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# UAS Partnership

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NOAA Unmanned Aircraft Systems (UAS) Program**

**15 August 2012**



# NOAA UAS Strategic Vision and Goals



- ***Vision***

- UAS will revolutionize NOAA observing strategies by 2015
- comparable to the introduction of satellite and radar assets decades earlier

- ***Goals***

- Goal 1: Increase UAS observing capacity
- Goal 2: Develop high science-return UAS missions
  - ***High impact weather monitoring,***
  - ***Polar monitoring***
  - ***Marine monitoring***
- Goal 3: Transition cost-effective, operationally feasible UAS solutions into routine operations

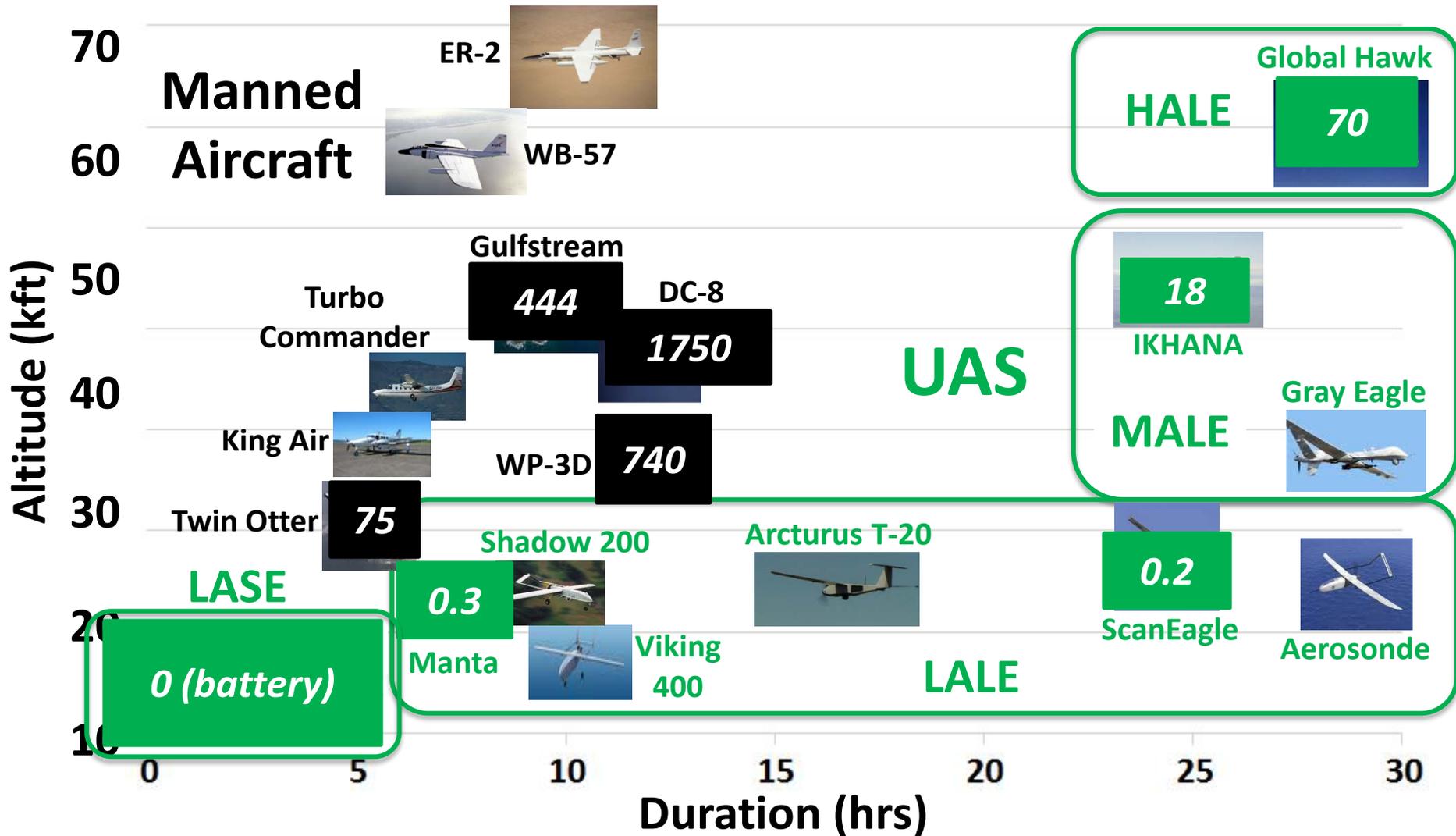




# NOAA and NASA Manned and Unmanned Flight Capabilities



## Fuel consumption (gph) for nominal mission



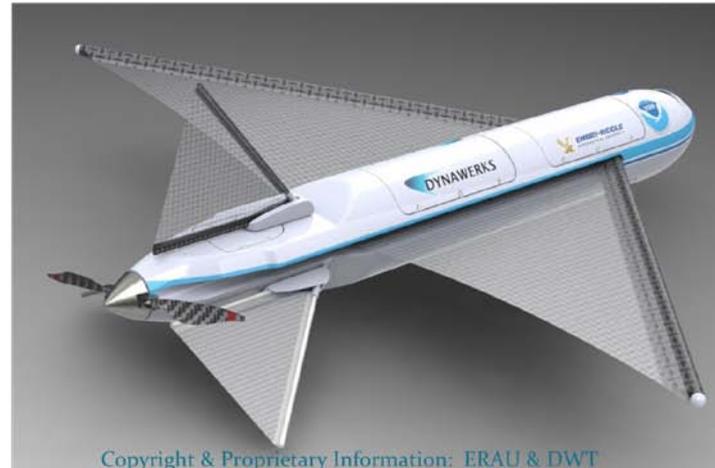


# Guided Dropsondes



## GALE UAS

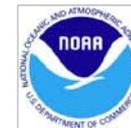
Partnership with  
NOAA, Embry-  
Riddle U., and  
Dynawerks



Copyright & Proprietary Information: ERAU & DWT

Performance Attribute	Estimated Performance
Mission Weight	8.0 lb
Cruise Speed	42 kts
Dash Speed	110 kts
Stall Speed	22 kts
Mission Endurance	60 minutes

Effort lead by  
Jose Cione, AOML-HRD  
and  
Nancy Ash,  
OMAO-AOC



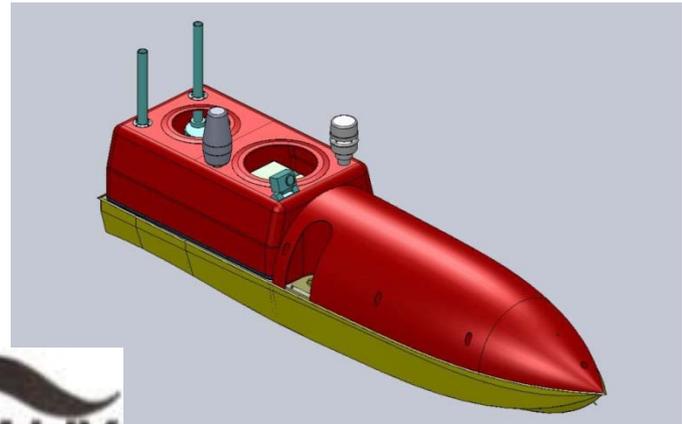
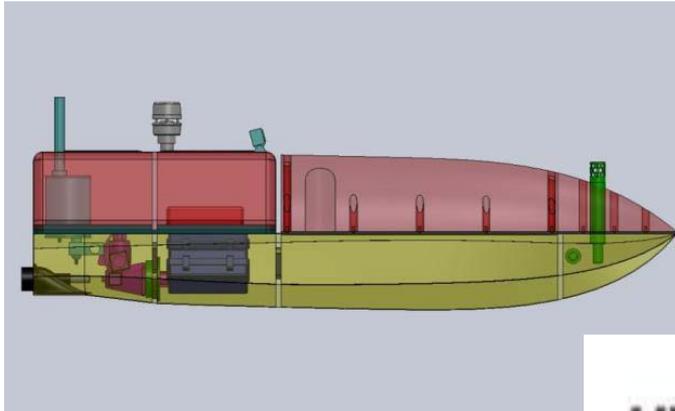


# Unmanned Surface Vehicles



## Emergency Integrated Life Saving Lanyard (EMILY)

- Developed through Phase 3 Navy SBIR
- 65 inch Unmanned Surface Vehicle (USV)
- Testing this summer with barometric pressure, air and sea surface temperature, salinity, wind speed and direction, humidity, camera, and satellite communication payload



HYDRONALIX



# Completed Science Campaigns



- **Global Hawk Pacific (March-April 2010)**
  - 11 instruments
  - 4 science missions, 76 hours
  - First Global Hawk Science Mission
  - Flights spanned 12 to 85 deg N Latitudes
- **Genesis and Rapid Intensification Processes (August-September 2010)**
  - 4 Instruments
  - 5 science missions, 114 hours total
  - First Global Hawk severe storm over flight
- **Winter Storm Pacific and Atmospheric Rivers (February-March 2011)**
  - 2 Instruments
  - 3 science missions, 70 hours total
  - First operational dropsonde deployment, 177 sondes total

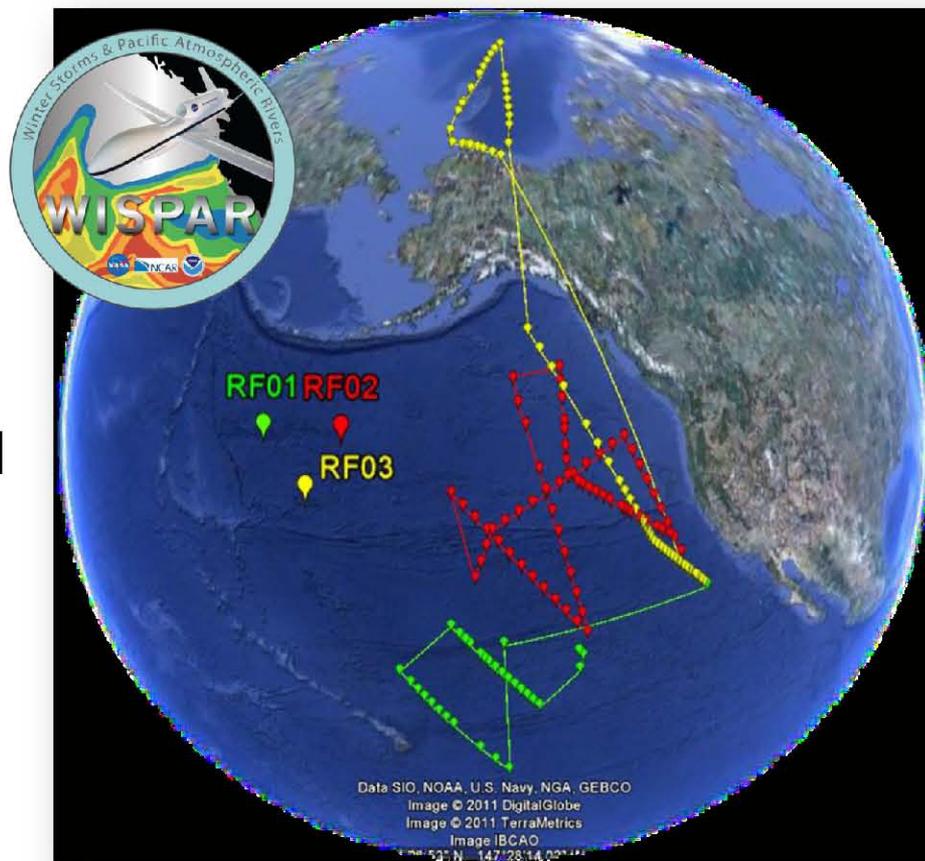


# WISPAR – Winter Storms and Pacific Atmospheric Rivers

WISPAR was conducted **Feb-Mar 2011** through a collaborative effort between **NOAA-NASA-NCAR**

WISPAR science missions targeted 3 scientific objectives:

- **Atmospheric Rivers**
- **Winter Storms Reconnaissance**
- **Arctic Atmosphere**



**Feb 11-12** – Atmospheric river (AR) with tropical-extratropical connection near Hawaii

**Mar 3-4** – Targeted observations of an extratropical cyclone in the Gulf of Alaska and AR transect

**Mar 9-10** – Arctic flight, dropsonde intercomparison with ground-based observations at Barrow, sampling within the Arctic stratospheric vortex, two AR transects in transit to Arctic



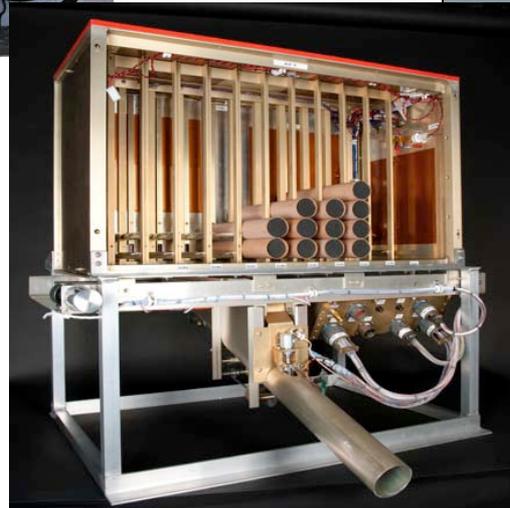
# NCAR/NOAA GH Dropsonde System



Dropsonde System Electronics



Dropsonde System Launch Tube



Dropsonde Launch Assembly

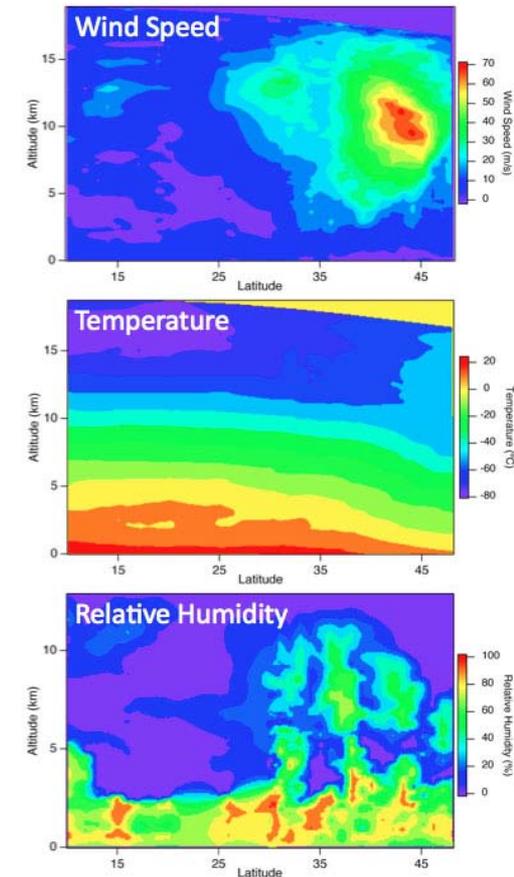




# Global Hawk Dropsonde Cross Section

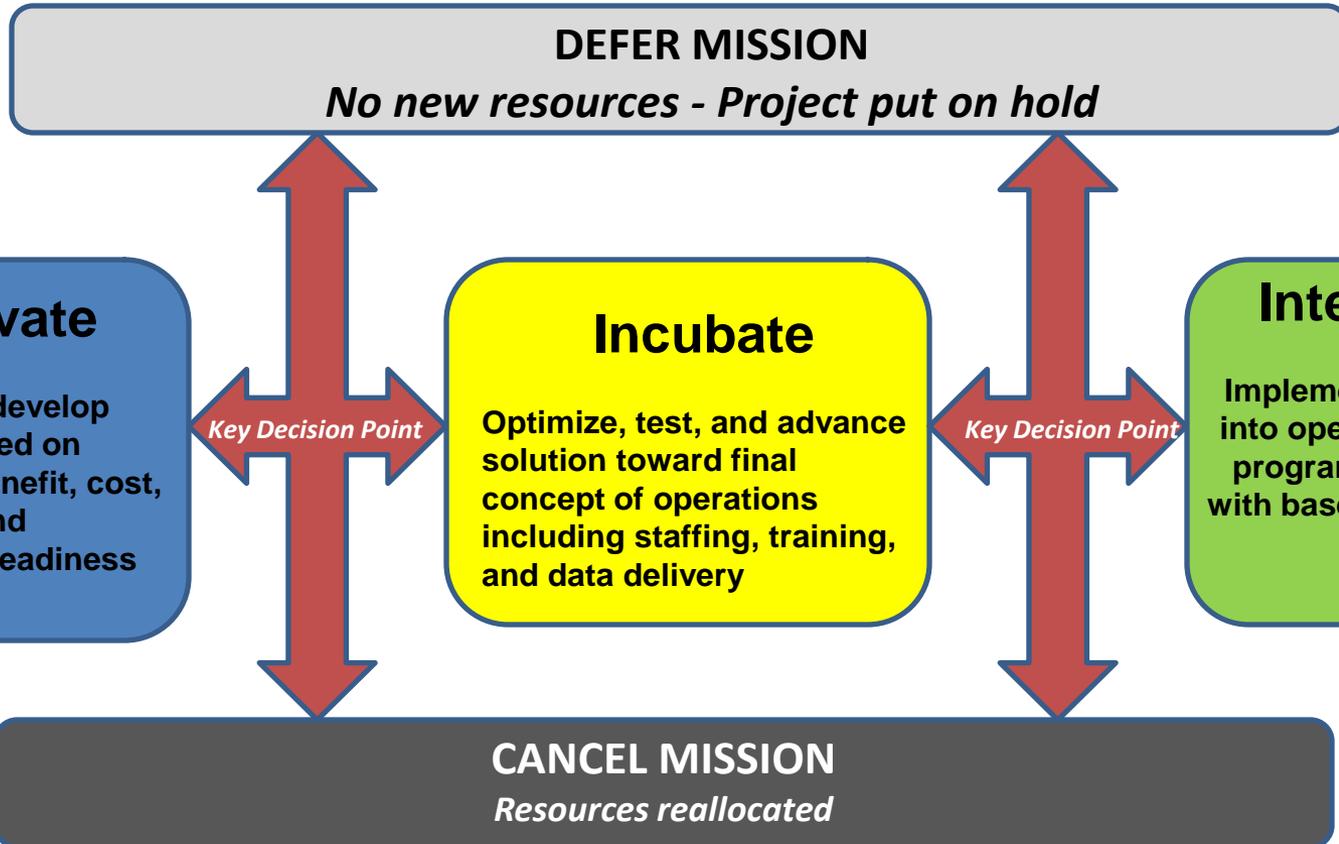


*Stitch the dropsondes  
together for a cross  
section*





# NOAA UAS Transition Process





# NASA HS3 Over Storm Products



## Real-Time Products—Over Storm

	Measurements	Horizontal Resolution	Vertical Resolution	Available in RT (yes/no)	Data formats	Method for sharing	Restrictions on sharing?
HIWRAP	Reflectivity	1.0 km	0.2 km	TBD			
	Doppler velocity	1.0 km	0.2 km	TBD			
	Horizontal winds	1.0 km	0.5 km	TBD			
	Surface winds	2.0 km	N/A	TBD			
HAMSR	Brightness Temperature	2 km	NA	YES			
	Profiles of temperature	2 km	2 km	YES			
	Profiles of humidity	2 km	2 km	YES			
	dBZ product	2 km	2 km	YES			
	TPW	2 km	NA	YES			
	CAPE, LI, etc.	2 km	NA	TBD			
HIRAD	Excess Brightness Temperature	<3 km	NA	TBD			
	Surface wind speed	<3 km	NA	TBD			



# NASA HS3 Environment Products



## Real-Time Products—Environment

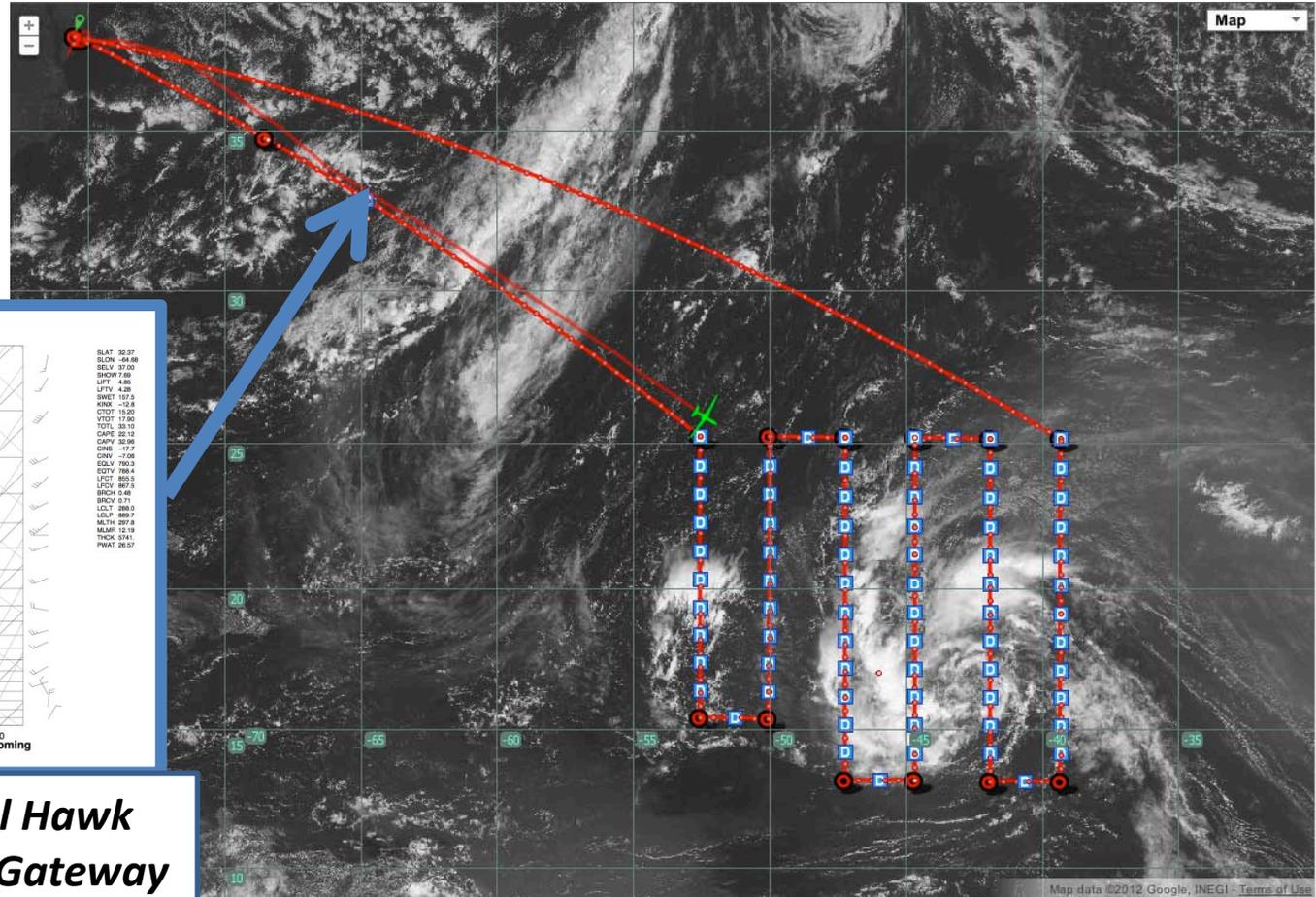
	Measurements	Horizontal Resolution	Vertical Resolution	Available in RT (yes/no)	Data formats	Method for sharing	Restrictions on sharing?
CPL	Attenuated backscatter profiles	1-sec to 1-min depending on KU system	30 m	YES			
	Cloud Top Height		NA	TBD			
SHIS	IR TB spectra	2 km	NA	TBD			
	Cloud Top T	2 km	NA	TBD			
	Preliminary Temperature profiles	2 km	1-3 km	YES			
	Preliminary Humidity profiles	2 km	1-3 km	YES			
TWILITE	Doppler velocity	2 km	250 m	YES			
	Horizontal winds	4-8 km	250 m	TBD			
Drosondes	Profiles of temperature	Varies	5-15 m	YES	ASCII, image(?)		
	Profiles of humidity	Varies	5-15 m	YES	ASCII, image(?)		
	Profiles of wind	Varies	5-15 m	YES	ASCII, image(?)		
	Profiles of pressure	Varies	5-15 m	YES	ASCII, image(?)		



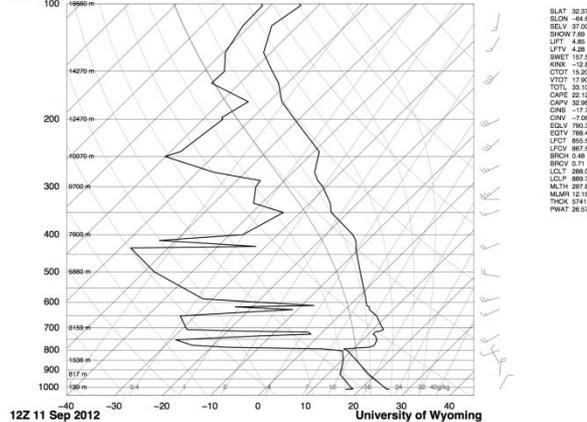
# NASA HS3 Mission Over Tropical Storm Nadine (11 – 12 Sept 2012)



3 NOAA Pilots  
Participated in  
25-Hour Mission



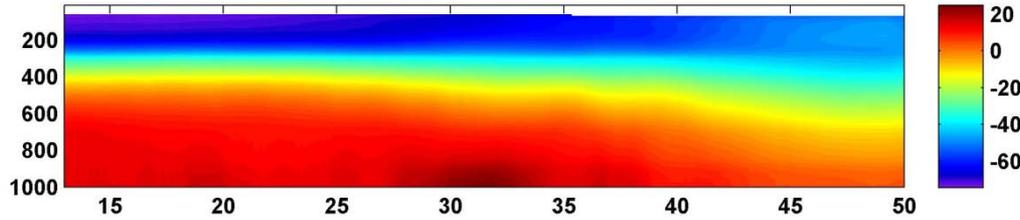
78016 TXKF Bermuda Nvl Stn Kindley



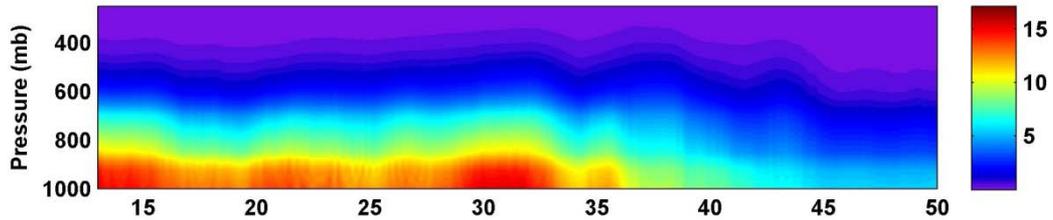
*First Real-time Global Hawk  
Dropsonde Into NOAA Gateway*



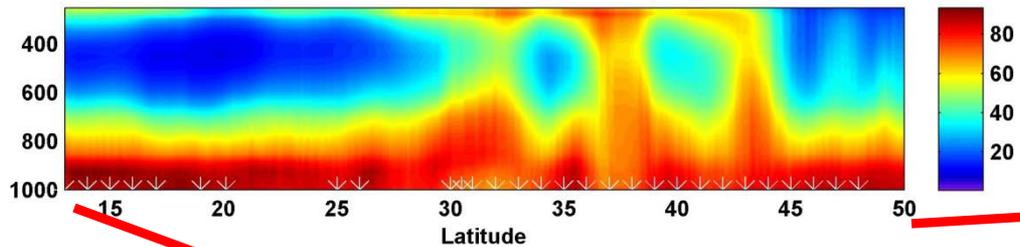
HAMSR Quick-Look Temperature (C)



HAMSR Quick-Look Absolute Humidity ( $\text{g/m}^3$ )

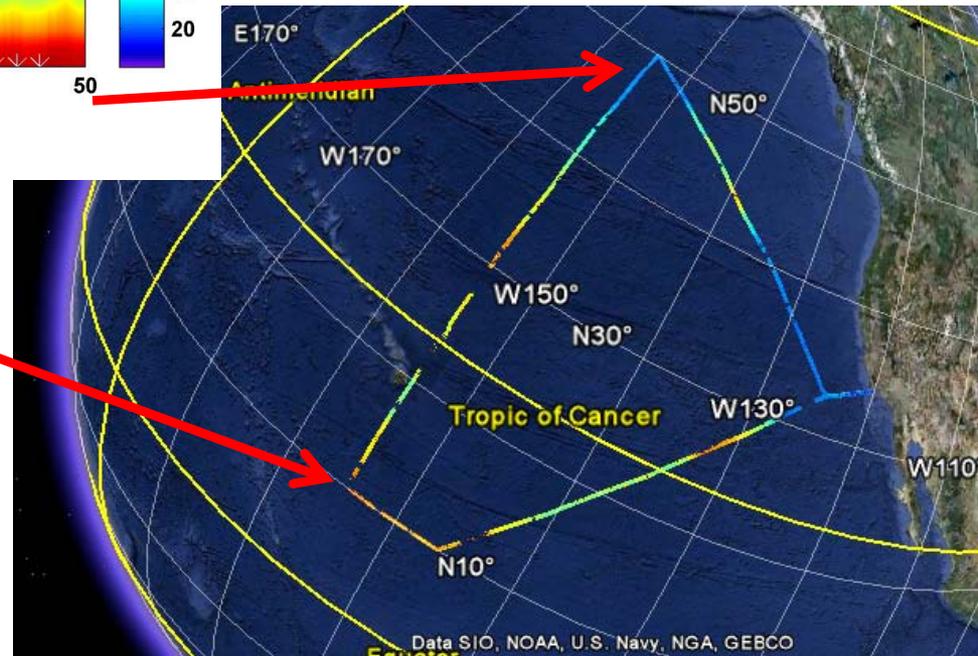


HAMSR Quick-Look Relative Humidity (%)



# HAMSR Cross Sections

- HAMSR quick-look profiles shown for N-S leg of flight path of 9/8 flight
- White arrows indicate dropsonde locations





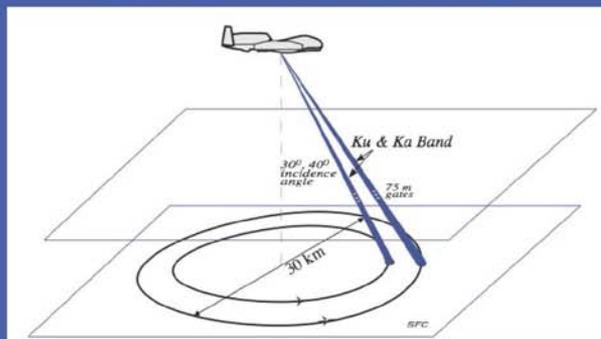
# NASA HIWRAP Retrieved Winds



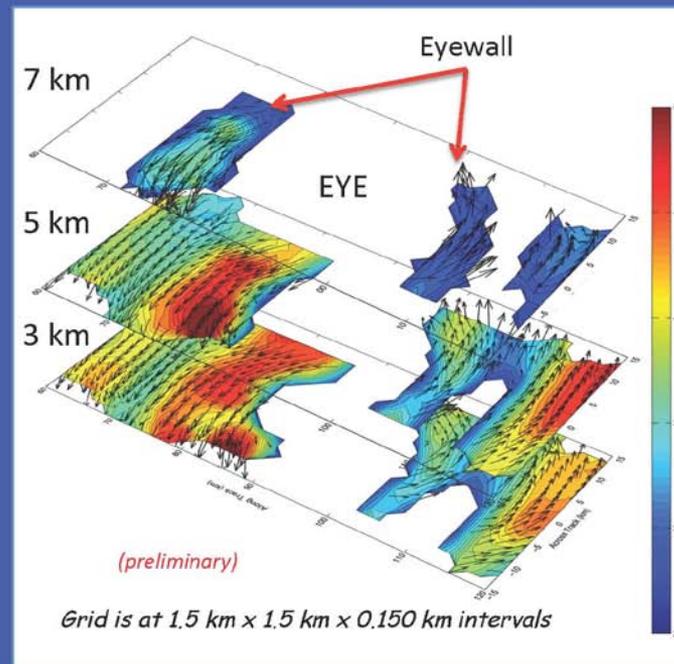
## Retrieved Winds from Hurricane Karl (2010)

- HIWRAP made 20 crossings of Hurricane Karl on September 17, 2010 during GRIP over 14 hours.
- Doppler line of sight wind measurements are continually profiled during the conical scans.
- Horizontal winds are calculated from Doppler winds from multi look angles as the Global Hawk passes across the storm.

HIWRAP Measurement Geometry



Horizontal winds (m/s) and reflectivity (dBZ) derived from one pass across Hurricane Karl's eye/eyewall region



Courtesy S. Guimond/ONAU/GSFC

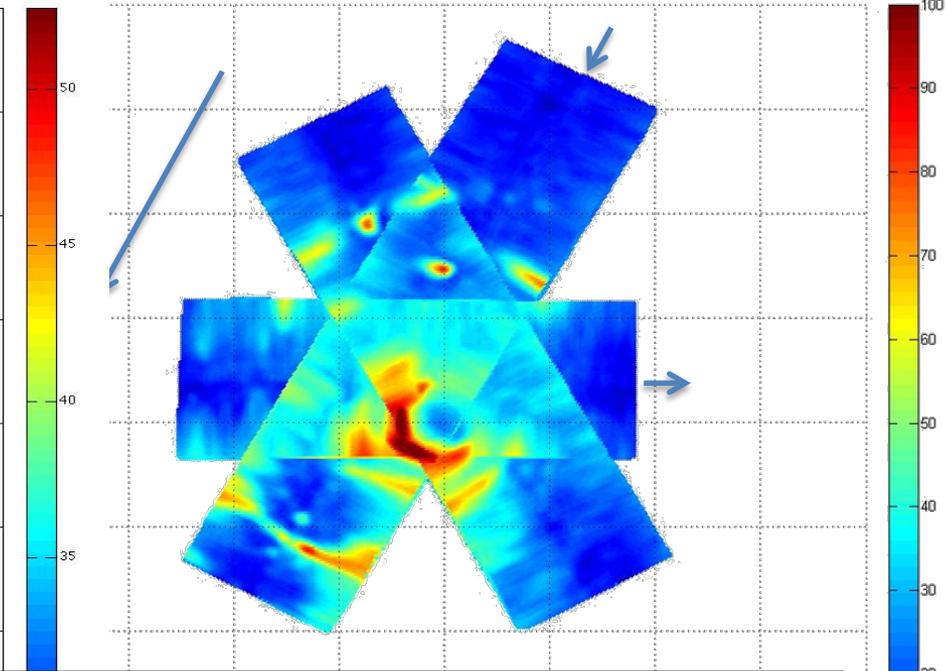
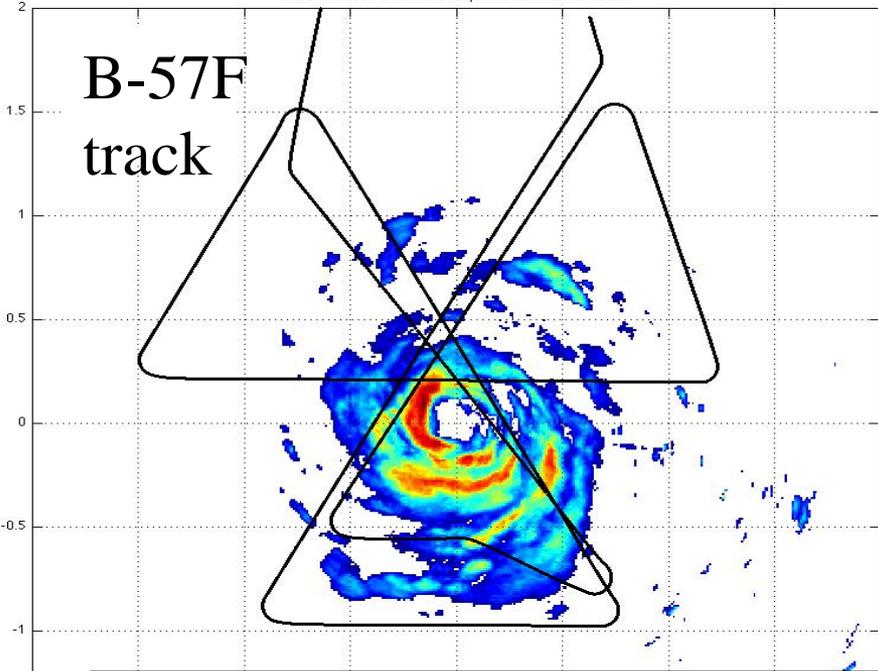


# P3 radar reflectivity (left) HIRAD Tb 5 GHz (right)



HIRAD 5 GHz excess  $T_B$  filtered 16 Sep Karl legs 2, 4 and 6, 65 deg

Storm-relative LF radar composite and WB-57 track



Good feature agreement between WP-3D LF radar composite (left) and HIRAD brightness temperature ( $T_B$ ) composite (right)

P3 radar center crossings

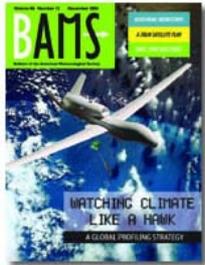
WB-57 HIRAD center crossings at  
19:16:49, 19:52:37, 20:33:44



# Roadmap for Transition of Unmanned Observations



## Vision of Global Profiling System



## Operational Test Program for Unmanned Observing Strategies

2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015





# Partnership Opportunity



- 4-year period partnership + option years
- Tiger team strategic planning in near-term
- Governing body for long-term
- Joint milestones and key decision points
- Observing requirements and mission goals of partners
- In-kind contributions
- Long-term acquisition strategy



# Contact Information



**UAS Web Site: <http://uas.noaa.gov/>**

**Questions should be directed to:  
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**Robbie Hood - NOAA UAS Program Director  
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# Backup Slides

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# Metrics for UAS Technology Assessment



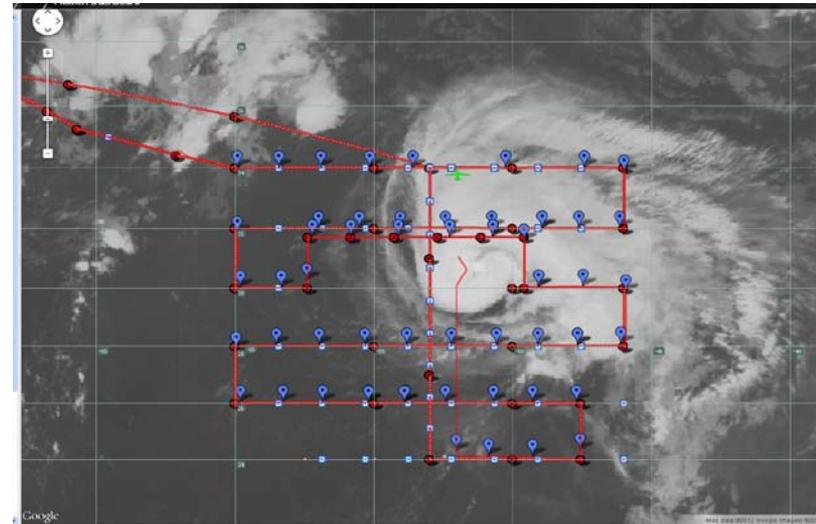
Technology Readiness Level	Description
TRL 1	Basic or fundamental research
TRL 2	Technology concept and/or application
TRL 3	Proof-of-concept
TRL 4	Concept validated in laboratory
TRL 5	Concept validated in relevant environment
TRL 6	Prototype demonstration in relevant environment
TRL 7	Prototype demonstration in operational environment
TRL 8	System demonstration in an operational environment
TRL 9	System totally operational



# HS3 Preliminary Results



- 5 science flights to date
  - 4 into various stages of Nadine
  - 268 sondes deployed
- Next flight scheduled for Wednesday
- NOAA-led real-time data processing
  - Data transmitted through GTS
  - Data incorporated in NHC discussions



***TROPICAL STORM NADINE  
DISCUSSION NUMBER 44  
NWS NATIONAL HURRICANE  
CENTER  
1100 AM AST SUN SEP 23 2012***

**BASED ON THE IMPROVED SATELLITE APPEARANCE AND TROPICAL CLASSIFICATIONS OF 2.5 AND 3.0 FROM SAB AND TAFB... NADINE IS CLASSIFIED AS A TROPICAL STORM ONCE AGAIN. DROPSONDE DATA FROM AN ONGOING NASA GLOBAL HAWK MISSION SUGGESTS THAT THE MAXIMUM WINDS ARE NEAR 50 KT. A DROPWINDSONDE NEAR THE CENTER AROUND 1030 UTC MEASURED A PRESSURE OF 989.9 MB WITH STRONG WINDS...SO THE ESTIMATED MINIMUM CENTRAL PRESSURE IS 986 MB.**