Woods Hole Oceanographic Institution, June 27-28,2013

NAVY/NSF-UNOLS SCOAR Meeting

(Scientific Committee on Oceanographic Aircraft Research)

# Coast Guard, US & International Unmanned Aircraft Operations

Dr. Phil McGillivary, USCG PACAREA & Icebreaker Science Liaison

# Summary: US & International UAS Activities

FAA ROAWG Meeting Results

USGS

NASA

NOAA

USCG

Oil Companies

Canada

Portugal

Norway

China

New technologies for UAS use on ships

Database management Issues for UAS

SARUMS Legal Status Update

# FAA ROAWG Meeting Results

## (ROAWG – Remote Operating Area UAS Working Group)

- ROAWG is a federal inter-agency WG set up to address the FAA budgetary requirement for operation of UAS in National Airspace by 2015.

- The Committee is chaired by CG CAPT Matt Sisson, the FAA CG Liaison (PH 202 365 7346; Email: matthew.sisson@faa.gov) and reports to the FAA Executive Committee (ExCom) on UAS ops at regular intervals.

- In 2012-2013 ROAWG focused on coordination of UAS operation off the North Slope of Alaska to establish UAS operational protocols.

- The WG focused on summer 2013 UAS operations by NASA, NOAA and USCG, in conjunction with Conoco-Phillips.

- Meetings were held at intervals @every 2 weeks to 2 months.

# FAA ROAWG Meeting Results

(ROAWG – Remote Operating Area UAS Working Group)

Key issues to be determined were:

1) Alaska N. Slope locations for onshore deployment of UAS
2) Establishment of onshore-offshore “corridor”* at Oliktok Point (*egress/ingress area per FAA)
3) Use of radars to avoid aircraft interactions, now allowed in place of human eyes by FAA
4) Additional Operational protocols for COA
5) Resolving issues of airframe certification vs sensor certification (ie to permit certification to be valid but sensors to be changed out)

# USGS, UAS POC: Bruce Quirk
# quirk@usgs.gov

USGS would like to fly UAS for walrus surveys around Alaska.

One of the issues they have been having with FAA permission is that they are currently using DoD comms frequency spectrum, but have been told to vacate those frequencies and use other frequencies. However they have not been told by FAA what other frequencies to use, and FAA will not tell them (not their job). “Aeronautical & Navigation frequencies are allocated geographically. Frequencies for up and downlinks are not. There is no book listing all these. This is controlled by NTIA. FAA COAs require listing of valid frequency allocations.”

Unresolved for USGS (and others) last I checked: TBD…

# NASA UAS Activities: 3 main Arctic projects

- MIZOPEX,the Marginal Ice Zone Observations & Processes EXperiment, will use three different unmanned aircraft systems (UAS) to map ice conditions off Alaska's North Slope in 2013 & 2014

- CARVE is the Carbon in Arctic Reservoirs Vulnerability Experiment mapping arctic CO2 and methane fluxes from a combination of ground, ship, and manned & unmanned aircraft studies on land and sea

- ICEBRIDGE flies a high altitude manned aircraft to map arctic ice conditions using a laser ice freeboard and ocean surface altimeter to estimate ice thickness, and distributes this data online

# NASA "Marginal Ice Zone Observations and Processes EXperiment" (MIZOPEX), July/August 2013


**http://ccar.colorado.edu/mizopex/index.html**

***POC: Dr. Matt Fladeland, NASA Ames,***

***Email: matthew.fladeland@nasa.gov***

***NASA supported, with contributions from NOAA***

Goals:

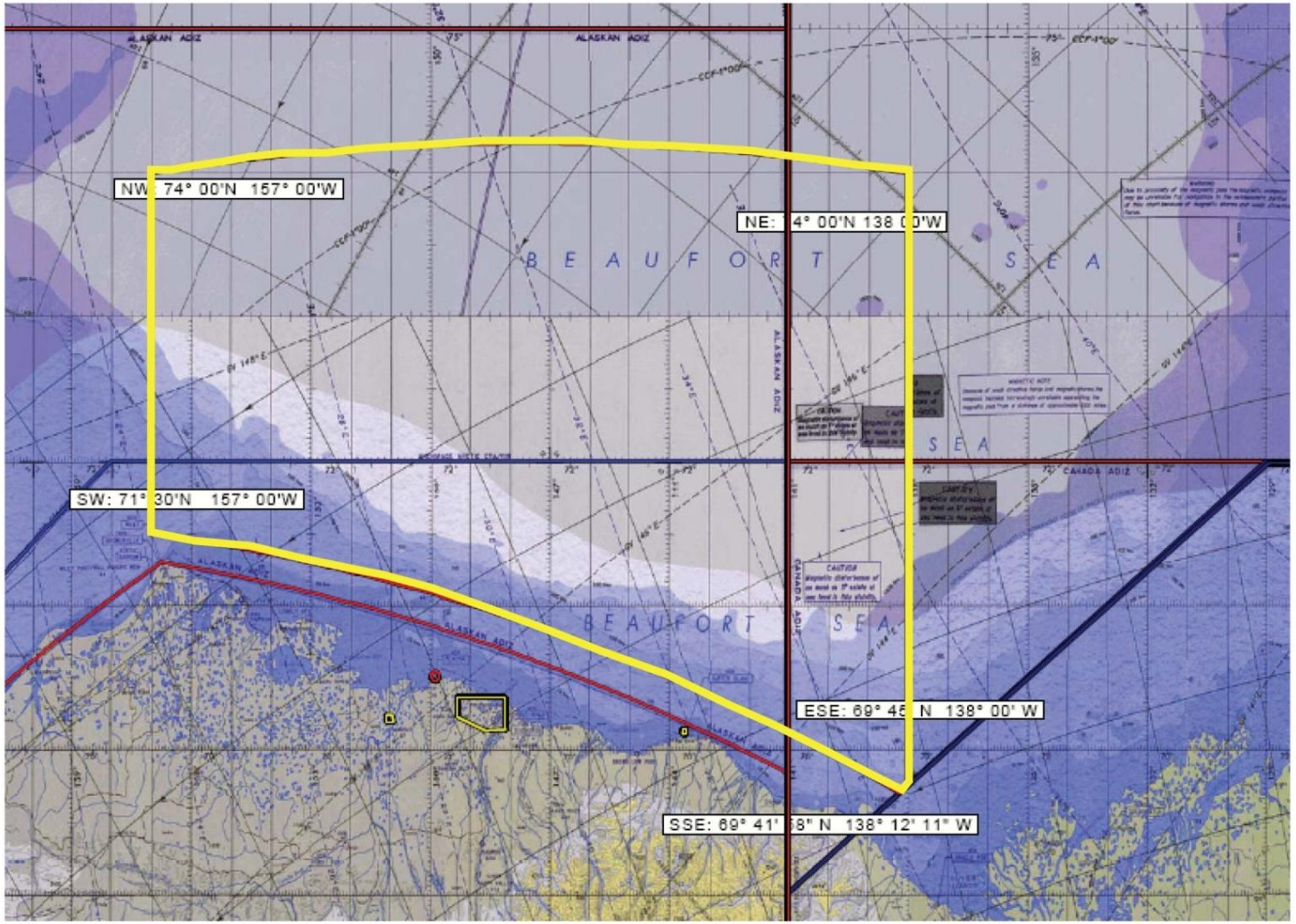
- Assess ocean and sea ice variability during the melt season within a key marginal ice zone region.
  - Amount and distribution of heat in the ocean mixed layer
  - Relationships between atmospheric conditions and solar heating
  - Sea ice characteristics and relationships to melt rates and change
  - Satellite product validation (SST, ice concentration)

- Demonstrate potential for geophysical research using multiple unmanned aircraft systems (UAS) in polar regions.

- Determine best practices with FAA regarding flight requirements & limitations.

# NASA MIZOPEX UAS Operational Area

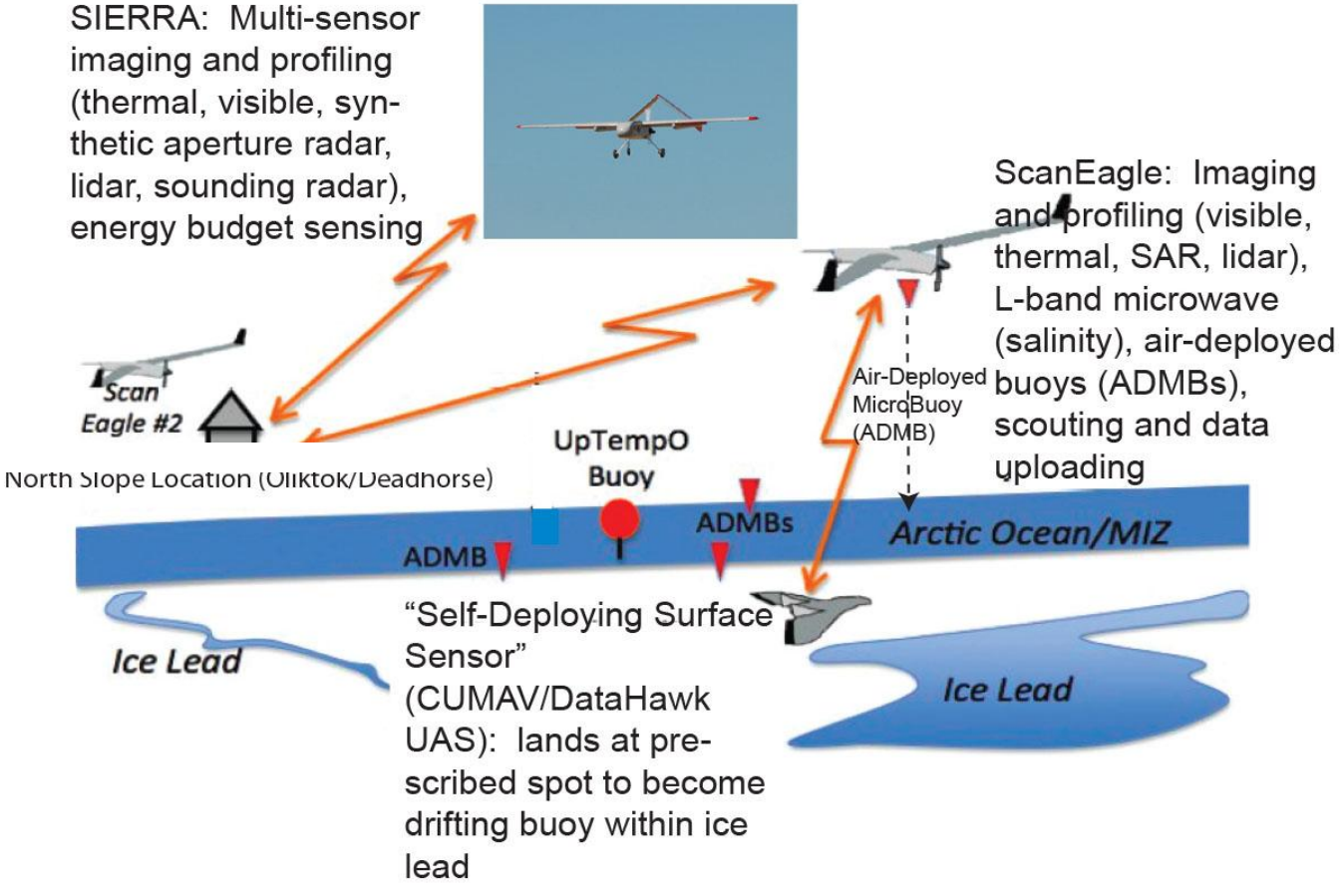
The Arctic Ocean domain for MIZOPEX is contained within the yellow boundary below:




Domain corners as defined above are: (NW) 74 deg. 00' N / 157 deg. 00'W; (NE) 74 deg. 00'N / 138 deg. 00' W; (SW) 71 deg. 30' N /157 deg. 00'W and (SE) 69 deg. 40'N /138 deg. 00' W.

# MIZOPEX Flight Profiles Over the Beaufort Sea

• NASA Ames SIERRA UAS flies long-range transects along straight-and-level tracks co-located with satellite overpass tracks.
• Univ. Alaska Fairbanks ScanEagle UAS focused on sustained, localized low altitude observations dropping "Air-Deployed Micro Buoys" (ADMB).
• Univ. Colorado Boulder DataHawk UAS "Self-Deploying Surface Sensor" (SDSS) mini-UAVs launched on one-way flights to land on water and deploy sensor strings.

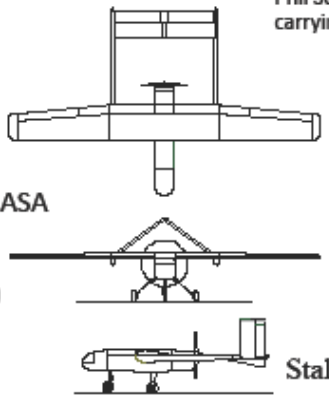


# NASA Ames SIERRA mid-size UAS (Matt Fladeland, Manager)

## NASA SIERRA UAV

- Science Instrumentation Evaluation Remote Research Aircraft (SIERRA)
- SIERRA complements other UAVs in the NASA science fleet by specializing in dangerous, low altitude missions that require larger payload capacity than Aerosonde class
- Airframe designed by NRL; systems development at NASA ARC
- First Flight October 2008
- Payloads flown include:
  - VIS/NIR Hyperspectral Imager (NASA Ames)
  - LIDAR Profilometer (CU-Boulder)
  - Ocean Color suite (NASA GSFC)
  - MMS (NASA Ames)
  - CO2/CH4/H20 (Los Gatos Research/ Picarro)
  - C-Band SAR (Artemis/BYU)
  - UHF/L-band SAR (Mirage Systems)

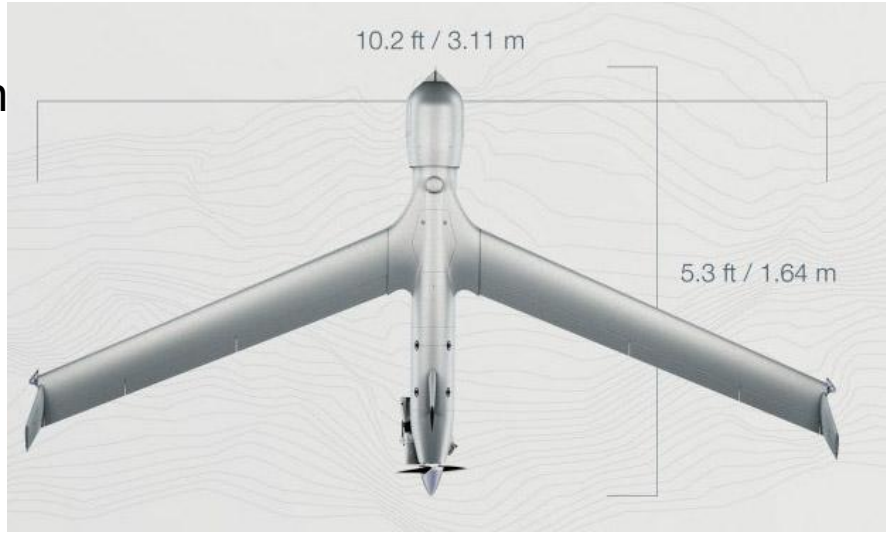
Phil Schulyer, SIERRA crew chief with the aircraft carrying a GP-SAR



| | |
|---|---|
| Wing Span | 20 ft. |
| Length | 11.8 ft. |
| Height | 4.6 ft. |
| Wing Area | 42.4 sq. ft. |
| Empty Weight | 215 lbs. |
| Gross Weight | 375 lbs. |
| Max Speed | 79 kts. |
| Cruise Speed | 55 kts. |
| Stall Speed (clean) | 30 kts. |
| Aspect ratio | 9.43 |
| Rate of Climb | 545 ft./min. |
| CG Position | 29-32% Chord |
| Payload weight | ~100lbs |
| Payload power | 28V DC |
| Duration | 8-10 hurs |

# MIZOPEX ScanEagle UAS

- Wingspan: 10.2 ft, Length: 4.5 ft
- Weight: 29 lbs (empty), 44 lbs (max takeoff wt.)
- Gas engine (1.9 hp), rear propeller, onboard generator for electric power
- 48 knot airspeed (cruise)
- Catapult launch, wing tip capture via cable
- Autonomous flight control with GCS control while in line of sight radio range (@40 km)
- Iridium satcom for over the horizon operation
- Endurance: 20+ hours
- Ceiling: 19,500 ft.
- Payload: up to ~6 lbs.
- Numerous FAA Certificates of Authorization, thousands of flight hours achieved.

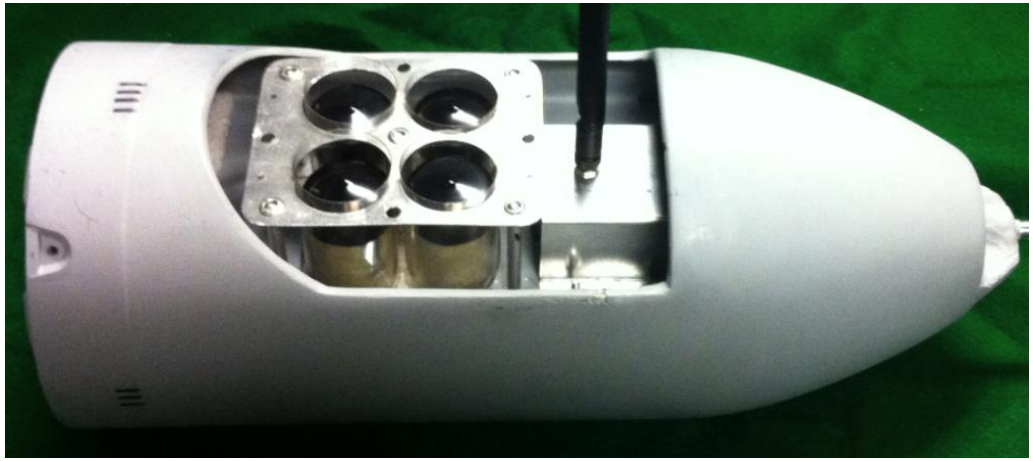


# MIZOPEX: Overview of the DataHawk/SDSS Vehicle

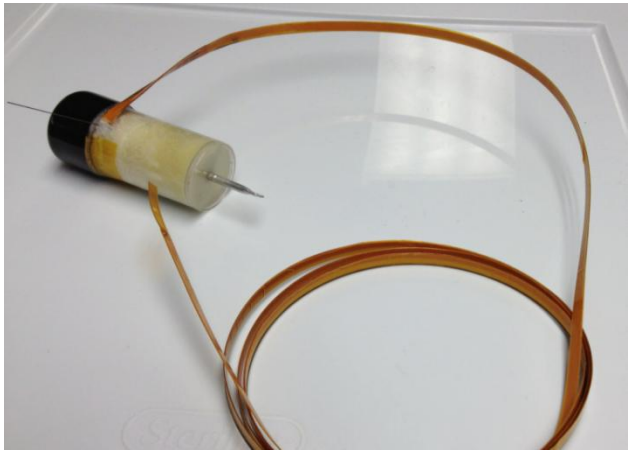
- Wingspan: 1m
- Weight: ~700 gm
- Electric propulsion
- Rear folding propeller
- 14 m/s airspeed
- Power: 40-min lifetime battery
- Cost: ~ $600
- Airframe: EPP  foam
- Autonomous flight control, with user supervision while in comm. range
- Comm. range: about 5km
- Flight range: ~30 km
- Has received multiple Certificates of Authorization from FAA

# Air-Deployed Micro-Buoy (ADMB) dropped by ScanEagle & DataHawks configured as Self-Deployed Surface-Sensor (SDSS) (to be deployed over open water offshore)

**ADMB Launcher in ScanEagle Payload Bay**

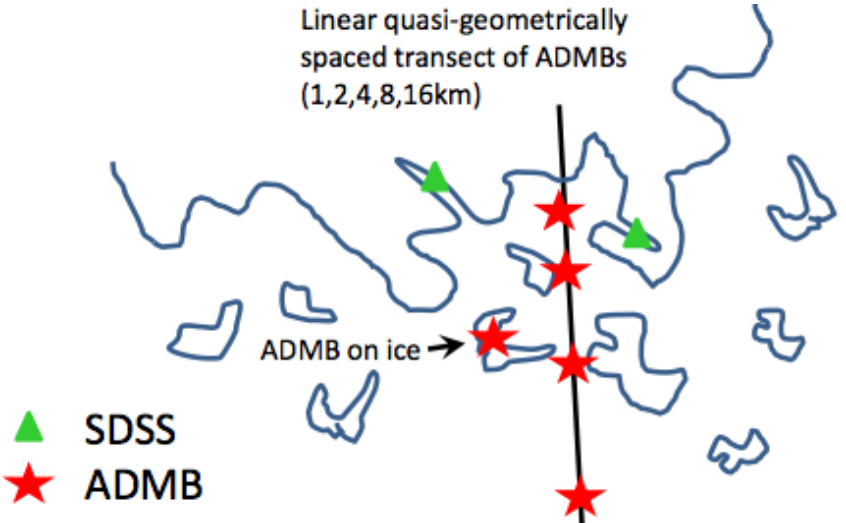


**ADMB with Thermistor String**



**SDSS Fleet**

**ADMB & SDSS Deployment Strategy**



# NASA Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE) 2012 into future

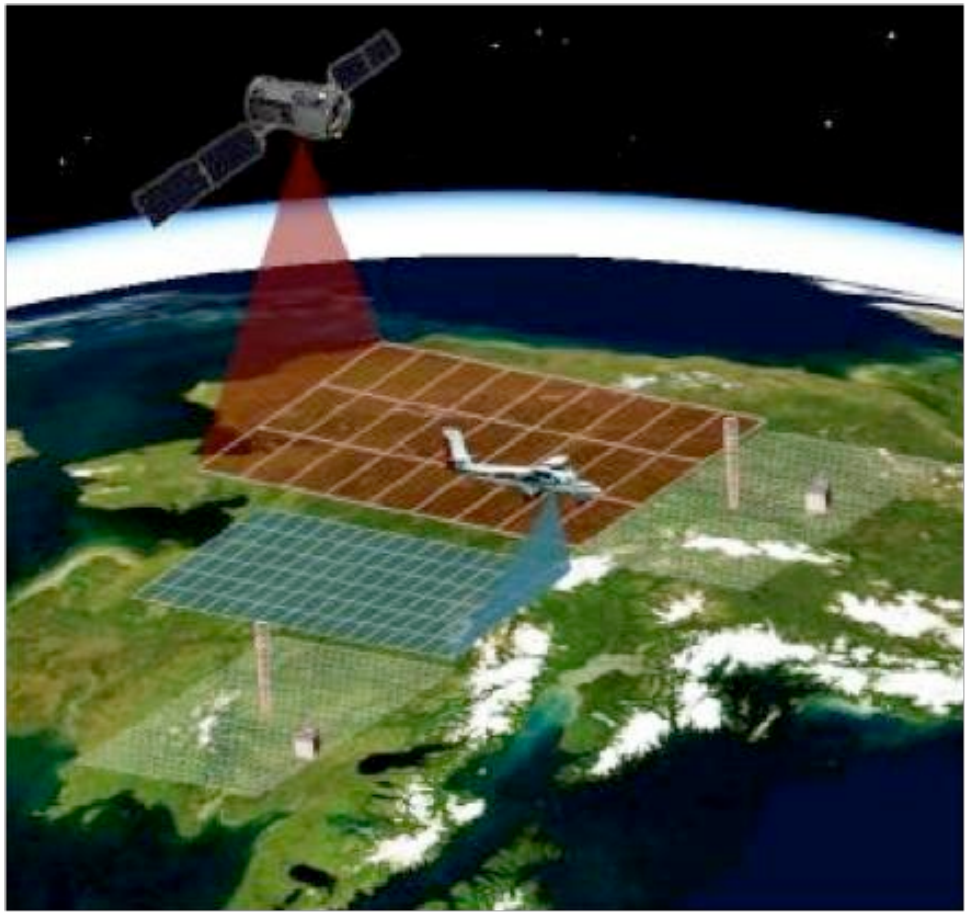
**POC: Dr. Charles Miller, NASA JPL**

**Email: charles.e.miller@jpl.nasa.gov**

In preparation for the Orbiting Carbon Observatory (OCO-2), the CARVE project will use a manned aircraft with an L-band radiometer/radar and spectrometer to take whole air column measurements of CO2, methane and CO, also measured with an onboard gas analyzer.

Arctic flights conducted 3X/year.

Data correlated with NOAA gas sampling from CG C130 aircraft



# Other NASA UAS programs

• Fall 2012 Global Hawk UAS fly from Wallops Island to N. Atl. Hurricanes for air-sea heat & gas flux study w NOAA Miami Hurricane Res. Div. and WaveGlider ASV for @1 month. Mission software to integrate data will available online soon for teaching purposes. (See details next slide.)

• Jan. 2013 Global Hawk UAS Earth Venture ATREX (Atmospheric Water Vapor) project in Pacific to measure H2O flux to Stratosphere.

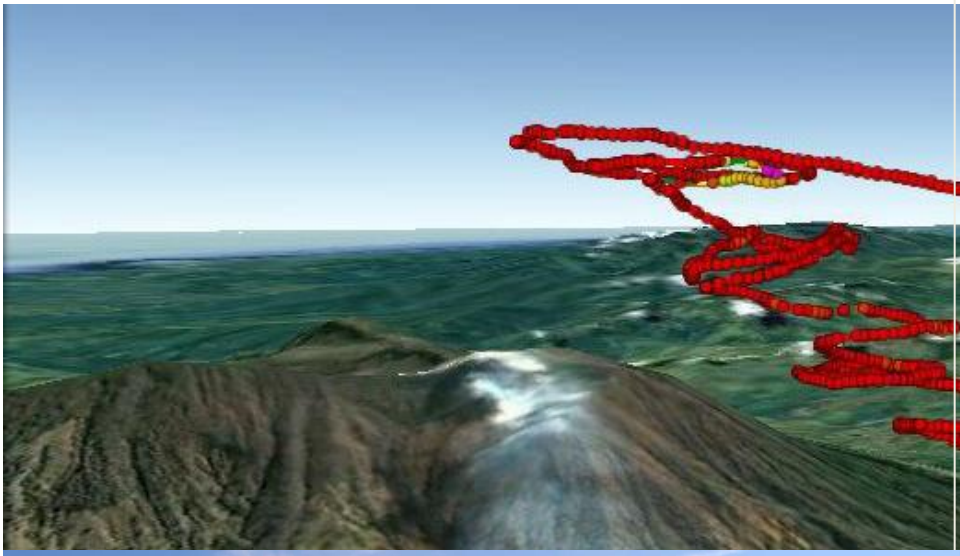
• April/May 2013: IKHANA UAS arctic sea ice studies, J. Maslanik (U. Colo.).

•SIERRA UAS: 3 upcoming missions:

1) NE CA Surprise Valley seismic fault mapping via wingtip magnetometer, early Sept. 2012;
2) Sugarloaf Key, FL, new hyper-spectral sensor (not PRISM!) similar to GALILEO satellite to map coral reefs & seagrass for satellite cal/val.
3) March 2013 Turrialba volcano, Costa Rica CO2 flux study joint w tethered balloon.

# NASA S-UAS: DragonEye
# (w Matt Fladeland, NASA Ames Small UAS Manager)

# Dragon Eye Deployment to Turialba Volcano in Costa Rica in Support of ASTER SO2 Data Product Validation



# NOAA UAS Activities: using PUMA

- NOAA to buy 2 PUMA Aerovironment UAS systems (of 3 UAS each) for NWHI debris, marine mammal & seabird studies after initial tests.
- June 2013 Tested PUMA off WA for marine mammals, debris, along w Quadrotor
- Todd Jacobs, NOAA UAS manager

# NOAA PUMA upgrade spiral

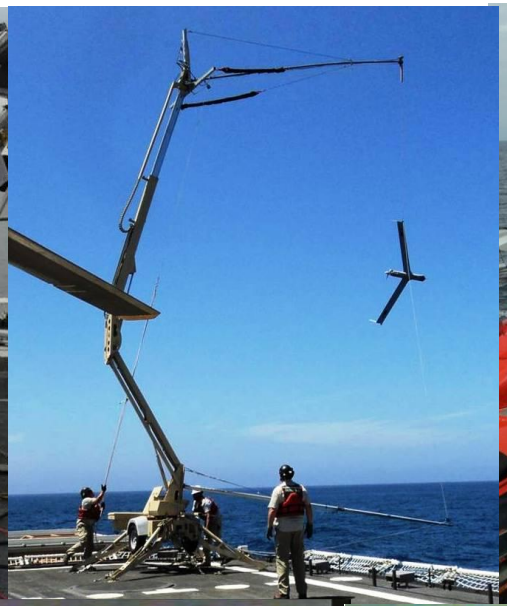
- New 3+ hour battery
- New 9dB antenna to increase omni-directional range
- Live Aerial ISR Link (LAIL) for video transmission via aerostat
- Gimballed camera
- Gimballed laser marker
- Piezoelectric video motion compensation system for increased video resolution

Other efforts considered by not yet funded:

1) Target tracking / Route Clearance Planning
2) Solar panels for wings
3) Precision recovery system

# USCG 2013 UAS Activities: BERTHOLF & HEALY deployments

(Pix from CGC BERTHOLF deployment)


# CGC BERTHOLF ScanEagle UAS SoCal Deployment, 5/2013

16 flights, 90.2 hrs flown w MWIR3, EO900, EO600

Two interdictions w contraband seized

Concurrent manned & unmanned aircraft operations

Successful cueing between ship, helo, UAS & Maritime Patrol Aircraft

Max range 60mi, typical range 30mi

# CGC HEALY Arctic Deployment, 9/2013

- Joint project w NOAA and UAF
- 2 PUMAs: one IR, one EO
- Standard issue PUMA w 2 hr battery
- Concurrent flying of both PUMAs: believe de-confliction of signal interference/degradation is resolved
- Flying as far north as required to test sea ice imaging
- Flying to image simulated oil spill (w organic materials)
- Flying upper aircraft for command & control/tasking, lower for object imaging
- Will not be flying MIZOPEX ScanEagle concurrently
- Possible in future to coordinate CG C130 Arctic Domain Awareness gas sampling for NOAA w concurrent NASA UAS gas sampling following standard C130 regulations: TBD

# CG RDC UAS Future Plans

Taking ‘Tech Transfer’ from Marines of several Aerovironment WASP-3s, the AquaWasp variant: for demos.
Characteristics: 2 cameras, 5km range, weight=1lb, cost @$50K

# Project Goals for Small UAS use on Icebreakers

Stream Full Motion Video from UAS to ship's bridge and between ships for:

- Sea ice ridge detection/monitoring
- Marine mammal detection
- Transmission to ships' bridge for ice navigation
- Location of AUV deployment/retrieval locations
- Assistance in emergency exercises
- Detection and monitoring of oil spilled from ship or oil exploration

# Data Ingestion, Geo-referencing, and Archiving

There are several data issues w UAS video:

- 1) How to ingest hi-bandwidth video into ship computers;
- 2) How to geo-reference UAS video to overlay on satellite ice cover imagery and ship tracks (lo-accuracy vs hi-accuracy);
- 3) How to Archive video imagery for ready access and use.

To address (1) servers have been purchased for HEALY to ingest and archive video in future.

Work is still needed to use HEALY MapServer to assist in geo-referencing UAS video, and incorporating into Science Computer System data streams to address (2) and (3).

# Near Term Needs

- Demonstrate utility of multi- or hyperspectral sensors and Interferometric SAR for studies of sea ice, marine mammals, and for search & rescue and oil detection

- Develop, implement & improve anti-icing methods for small UAS, including both entire UAS and specifically optical systems (video and still camera housings)

- Complete UAS video integration with HEALY MapServer and ship computer systems

# Legal Concerns for Autonomous Technologies

1) Responsibility/liability : UK & EU Perspectives in SARUMS (Safety And Regulations for Unmanned Maritime Systems) documents

   (EU perspective key as systems easily cross national borders)

2) [FAA] Privacy (re UAS):

   … a maritime government use perspective is needed!

3) National Security: coordinating w/ military for removing detections of military ships/subs & avoiding system loss in foreign waters

4) Right of Way & SOLAS (Safety of Life At Sea):

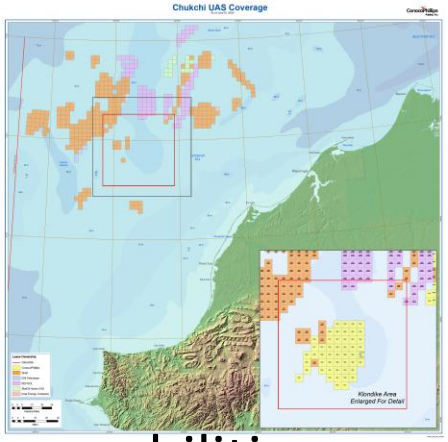
   "Your UAS/ASV/AUV ran in front of my airplane/ship/diver!"

5) International: Errant systems = "Spies" or "Terrorists"…

   Open Ocean incidents-issues / Port & Harbor Security issues

# Oil Company UAS Activities (US only)

Conoco Phillips will contact w InSitu to fly ScanEagles over Chukchi summer 2013 as test exercise for future. Launching from ship offshore, will stay >12mi offshore at 2000' height w range of 50-60mi from ship. POC is Dennis Parrish at C-P. Not flying under COA, rather OTA=Other Transaction Authority. Their 2013 UAS mission goals are:




1) UAS operational familiarization;
2) marine mammal spotting/tracking;
3) search and rescue capability; and,
4) oil spill response capability.

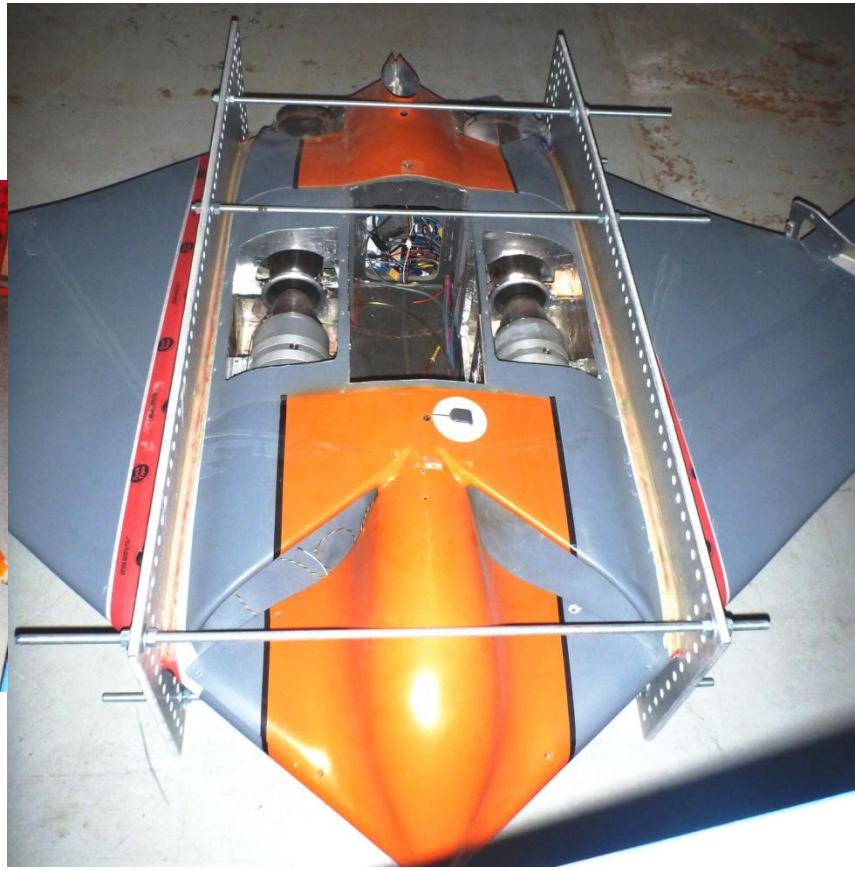
In future may develop UAS ice monitoring capabilities. Currently stuck using only sensors already approved by FAA on ScanEagle, ie IR/EO, not multispectral or SAR options ATT. Hopefully next year.

# New Canadian UAS Center for Aerospace Research (CfAR) at U. Victoria, BC.

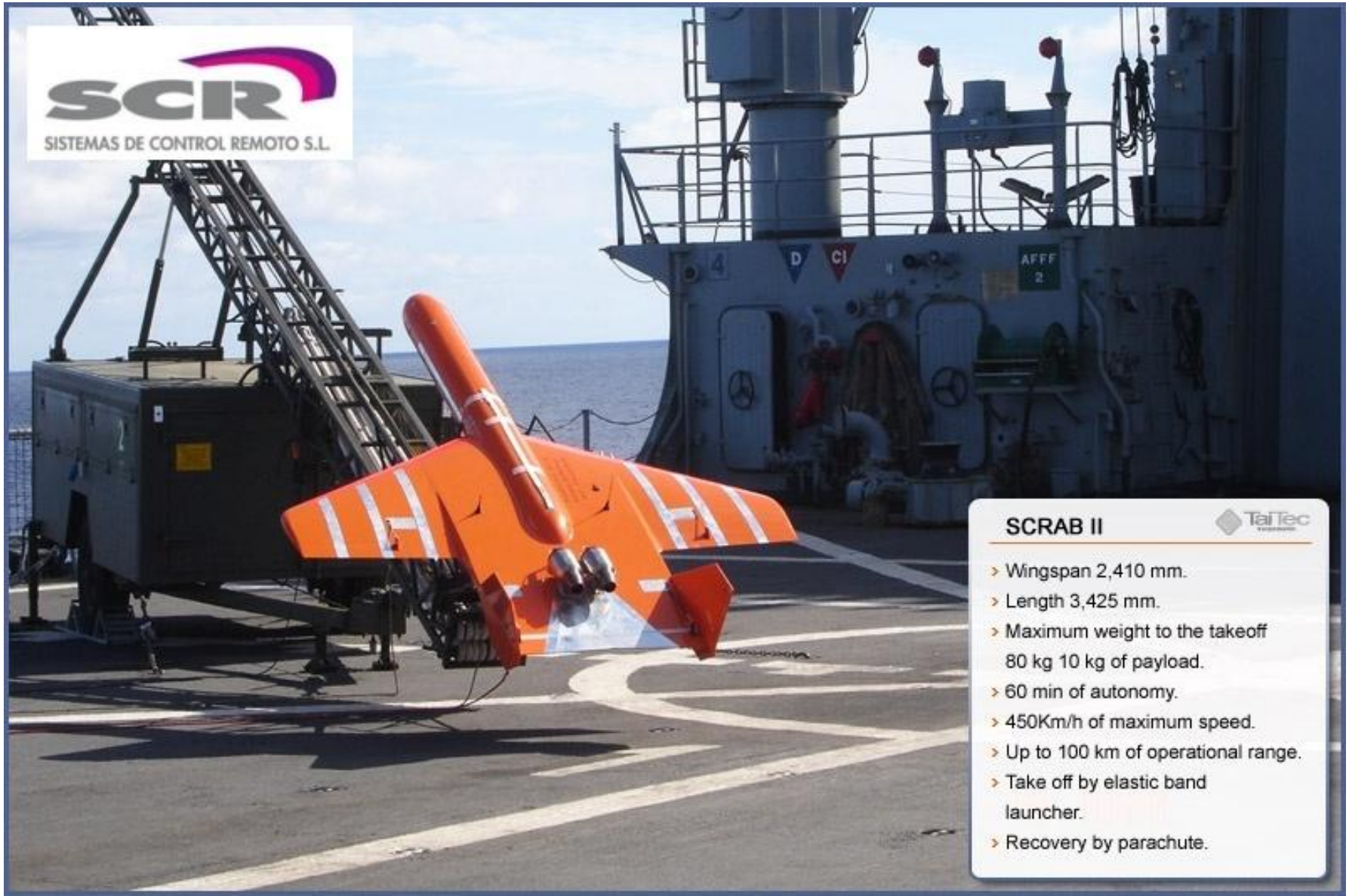
# http://aero-cfar.uvic.ca/?section=home

# U. Victoria CfAR UAS Jet (Boeing supported)

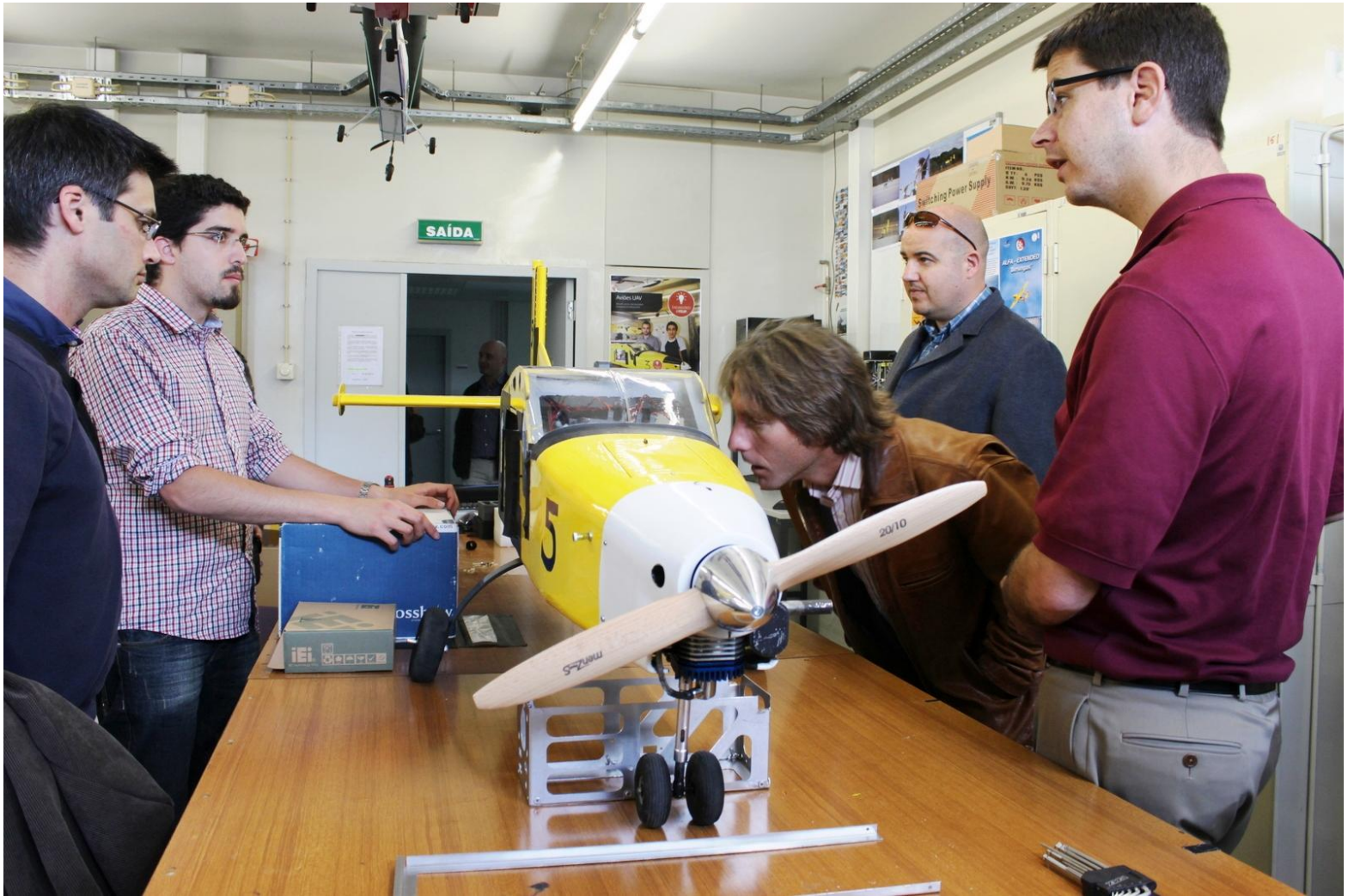
RE: Canadians have option to fly under “Special Flight Operation Certificate” which is less burdensome than US FAA COA.



# U. Victoria CfAR Scrab UAS (Spanish)



# Portugal UAS Program Activities
# Visit to Univ. Porto Engineering Dept.
# Unmanned Systems Lab



# Some of the S-UAS platforms used by U. Porto in conjunction with Portuguese Air Force

ANTEX-X02 (AFA)

Silver Fox (ACR)

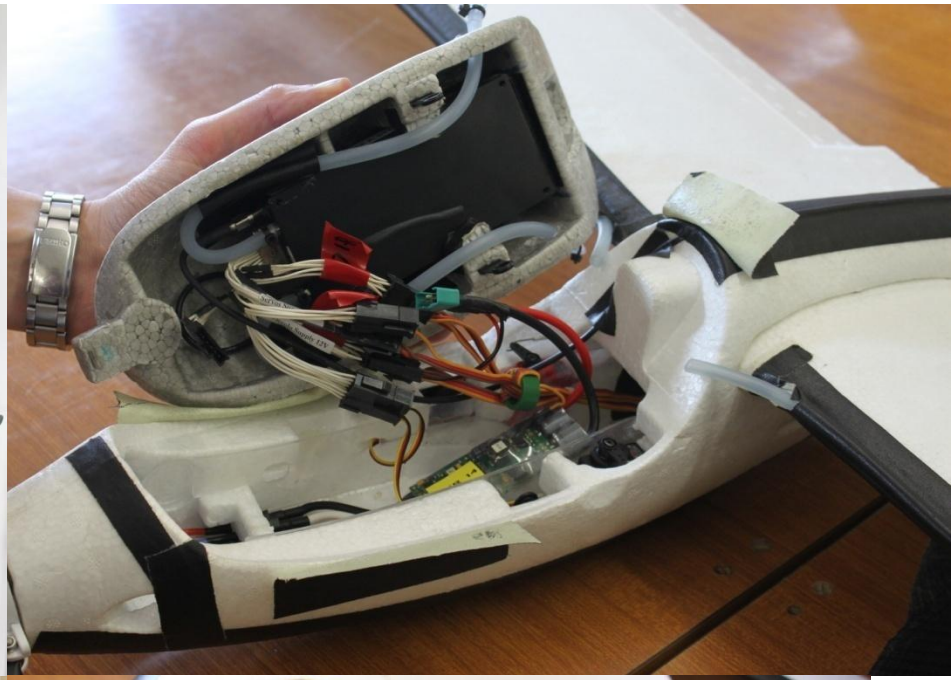
ANTEX 02 Extended

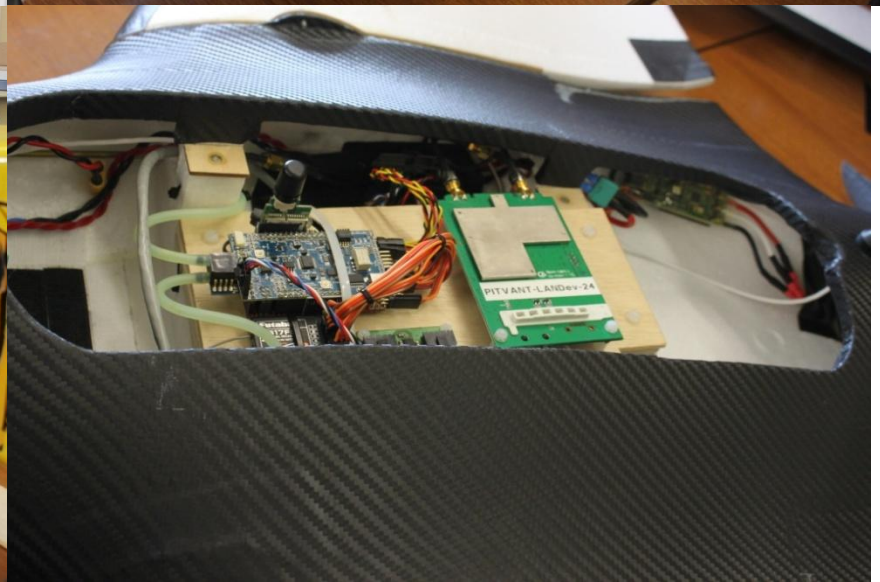
Lusitânia (FEUP)

ANTEX-X03 (AFA)

Flying Wing (AFA)

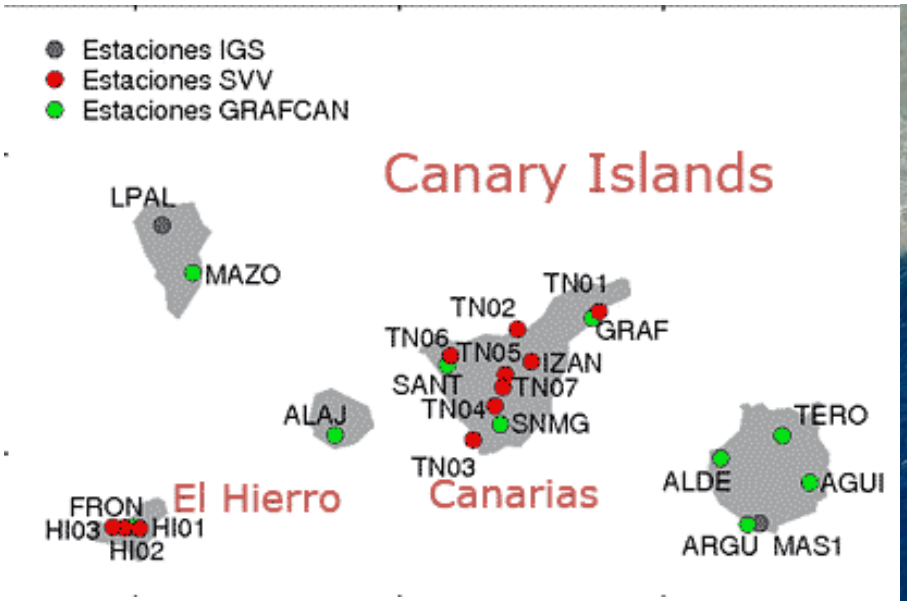
# Additional Univ. Porto UAS



# U. Porto UAS Activities 2013

1) REP-13 Rapid Environmental Program exercise off Lisbon for joint AUV-ASV-UAS & ship ops
2) Field program at Azores & Canary Islands, the later joint w PLOCAN at El Hiero submarine volcano with goal of air-sea gas flux measurements (pix below)
3) Fall field effort with MBARI using UAS for front location and direction of AUVs and ASVs.




# Norwegian UAS Program Activities

- Program at Norwegian University of Science & Technology (NTNU) in Trondheim, Norway w goal of persistent coastal UAS surveillance capability within @4 years
- In 2013-2104 supporting one post-doc, 4 doctoral students
- PhDs will focus on anti-icing methods, UAS ops/sensor integration/DTN, ice image processing, and ice model updates
- Using Penguin UAS, from Latvia (NY dealer too), w/ 54+hr endurance record, base cost $30K+10K for autopilot/avionics @ c.f. http://www.uavfactory.com/prodcat/1
- Also Dolphin and Quadrotor UAS (see next slide)
- NTNU Partnered with Maritime Robotics and Radionor Comms

# Norway: NTNU partnered with Maritime Robotics (www.maritimerobotics.com/ )

Modified Penguin w/ CloudCap Autopilot; over ocean from private Oslo airfield. Also land = magnetometer surveys (mines, also kimberlite, ie diamonds)

Cybaero to be tested shortly for ship ops.


Dolphine fixed wing UAS = very stable

Aerovironment Cybaero

# Maritime Robotics Ocean Eye Aerostat

(distributed by Elkat Co., Illinois) using IR for:
oil spill detection (left) and oily bilge discharge (right).
Useful feature: displays IR overlay as transparent on visual

# Norway: NTNU partnered with Radionor Communications

## http://www.radionor.no/

- Developed own wifi protocol for phased array antennas w >100(-300) km range, not affected by clouds/rain/fog
- Provide long range broadband microwave data link & positioning
- 5 GHz antennas support omni-directional 5Mb/sec radio comms over long ranges w @1KWatt power
- Ability to position UAS by measuring angle of signal to +/-1o, distance to +/-15m: useful for tracking UAS
- Antennas are lightweight (2.7kg) can be used on aerostats w single antenna facing down, eg video from UAS GoPro
- Have tested with ships and UAS and milcoms

# Norwegian Arctic (Hi-latitude) Adaptations: Anti-Icing Methods

NTNU personnel will visit Battelle to consider use of their carbon nano-tube spray on paint for UAS which is electrically conducting and can be 'wired' to heat up and melt ice on UAS wings when detected. The paint is not expensive, the control system is on the order of @$90K. This or a similar home-grown system is planned for implementation on the newly funded Norwegian UAS ice reconnaissance program.

A similar electrically conducting paint (Bare Paint) has been recently developed which may also be useful in this regard:

http://www.electronicproducts.com/Packaging_and_Hardware/Adhesives_Sealants_Coatings/Special_Paint_Is_a_Conduit_for_Electricity.aspx

# Norway 2013 Planned UAS Field Ops

- Participate in ODEN icebreaker cruise off E. Greenland in Aug/Sept (partially organized by Statoil)
- Use Microdrone Quadcopter to drop/track transponders on ice
- Use Dolphin UAS for ice observations
- Two doctoral students to develop capability for UAS to also deploy/retrieve sensor nodes in the field, starting w Quadrotor
- Take delivery of 2 Penguin UAS (w option for 2 more) and Quadcopter, develop these along w 'Flying Wing' UAS
- Continue to coordinate with "UAS Norway" which is the Norwegian UAS user group

# China UAS Program Activities

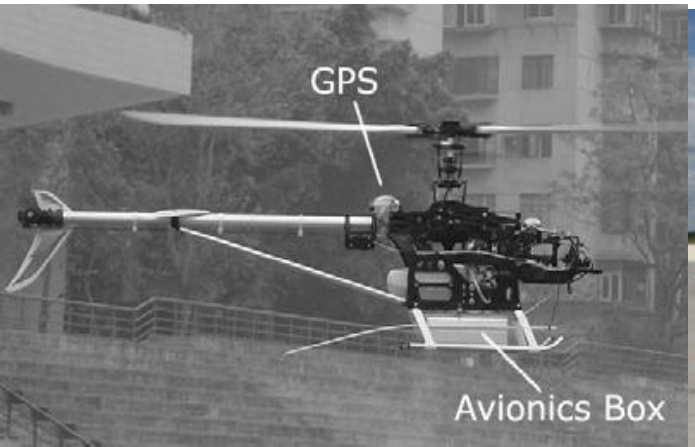
China is setting up a network of 11 UAS operational centers for routine patrols of its' entire coastline, c.f. http://www.chinadaily.com.cn/china/2012-08/28/content_15713428.htm

It has also begun using UAS for routine fisheries and maritime law enforcement capabilities as shown in photo on right below, c.f. also: http://www.afcea.org/content/?q=node/2918

Both fixed wing and helos are being used for MLE, size of helos is 2.4m long, 25kg, 10kg payload, 1(-4) hr endurance at 1000m.

First UAS is deployed at S. China Sea UAS Center.

China is marketing UAS at venues like the Paris Airshow.




# New Technology: Propulsive Wing Aircraft

[www.propulsivewing.com/](www.propulsivewing.com/)

Specs: Regular shown,

Also mini version:

20”wingspan; 3.5lb wt.

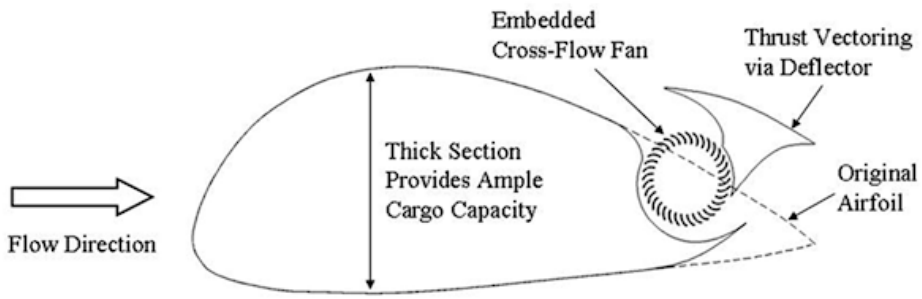
NASA funded through

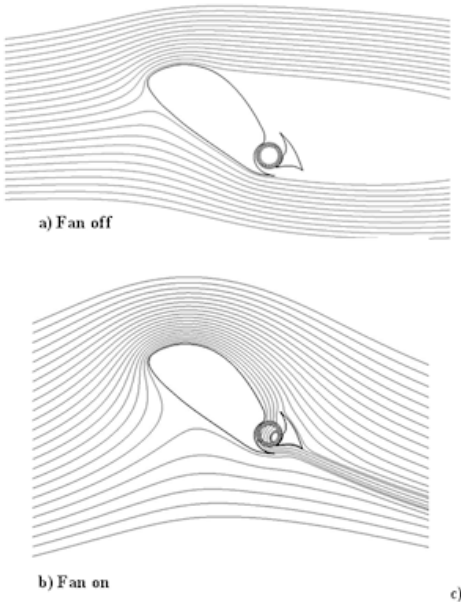
Syracuse University (NY)

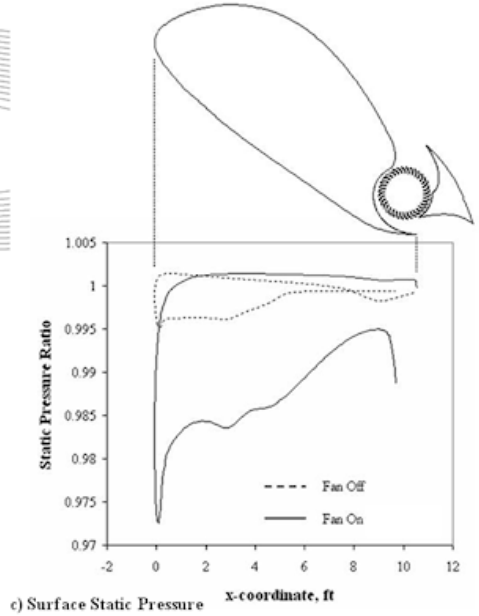
Advantages:

1) 2-3X lift/airframe weight of usual UAS
2) 10X > payload volume
3) High angle of attack flights for take-off and landing, ie for ships
4) Pitch/roll control by vectoring exhaust

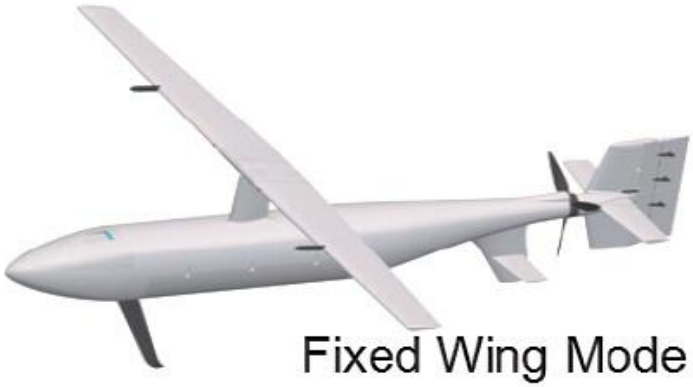
# Propulsive Wing Aircraft Technology & Performance



# New Technology: Navy Research Lab Stop-Rotor UAS converts from rotary to fixed wing, good for ship ops as above, without need for launch/land platform


## New Technology: Medium & Hi Altitude long endurance UAS

MALE & HALE: now>1mo., increasing. DARPA & companies pursuing independently.

DARPA TERN (Tactical Exploited Reconnaissance Node) MALE RFP 3/13

DARPA VULTURE HALE UAS (@60K feet altitude) to fly 2014

Lo altitude: 2 recharge methods - induction and lasers , both portable.
Laser recharge COTS from LaserMotive, Inc.


# New Technology: Small SWAP 3D (fan beam) Lidar from Boeing

## High Resolution Photon Counting Lidar

Provides highly precise range measurements and resolutions down to 6 cm accuracy

## Compact Size, Weight, and Power

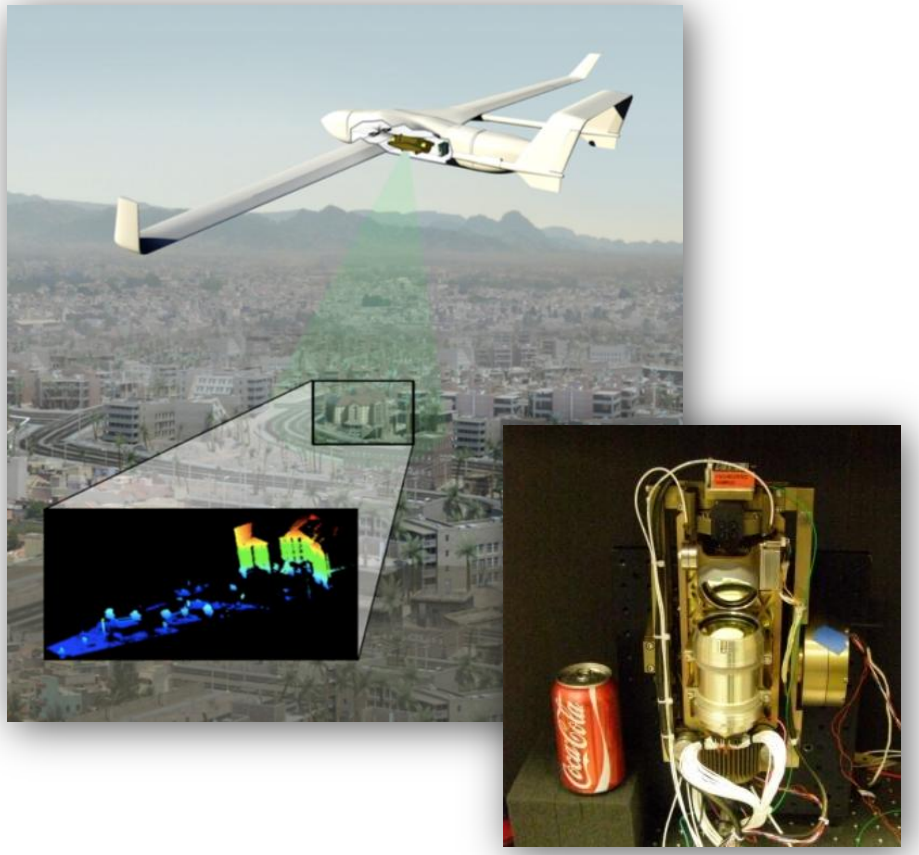
Small configuration and footprint enable the user to integrate on many platforms, including UAVs.

## Near-real-time Processing

Data reduction of 100s of MB/s raw data to ~20 MB/s download information, giving the user rapid 3D imagery to assess the mapped area quickly and accurately

## Potential Applications

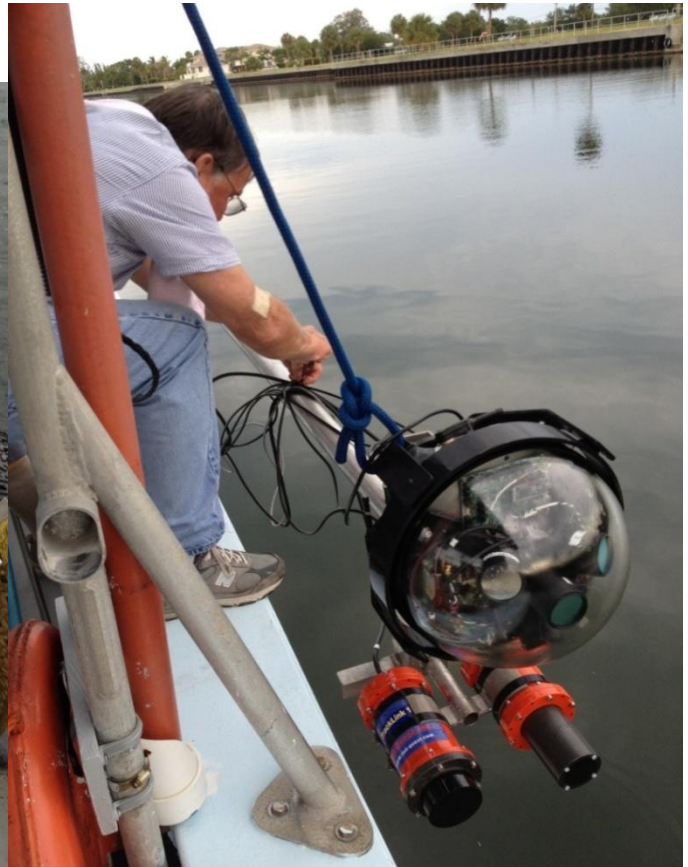
Strategic: target identification, precision tracking
Tactical: foliage penetration, surveillance, change detection, mission planning
Commercial: railroad survey, infrastructure/street mapping, Lunar and Mars Landing, airport survey



| | |
|---|---|
| **Size** | 7.5” x 22” x 6” |
| **Weight** | < 20 lbs |
| **Power** | 325 W |

# New Technology: Optical Comms

Summer 2012 successful test of omni-directional ONR-funded laser comms @20Msymbols/sec (F. Dahlgleish, HBOI/FAU). Transmitter on left; receiver on right. Both omni-directional. Next: AUV-UAS comms tests!



# New Technology: Adaptive Sampling Software

- Objectives: anomaly detection & mapping (eg fronts, internal waves, red tides, oil spills, etc.)
- T-REX (MBARI): Teleo-Reactive Executive software
- CANON (MBARI): Controlled, Agile & Novel Observing Network
- Integration of Autonomous Systems using Adaptive Sampling / Anomaly Mapping Software, including Human-in-the-Loop capabilities

# New Technology: UAS for Animal Tracking

- Working w Customized Animal Tracking Solutions (http://animal-tagging.com/index.html ) to develop animal tags (based on “Daily Diary” Tags) that report to satellites & UAS for arctic and other communications-challenged environments (eg high arctic, narrow valleys).
- Tags work at lo-latitudes but are optimal for hi-latitude species in areas of poor sat-com coverage (polar bears, walrus, seals, whales) & include interface w/ recent $5M Google grant for UAS endangered species monitoring.
- New tags adopt motion-activated and solar power systems to improve battery endurance; and,
- New tags adopt use of graphene supercapacitors to harvest animal motion to power tags for indefinite periods.

# Future Issues: Database Management

Bandwidth sources from UAS or from sensors via UAS:

HD-video and hi-resolution IR imagery;

Hyperspectral/multispectral ocean color data;

Lidar wave field and ice ridge mapping data;

AUV multibeam bottom mapping or upward-looking ice keel mapping data;

Hydrophone acoustic marine mammal [whale, etc.] and/or background noise monitoring data.

# Future Issues: Database Management

Issues include:

1) Hi-bandwidth data ingestion (hardware and software), eg NSF R-2-R (Rolling Deck to Respository) automated data system
2) Geo-referencing of all ingested data, eg NSF/HEALY icebreaker “MapServer” system
3) Archiving & Accessibility/Retrieval of high bandwidth data: being developed by NSF & NOAA
4) Transmission of high bandwidth data in near-real time (addressed previously)
5) Analysis of high-bandwidth data: the future!

# New Technology: Database Management

HADOOP software is used by CIA, DoD & National Geospatial-Intelligence Agency (NGA) for UAS video archiving and analysis.

Because HADOOP is the same software used by national geospatial data agencies, it should be used by data aggregators.

Google offers HADOOP for video storage and analysis 'in the cloud' relatively inexpensively, with the ability to convert video to all data formats and convert all voice accompanying video to text.

Google durable storage cost (up to 4.5Petabytes=4500Terabytes) is = $0.042 / GB /month. 24hr of HD video is 5.73TB, which would be $43/month. A month of 24hr HD video would be then $6450/mo. So, the cost of storage, even in Google, adds up, but is purportedly cheaper than other storage options.

See: https://cloud.google.com/pricing/cloud-storage

And about HADOOP processing:

https://cloud.google.com/products/compute-engine

# New Technology: Database Management

Still needed are:

1) Data ingestion and archiving standard methods (eg HADOOP)
2) Improved data integration & displays, especially for ships
2) Near real-time optical data communication (incl. military 'scrubbing')
3) New sensor capabilities development/testing (eg multispectral)
4) New persistence capabilities (powering systems)
5) Operator (and scientist and manager) training requirements
6) Assessment and demonstration of potential for more cost-effective & directed MLE

# SARUMS

## Safety And Regulations for Unmanned Maritime Systems

This EU document has been drafted for all unmanned systems ranging from underwater and surface vessels as well as unmanned aircraft. While the draft document is very extensive, not all the sections relate to reality particularly well. It is an EU priority to make progress on agreeing on the SARUMS protocol. This will, however, require additional work at meetings planned for the coming year. Because the SARUMS document is still in a draft stage only participants in the SARUMS process have copies at this time.

A draft version is available on enquiry for review however.