Hurricane and Severe Storm Sentinel (HS3)
A Multi-Year Investigation of Atlantic Hurricanes

PI: Scott Braun (NASA/GSFC)
Deputy PI: Paul Newman (NASA/GSFC)
Project Man.: Marilyn Vasques (NASA/ARC)
Deputy Proj. Man.: Bernie Luna (NASA/ARC)
Outline

- Science Goals
- Mission Overview
- Instruments
- Schedule
- Data policy
Overarching Science Questions

• What impact does the large-scale environment have on intensity change?

• What is the role of storm internal processes in intensification?

• To what extent are these processes predictable?
The Saharan Air Layer

- Research has suggested both positive and negative influences on hurricane formation and development.
- Hypothesis: Once TS formation occurs, the SAL is not a major determinant of subsequent intensification.
- Payloads for environmental GH selected specifically for this topic.

Key focus of HS3 proposal—Environment
Key focus of HS3 proposal—Environment

Environmental Winds

- Shear generally unfavorable, but sometimes beneficial
- Dependence on shear profile?
- Hypothesis: Potential for RI increased when upper-level westerlies are weak and when broad outflow is favored.
Recent additional focus area

**Outflow Layer Interactions**

- How does outflow interaction with the environment affect storm evolution?
- How does outflow modify the environment or impact other tropical disturbances?
Genesis and Pouch Theory

Role of the pouch

- What is the structure of the pouch and how well does it protect incipient disturbances from the SAL?

HS3 will likely NOT answer questions related to
- Detailed evolution of the pouch
- Top–down/bottom–up development
Deep, Strong Convection

Are the deep towers the building blocks of the vortex or just contributing to the total mass flux needed for development?

Hypothesis: Hot towers actively contribute to genesis and RI through vortex tube stretching and convergence of low-level angular momentum.

Over-storm payload chosen to measure the wind field response to convection and the formation/evolution of the warm core.
NASA’s Global Hawk UAS

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endurance</td>
<td>&gt; 30 hours</td>
</tr>
<tr>
<td>Range</td>
<td>&gt;11,000 nmi</td>
</tr>
<tr>
<td>Service Ceiling</td>
<td>65,000 ft</td>
</tr>
<tr>
<td>Airspeed (55K+ ft)</td>
<td>335 KTAS</td>
</tr>
<tr>
<td>Payload</td>
<td>1,000-1,500 lb</td>
</tr>
<tr>
<td>Length</td>
<td>44 ft</td>
</tr>
<tr>
<td>Wingspan</td>
<td>116 ft</td>
</tr>
</tbody>
</table>

Cruise Climb from 56–65K ft (max takeoff weight)

Hurricane Earl’s eye as seen from the GH
HS3 Mission Overview

• Two aircraft, one equipped for the storm environment, one for over-storm flights

• Deployments of GHs from the East Coast—Wallops Flight Facility in VA

• One-month deployments in 2012, 2013, and 2014

• 275 flight hours per deployment (10-11 flights)

Dots indicate genesis locations. Range rings assume 26-h flights.
Environmental Payload

AV-6 “Environmental” Instrument Configuration

2012

NOAA AVAPS

872 (AV-6)

S-HIS

CPL

U. Wisc.

NASA/GSFC

Aerosol Backscatter
Environmental Payload

2013–2014
AV-6 “Environmental” Instrument Configuration

TWiLiTE wind lidar to be added in 2013

Rocky Mountains
Over-Storm Payload

HIRAD excess $T_B$

HIRAD Derived Warm Core Anomaly for Karl 2010 17-Sep-2010 06:44:05

AV-1 “Over Storm” Instrument Configuration

a) 3 km
b) 5 km

HIWRAP dBZ and vector winds
Possible Piggybacks for 2013–2014

- Yankee Environmental Systems dropsonde
- GPS surface wind sensors
- Gamma ray detector
HS3 Mission Overview

- Environmental and Over-Storm GH flights will not be simultaneous, but in series
- ~48-h turn around time

- Outflow interaction with environment
- Warm core structure
- Favorability of environment
- Convective structure at onset of intensification

Blue line: Minimum SLP
Green line: Max wind speed
Red line: Lightning occurrence

Convective structure at onset of intensification
HS3 Mission Overview

- Environmental and Over-Storm GH flights will not be simultaneous, but in series
- ~48-h turn around time

- Collaboration with NOAA very important

![Graph showing storm conditions and lightning occurrence](chart.png)

- Blue line: Minimum SLP
- Green line: Max wind speed
- Red line: Lightning occurrence

Over–Storm GH
Environmental GH
NOAA P–3 (on–station only)
Schedule

- 2012
  - Env. GH Sept. 1 to Oct. 5
  - Over-storm GH Sept. 8 to Oct. 5
- 2013–2014
  - Integration of TWiLiTE, piggybacks in 2013
  - Science flights: Aug 22–Sept 22
HS3 Data Plan

- All data to be publically available
- Some data products to be made available in real time
- Following each deployment, ~6–9 months for data QC, processing
  - Includes all Level–1 and higher products
<table>
<thead>
<tr>
<th>Instrument</th>
<th>Data Product</th>
<th>Description</th>
<th>Data Delivery Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIWRAP</td>
<td>Level 1</td>
<td>Calibrated reflectivity, Doppler velocity</td>
<td>3 months</td>
</tr>
<tr>
<td>HIWRAP</td>
<td>Level 2</td>
<td>Radial coordinate products including VAD, surface winds</td>
<td>6-9 months</td>
</tr>
<tr>
<td>HIWRAP</td>
<td>Level 3</td>
<td>Gridded reflectivities, winds</td>
<td>Mission close out</td>
</tr>
<tr>
<td>HAMSR</td>
<td>Level 1</td>
<td>Calibrated radiances</td>
<td>3 months</td>
</tr>
<tr>
<td>HAMSR</td>
<td>Level 2</td>
<td>Retrieved temperature and humidity, precipitation profiles</td>
<td>6-9 months</td>
</tr>
<tr>
<td>HIRAD</td>
<td>Level 1</td>
<td>Calibrated radiances</td>
<td>3 months</td>
</tr>
<tr>
<td>HIRAD</td>
<td>Level 2</td>
<td>Retrieved surface wind speed and rainfall rate</td>
<td>6-9 months</td>
</tr>
<tr>
<td>S-HIS</td>
<td>Level 1</td>
<td>Calibrated radiances</td>
<td>3 months</td>
</tr>
<tr>
<td>S-HIS</td>
<td>Level 2</td>
<td>Retrieved profiles of temperature and humidity</td>
<td>6-9 months</td>
</tr>
<tr>
<td>CPL</td>
<td>Level 1</td>
<td>Calibrated 1064 and 532 nm backscatter</td>
<td>3 months</td>
</tr>
<tr>
<td>CPL</td>
<td>Level 2</td>
<td>Cloud and aerosol 1064 and 532 nm extinction, optical depth, and lidar ratio</td>
<td>6-9 months</td>
</tr>
<tr>
<td>Dropsonde</td>
<td>Level 1</td>
<td>Quality controlled profiles of temperature, humidity, winds</td>
<td>3 months</td>
</tr>
<tr>
<td>TWiLiTE</td>
<td>Level 1</td>
<td>Calibrated backscatter and radial velocities</td>
<td>3 months</td>
</tr>
<tr>
<td>TWiLiTE</td>
<td>Level 2</td>
<td>Retrieved horizontal wind velocities, direction</td>
<td>6-9 months</td>
</tr>
</tbody>
</table>
Goals of this meeting

- Review instrument status
- Discuss real-time products and possible PREDICT-style data catalog
- Lessons learned from 2011 dry run and test flights
- Review science goals
- Discuss operational strategies
- Go over deployment details
- Tour WFF