Unmanned aircraft hurricane reconnaissance

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Perhaps the best potential for improved understanding of hurricane science and advancing their forecasting skill is with unmanned platforms released into the tropical cyclone environment. NOAA is pursuing two methodologies with this goal: Unmanned Aircraft Systems (UAS), and constant altitude balloons. These platforms can take measurements in data-sparse regions and/or otherwise dangerous regions that reconnaissance flights need to avoid.

While a variety of UAS platforms exist for a variety of military and marine science applications, the primary plane used for hurricanes is the *Aerosonde*. The Aerosonde has been in development since the 1990s, and even flew across the Atlantic in a test flight in 1998, taking observations continuously. From 2000-2004, prototype flights into typhoons from Taiwan were unsuccessful, crashing into spiral bands or the eyewall. However, in 2005, one successfully circled Hurricane Ophelia and returned to its base, and another Taiwan flight successfully penetrated Typhoon Longwang's eyewall.

In 2007, the first successful flight into an Atlantic hurricane (Hurricane Noel) occurred. A NASA chase aircraft escorted the Aerosonde for the first three hours of the mission at a nominal altitude of 4,000 ft. until well offshore, and returned to Wallops when weather conditions deteriorated in closer proximity of the hurricane. The UAS mission continued overnight with the Aerosonde being drawn into the core of the hurricane, and measured winds as high as 80 mph. The Aerosonde followed the storm core taking measurements and loitering in the eyewall with several ascending/descending passes. As the Aerosonde approached the center of Noel from the north around 400 m altitude, a reconnaissance P-3 penetrated from east to west at around 3500 m altitude and also released GPS dropsondes. This shows some of the UAS advantages: it can collect data right above the sea (in the boundary layer) where P-3s cannot, can take measurements at many different levels as well as with multiple vertical ascents and descents, and can supplement reconnaissance flights with simultaneous observations. Other advantages of the Aerosonde include its potential recoverability (such as in Ophelia) and its lower cost compared to manned flights.

A current disadvantage involves flights restrictions from the FAA for a variety of reasons, including around offshore oil rigs.

The Aerosonde has the following specs:

- Wing span: 2.9 m
- Flight speed: 15-60 m/s
- Max range: 2500 km (less for high speed, low altitude missions)

- Altitude range: 100-5000 m
- Launch system: car/roof-rack system (55 mph launch speed needed)
- Measurements: pressure, temperature, relative humidity, winds (Errors: 1 mb, 0.1 C, 2-5%RH, 1 m/s)

More information is available at http://uas.noaa.gov and http://www.aerosonde.com .

Another NOAA initiative is called the Weather In Situ Deployment Optimization Method (WISDOM). The WISDOM project seeks to improve 3-7 day hurricane track and intensity predictions by deploying "super pressure" near-constant altitude balloons into the hurricane environment. In this application, WISDOM GPS/SATCOM Radio attached to the balloon is used to measure wind via measurement of latitude, longitude, and altitude over a period of 5-10 days. Future generations of the payload will also include measurements of temperature, pressure, and relative humidity. A proof of concept occurred in 2008, in which balloons were successfully launched from Colorado by NOAA employees, and from Mississippi, Florida, Puerto Rico, and Barbados by students from Mississippi State University, the University of Miami, and the Caribbean Institute for Meteorology and Hydrology. Post-launch teleconference briefings included meteorological, ensemble models, and trajectory discussions.

It is anticipated that the WISDOM Project will expand in the 2009 hurricane season, including possibly a mission in which hundreds of balloons launches will "saturate" a major hurricane environment (based on trajectory models) which could be used for a field study and modeling tests.

More information is available at http://wisdom.noaa.gov , which also contains data archives.