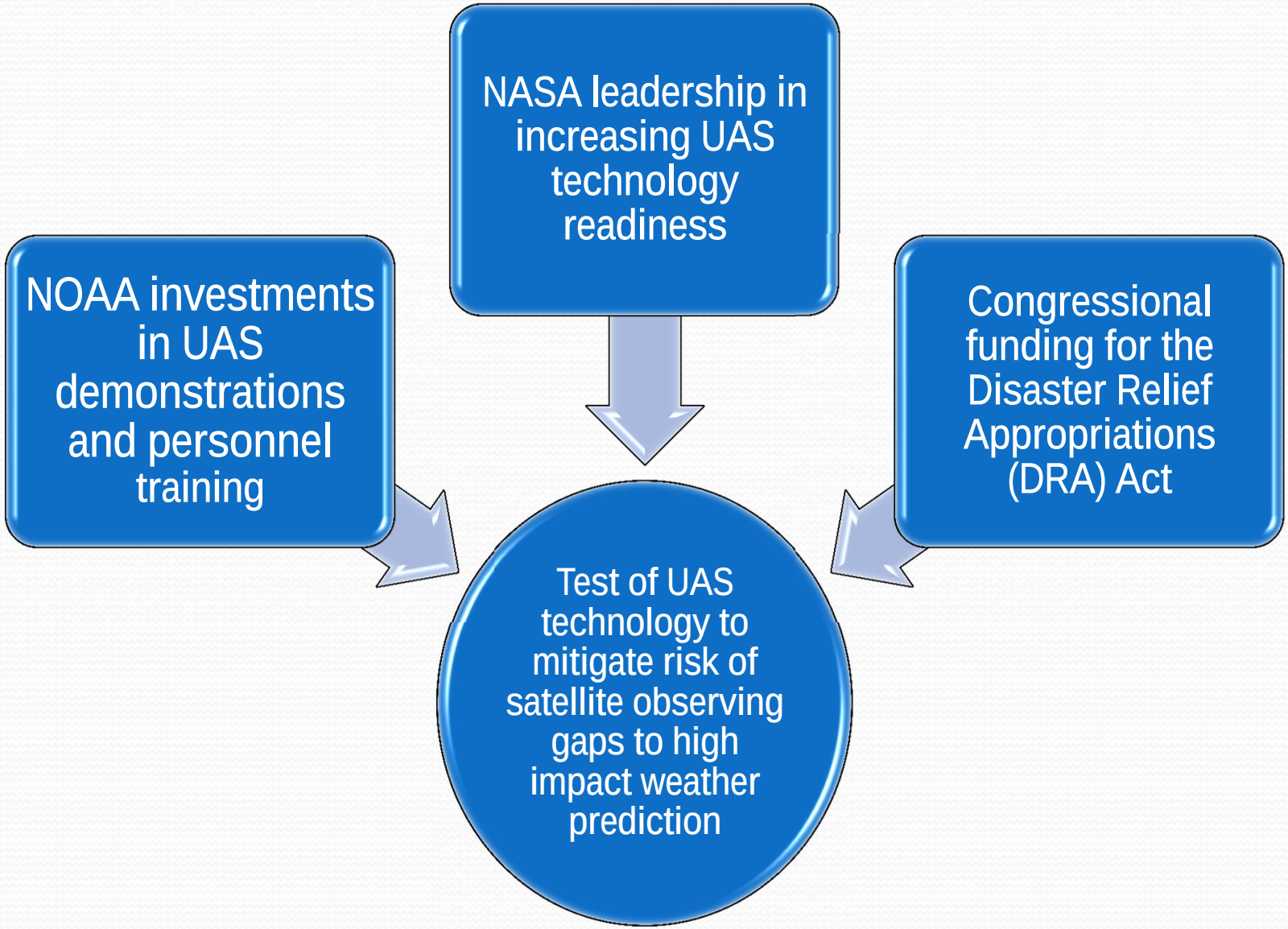
Sensing Hazards with Operational Unmanned Technology (SHOUT) to Mitigate the Risk of Satellite Observing Gaps

Robbie E. Hood *(NOAA)*, Michael Black *(NOAA)*, Gary Wick *(NOAA)*, Philip Kenul *(TriVector Services)* and JC Coffey *(Cherokee Nation)*

Synergistic Contributions



Project Objectives

Overall Goal

- Demonstrate and test prototype UAS concept of operations that could be used to mitigate the risk of diminished high impact weather forecasts and warnings in the case of polar-orbiting satellite observing gaps

Objective 1

- Conduct data impact studies
  - Observing System Experiments (OSE) using data from UAS field missions
  - Observing System Simulation Experiments (OSSE) using simulated UAS data

Objective 2

- Evaluate cost and operational benefit through detailed analysis of life-cycle operational costs and constraints

General Plan

FY14

- OSE with previous HS3 data underway
- OSSE with simulated data starting soon
- 5 extra missions added to HS3
- NOAA aviation personnel supporting NASA and NOAA Global Hawk missions

FY15

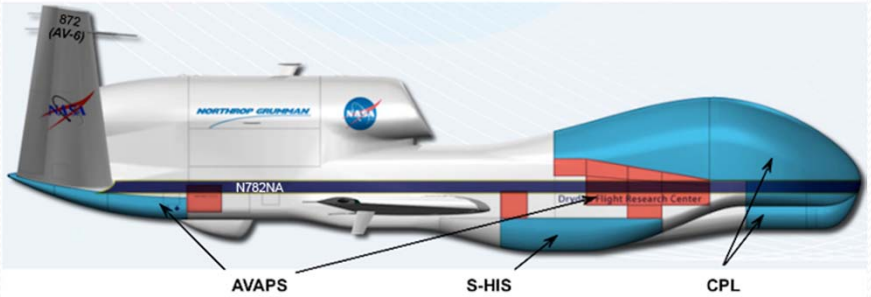
- OSSE for Pacific and Arctic weather systems
- 10 – 16 NOAA-dedicated Global Hawk missions
- NOAA aviation personnel supporting NASA and NOAA Global Hawk missions

FY16

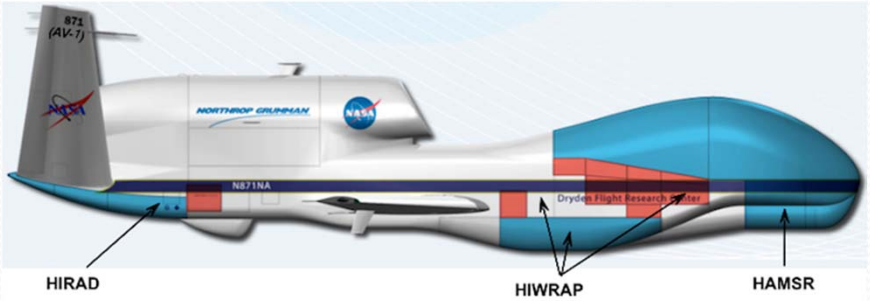
- NOAA-dedicated Global Hawk missions and possible partnership with NASA Earth Venture experiment
- NOAA aviation personnel supporting NASA and NOAA Global Hawk missions
- Finalize data impact studies and analysis of cost and operational benefits

NOAA Benefit From NASA Hurricane Severe Storm Sentinel (HS3) Experiment

HS3 *Environmental Payload (AV-6) @ WFF '12*



HS3 *Over-Storm Payload (AV-1) @ WFF '12*



Environment Observations

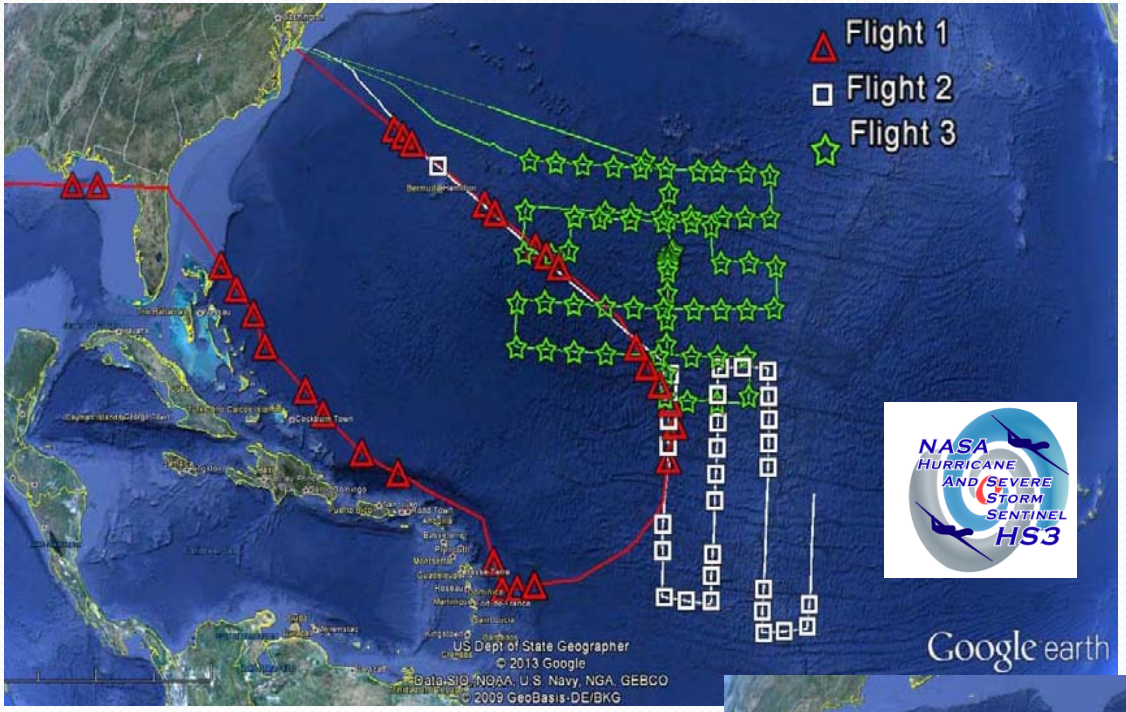
- **Profiles of temperature, humidity, wind, and pressure (AVAPS)**
- **Cloud top height (CPL)**
- **Cloud top temperature and profiles of temperature and humidity (S-HIS)**

Over-storm Observations

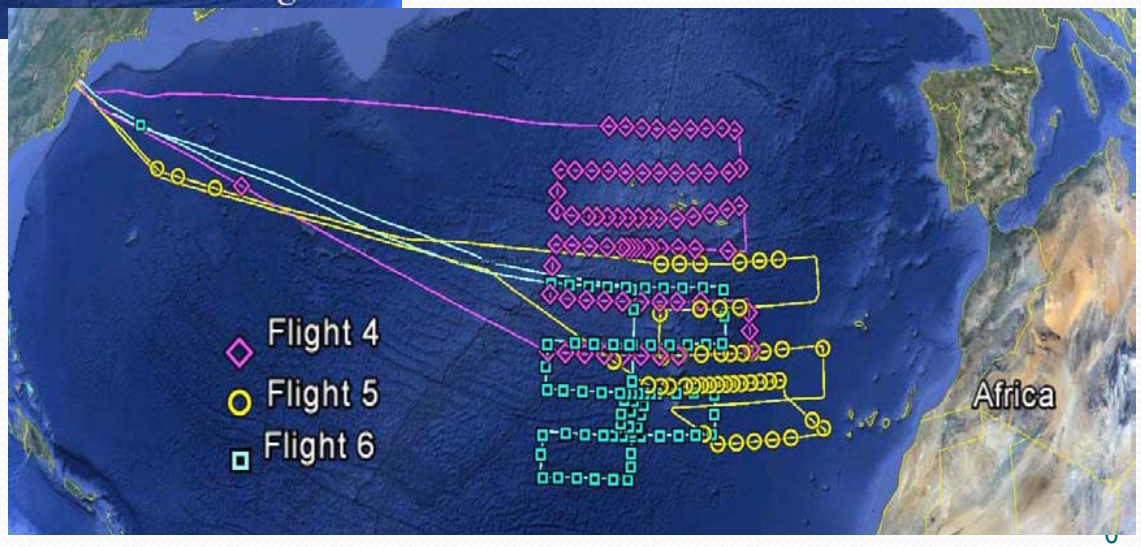
- **Doppler velocity, horizontal winds, and ocean surface winds (HIWRAP)**
- **Profiles of temperature and humidity and total precipitable water (HAMSR)**
- **Ocean surface winds and rain (HIRAD)**

NASA Hurricane and Severe Storm Sentinel HS3

Hurricane and Severe Storm Sentinel

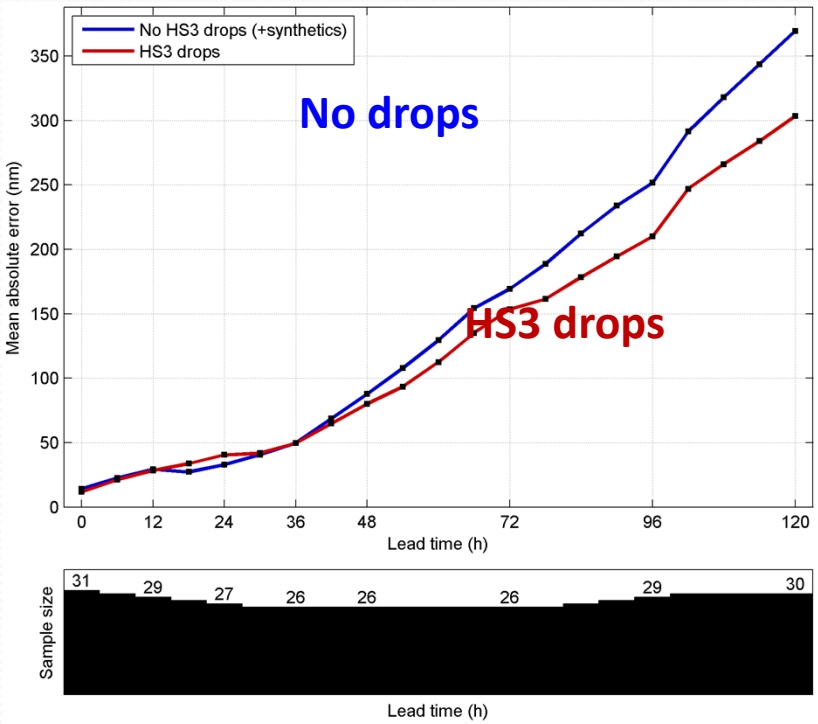


- 6 flights in 2012 into Leslie and Nadine
- Range capabilities clearly demonstrated
- 337 soundings obtained
- Data processed and transmitted in near-real time

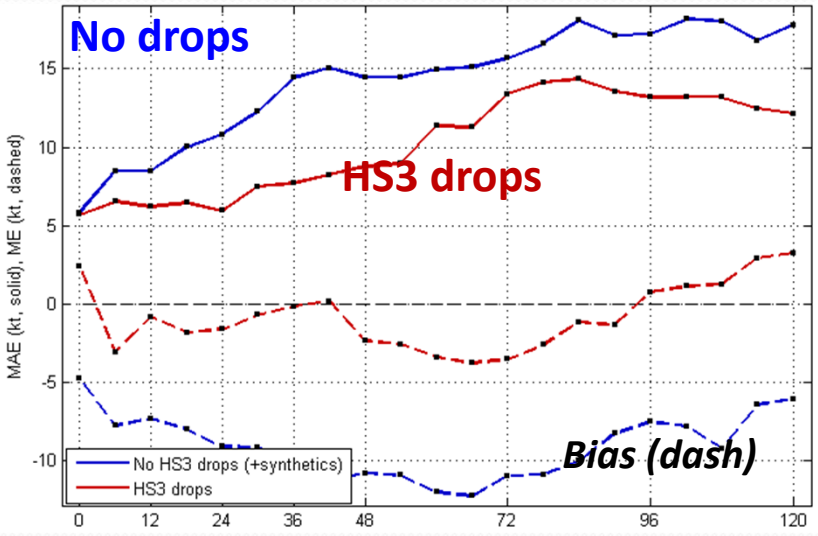


Impact of HS3 Dropsondes for Navy COAMPS-TC Hurricane Nadine Predictions

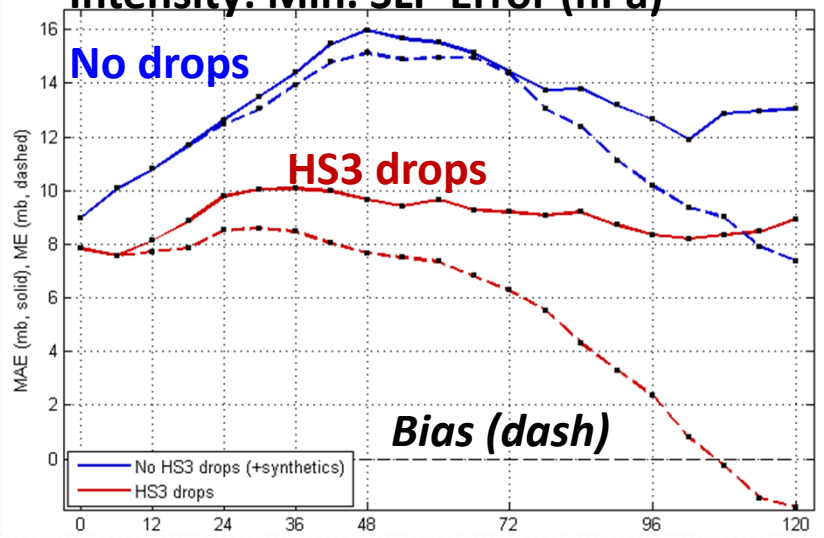
Track Error (nm)



Intensity: Max. Wind Error (kts)



Intensity: Min. SLP Error (hPa)

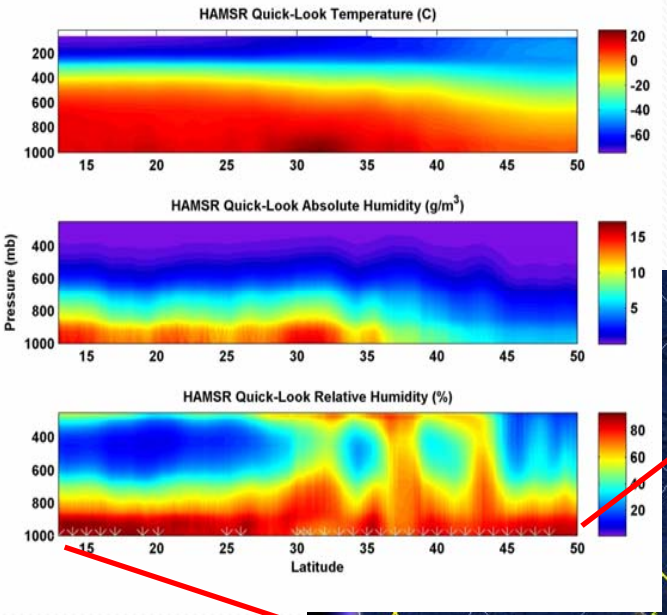


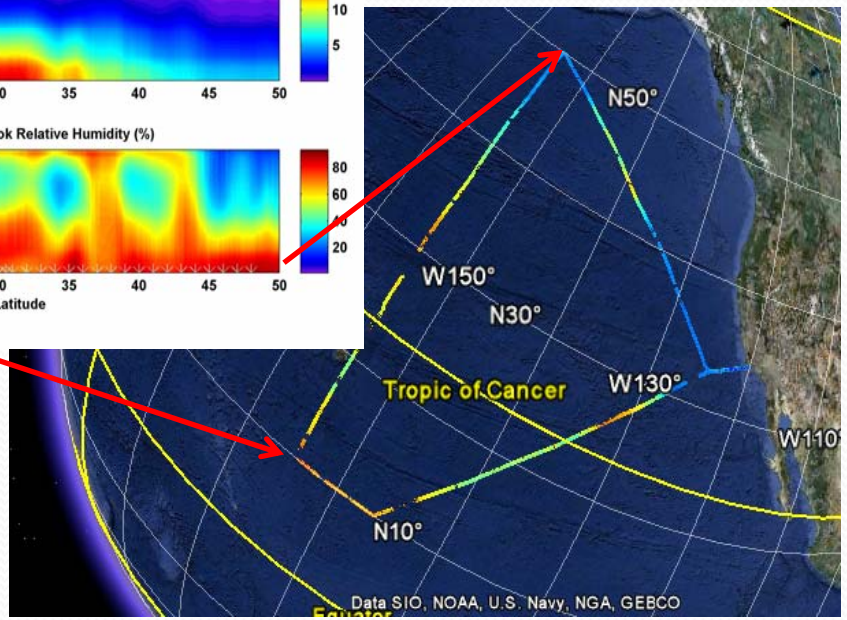
- Dropsonde impact experiments performed for 19-28 Sep. (3 flights)
  - **Red**: with HS3 drops
  - **Blue**: No drops with synthetics
- COAMPS-TC Intensity and Track skill are improved greatly through assimilation of HS3 Drops.

Slide courtesy of James Doyle / NRL

Remotely Sensed Vertical Profile Observations

NASA High Altitude MIMC Sounding Radiometer (HAMSR)

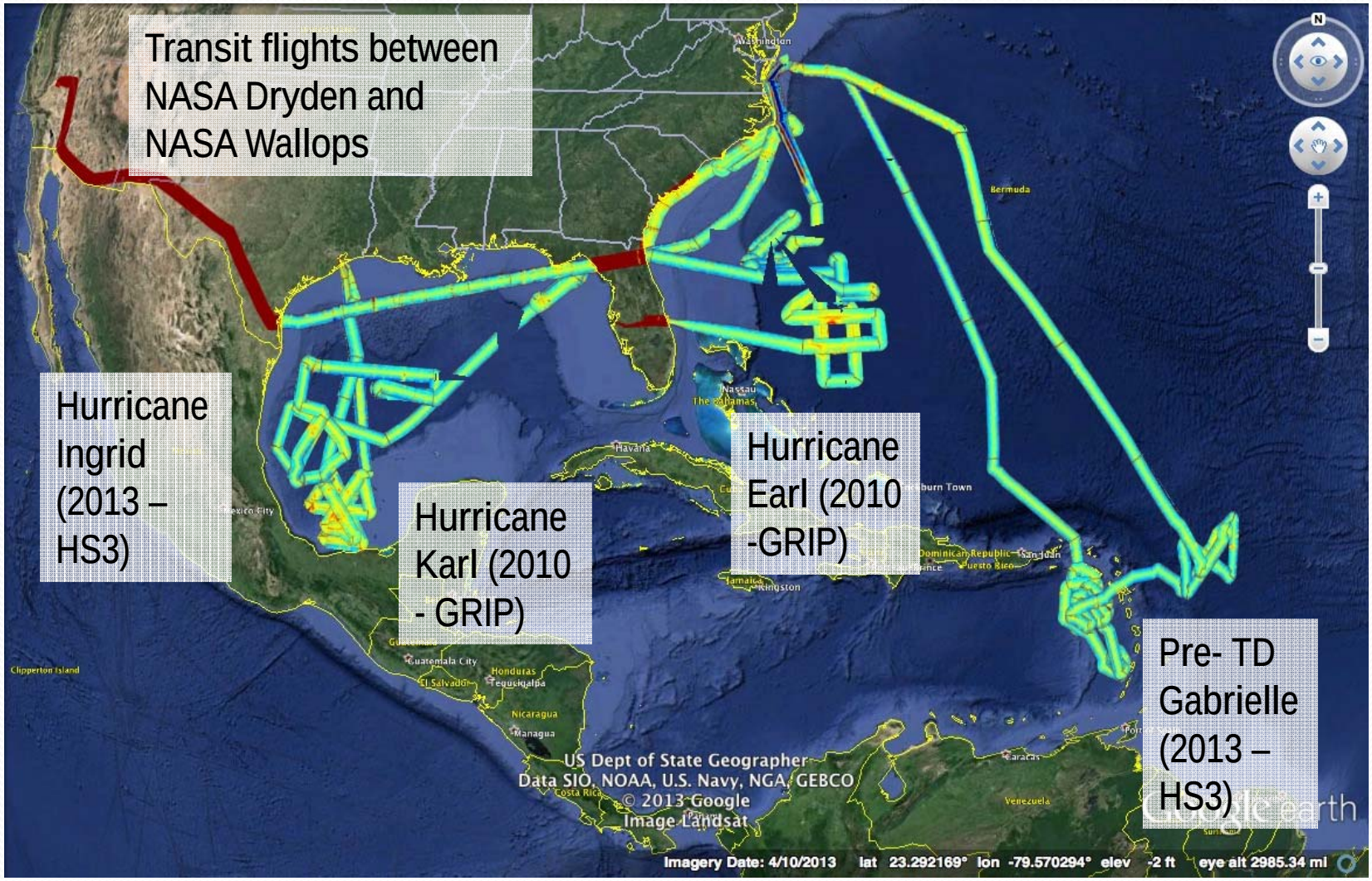




HAMSR profiles for N-S leg of 8 September 2011 Flight

Potential for Remotely Sensed Ocean Surface Winds

Flights in 2010 & 2013 - HIRAD 6.6 GHz TB



Management Team

Principal Investigator	• Robbie Hood, *NOAA UAS Program Director*
Project Scientists	• Michael Black, *NOAA OAR AOML* • Gary Wick, *NOAA OAR ESRL*
Project Managers	• Philip Kenul, *TriVector Services* • JC Coffey, *Cherokee Nation Technologies*

SHOUT Working Group

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NOAA Office of Marine and Aviation Operations (OMAO)	• Philip Hall
NOAA National Environmental Satellite, Data, and Information Service (NESDIS)	• Mitch Goldberg • Steven Goodman
National Weather Service (NWS)	• William Lapenta • John Murphy • Fred Toepfer • Chris Landsea • Carven Scott • Bill Ward

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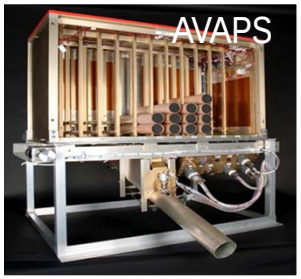
Backup Slides

Global Hawk and Advanced Vertical Atmospheric Profiling System (AVAPS)


Global Hawk UAS

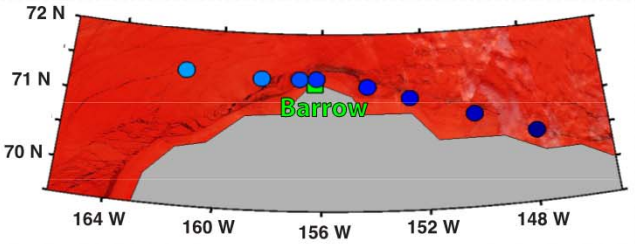


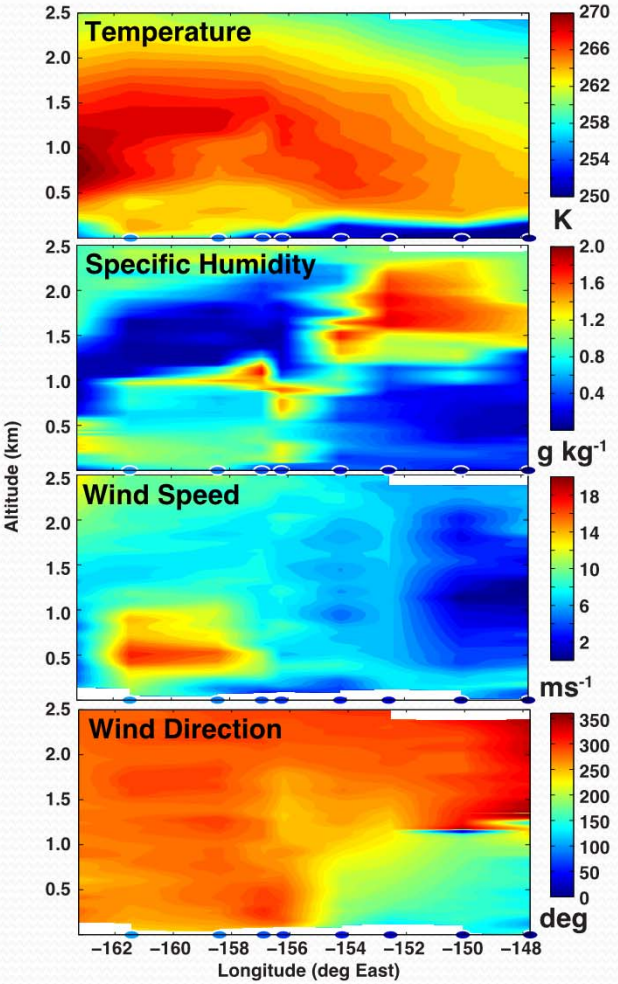

Dropsonde

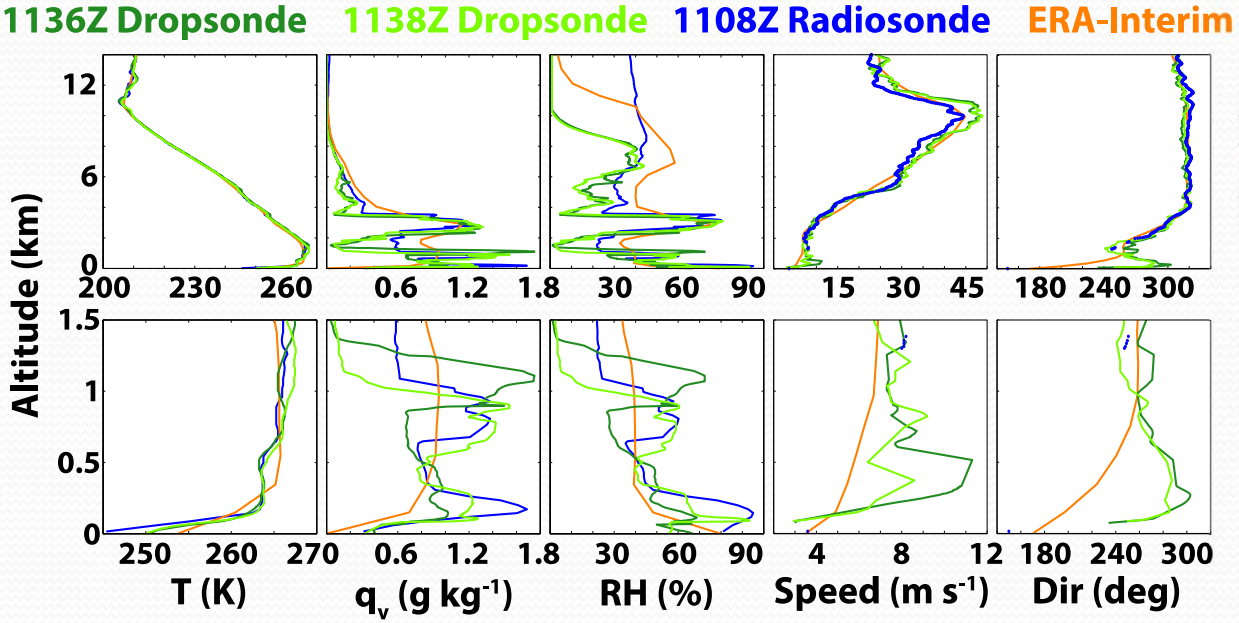
- High-altitude, long-endurance UAS
  - 55,000 – 65,000 ft
  - 28 hour endurance
  - Payload >1500 lbs
- NOAA/NCAR dropsonde system
  - 88 sonde capability
  - High vertical resolution measurements of temperature, humidity, and wind speed

WISPAR Arctic Observations

- Dropsondes deployed north of Alaska coast over sizable lead during arctic flight
- Results show high level of structure and variability
- Provides detailed observations in harsh, data sparse regions







J. M. Intrieri et al., GRL, submitted

Thermodynamic Observations for Tropical Cyclones

Obs	TPIO – Validated Requirements			HAMSR Capabilities (TRL – 7/8)			AVAPS Dropsonde Capabilities (TRL – 7/8)		
	VR	HR	A	VR	HR	A	VR	HR	A
Temp. Profiles	*O* 500m	*O* 50 km	*O* 1 K	1 km	2 km	0.5 K	5 – 15 m	< 1 km	0.5 K
	R 45 m	*R* 1 km	*R* 1 K						
Pressure Profiles	*O* - 9 m	*O* 10 km	*O* 1 hPa	N/A	N/A	N/A	5 – 15 m	< 1 km	0.1 hPa
	R 45 m	*R* 1 km	*R* 1 hPa						
Humidity Profiles	*O* 1 km	*O* 20 km	*O* 8%	2 km	2 km	15 – 20%	5 – 15 m	< 1km	5%
	R 90 m	*R* 4 km	*R* 20%						

Obs – Observations Temp - Temperature VR – Vertical Resolution HR – Horizontal Resolution
A- Accuracy
O- Operations *R* – Research

Wind Observations for Tropical Cyclones

Obs	TPIO – Validated Requirements			HIWRAP Capabilities (TRL – 7/8)			HIRAD Capabilities (TRL – 6/7)			AVAPS Dropsonde Capabilities (TRL – 7/8)		
	VR	HR	A	VR	HR	A	VR	HR	A	VR	HR	A
WS Prof.	*O* 500 m	*O* 50 km	*O* 1 m/s	500m	1 km	0.5 K	N/A	N/A	N/A	5- 15 m	< 1 km	0.5 m/s
	R 100 m	*R* 50 km	*R* 1 m/s									
WD Prof.	*O* 500 m	*O* 10 km	*O* 10 deg	500m	1 km	15 deg	N/A	N/A	N/A	5- 15 m	< 1 km	10 deg
	R 100 m	*R* 1 km	*R 10 deg*									
Sfc. WS	N/A	*O* 1 km	*O* 1m/s	N/A	1 km	2 m/s	N/A	1-2 km	1 - 5 m/s	N/A	< 1 km	0.5 m/s
	N/A	*R* 12 km	R 2 m/s									
Sfc WD	N/A	*O* 2.5km	*O* 10 deg	N/A	2 km	15 deg	N/A	N/A	N/A	N/A	< 1 km	10 deg
	N/A	*R* 12 km	*R* 20 deg									

VR – Vertical Resolution HR – Horizontal Resolution A- Accuracy WS – Wind Speed WD – Wind Direction
O- Operations *R* – Research