Unmanned Aircraft Systems (UAS) Program ICCAGRA 2011

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Office of Oceanic and Atmospheric Research
September 2011

NOAA UAS Roadmap

Innovate	*Incubate*	*Integrate*

	STEP 1 Identifying Promising Technologies	STEP 2 Optimizing Observing Strategies	STEP 3 Testing and Optimizing Concept of Operations	STEP 4 Implementing Operations to Address NOAA Goals
High Impact Wx	Long Endurance High and Low Altitude Transportable	High Resolution Imaging Vertical Meteorological Profiles Ocean Surface Meteorology	Tropical Storms Winter Storms Atmospheric River Storms Flooding Fire Weather	Weather-Ready Nation Sustainable Coastal Communities Climate Adaptation and Mitigation
Polar Monitoring	Long Endurance High and Low Altitude Transportable Quiet	High Resolution Imaging Vertical Meteorological Profiles Air Chemistry	Sea Ice Conditions Storm Forecasting Wildlife Assessment Air Chemistry Disaster Response	Climate Adaption and Mitigation Sustainable Ocean Ecosystems Arctic Strategy National Ocean Policy
Marine Monitoring	Long Endurance High, Medium, and Low Altitude Transportable Quiet	High Resolution Imaging Ocean Color Air Chemistry	Wildlife Assessment Fisheries Law Enforcement Marine Debris Coastal Ecosystems Disaster Response	Sustainable Ocean Ecosystems Sustainable Coastal Communities Arctic Strategy National Ocean Policy

High Impact Weather Monitoring

YEAR	2008	2009	2010	2011	2012	2013
Tropical Storms		Dropsonde System & OSSE	Global Hawk – GRIP & OSSE	GALE test flights & OSSE	GALE, EMILY, HS3	HS3
Atmospheric Rivers		Manta – Land Test Flights		Global Hawk - WISPAR	Manta – Ocean Test Flights	TBD
Pacific Winter Storms				Global Hawk - WISPAR		Global Hawk NCEP CONOPS
Flooding			*CBP – Red River*	*CBP – Red River*	NGI Science Team Study	LALE River Demo
Severe Storms			*NSF VORTEX-2*		TBD	TBD
Fire Weather					TBD	TBD

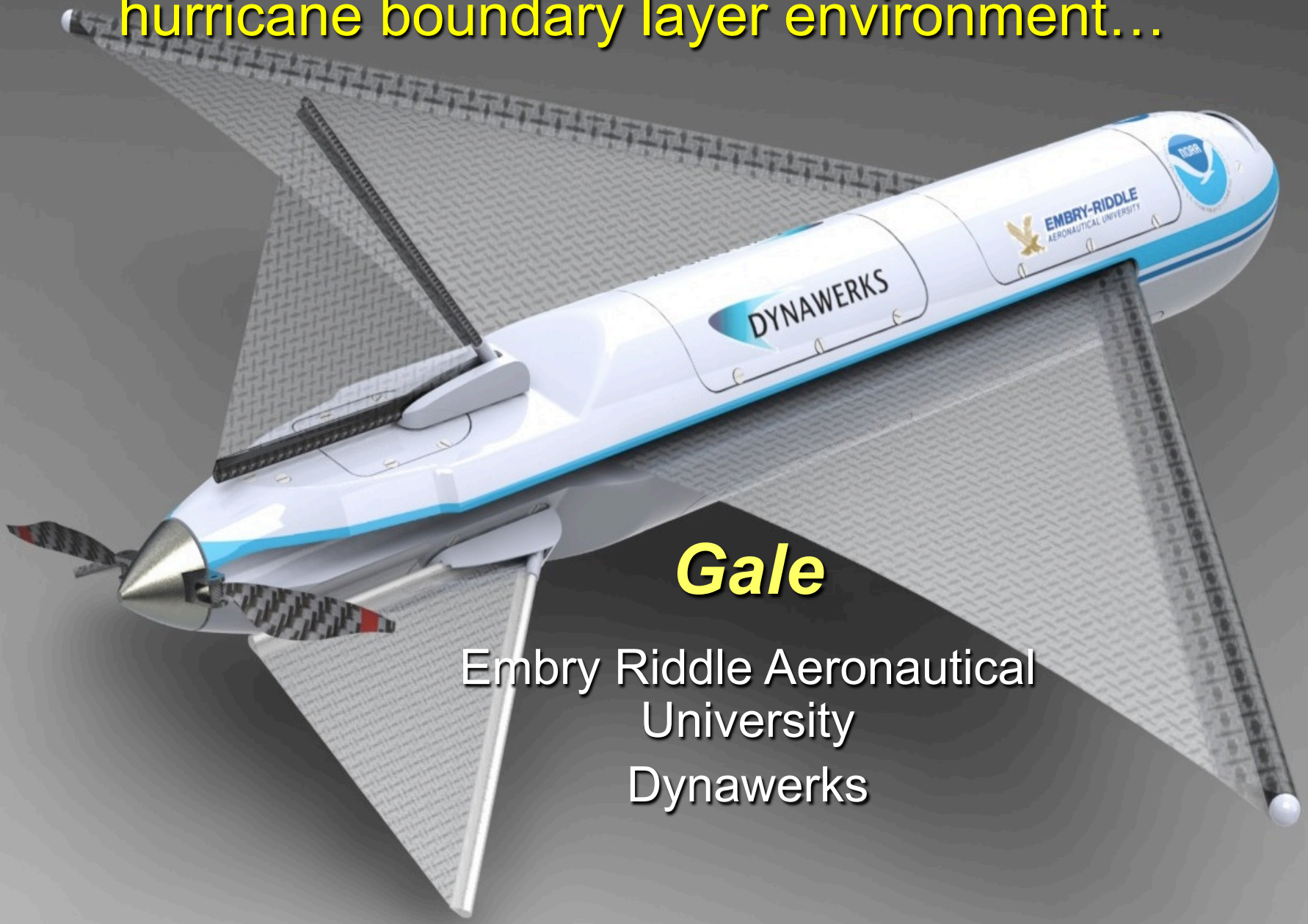
Polar Monitoring

YEAR	2008	2009	2010	2011	2012	2013
Goal 1 – Sea Ice	Manta - MUSCOX	*NASA SIERRA - CASIE*	Global Hawk - GloPac	*NASA ICE BRIDGE*	Arctic Science Team Study	Ikana - MIZOPEX
Goal 2 - Wildlife		Scan Eagle – Ice Seals		VTOL – Penguins & *UAK Puma*	Multiple Vehicle Demo	Polar Wildlife Study
Goal 2 – Gases & Aerosols			Black Carbon & Methane sensors	Manta – STADS/CICCI	Methane Demo	STADS -2 or Global Hawk
Goal 3 – Weather & Water				Global Hawk - WISPAR	Science Team Study	TBD
Goal 4 – Partnerships			GloPac	WISPAR & CICCI	STADS / CICCI Workshop & MIZOPEX	Joint Federal or International Study

Marine Monitoring

YEAR	2008	2009	2010	2011	2012	2013
Sanctuary Surveillance		Puma Small Boat Demo		Puma Oil Spill Demo	Ikana - Hawaii	TBD
Marine Debris	NESDIS/NOS Manolo				LALE UAS – Hawaii or Alaska	TBD

Using the Gale air-deployed UAS to study the hurricane boundary layer environment…



Gale

Embry Riddle Aeronautical University

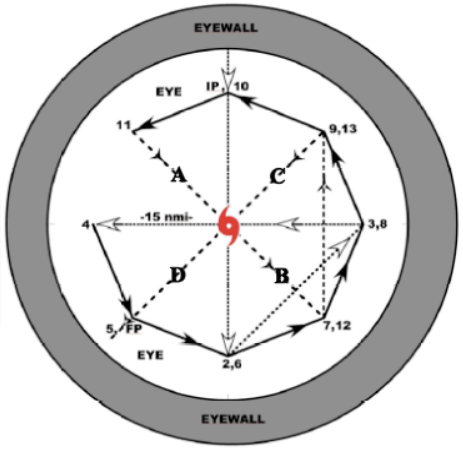
Dynawerks

Primary Gale UAS In-Storm Mission Objectives:

- **Fill critical data gaps in regions of the tropical cyclone that are very difficult (and dangerous) to otherwise observe.**
  - **Provide high resolution near-surface observations (PTHU)**
    - **2-4hz data should provide ~50m horizontal resolution data coverage**
  - **(Ultimately) provide real-time data availability** (NHC/EMC & other partners)
- **Fully demonstrate the UAS' platform's overall capabilities and survivability in a variety of meteorological conditions.**
  - ***Attempt to fly at very low altitudes (≤200m) in high wind conditions (incl eyewall)***
  - ***Fully test the UAS platform's endurance***
  - ***Test the integrity and limits of the onboard meteorological sensors (in a very harsh weather environment)***
  - ***Push operational feasibility limits as well…***
    - ***Mission readiness once operational green light established (48h? 72h?)***
    - ***In-flight mission flexibility (how often and how fast can we adapt and adjust)?***
    - ***(Ultimately) Multiple UAS configurations possible? (e.g. one in one out; 2 at once?)***
- **Continue to utilize and leverage NOAA P-3 manned aircraft assets to further enhance the utility and feasibility of UAS-tropical cyclone missions.**

Operational Flight Plan: Eye Module

UAS - P3 Mature Hurricane Eye Module



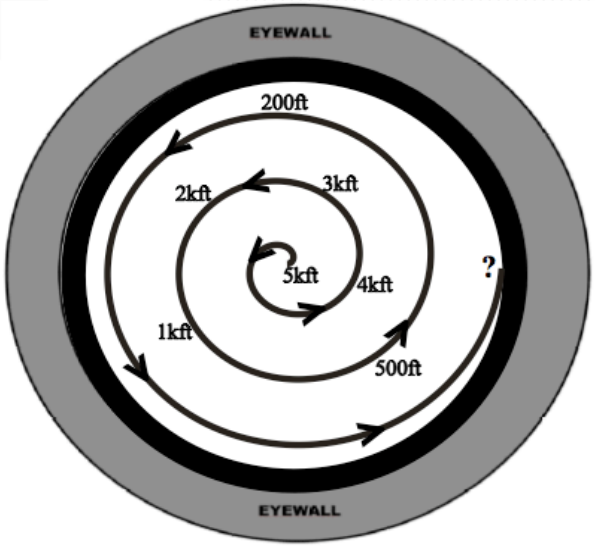
P-3 FLIGHT PATTERN

P-3 Alt/UAS launch 10kft
- 14 Dropsondes launched
- 9 AXBTs launched

–UAS enters flight regime at 5,000 ft
–From, 5,000 ft to 1,000 ft,
- Hold for 3 minutes
- Descent increment: 1000 ft

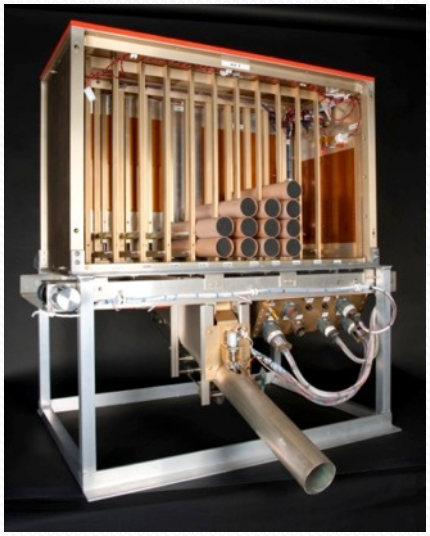
–From 1,000 ft to 200 ft
- Hold for 3 minutes
- Descent increment: 100 ft.

–Eyewall penetration if aircraft reaches 200 ft



UAS
FLIGHT PATTERN

Winter Storms and Pacific Atmospheric Rivers (WISPAR) Experiment



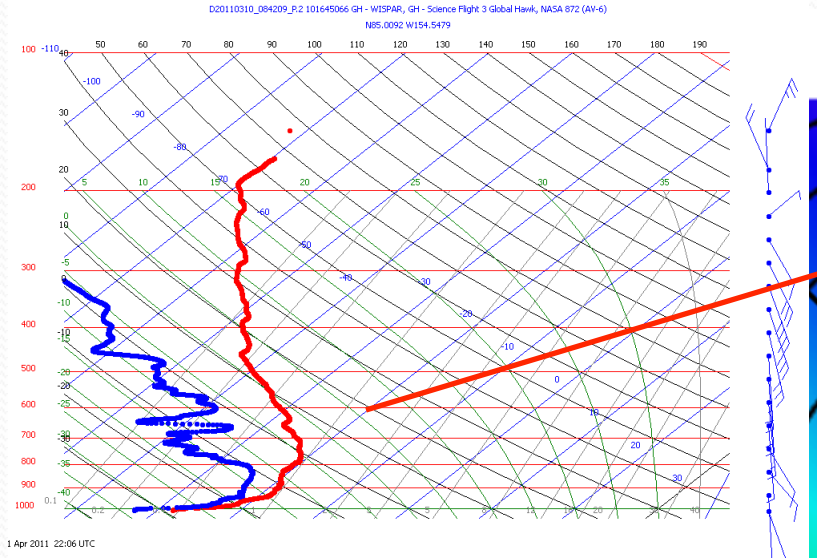
Mission Scientists: Gary Wick (NOAA/ESRL) and Michael Black (NOAA/AOML)

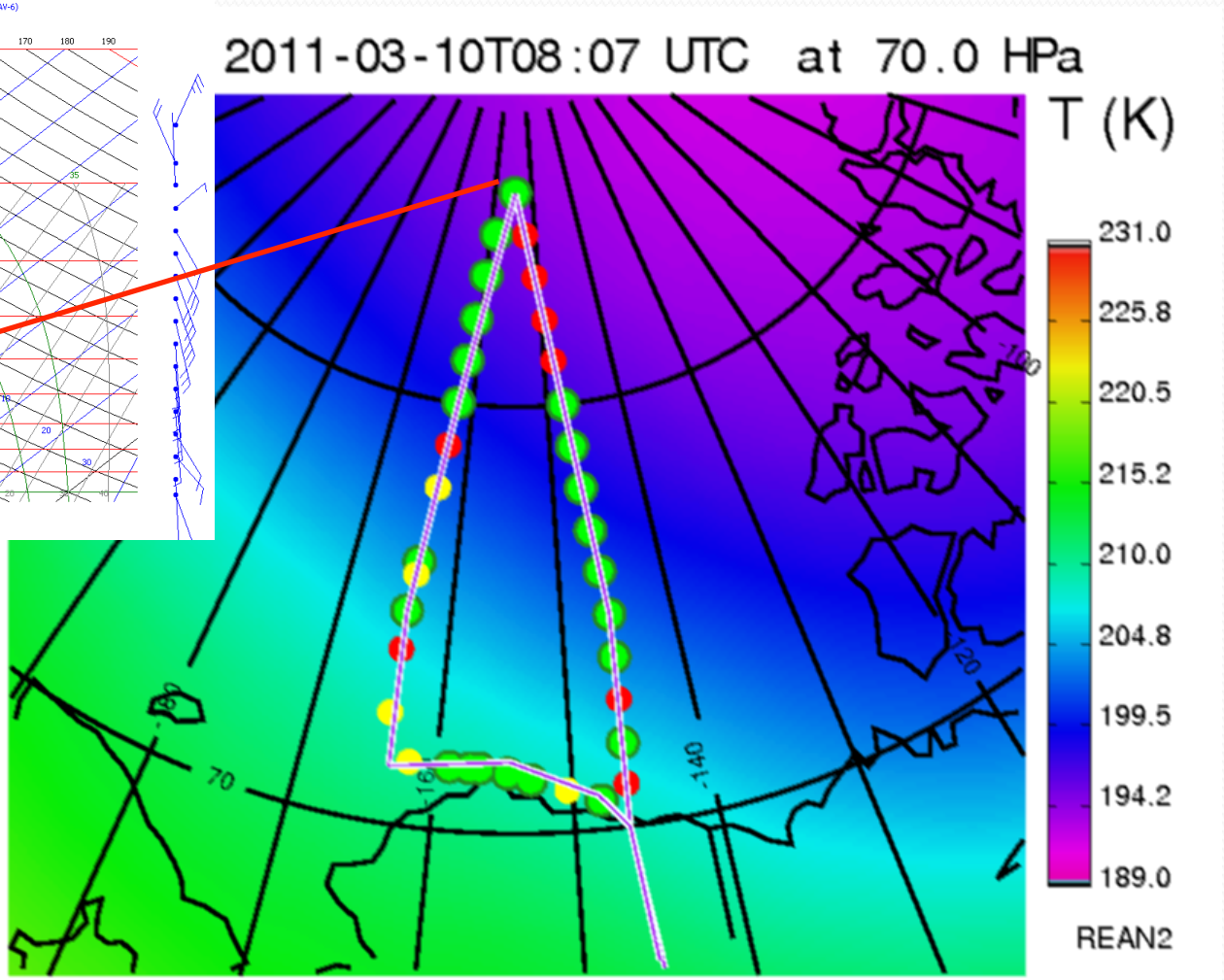
Partners: Yucheng Song (NOAA/NCEP), Janet Intrieri (NOAA/ESRL), Ryan Spackman (CU), NASA, NSF/NCAR

Dropsonde System – NCAR development / NOAA and NSF sponsorship
88 sonde total capacity

First dropsonde release from a Global Hawk

WISPAR Arctic Dropsonde Mission
9-10 March 2011

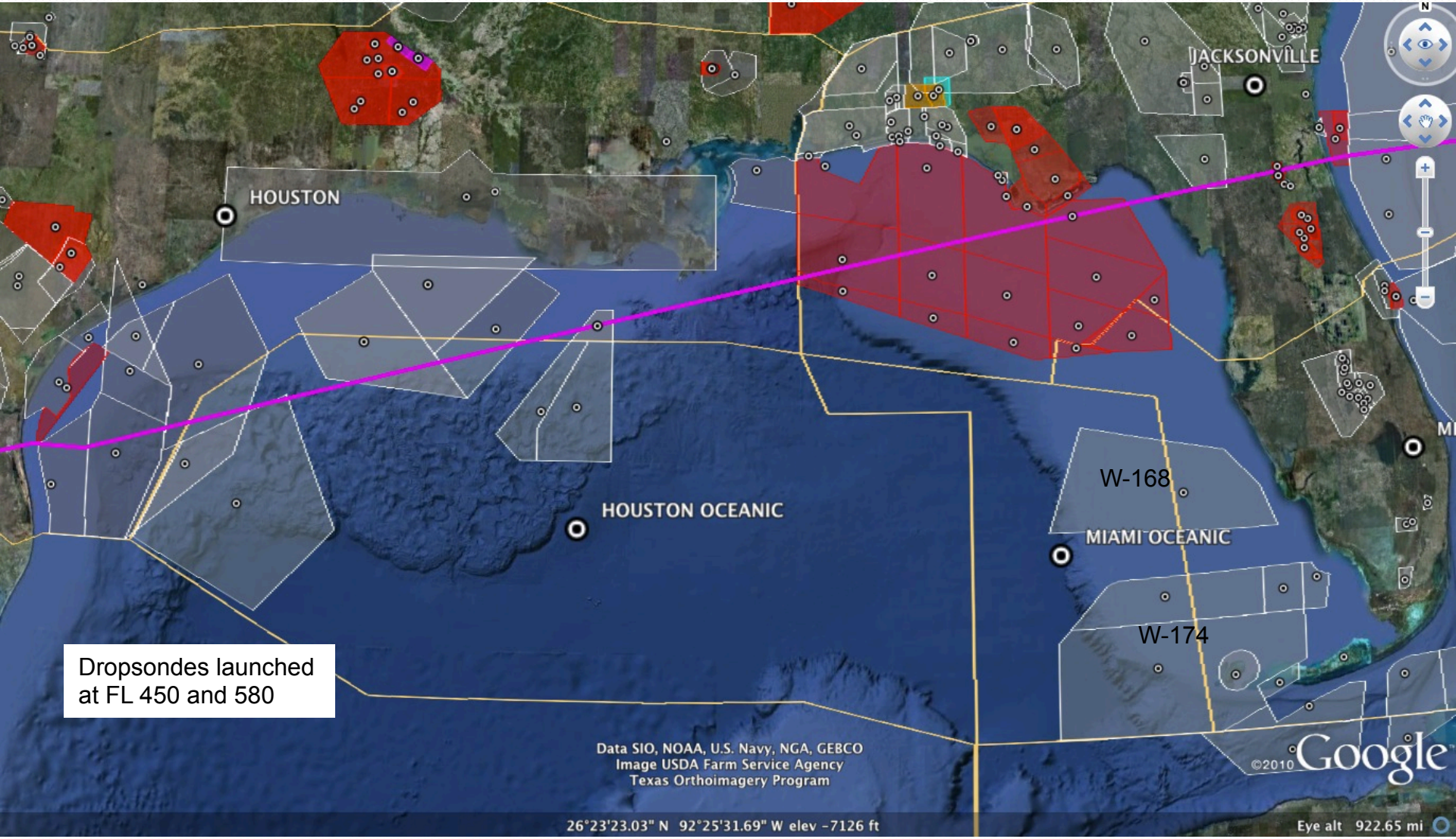




Drop locations superimposed on 70 mb temperatures from the NCAR/NCEP V2 reanalysis data

Courtesy of Leslie Lait, Paul Newman (NASA GSFC)

NASA Global Hawk & NOAA GIV Dropsonde Inter-comparison Flight Proposed Warning Areas W-168 & W-174



Small UAS in Oil Spill Remote Sensing

Vessel Based sUAS Operations to characterize and quantify geographic extent of simulated oil spill

Vessel Based sUAS Operations to conduct shoreline assessments

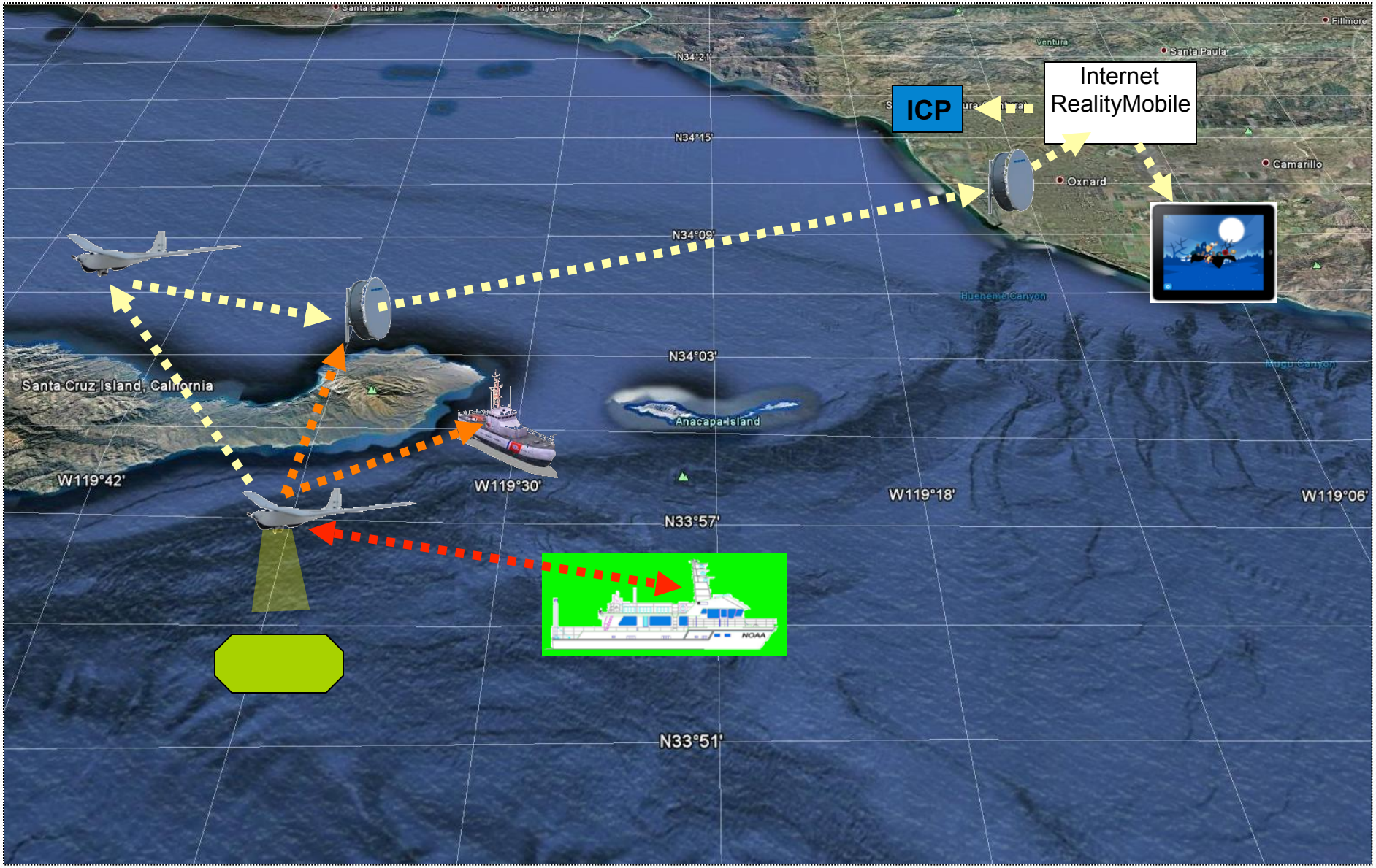
Transmit real-time Video (FMV + Meta data) from the field to ICP

Demonstrate sUAS to sUAS data/communications relay

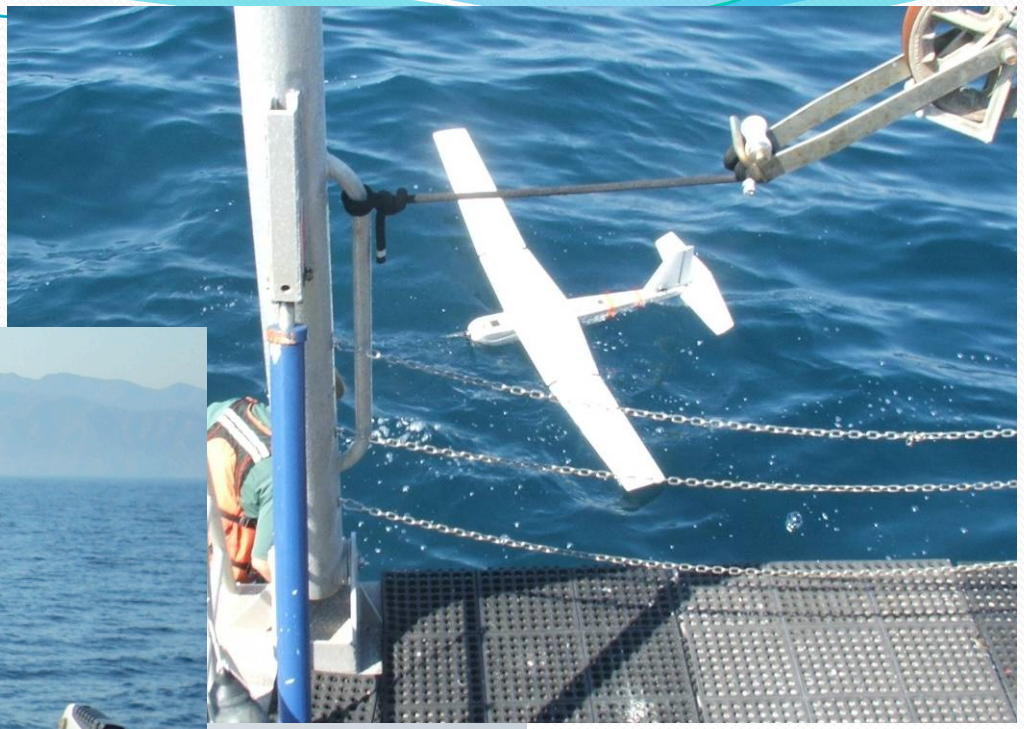
Participants - NOAA UAS Program, NOAA Channel Islands National Marine Sanctuary, AeroViroment Inc, Chevron Shipping, Reality Mobile, NAWS Point Mugu/NAVAIR Range Control, Ventura Co Office of Education, Channel Islands National Park, USCG Sector LA-LB and USCGC Blacktip

Concept of Operation

Oil Spill, Relay Link, Shoreline Assessment



AV Puma AE

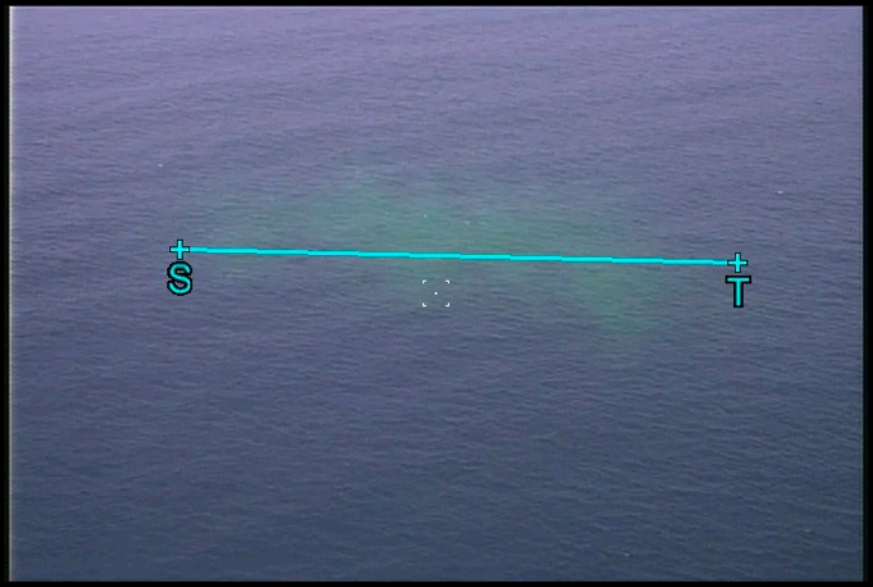


Simulated Spill

Santa Cruz Island Relay Point

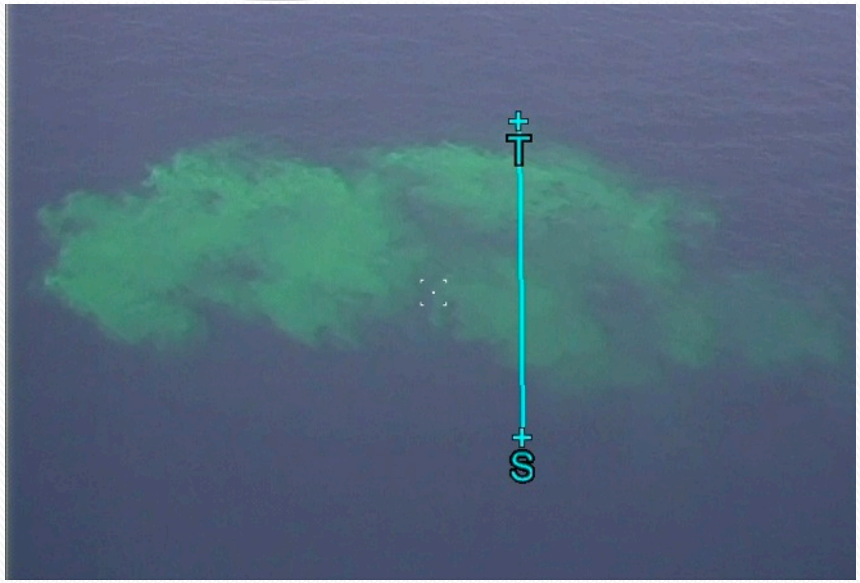
Measurement Tools

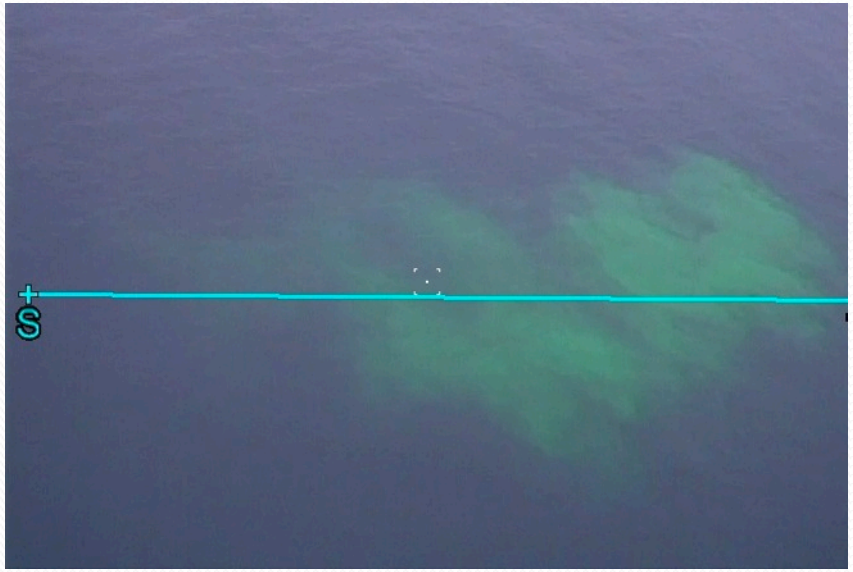
Lat/Lon: N 33° 48' 31.53" W 119° 46' 18.60"
Alt: 351 ft MSL
Mag: 39°



Gimbal
FOV Data:
Slant Rng: 259 m
CFOV Hdg: 320°
CFOV Lat/Lon: N 33° 48' 37.61" W 119° 46' 23.82"
Horiz. FOV: 29.6°

Targeting Data:
Target S Lat/Lon: N 33° 48' 36.66" W 119° 46' 26.12"
Target T Lat/Lon: N 33° 48' 39.29" W 119° 46' 23.45"
ADD 94 m RIGHT 48 m
Range: 106 m Mag Bearing: 27°





Shoreline Assessment

Issues & Barriers to Success

Unmanned Systems have been “Wildly successful!”

Plenty of issues but, “We have chosen to admire the problem.”

Issues & BtS

- Airworthiness
- Operator & Maintenance Qualifications
- FAA Airspace Regulations & Access
- Program Management
  - Engineering, Logistics, T&E, Operations, Contracting…
  - Cost, Schedule, Performance, Risk, **Requirement Traceability, Commonality**
- Administrative hurdles to cooperation & asset pooling
  - MOUs & IAAs
  - Buying data or capability (assets, personnel, infrastructure)?
  - Understanding utilization rates
    - S&T… R&D… “Three months of install and ground test for 1 Flt-Hr
    - Flt Hours vs On-station Hours vs Sensor Hours vs Data Hours vs Used DH

Success!

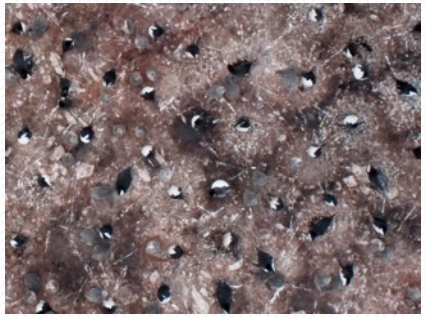
High Utilization Rate

- FAA Airspace Access
  - Dangerous, Dirty, Dull, Denied, Economical, Green
- Common and Pooled Assets
  - Logistic, Configuration Management, Training
  - Data Standardization, Quality, Storage and Cataloging
  - Overarching Inter-Agency Agreement (IAA) & Scheduling

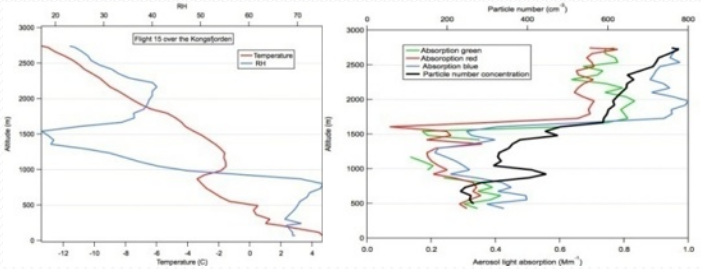
Cheaper & Greener

- Autonomous
  - Completely
  - Multiple platforms controlled by single operator
- Uses 10% of the fuel or “new fuels”

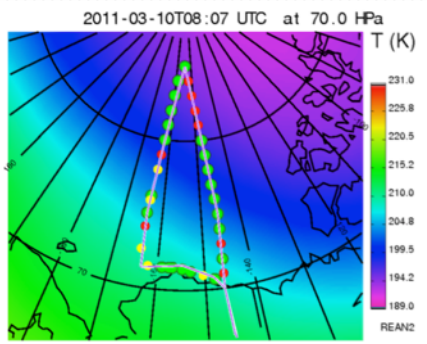
Wide Range of Innovative UAS Observing Solutions



Quiet and Easily Transportable for High Resolution Imaging



Versatile Platform and Payload Capabilities for Low Altitude Profiling



High Altitude Long Endurance for Comprehensive Imaging and Profiling

Contact Information

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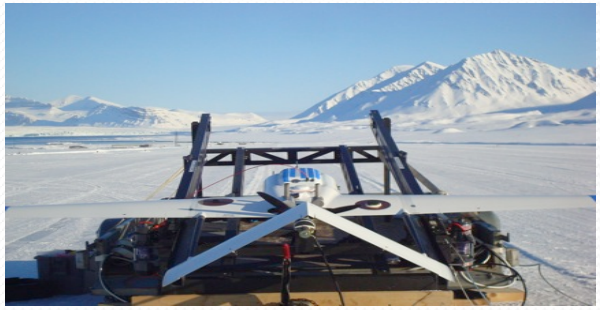
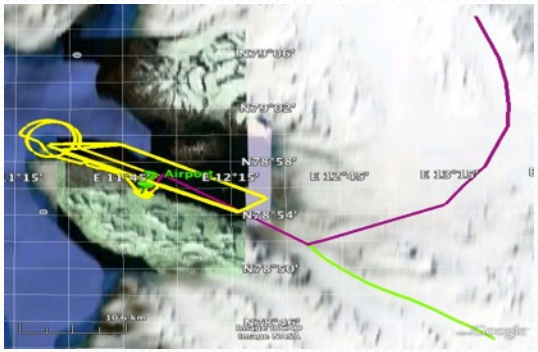
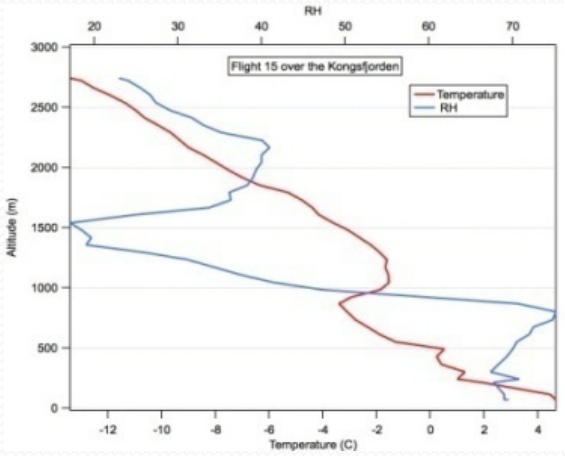
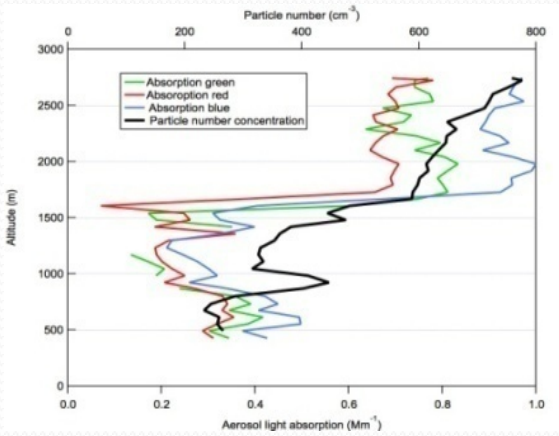
Soot Transport, Absorption, and Deposition Study (STADS)









NOAA component of the Coordinated Investigation of Climate-Cryosphere Interactions (CICCI) collaboration with Norwegian and Russian scientists

STADS Mission Scientists: Tim Bates and Patricia Quinn (NOAA/ESRL)