NSF/NAVY/UNOLS Scientific Committee on Aircraft Research (SCOAR)
June 22,23, 2011 Meeting, NPS CIRPAS, Monterey, Ca.
USCG REPORT

Dr. Phil McGillivary, USCG PACAREA & Icebreaker Science Liaison
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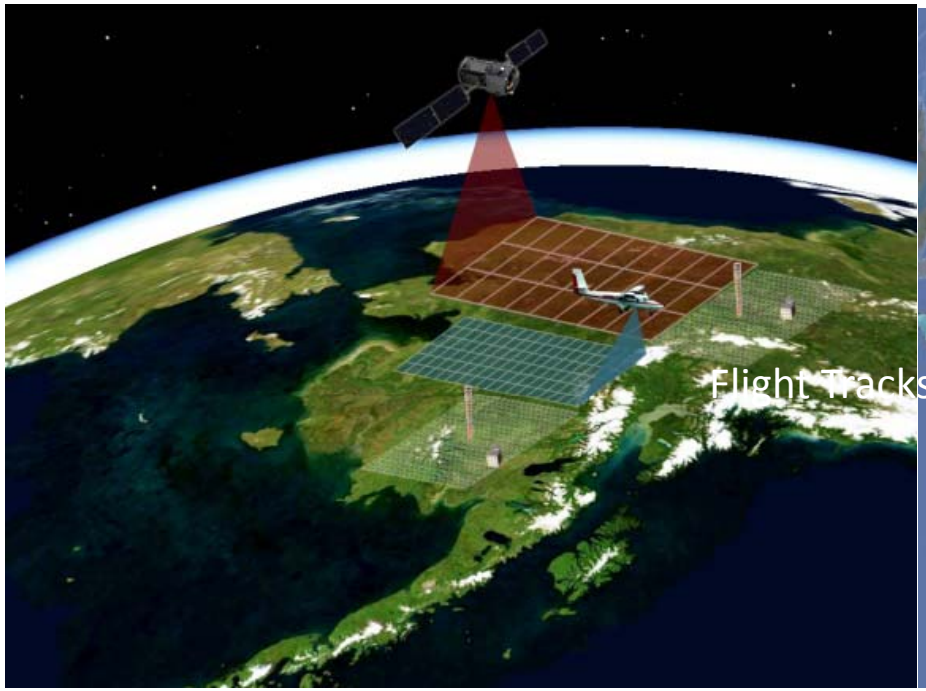
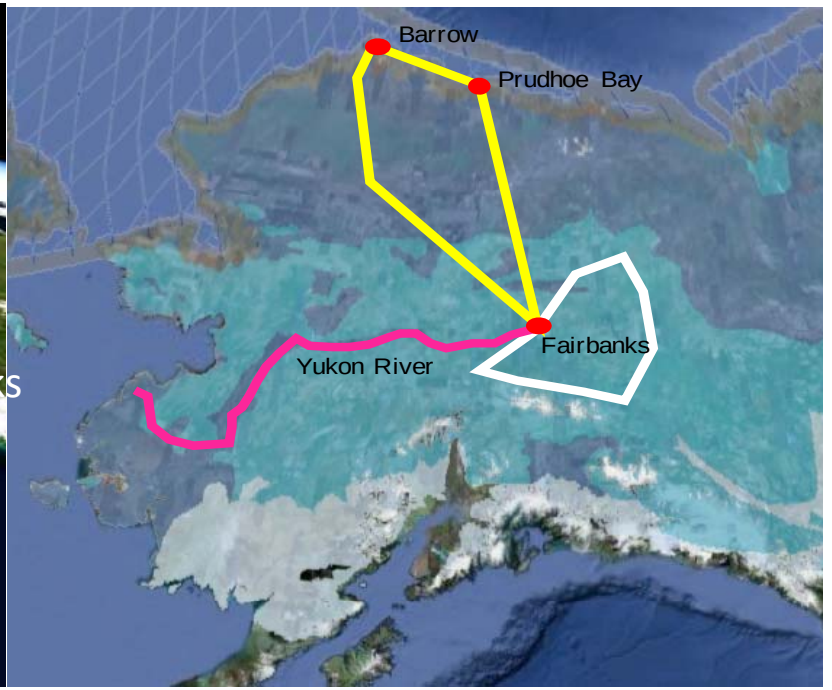
CG Manned Aircraft Research

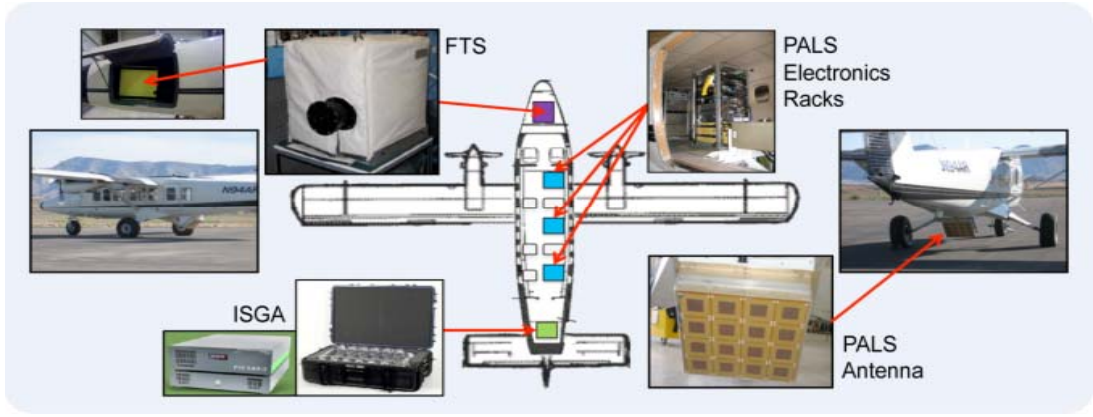
- Continuation of CG C130 Arctic Domain Awareness (ADA) biweekly flights from Kodiak to Barrow and Prudhoe Bay
- Continue NOAA Gas Sampling for CO2, Methane, 18 other gases, with altitude
- Joint program with NASA CARVE effort to map methane fluxes from melting tundra
- Still awaiting final CG HQ approval for FLIR tube lidar from Jim Maslanik. Expected in 2011, but not in time for deployment this year

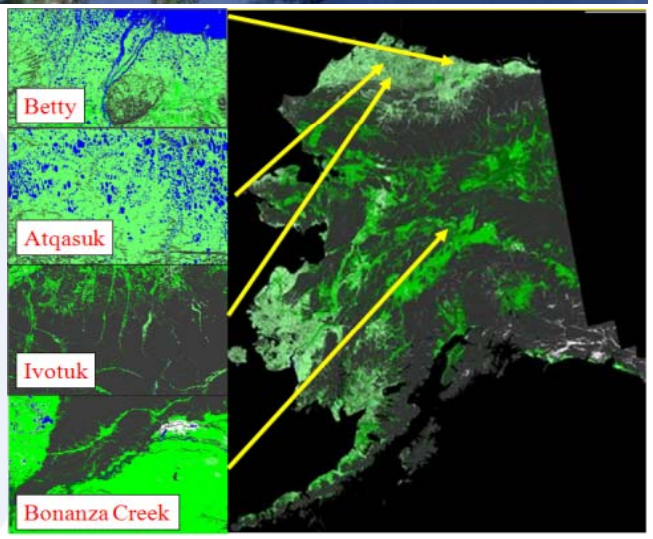
Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE): An EV-1 Investigation





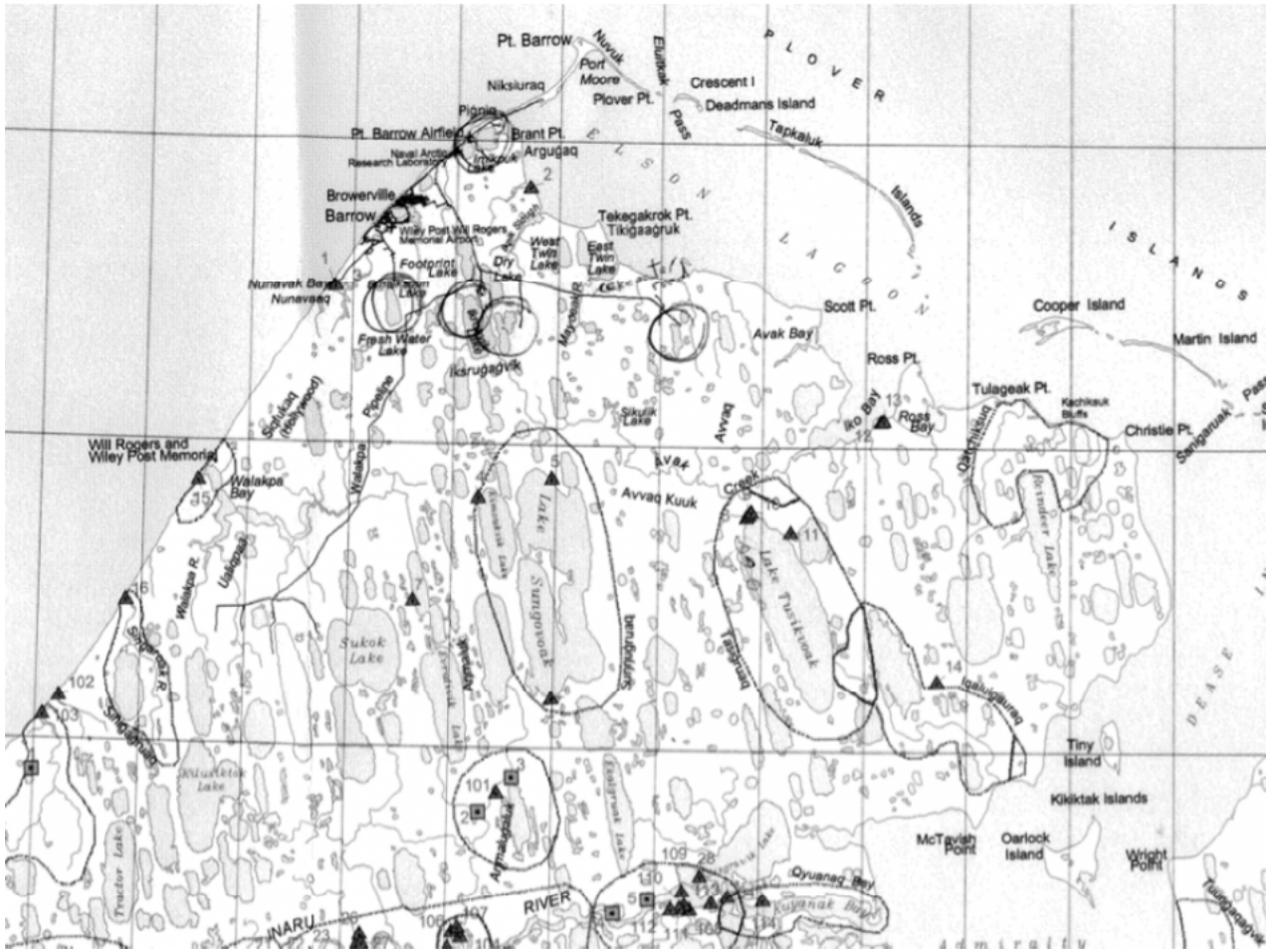
Principal Investigator : Charles Miller
Project Manager: Steve Dinardo
Implementation Center: JPL





Barrow Vicinity Lakes w Known Methane Seeps;

TEK: “Don’t sleep at north end of lakes, especially if winds are from north, or you won’t wake up”



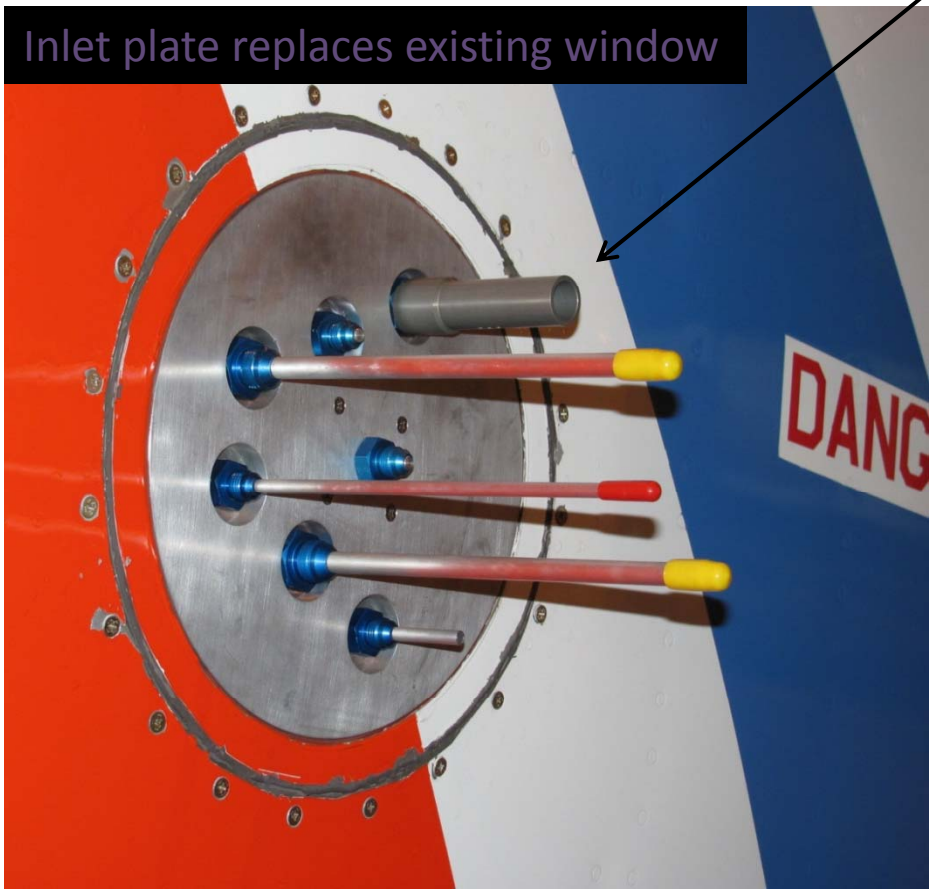
Alaska Coast Guard (ACG) Aircraft Site

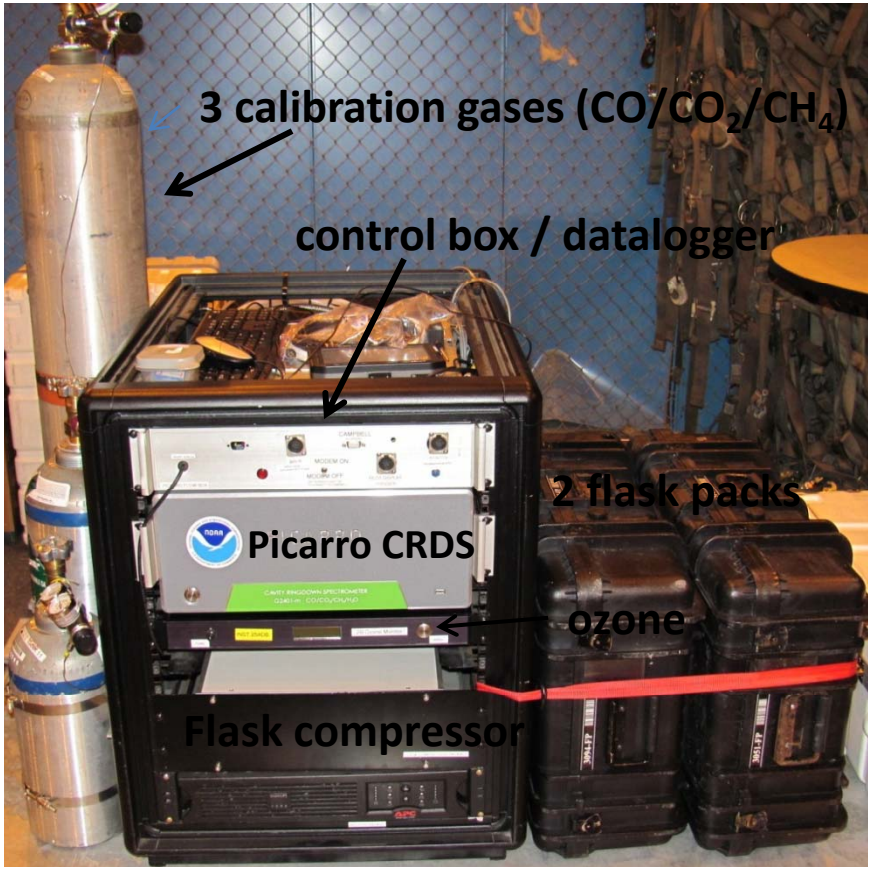
- U.S. Coast Guard conducts regular flights across Alaska for **Arctic Domain Awareness (ADA)**; for search and rescue operations as sea ice melts.
- NOAA/USCG collaboration – flights of opportunity
- Test bed for instrumentation for commercial aircraft
- Unprecedented scientific opportunity
  - monitoring Arctic response to warming and sea ice melting
  - establish baseline and monitor inter-annual variability
  - stratospheric/tropospheric exchange

Alaska Coast Guard Flights
CH4, CO2, CO, O3

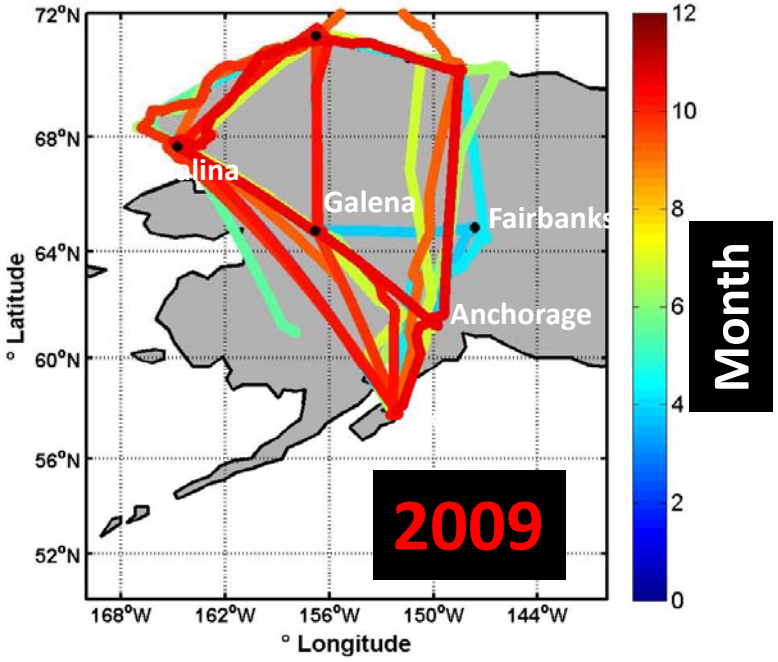
Alaska Coast Guard (ACG) Aircraft Site

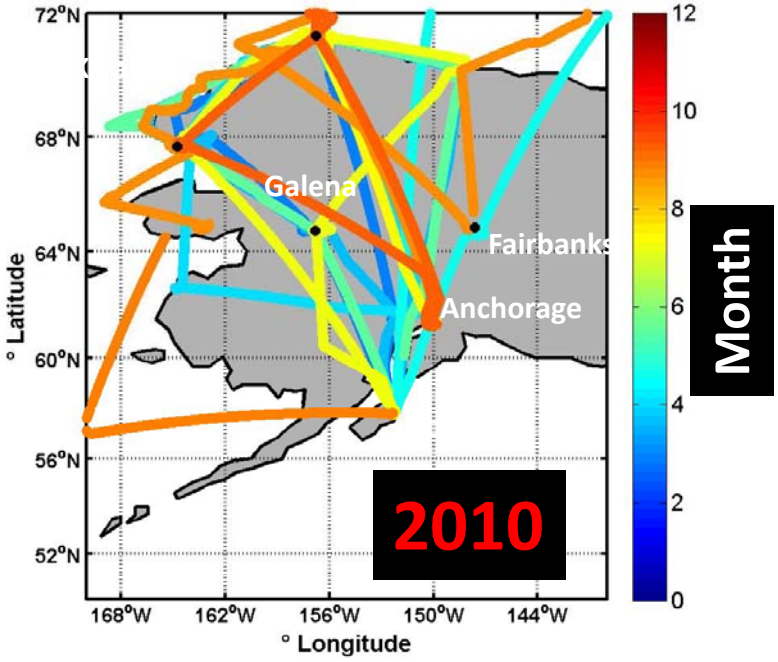
Temperature, RH, and Pressure also measured

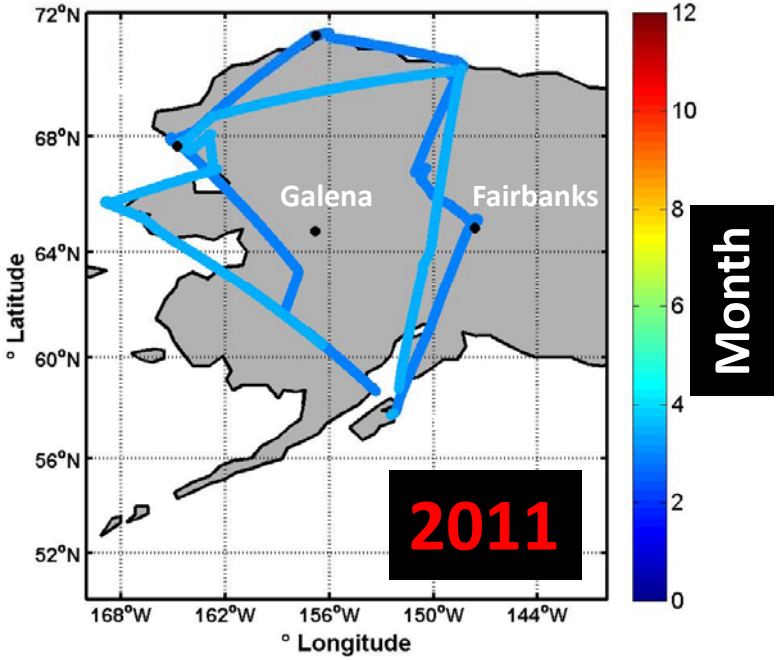




*Thanks to Duane Kitzis, Pat Lang, Paul Novelli for tanks and flask analysis.







- Bi-weekly 8-hour flights on C-130
- March – November
- 16 flights per season
- large spatial extent (> 3000 km & 3 profiles per flight)
- much of the sampling occurs at high altitude (~8000 m)

USCG Unmanned Aircraft Operations

- UAS general ops plan: focus on FireScout
- Ongoing discussions re small UAS
- Approval in principle ScanEagle ops from HEALY summer 2012 by Greg Walker (UAF) as part of DHS S&T UH CIMES program (Center for Island, Maritime & Extreme Environment Security) (M. Edwards, Dir.)
- Plan for USAF/NORTHCOM test of hand-launch/retrieval of RAVEN UAS from HEALY summer 2011 from ship or ice, TBD

CG ‘Historical’ UAS Ops, SilverFox launch off 110’ Cutter, Hono, 2006, pre-NAVAIR Certification requirement

USCG Unmanned Aircraft Operations, partnered w DHS (Customs & Border Patrol), DoD

- Cutter-based: FireScout VTUAS to extend ship surveillance. Demo w Navy on Nat. Security Cutter (NSC) still TBD
- Land-based: joint CBP office 2008, joint training program w 8 CG trained in 2009/2010 on 'Guardian' (Maritime Variant Predator, MVP) - CG responsible for sensor maintenance, data analysis; CG UAS Center set up at CG Aviation Training Center
- HALE = Hi-Alt. Long Endurance UAS, part of Navy Broad Area Surveillance (BAMS) program: CG will subscribe to products.

DARPA Arctic UAS VULTURE program

Dan Newman

Program Manager, Tactical Technology Office

Defense Advanced Research Projects Agency

daniel.newman@darpa.mil

DARPA VULTURE Overview

Program Goals and Objectives

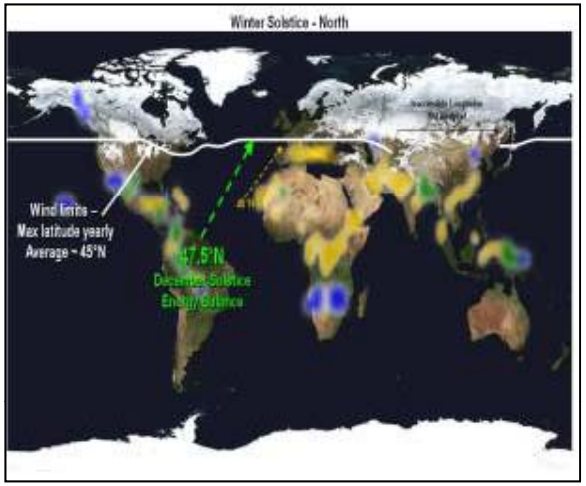
- Develop a HALE UAV that can maintain a 1000 lb, 5kW payload on-station continuously for 5 years

Technical Challenges

- Closing on the Energy Cycle: Harvesting & Storage
- Structural Integrity & Control System Coupling
- Reliability

Technical Approaches

- Solar Electric (Photovoltaic) Energy Collection
- Fuel Cell / Battery Energy Storage
- Single System vs Airborne Docking/Replacement
- Satellite Design Paradigm for Reliability
- Redundancy for Planned Degradation
- Few Moving Parts (e.g. Propulsion as Flight Control)
- Efficient Electric propulsion
- High L/D (~40), Low Mass Fraction Structure



DARPA VULTURE ‘contenders’

3 Performers awarded Phase I contracts April 2008

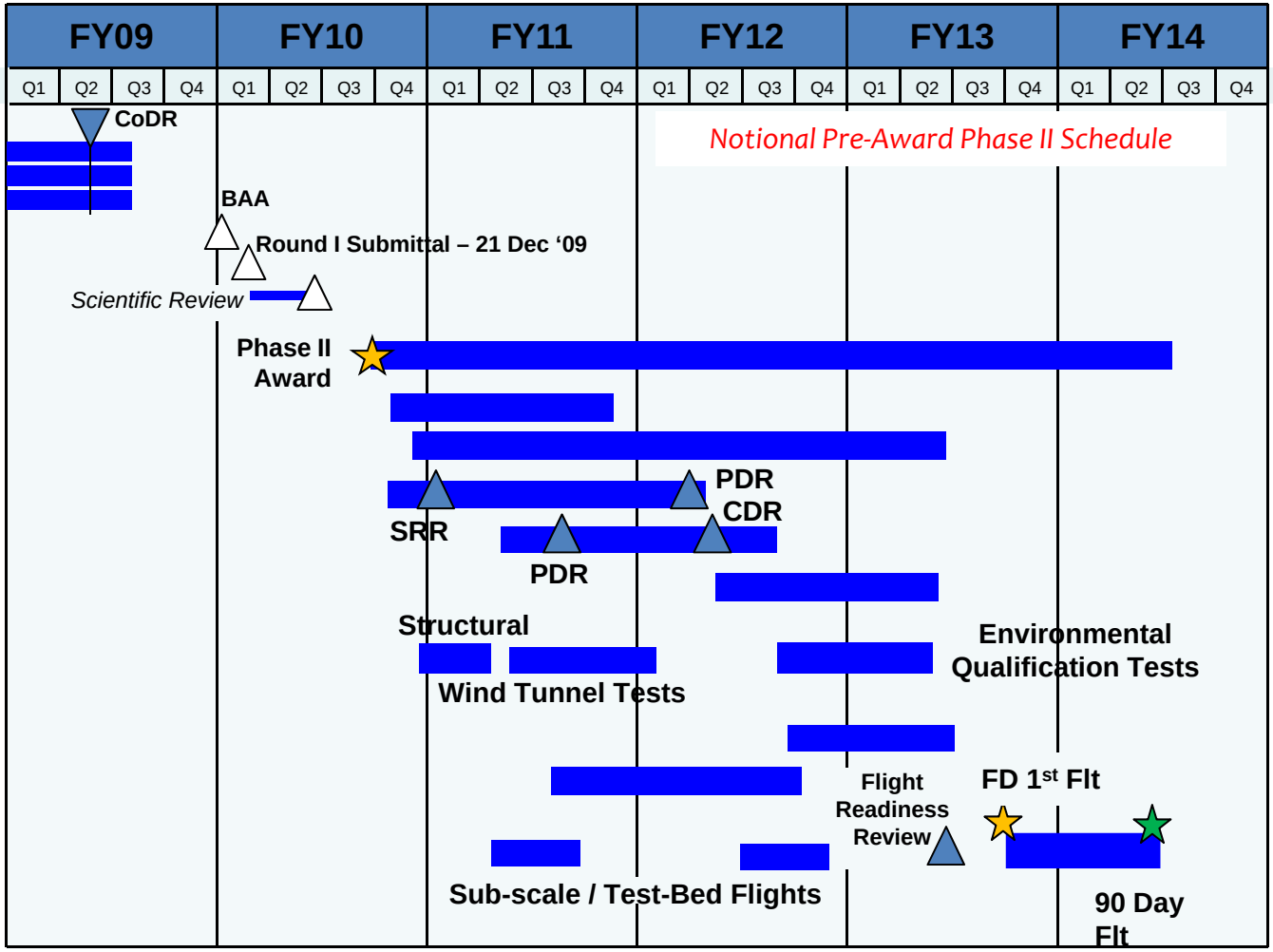
- Aurora Flight Sciences
- Boeing
- Lockheed Martin

DARPA Vulture Timeline

Phase I - Concept Definition
4/08 – 6/09

Phase II - Tech Mat./ Demonstration

- **Component Risk Mitigation / Testing**
- **Military Utility Study**
- **Objective System Preliminary Design**
- **Flight Demonstrator (FD) Detail Design**
- **FD Fabrication / Assembly**
- **FD Component/System Ground Test / System-Integration Laboratory / Hardware-in-the-Loop Testing**
- **Reliability Ground Demo**
- **Flight Demonstrations**



USCG Unmanned Aircraft Operations
HEALY ScanEagle, summer 2010 (G. Walker, UAF)

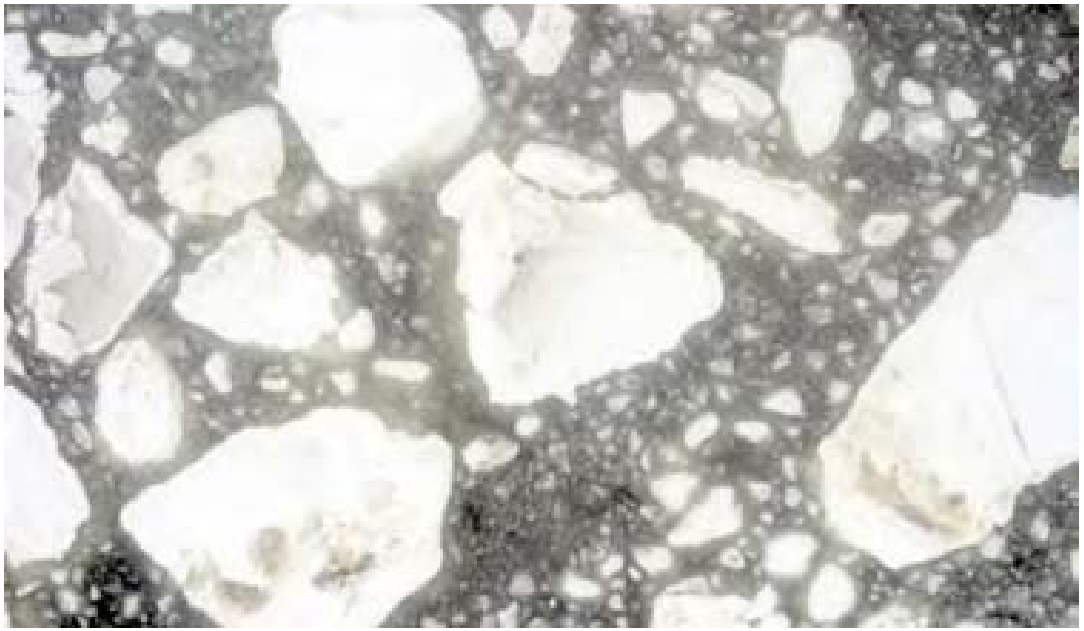
Sensors: visible camera; long-wave IR camera; Short-wave IR camera; X-band SAR; ice-roughness lidar

Goals:

- to improve/validate satellite imagery
- resolve issue of cloud/fog obscuration of non-SAR satellite imagery (US has no SAR satellite of its' own)
- provide data on ice ridging
- Improve assessment of ice conditions suitable for helo landings

USCG Lt Sam Edwards (RDC) launching ScanEagle Oct.2008, OSCAR DSYSON

ScanEagle Imagery from Bering Sea
Left: Visible 2cm resolution, 5/09
Right: X-band SAR 30cm resolution of iced up creek, Brooks Range, 2/11
(Imagery from Greg Walker, UAF)



UAF ScanEagle Status

- Letter from RADM Vince Edwards, CG HQ supporting idea, noting NAVAIR ship certification requirement, and requirement for ‘further discussion of risks and costs’
- Planned meeting G. Walker and CG HQ personnel in coming week(s)
- TBD

USAF / Nat. Def. Intel. Univ. RAVEN Ops plan for HEALY

Demonstrate value added of Full Motion Video (FMV) streaming from Small Unmanned Aerial System (SUAS) during Arctic Ops

GOALS:

- Demonstrate SUAS ops can be done *SAFELY* on/off ships
- Demonstrate Intel, Surveillance, Reconnaissance (ISR) capabilities of SUAS
- Stream Full Motion Video from RAVEN SUAS on to ROVER for
  - Sea ice ridge detection/monitoring
  - Marine mammal detection
  - Assistance in emergency exercises
  - Detection/monitoring oil spills from ship or oil exploration
- Integrate lessons learned/ops concept into NDIC thesis research for Masters of Science in Strategic Intelligence

RAVEN

Complete System

Manufacturer	Wingspan
AeroVironment Inc	4ft 3in
	Length
Launch Method	3ft (0.9m)
Hand-launched	**Weight**
Recovery	4.2lb (1.9kg)
Method	**Cruise Speed**
Deep-stall landing	30mph
CameraPayload	
Color/IR/Thermal	

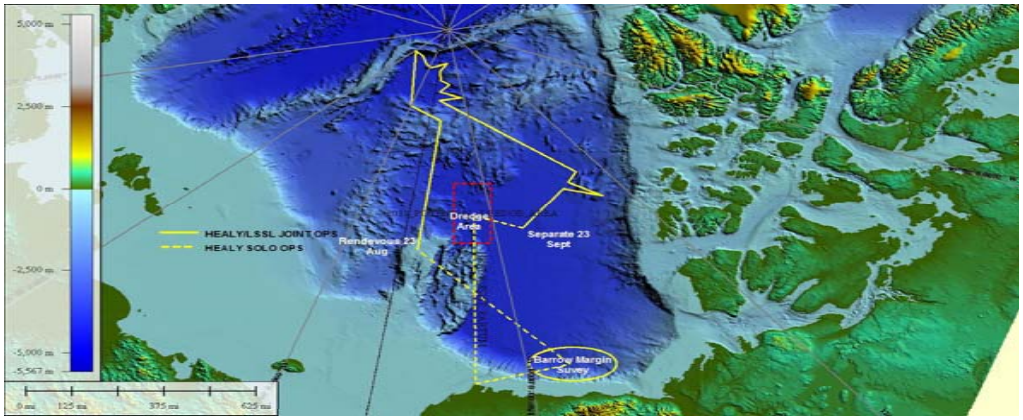
- Employed since 2002
- Hand launch/recovered
- Battery powered (60-90min endurance)
- Line-of-sight command and control
- Full color and IR capable payloads
- System fits into a large backpack
- Units owned (and expendable) by A2Q
- System is constructed to break apart upon impact with land/obstacles to minimize kinetic damage

RAVEN FMV Snapshots *video is archiveable and can be streamed live on the internet with proper bandwidth

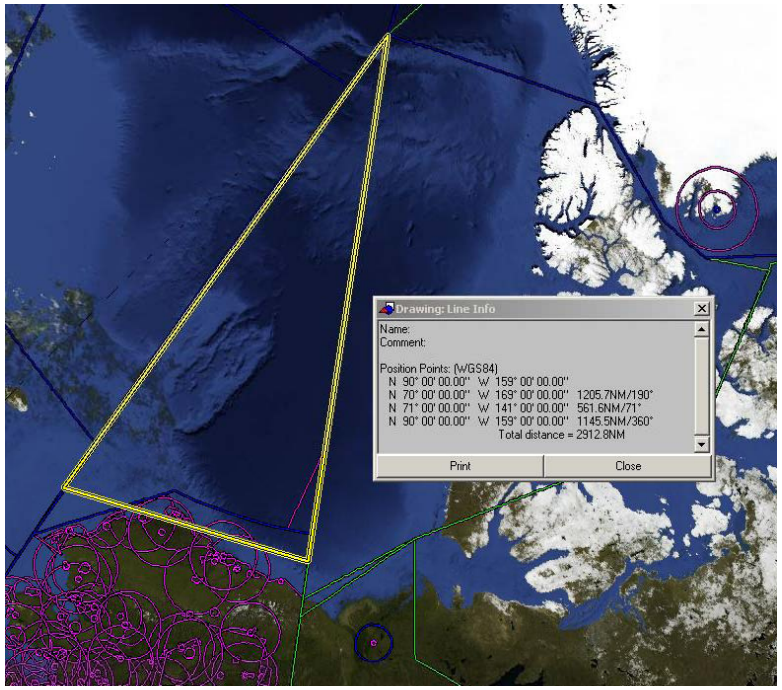
Certificate of Authorization

Out of an abundance of caution a Certificate of Authorization (COA) for RAVEN flights in the Arctic from the FAA is being requested

- **Air Force Special Operations Command (USAF lead on Small UAS) is pursuing a COA through FAA channels**
- **COA application has cleared FAA administrative reviews and final determination is due by mid-July**
- **COA application is for entire Alaskan airspace above Barrow, encompassing over 60% of HEALY's ECS mapping mission**



HEALY cruise track



Area of operations requested in COA

ROVER 5

- Capable of receiving FMV from C-130J FLIR sensor
- Battery operated
- PSP-like Design
- Receive frequencies do NOT conflict with HEALY
- Five Band Transceiver (UHF, L, S, C, Ku)
- Touch Screen Programming
- Integrated Antennas
- All Industry Standard Video
- Laptop connectivity
- Employed since 2009
- Releasable to certain NATO nations

Requirements/Limitations

- ROVER can be packed in briefcase
- 6 RAVENs can be packed into (2) large pelican cases 3'x4' under 50lbs each
- System can be launched recovered by 1 person – 2 is preferred—an assistant can be trained while underway
- All systems are battery powered
- RAVENs can be set up/broken down in under 5 minutes
- While windward launch is preferred; there is no need to turn ship to launch (assuming 180 degrees of free range to launch and recover)
- Operations not preferred in winds over 20knts and/or precipitation over ½" per hour but limitations can be waived by CO
- Launch can be done anywhere on deck
- Recovery can be done on helicopter pad automatically or under human control
- In advent of water landing equipment is expendable if recovery is implausible or detrimental to ships' operations (these systems have been phased out service declared excess)

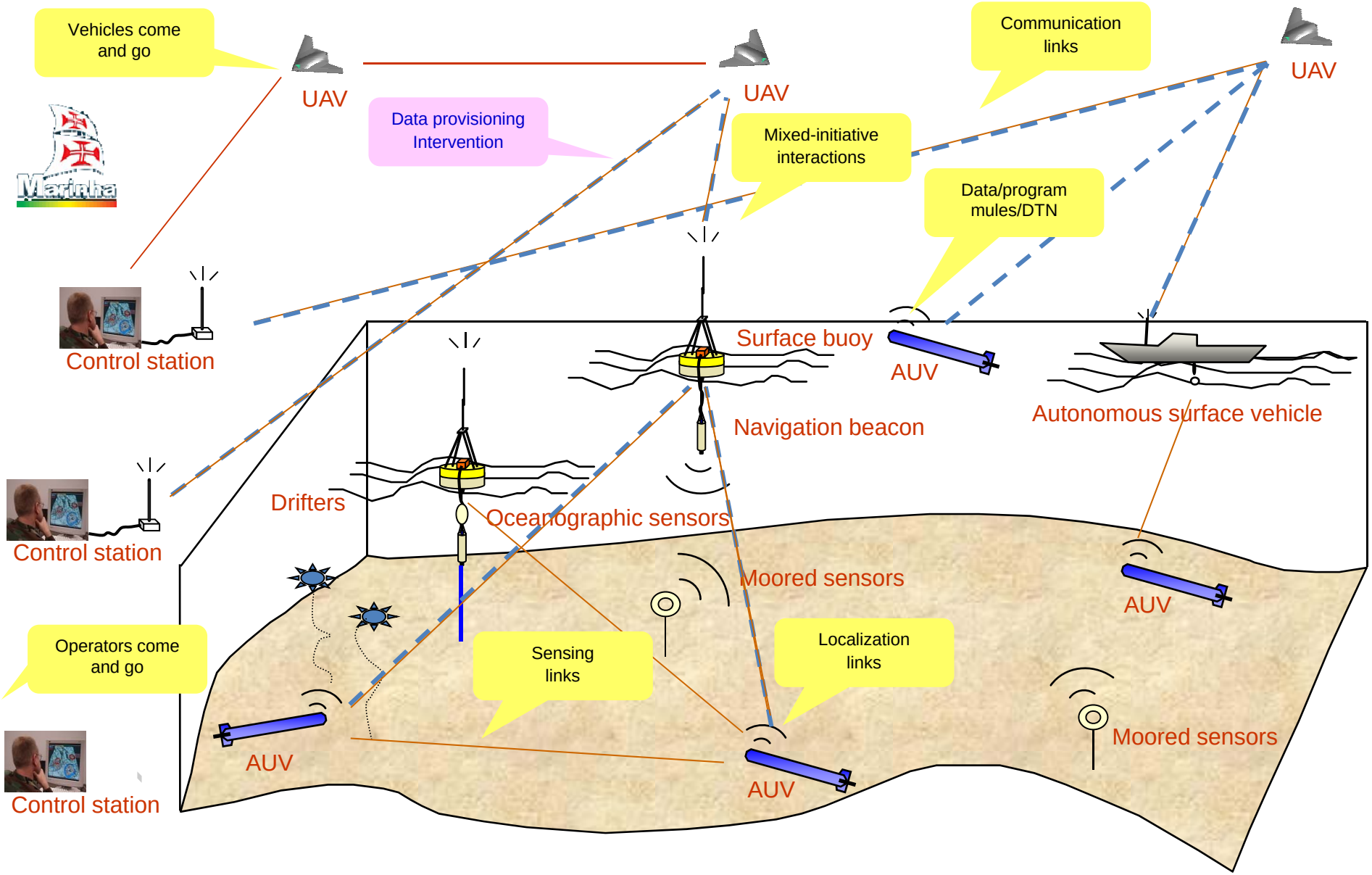
RAVEN and Pelican Cases

RAVEN position and FMV viewed on Falconview-enabled thoughbook

Non-CG UAS Ops of Note: NATO

- Summer 2010 UAS testing w subs, UAVs, ASVs, ships and manned aircraft of DTN (Delay/Disruption Tolerant Wireless Comms) : proved it worked on all platforms
- Summer 2011: repeat exercise in Portuguese coastal Marine Protected Area to determine bandwidth capabilities/limits of DTN
- Fall 2011: repeat exercise with multiple UAS
- Summer 2012: repeat exercise in open ocean MPA (Azores) and/or Mediterranean, TBD

Vision


Vehicles come and go
UAV
UAV
Communication links
UAV
Data provisioning Intervention
Mixed-initiative interactions
Data/program mules/DTN
Control station
Surface buoy
AUV
Navigation beacon
Autonomous surface vehicle
Drifters
Oceanographic sensors
Control station
Moored sensors
AUV
Operators come and go
Sensing links
Localization links
AUV
AUV
Moored sensors
Control station

Team

- Portuguese Navy
  - Bacamarte crew
  - Mine warfare detachment
  - Divers detachment
- Portuguese Air Force
  - Air Force Academy
- Porto University
  - Faculty of Engineering
- Portuguese Task Group for Maritime Affairs
  - ROV team
- International cooperation
  - MBARI
  - NURC
  - Intel research
  - Liquid robotics

Gavia Defence (2) – PO Navy

- Length: 260 cm
- Diameter: 20 cm
- Weight: 72 Kg
- Endurance: 4 hours @ 3 knots*
- Navigation: INS, DVL, GPS and LBL
- Sensors: Dual Frequency Sidescan, Gray Scale Camera, CTD
- Communications: Wi-Fi, Acoustic Modem
- Maximum Depth: 200m

NAUV (1) – Porto University

- Length: 190cm
- Diameter: 20cm
- Weight: 40 Kg
- Endurance: 4 hours @ 3 knots
- Navigation: AHRS, DVL, GPS, LBL
- Sensors: ADCP, Dual Frequency Sidescan
- Communications: Wi-Fi, Acoustic Modem, 3G
- Maximum Depth: 100m
- CCU: Neptus

Seacon AUV (3) – Porto University

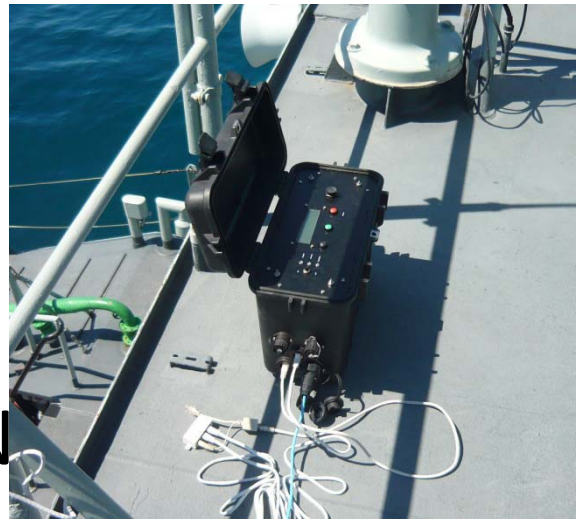
- Length: 110cm
- Diameter: 16 cm
- Weight: 18 Kg
- Endurance: 8 hours @ 3 knots
- Navigation: AHRS, DVL, GPS, LBL
- Sensors: Dual Frequency Sidescan, CTD
- Communications: Wi-Fi, Acoustic Modem, 3G
- Maximum Depth: 50m
- CCU: Neptus

Swordfish (1) – Porto University

- Length: 4.5 m
- Width: 2.20 m
- Height: 1.8 m
- Weight in air: 200 Kg
- Endurance: 6 hours @ 3 knots
- Navigation: AHRS, GPS Compass
- Sensors: Dual Frequency Sidescan, Imaging Sonar, Color Camera
- Communications: IEEE 802.11gn

Manta Gateway (4) – Porto University

- Battery powered portable communications hub
- 802.11gn 2.4GHz and 5Ghz
- Acoustic Modem
- Delay Tolerant Networking (DTN)
- LBL Tracking
- GSM



- Deployed from ship, RHIBs and buoys

Mini-UAV (Level 0): to be ship launched, recovered

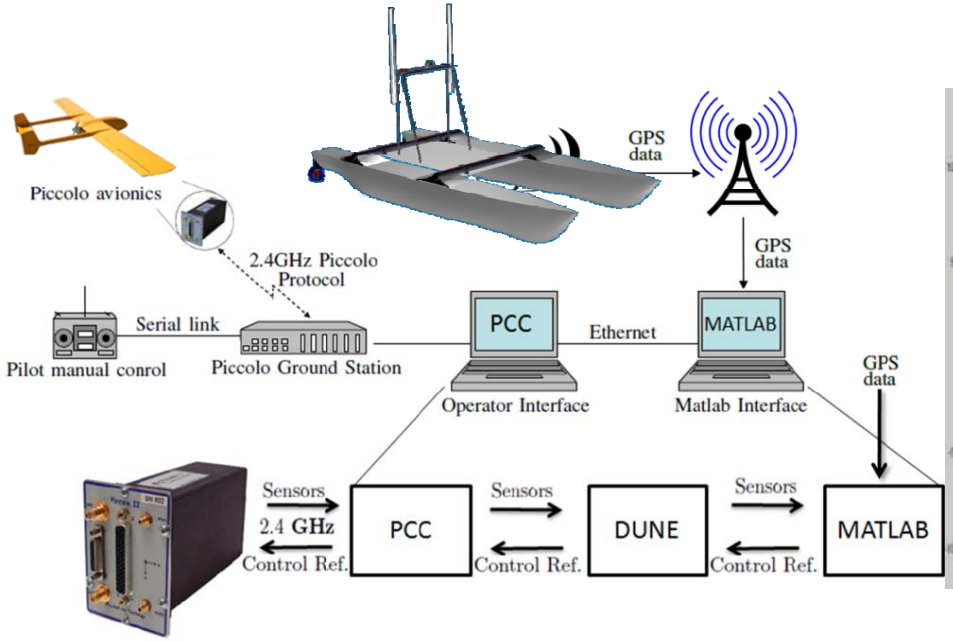
Mini-UAV Max take-off weight	4.5 kg
Wingspan	2.4 m
Autonomy	40 min
Max velocity	90 km/h
Hand-launched	
Real-time video feed	
On-board computer system	

Antex-X02 (Level 1): Multi-UAS, multi-altitude ops

Antex-X02	
Max take-off weight	11 kg
Wingspan	2.4 m
Payload	4.5 kg
Autonomy	3 h
Real-time video feed	
On-board computer	
WiFi	
Iridium	

Antex-X02 (E)	
Max take-off weight	20 kg
Wingspan	3.5 m
Payload	8 kg
Autonomy	4 h
Real-time video feed	
On-board computer	
WiFi	
Iridium	

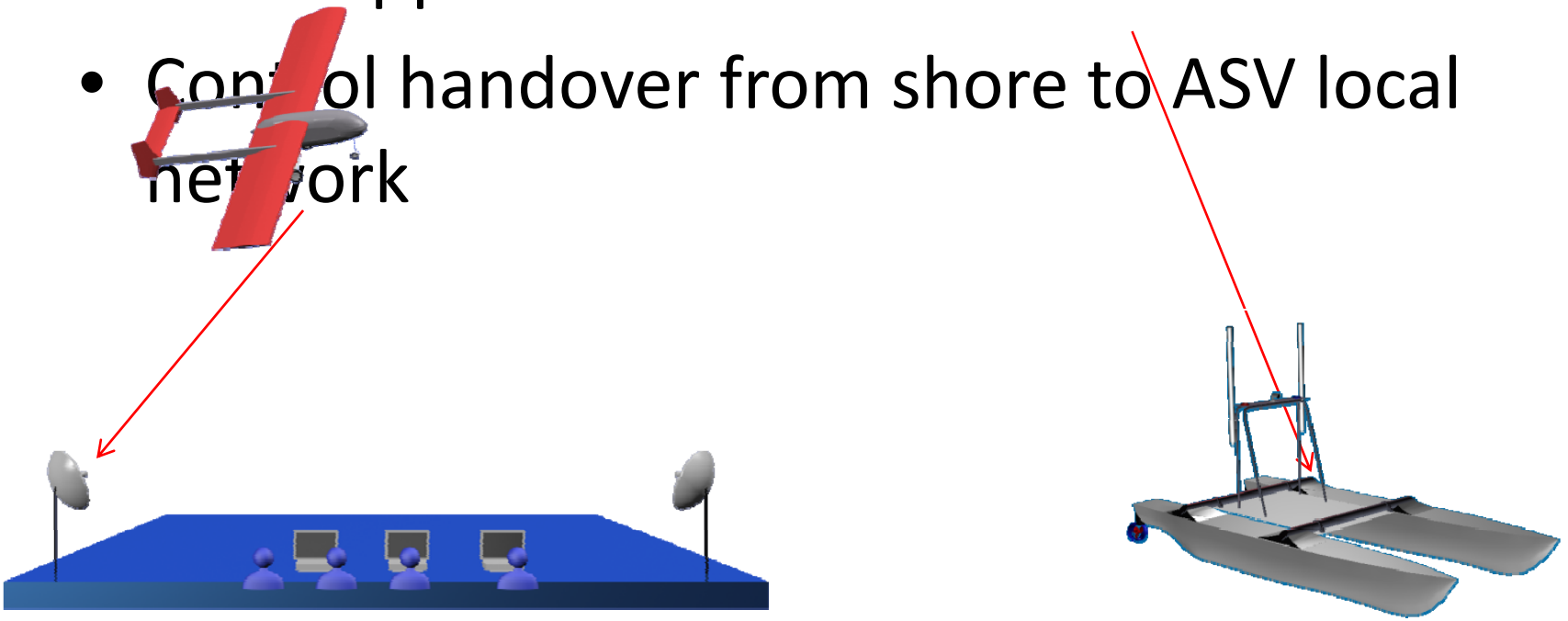
UAV tracking ASV



- Take-off and landing from shore
- Tested with cars (communicating GPS signal)

Operations BLOS

- Take-off and landing from shore
- UAV/ASV rendezvous for extracting data with DTN support
- Control handover from shore to ASV local network



BOEM N.Carolina Offshore Wind Farms Bird/Bat Monitoring: Dr. Donald K. MacArthur, CTO IATech - Innovative Automation Technologies

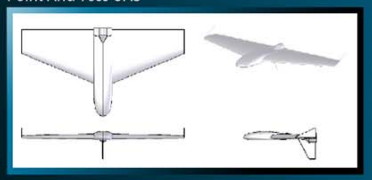
http://www.iat-llc.com (352)505-7428

CREATING TOMORROW'S UNMANNED SYSTEMS AND TECHNOLOGIES

Aircraft Systems

One of IATech's core competencies is our ability to create custom aircraft systems that incorporate lightweight composites and emergent sensor technology. Our design flexibility and efficiency allow for application-specific tailoring of the aircraft systems.

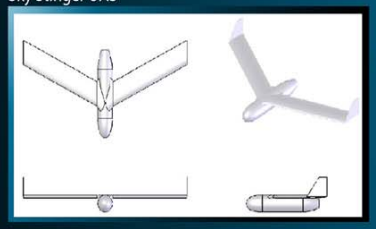
Point And Toss UAS



Predominantly used as a single user reconnaissance sensor that can either store or transmit video data. Simple to operate, yet rich in ISR quality and capability.

Wingspan	36 in
Length	16.5 in
Height	5 in
Weight	2.5 lbs
Endurance	45 min
Speed	30-40 mph
Propulsion	Electric Brushless Outrunner
Power System	Lithium Polymer

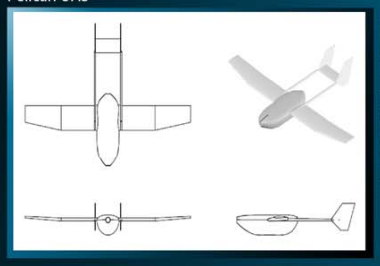
Sky Stinger UAS



Predominantly used as a multi-aircraft control and payload testing platform. Multiple modular payload bays allow for various perception and targeting payloads.

Wingspan	40 in
Length	20 in
Height	8 in
Weight	4 lbs
Endurance	90 min
Speed	30-40 mph
Propulsion	Electric Brushless Outrunner
Power System	Lithium Polymer

Pelican UAS



Predominantly used for endurance and large volume payload experiments. It can accommodate a payload volume of over 2000 in^3.

Wingspan	10 ft
Length	74 in
Height	20 in
Weight	35 lbs
Endurance	4 hrs
Speed	30-40 mph
Propulsion	Dual 4-Stroke Engines
Power System	Gasoline

IATech, LLC
Phone: 352-505-7428
E-mail: info@iat-llc.com, Web: www.iat-llc.com
1315 NW 53rd Avenue Suite B
Gainesville, Florida 32609

CREATING TOMORROW'S UNMANNED SYSTEMS AND TECHNOLOGIES

SmartSensors

IATech's SmartSensors form the core of our unmanned systems. They provide a fully integrated, compact inertial and global positioning sensor that can be used for various applications. In addition to our standard message sets, we are able to create custom binary and ASCII message sets for specific applications.

SmartIMU300

The SmartIMU provides a robust orientation and positioning solution in a compact footprint. The combination of a tri-axial magnetometer, three orthogonal rate gyros, a tri-axial accelerometer, and GPS module allow for accurate measurement of position and orientation in static and dynamic environments. The programmable output format provides flexible integration into UAV, UGV, and other unmanned systems.

Features: Digital Output, Dynamic Calibration, RS-232 Interface, Integrated or External GPS Antenna, 9V-24V Power Supply, Air Vehicle Version Available

SmartTracker

The SmartTracker is based on our SmartIMU technology but takes data measurement one step further. SmartTracker provides continuous measurement and data capture in a unique, compact package. It records orientation, position and velocity data at 100 Hz. Plus, you get better than a millisecond accuracy with time stamping. A fully integrated camera system with onboard data storage allows for synced video, inertial, and GPS data. The SmartTracker system is incredibly light with a weight of under 100 grams!

Features: GPS based position and velocity, 640 x 480 MPEG4 video data with time stamp, g-force measurement of up to 16Gs, pressure based airspeed and altitude sensors, removable SD card, external video input.

Applications: Continuous measurement and data acquisition, unmanned vehicles, tracking movement of objects, asset tracking.

IATech, LLC
Phone: 352-505-7428
E-mail: info@iat-llc.com, Web: www.iat-llc.com
1315 NW 53rd Avenue Suite B
Gainesville, Florida 32609

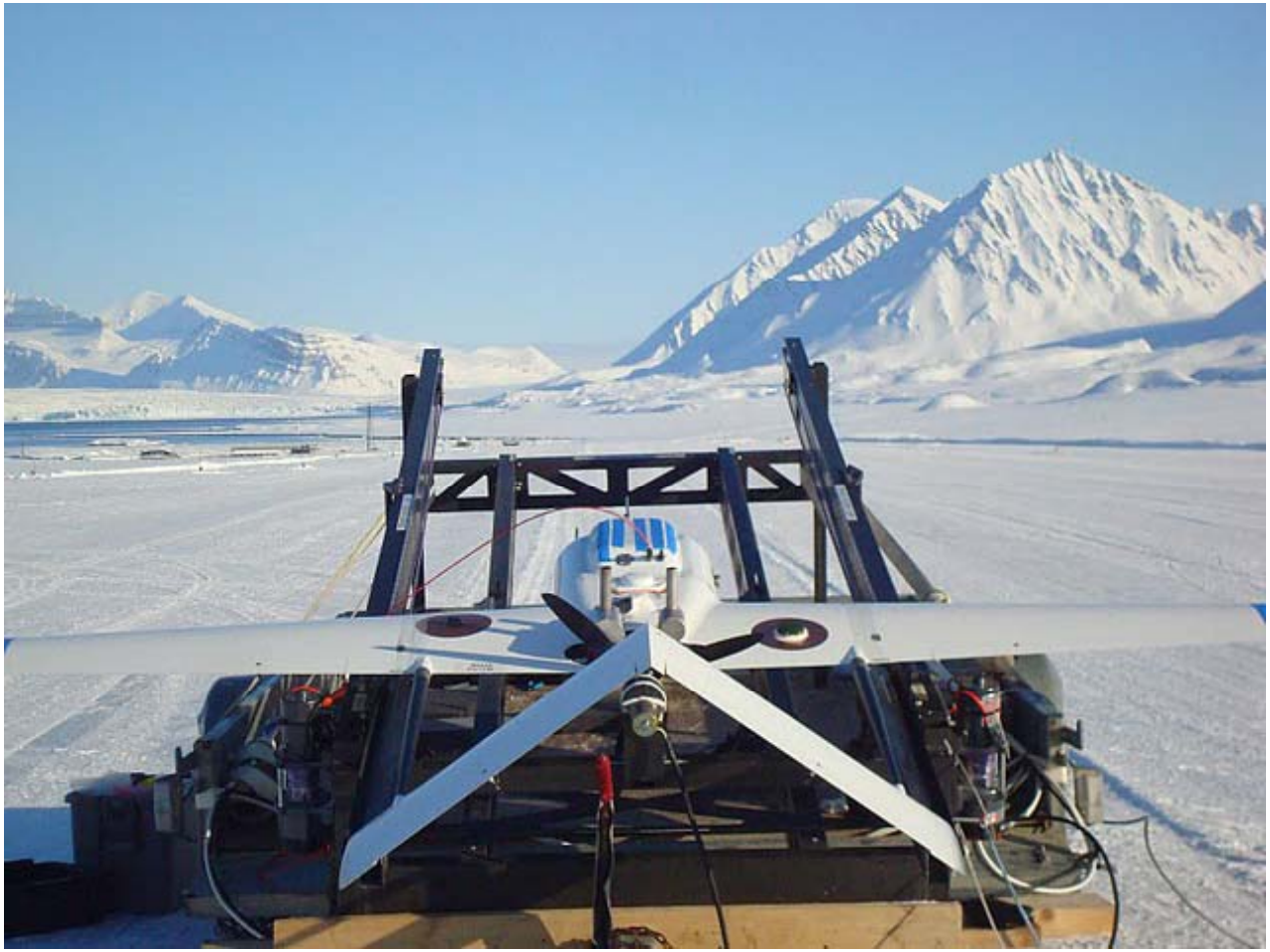
UK Shoreline Mapping w Quadrotor, staring 2011

Feb. 2010 California Coastal LiDAR Project

Toward a modern topography of the coastal zone

NOAA PMEL UAS, Ny-Alesund, Norway, 2011

Norwegian UAS, Ny-Alesund, Norway, 2011



Use of “Hyperblimps” by US Scientists to Study South Atlantic Right Whales off Argentina

Sentient (Australia) life-jacket detection software for UAS w Kestrel Maritime software

Northrup Grumman Army Long Endurance Multi-Intelligence Vehicle (LEMV), w 21 day endurance ($500+M contract)

Canada Helo w EM ice thickness sensor, 2006