

Unmanned Aircraft Hurricane Reconnaissance

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Outline

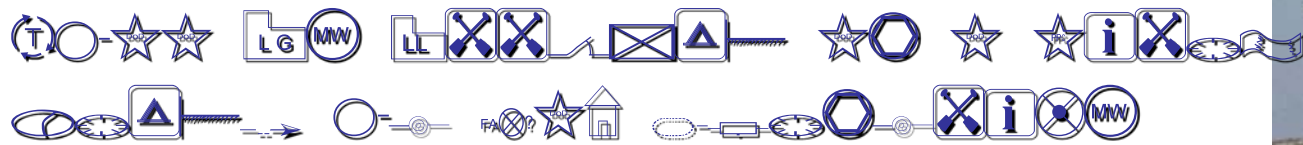
- Motivation
- Unmanned Aircraft Systems (UAS) [also called UAV]
- Constant Altitude Balloons from the **Weather *In Situ* Deployment Optimization Method (WISDOM)**

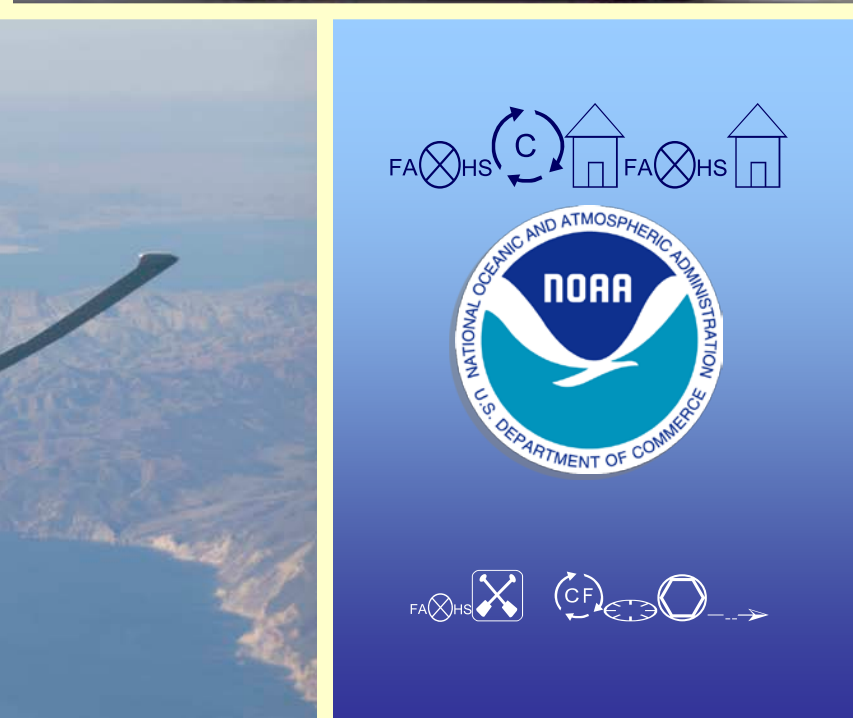
Best potential for advancing hurricane science and forecasting

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>





Unmanned Aircraft Systems

UAS Test Beds

Arctic



Pacific



Hurricanes



Aerosonde 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)
- Flown in a variety of weather situations

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

Some historical flights

- **August 21–22, 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 2 gallons of fuel, continuously measuring meteorological observations the entire time.
- **2000-2004**: Earlier versions, flights attempted into 6 typhoons from Taiwan, all crashed in rainbands or eyewall
- **September 16, 2005**: successful flight at 2500-ft circled the outer rainband of Hurricane Ophelia, measured winds up to 38 m/s, then returned to base.
- **October 1, 2005**: successful flight into Typhoon Longwang, penetrated eyewall, continuous measurements for 10 h at 3000 m, with vertical measurement in eye, then crashed into sea. Peak wind measured 62 m/s
- **November 2, 2007**: first successful flight into Atlantic hurricane (Hurricane Noel). Flown until ran out of gas, continuously taking measurements. Noel was undergoing extratropical transition.

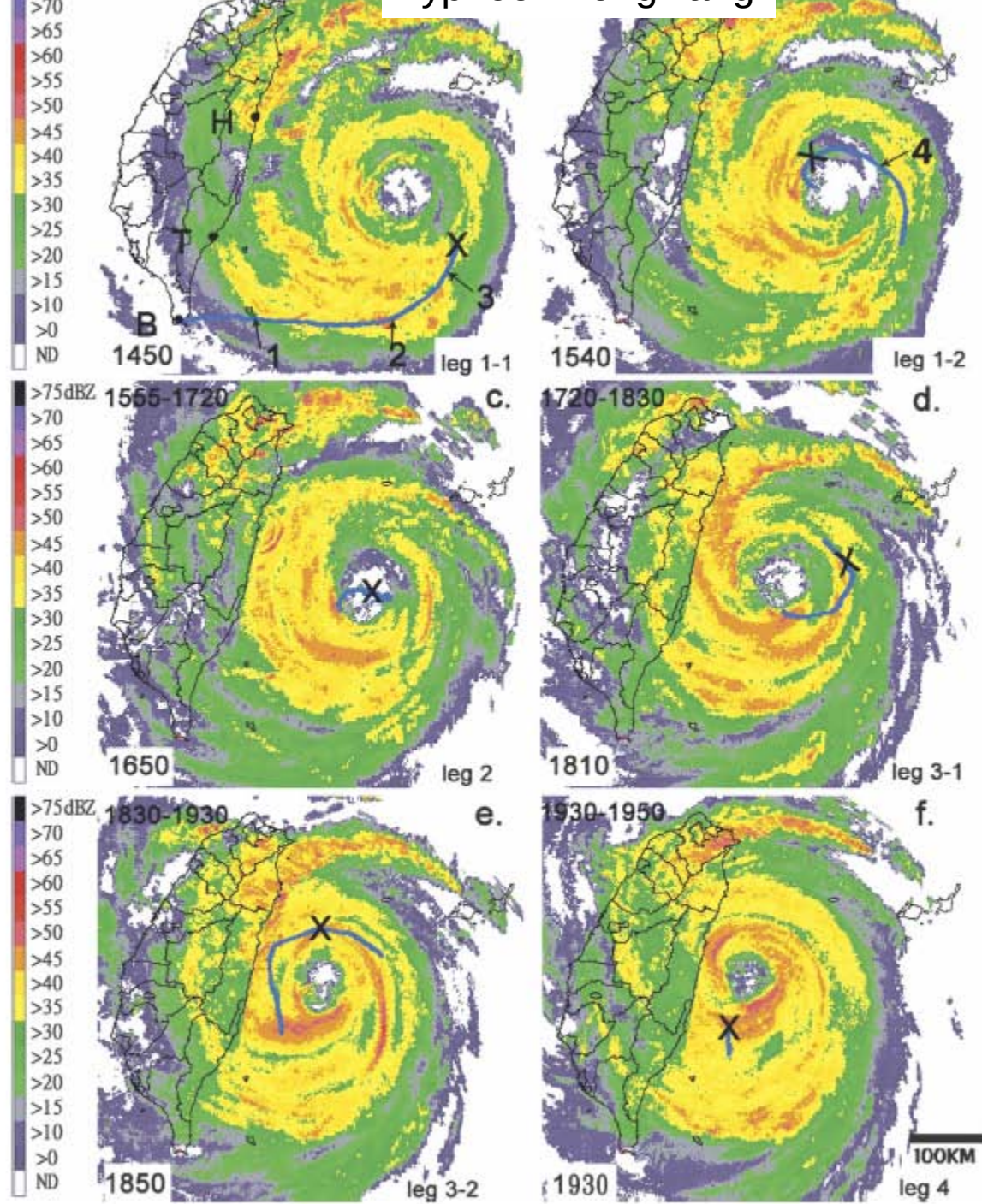


FIG. 3. The composite radar reflectivity with Aerosonde location marked by the black "X" at time (UTC) shown at the bottom left

NOAA/NASA Noel Aerosonde UAS mission

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

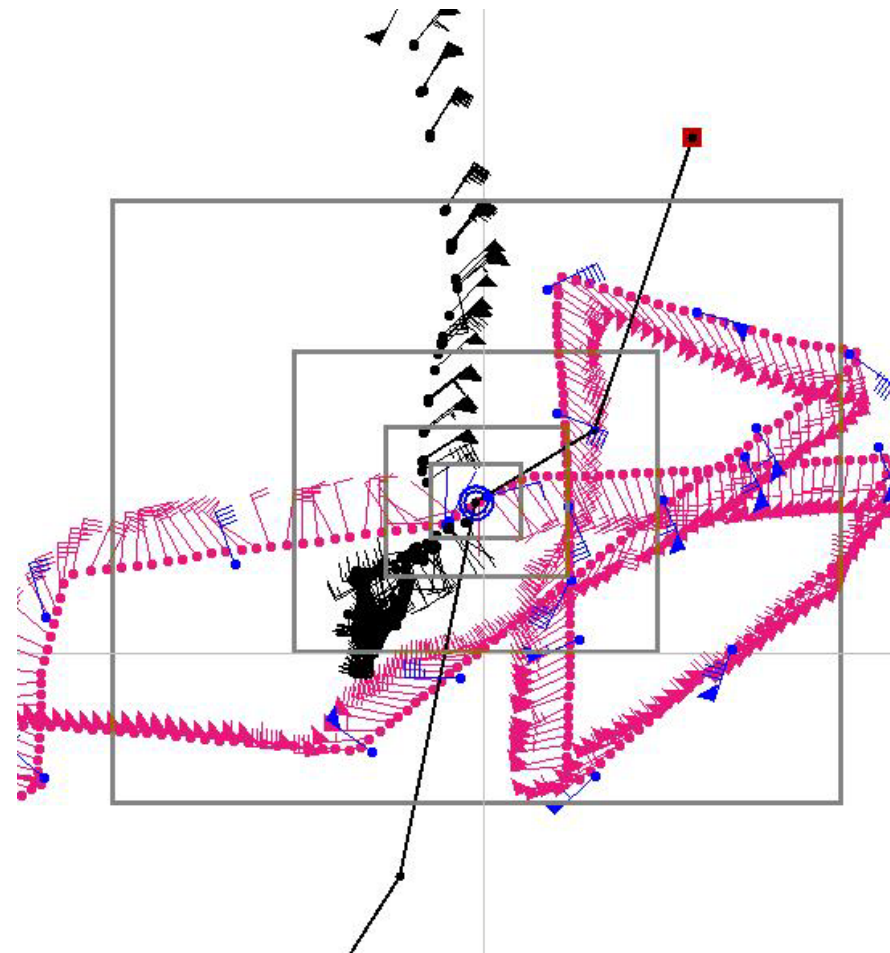
The mission lasted 17 hours 27 minutes and resulted in approximately 7.5 hours of data collection in the core of the hurricane.



NOAA/NASA Noel Aerosonde UAS mission coordinated with NOAA P-3

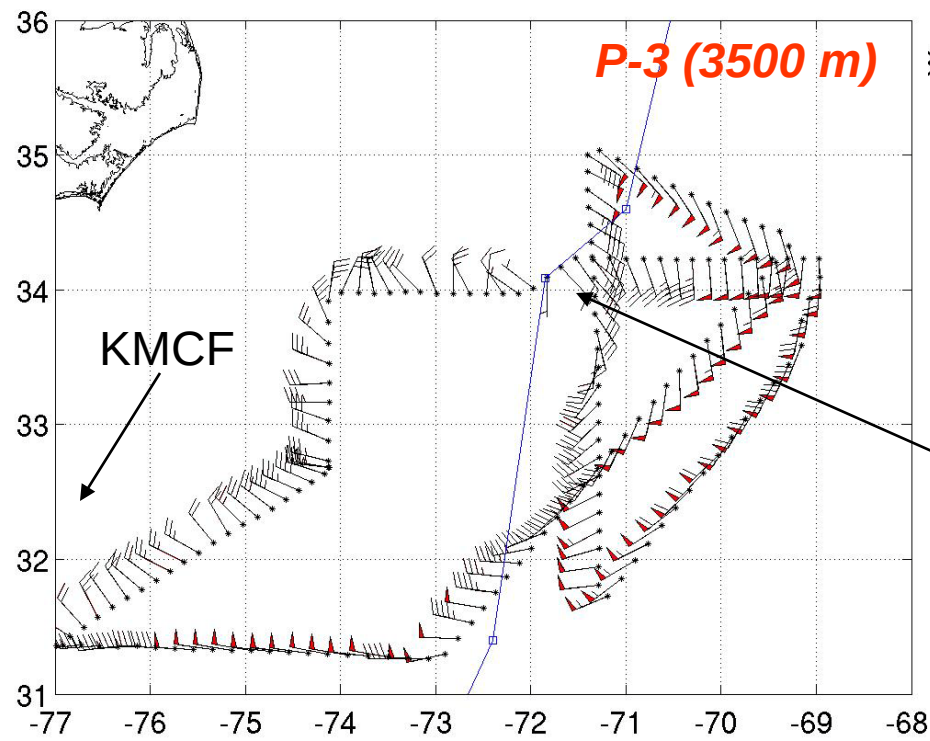
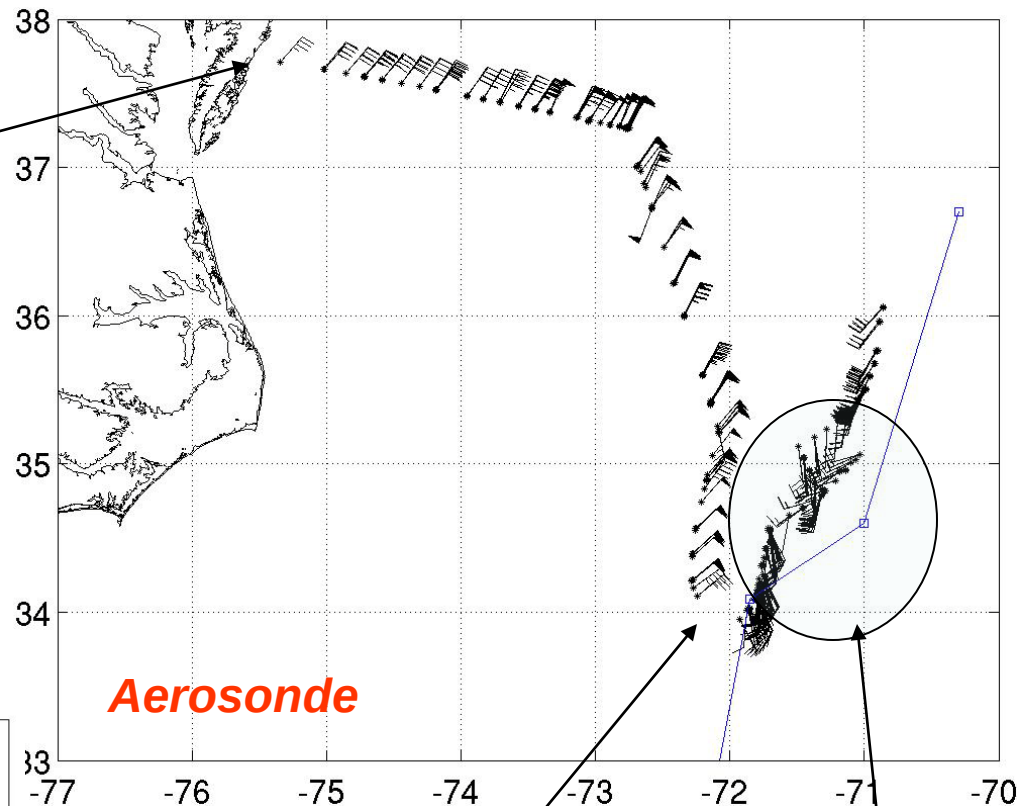
A NASA chase aircraft escorted the Aerosonde for the first three hours of the mission at a nominal altitude of 4,000 ft. until well offshore, and returned to Wallops when weather conditions deteriorated in closer proximity of the hurricane. The mission continued overnight with Aerosonde being drawn into 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 3500 m altitude. GPS dropwindsondes (blue) were deployed from the P-3.



Take-off from Wallops Flight Facility

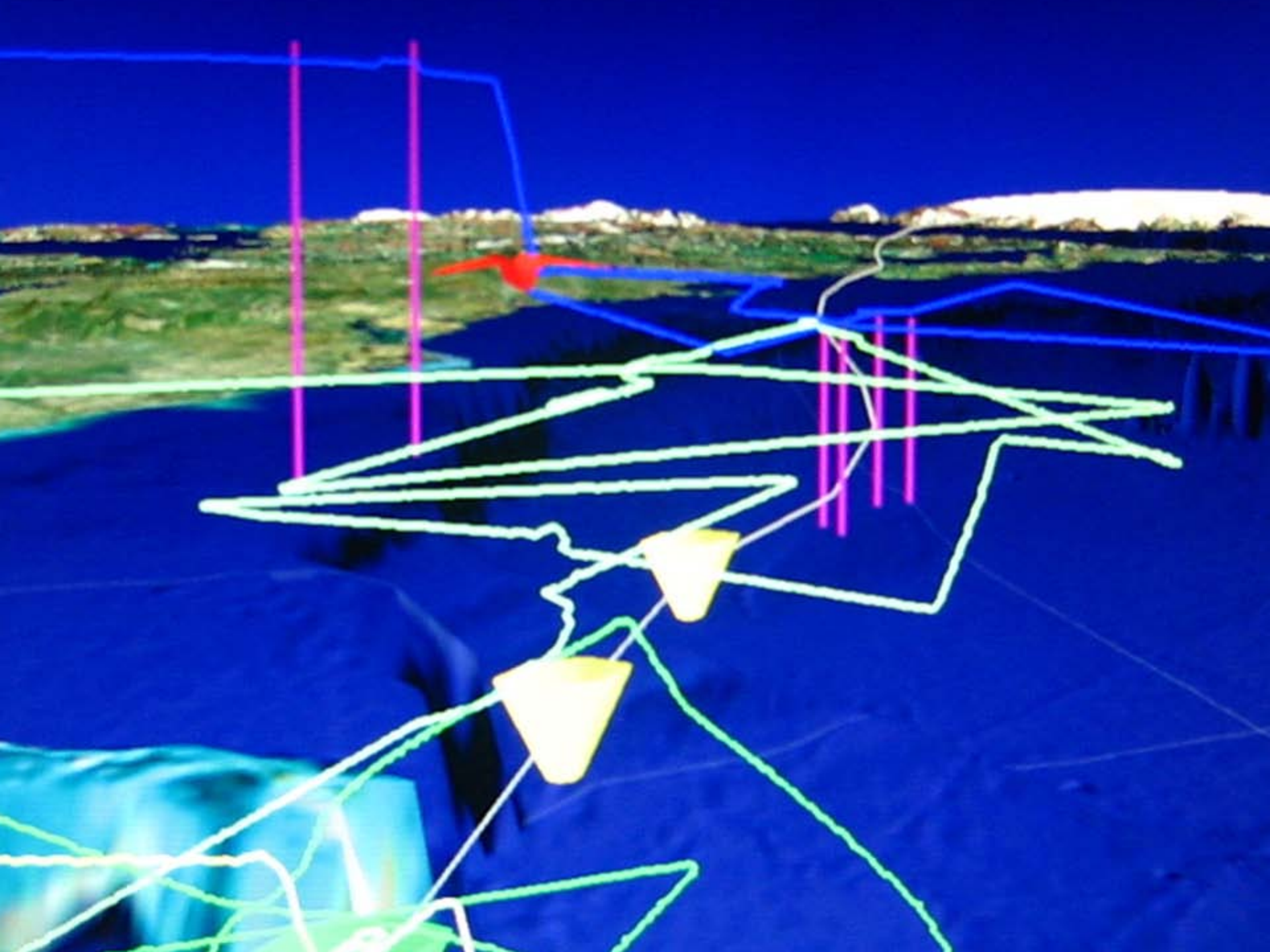
Nominal altitude for the Aerosonde was 500 to 2,000 feet.

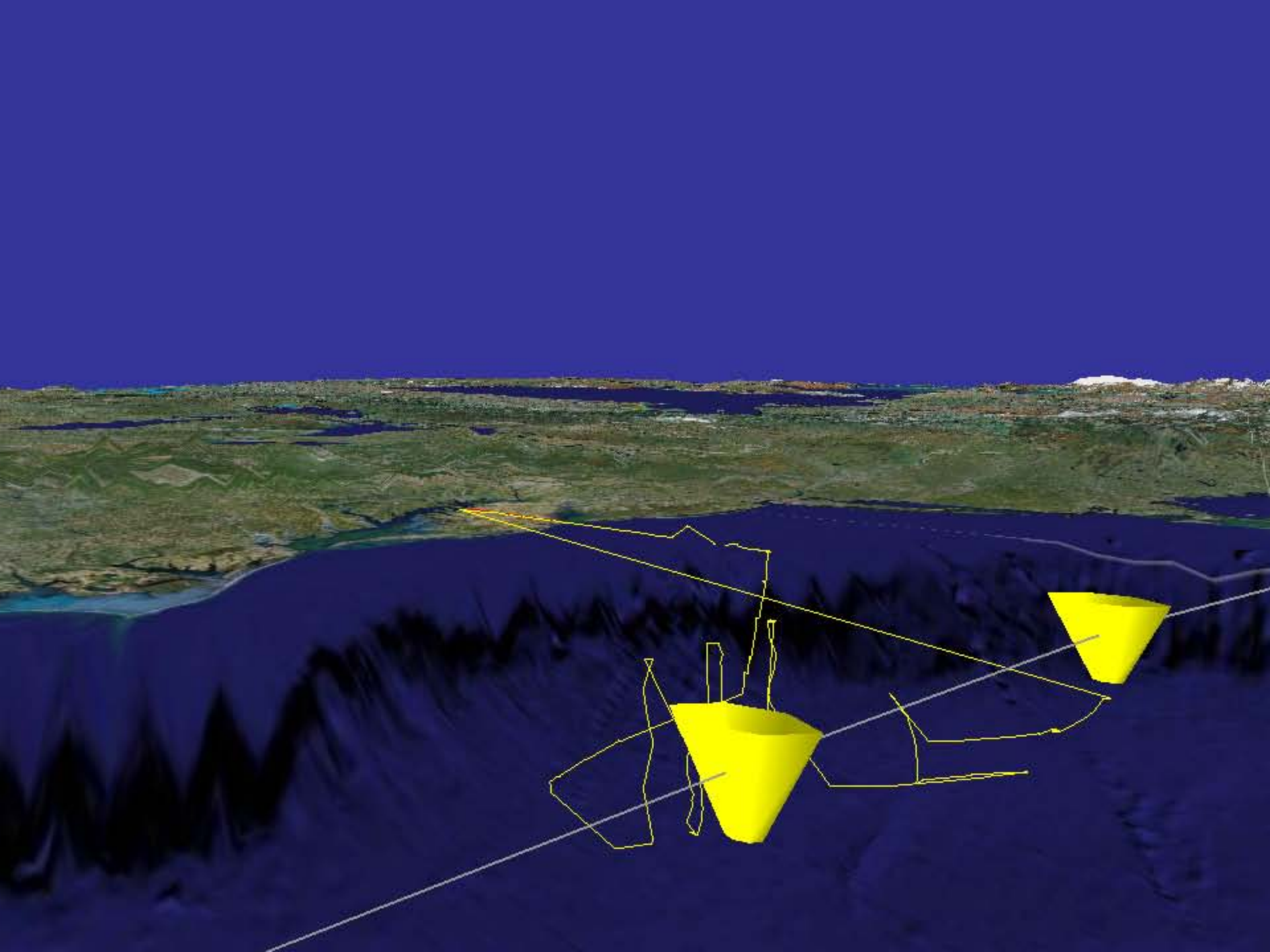


**"Eye" loitering
with vertical
soundings (100-
1500 m)**

**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*

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





