What should our operational airborne “fleet”
comprise in 2030?

Robbie Hood, UAS Program Director
Office of Oceanic and Atmospheric Research
National Oceanic and Atmospheric Administration

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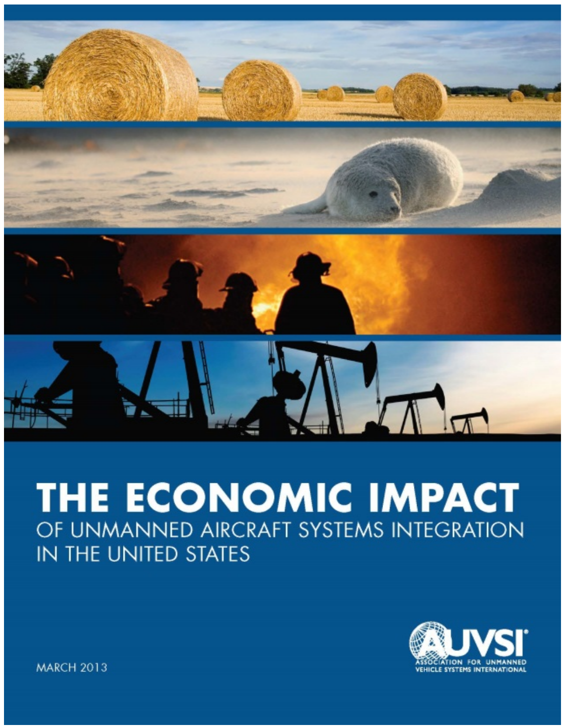
Unmanned Aircraft Systems (UAS) Industry



Estimated USA Economic Impact

2015 - $13 Billion
2025 - $82 Billion

2013 Forecast by Association of Unmanned Vehicle Systems International (AUVSI)

Sensing Hazards with Operational Unmanned Technology (SHOUT)

FEASIBILITY EVALUATION

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**

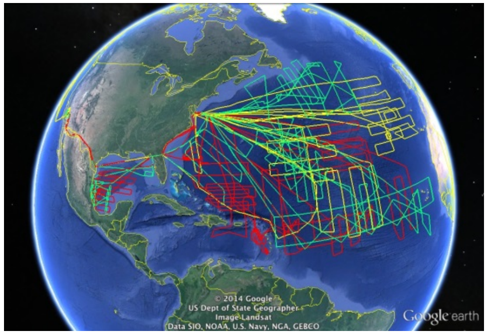
Objective 2

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

SHOUT – Satellite Gap Mitigation

Satellite Gap Mitigation Study using NASA Global Hawk

- **NOAA Flight Level: ~55-63,000 ft**
- **Duration: ~26 hr**
- **Range: 11,000 nm**
- **Payload: 1,500+ lbs**
- **Deployment Sites:**
  - **NASA Wallops Flight Facility (Wallops Island, VA)**
  - **NASA Armstrong Flight Research Center (Edwards AFB)**



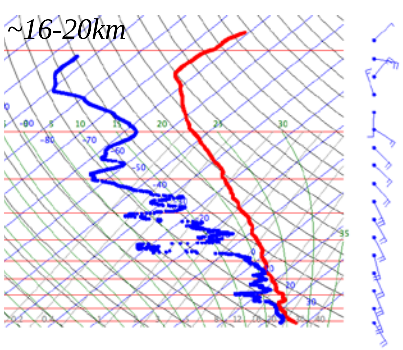
SHOUT 2015 Field Demonstration Payload

Airborne Vertical Atmospheric Profiling System (AVAPS)

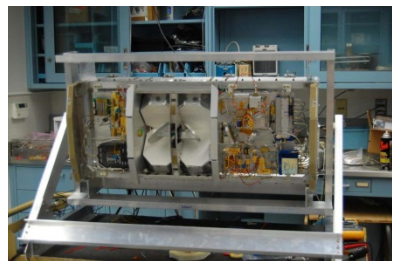
***PI**: Terry Hock, NCAR / Gary Wick, NOAA*

***Measurements**:*
- *temperature, pressure, wind, humidity (vertical profiles);*
- *88 dropsondes per flight;*

***Resolution**:*
- *~2.5 m (winds), ~5 m (PTH)*



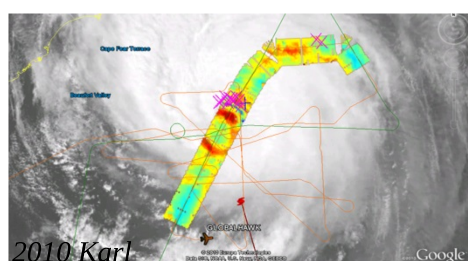
High Altitude Monolithic Microwave Integrated Circuit (MMIC) Sounding Radiometer (HAMSR)



***PI**: Dr. Bjorn Lambrigtsen, JPL*

***Measurements**:*
- *Microwave AMSU-like sounder;*
- *25 spectral channels in 3 bands;(50-60 GHz, 118 GHz, and 183 GHz)*
- *3-D distribution of temperature, water vapor, & cloud liquid water;*

***Resolution**:*
- *2 km vertical; 2 km horizontal (nadir)*
- *40 km wide swath*

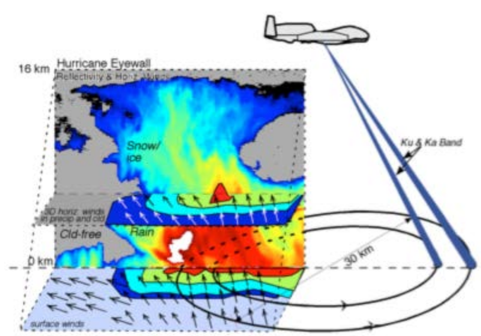


High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP)

***PI**: Dr. Gerald Heymsfield, NASA GSFC*

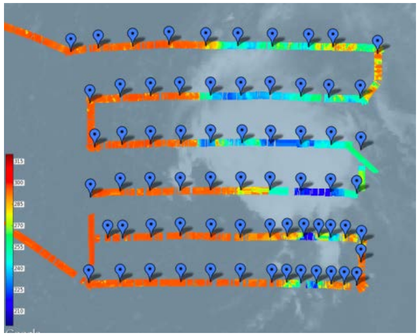
***Measurements**:*
- *Dual-frequency (Ka- & Ku-band), dual beam, conical scanning Doppler radar*
- *3-D winds, ocean vector winds, and precipitation;*

***Resolution**:*
- *60 m vertical, 1 km horizontal;*



Other SHOUT Global Hawk Payload Options for Data Impact Studies

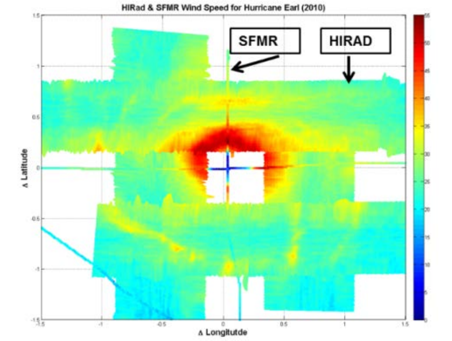
S-HIS, TS Humberto, September 16-17, 2013



Scanning High-resolution Interferometer Sounder (S-HIS)

PI – Dr. Hank Revercomb (U. of Wisconsin)

- **Infrared sounder similar to CrIS satellite sensor (3.3 – 18 mm)**
- **Provides brightness temperature spectra, cloud top temperature, profiles of temperature and water vapor in clear sky conditions**
- **Resolution: 2 km horizontal, 1-3 km vertical**



Comparison of joint HIRAD and SFMR ocean surface wind observations collected for Hurricane Earl during 2010

NASA Hurricane Imaging Radiometer (HIRAD)

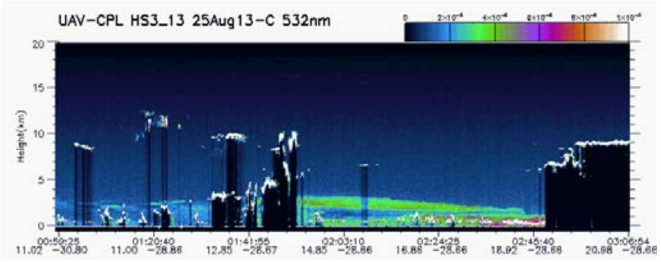
PI – Dr. Daniel Cecil (NASA MSFC)

- **Four frequency synthetic array passive microwave radiometer**
- **Provides ocean surface wind speed and precipitation over 40 km swath**
- **1.5 – 2.5 km horizontal spatial resolution**

NASA Cloud Physics Lidar (CPL)

PI – Dr. Matt McGill (NASA GSFC)

- **Cloud/aerosol boundaries, optical depth, extinction**
- **Resolution: ~200 m horizontal, ~30 m vertical**



Aircraft-Launched UAS

Raytheon Coyote

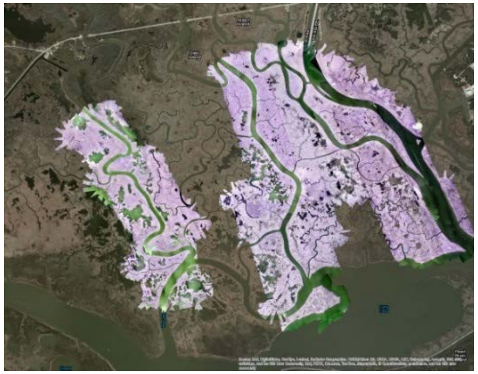
Piasecki Whimbrel

SHOUT4RIVERS

Leadership – Northern Gulf Institute

Objective

- **Document requirements of NOAA NWS River Forecast Centers**
- **Conduct technology demonstrations**
- **Develop effective observing strategy and information management plan**

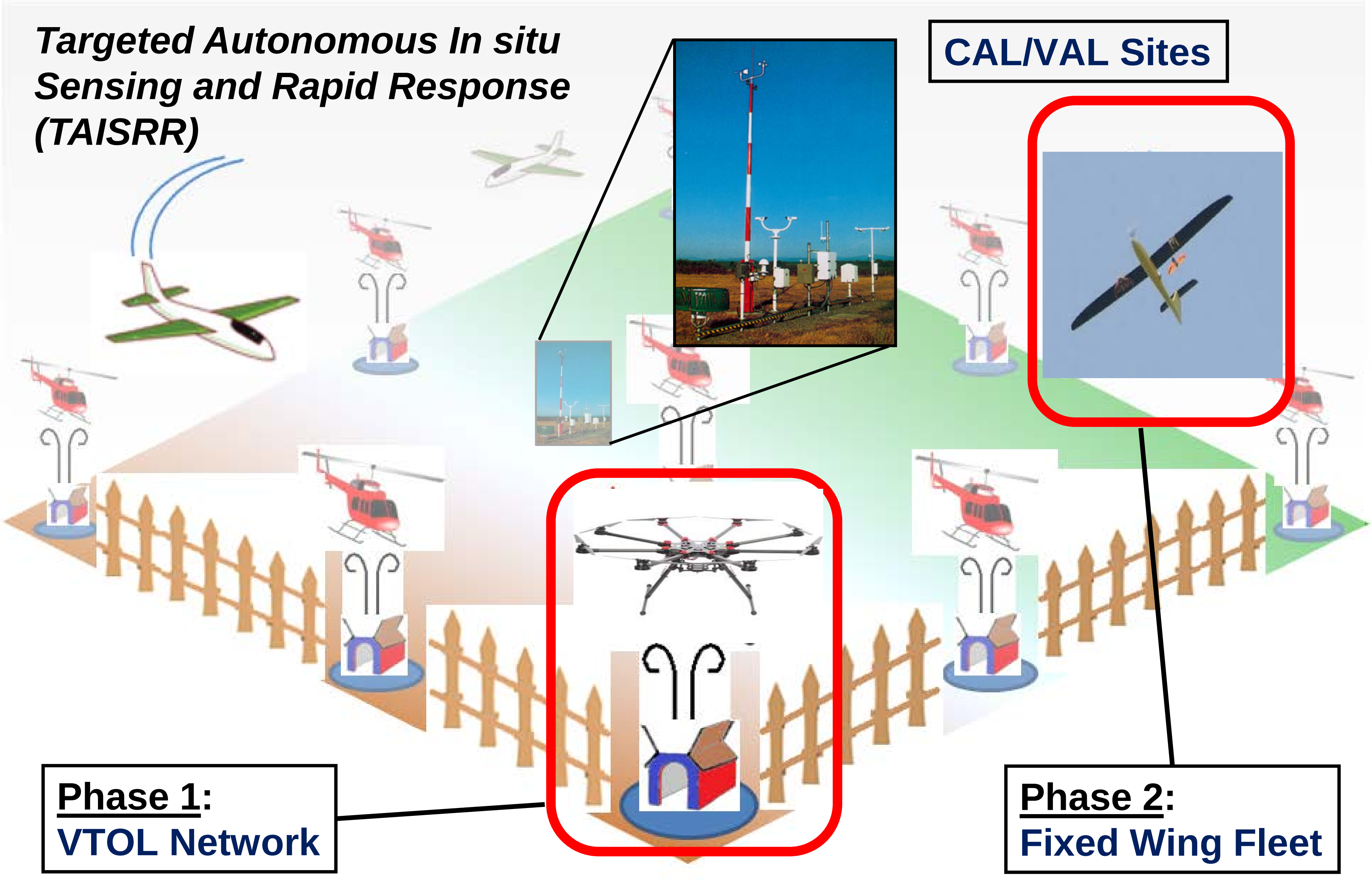


Current Demonstration

- **High-resolution monitoring of Pearl River Basin with Puma and Altavian aircraft**
  - **Detailed land/water maps**
  - **Digital elevation maps**
  - **Flow estimates**

SHOUT Low Altitude UAS Network

Targeted Autonomous In situ Sensing and Rapid Response (TAISRR)



Contact Information

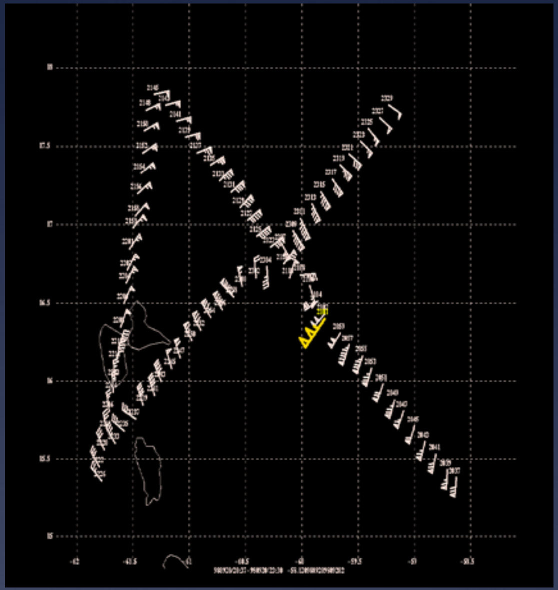
UAS Web Site: http://uas.noaa.gov/

Questions should be directed to:

Robbie Hood - NOAA UAS Program Director
(robbie.hood@noaa.gov / 303-905-3411)

Gaps/Future Needs

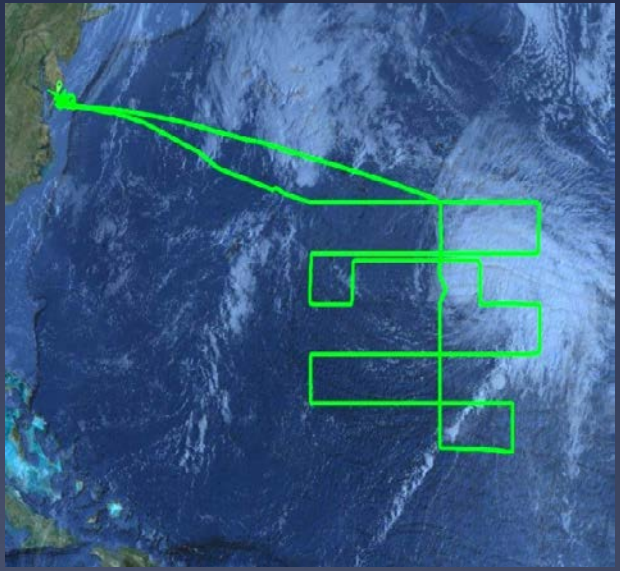
- NHOP: Surface center, continuous SST.
- Despite the relative speed of today's heavy aircraft, only a small fraction of the storm circulation is currently sampled.
- Improved temporal and spatial resolution of the eyewall, primarily for forecaster use.
- Three-dimensional depiction of wind (including where there are no scatterers), temperature, and humidity fields for model initialization and forecaster interpretation.



- HIRAD swaths for wider surface winds
- Combined Doppler/Lidar
- Thermodynamics??

Unmanned Aircraft

* Long-endurance high-altitude aircraft could perform surveillance-type missions for more remote systems, although their slow speed places stresses on a model's data assimilation system.



* Similar missions could potentially improve model genesis forecasts.

Unmanned Aircraft

- NHC has had limited enthusiasm for unmanned aircraft.
  - They're slow (G-IV ~30% faster than Global Hawk)
  - Cannot survey a storm in a reasonable period of time.
  - Could have specialized operational function if they can continuously monitor a specific area (e.g., RMW).

NOAA UAS Program

- **Goal to evaluate utility of UAS for NOAA operations and research**
- **Three focus areas**
  - **High-impact weather**
  - **Marine monitoring**
  - **Arctic research**
- **Wide range of platforms evaluated**

Fixed-Wing UAS Capabilities

High Altitude Long Endurance (HALE)

- Maximum Altitude 65,000 ft
- Maximum Endurance 25 hrs
- Maximum Payload Weight 1200 lbs

Medium Altitude Long Endurance (MALE)

- Maximum Altitude 40000 ft
- Maximum Endurance 24 hrs
- Maximum Payload Weight 400 lbs int, 2000 lbs ext

Low Altitude Long Endurance (LALE)

- Maximum Altitude 19,500 ft
- Maximum Endurance 24 hrs
- Maximum Payload Weight 13.5 lbs

Low Altitude Short Endurance (LASE)

- Maximum Altitude 1000 ft (operating altitude, higher capable)
- Maximum Endurance 2 hrs
- Maximum Payload Weight approx 2 lbs

Other Unmanned Capabilities

Vertical Takeoff and Landing (VTOL)

- Maximum Altitude 3280 ft
- Maximum Endurance 1.4 hr
- Maximum Payload Weight 1.7 lb

Aircraft-launched UAS (ACL)

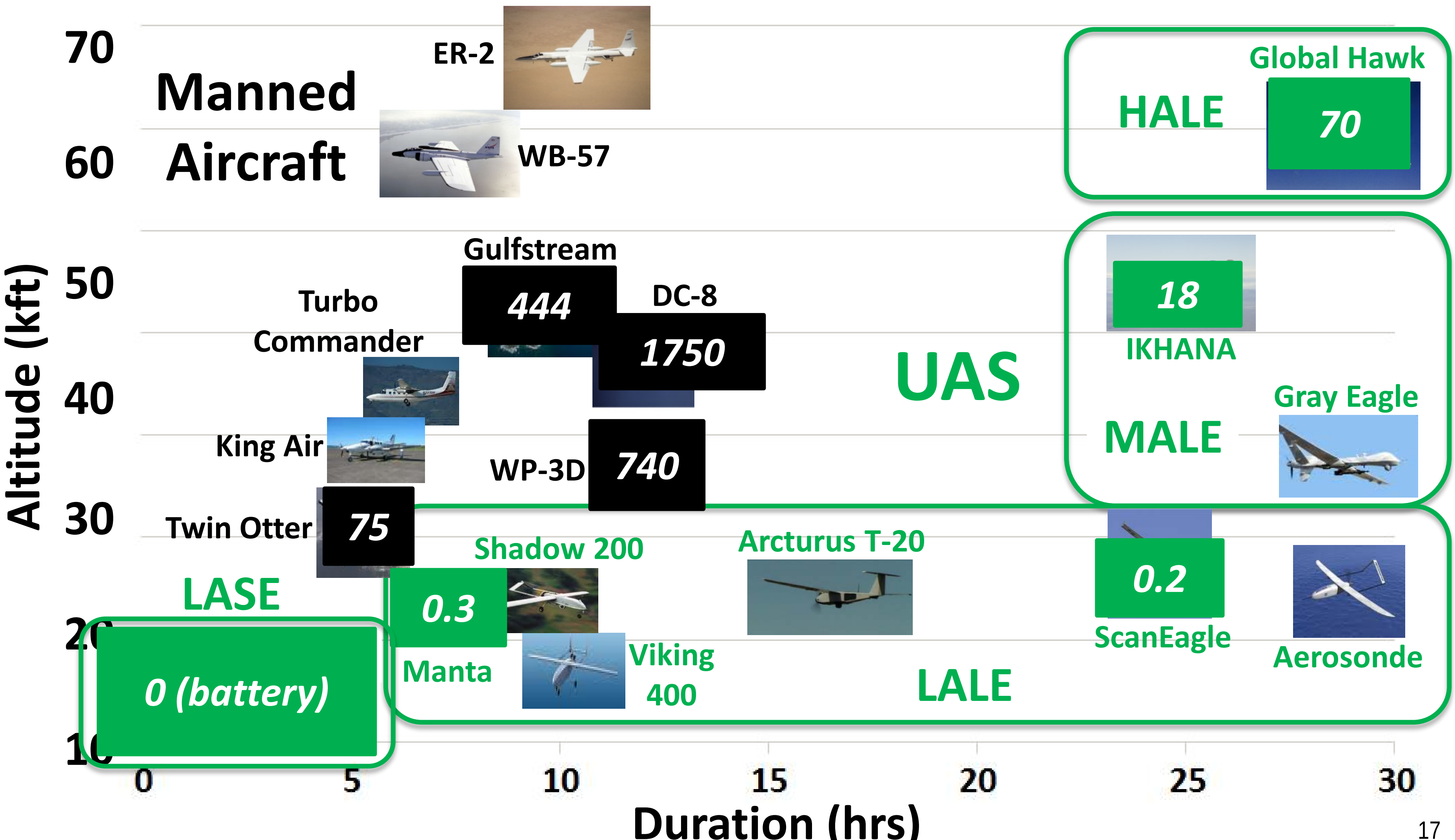
- Maximum Altitude 20,000 ft
- Maximum Endurance 1.5 lbs
- Maximum Payload Weight 0.9 lbs

Balloon-launched UAS (BL)

- Maximum Altitude 100,000 ft
- Maximum Endurance N/A
- Maximum Payload Weight 3 lbs

NOAA and NASA Manned and Unmanned Flight Capabilities

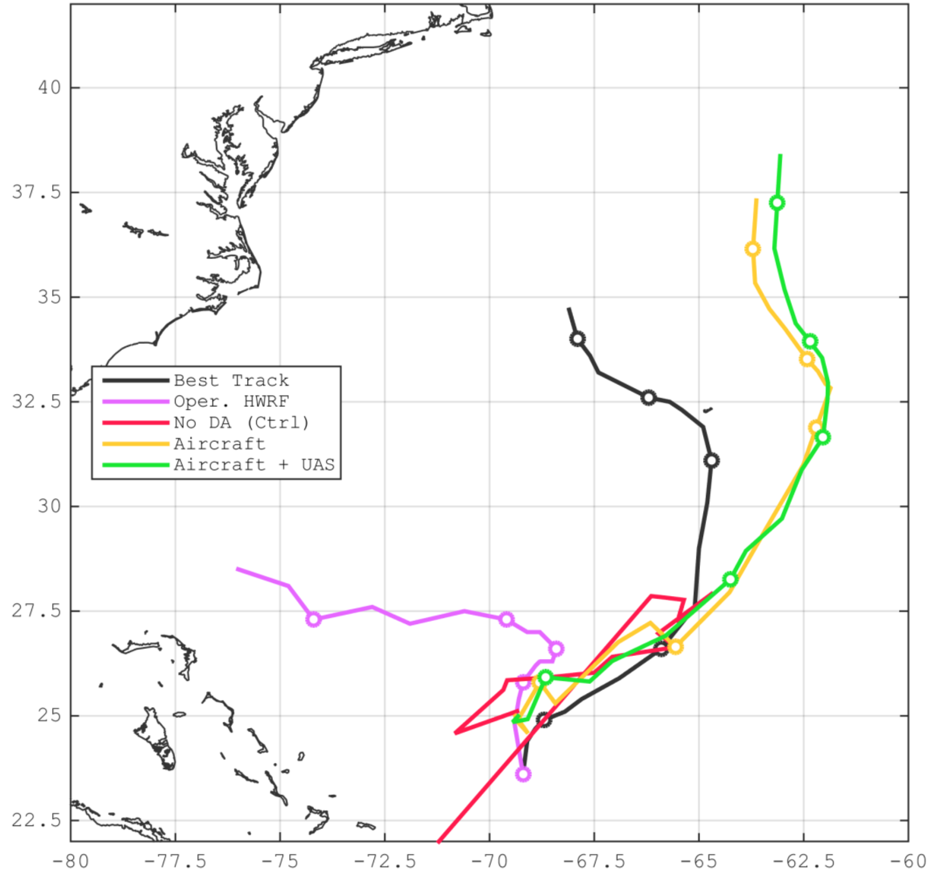
Fuel consumption (gph) for nominal mission



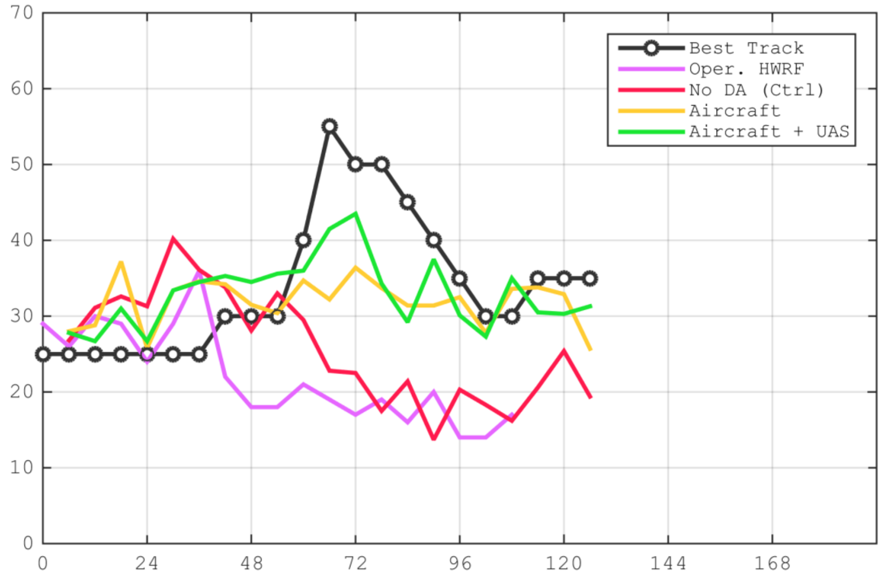
Example of SHOUT Data Assessment

Tropical Storm GABRIELLE 2013 - 7 SEP 18Z FORECAST PERFORMANCE

Track



Intensity (knots)



- Environment alone ("No DA") is not sufficient for a good track forecast (may be especially critical for weaker systems)
- Standard observations ("Aircraft") help maintain a weak depression, but with UAS observations ("Aircraft + UAS") strengthening occurs with good timing

Slide Courtsey of Dr. Altug Askoy / OAR -AOML-HRD - CIMAS