists a better

understanding about atmospheric conditions that spawn any number of weather conditions. Hock expects this will help forecasters make earlier and more precise hurricane predictions, giving people in the path of a killer storm more time to get out of harm's way.

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