

Unmanned Aircraft Hurricane Reconnaissance

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Outline

- Motivation
- Unmanned Aircraft Systems (UAS) [also called UAV]
- Constant Altitude Balloons from the **Weather *In Situ* Deployment Optimization Method (WISDOM)**

Best potential for advancing hurricane science and forecasting

Motivation

- Collect data right above the sea, called the boundary layer
- Multiple vertical ascents and descents
- Supplement manned missions with simultaneous observations
- Measure air-sea interactions (fluxes, sea spray)
- Potentially recoverable for future missions
- Potentially lower cost than manned flights

Website: <http://uas.noaa.gov>

NOAA Is Looking At A Broad Range Of UAS Platforms





Feb 2006, Point Upolu,
Hawaii, NOAA NMSP
Silver Fox and Manta
Project to monitor marine
mammals



Tropical Storm
Ophelia Sept 2005,
NASA Wallops
Aerosonde launch



Altair Mission, Channel Islands and
eastern Pacific, 2005

TESTS



To Date

Unmanned Aircraft Systems

UAS Test Beds



Arctic



Pacific



Hurricanes

Aerosonde Specs

- Wing span: 2.9 m
- Flight speed: 15–60 m/s
- Max range: 2,500 km (less for high speed, low altitude missions)
- Altitude range: 100–5,000 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)
- Flown in a variety of weather situations

Website: <http://www.aerosonde.com>

Some Historical Flights

- 21–22 August 1998: First flight across the Atlantic Ocean. Departed from St. John's, Newfoundland, Canada, and completed the 2,000-mile trip to the west coast of Benbecula in the Outer Hebrides of Scotland in just over twenty-six hours. The trip is completed using less than two gallons of fuel, continuously measuring meteorological observations the entire time.
- 2000–2004: Earlier versions, flights attempted into six typhoons from Taiwan, all crashed in rainbands or eyewall
- 16 September 2005: successful flight at 2,500-ft circled the outer rainband of Hurricane Ophelia, measured winds up to 38 m/s, then returned to base.
- 1 October 2005: successful flight into Typhoon Longwang, penetrated eyewall, continuous measurements for 10 h at 3,000 m, with vertical measurement in eye, then crashed into sea. Peak wind measured 62 m/s
- 2 November 2007: first successful flight into Atlantic hurricane (Hurricane Noel). Flown until ran out of gas, continuously taking measurements. Noel was undergoing extratropical transition.

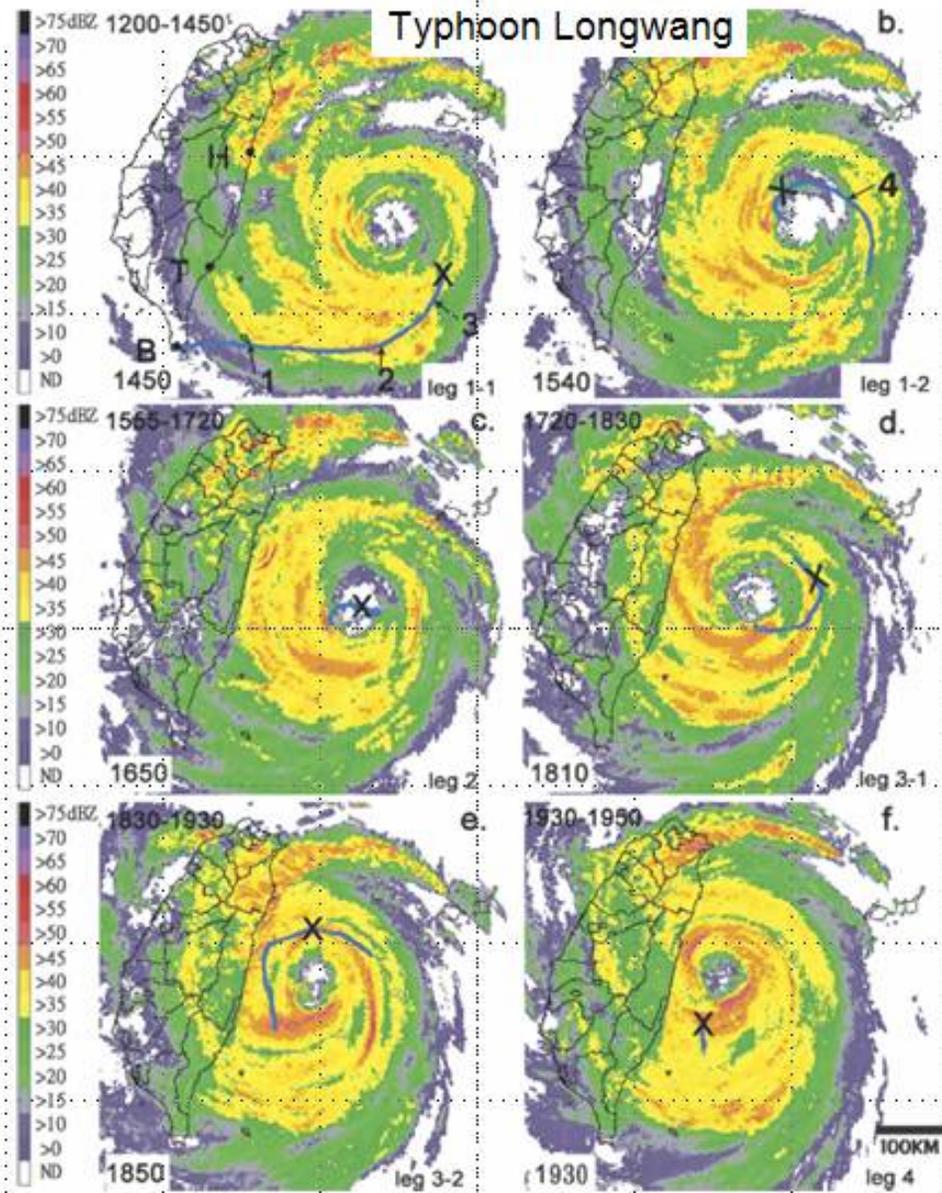


FIG. 3. The composite radar reflectivity with Aerosonde location marked by the black "X" at time (UTC) shown at the bottom left of 1 Oct 2005. The blue curve shows the flight track during the period (UTC) shown at the upper left, and the corresponding flight leg is shown at the bottom right. Numbers 1, 2, 3, and 4 show the locations of Aerosonde at 1300, 1400, 1430, and 1510 UTC, respectively. The letters "H," "T," and "B" show the location of Hua-lien radar, Tai-tung, and the ground base, respectively.

NOAA/NASA Noel Aerosonde UAS mission

Aerosonde was launched from the NASA Wallops Research Range at 14:08 EST on Friday 2 November 2007.

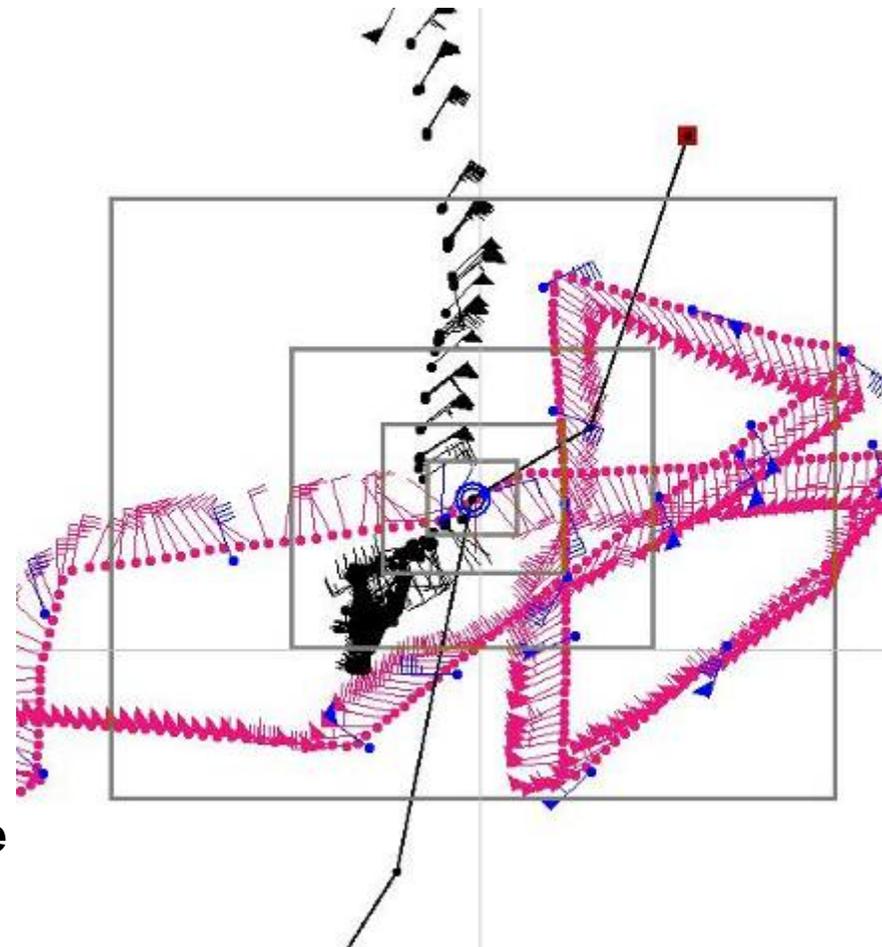
The mission lasted 17 hours 27 minutes and resulted in approximately 7.5 hours of data collection in the core of the hurricane.



NOAA/NASA Noel Aerosonde UAS Mission Coordinated with NOAA P-3

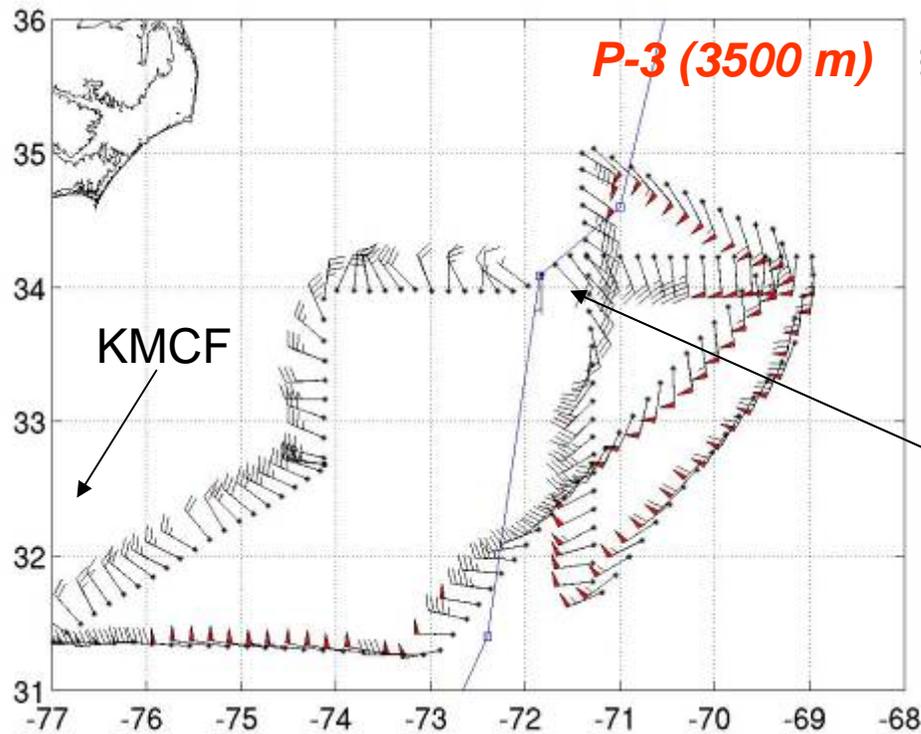
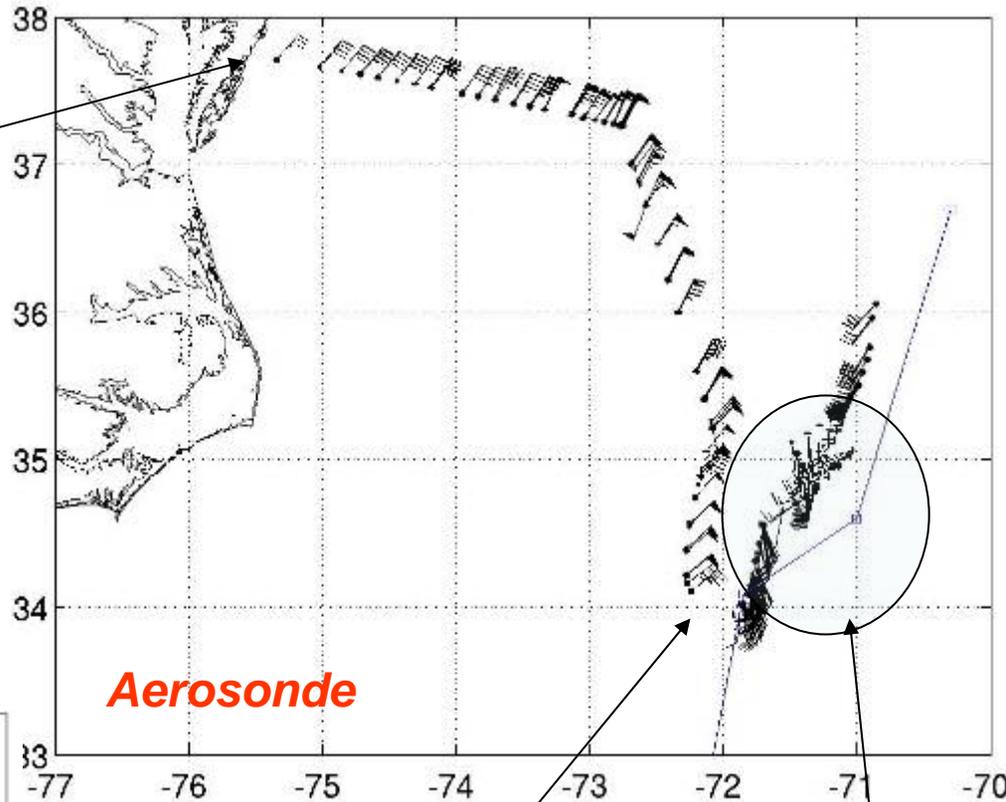
A NASA chase aircraft escorted the Aerosonde for the first three hours of the mission at a nominal altitude of 4,000 ft. until well offshore, and returned to Wallops when weather conditions deteriorated in closer proximity of the hurricane. The mission continued overnight with Aerosonde being drawn into the core of the hurricane and measuring winds as high as 80 mph.

The Aerosonde UAS approached the center of Noel from the north (black), at around 400 m altitude. At the same time, the P-3 (red) was making a penetration from east to west at around 3,500 m altitude. GPS dropwindsondes (blue) were deployed from the P-3.



Take-off from Wallops Flight Facility

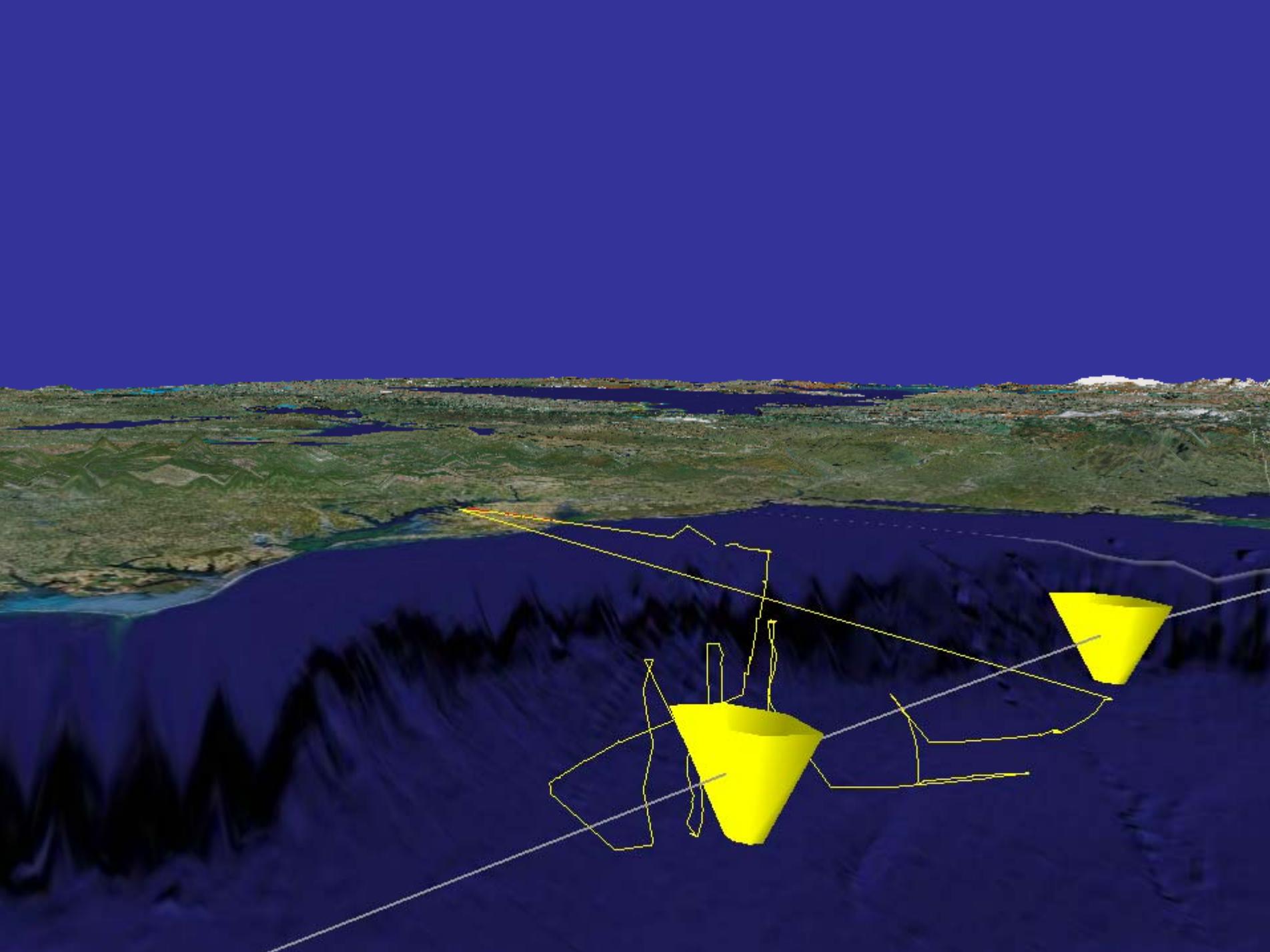
Nominal altitude for the Aerosonde was 500 to 2,000 feet.



“Eye” loitering with vertical soundings (100–1,500 m)

Rendezvous with P-3 at storm center 0525 UTC

Courtesy Joe Cione



Weather *In-Situ* Deployment Optimization Method (WISDOM)

- *Near constant altitude “super pressure” balloons over a period of 5–10 days prove NOAA data for improved hurricane track predictions. Future generations will additionally include measurements of temperature, pressure, and relative humidity.*
- *Balloons successfully launched by students from Colorado, Mississippi, Florida, Puerto Rico, and Barbados*
- *Deployments will be based on trajectory forecasts for data-sparse regions around hurricanes*
- *Plans are to “saturate” a hurricane environment with hundreds of these balloons in upcoming seasons*





