Scientific Committee for Oceanographic Aircraft Research (SCOAR)
University of Alaska Fairbanks - International Arctic Research Center
Day 1 - Syunichi Akasofu Building Room 501
Day 2 – Poker Flat Research Range
Fairbanks, AK
August 14-15, 2012

Meeting Minutes

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Day 1, August 14th - UAF International Arctic Research Center, SyunIchi Akasofu Building Room 501

Welcome and Introduction - Daniel Schwartz, SCOAR Chair, called the meeting to order at 8:30 am on August 14, 2012. The meeting was held at the University of Alaska, Fairbanks. Meeting participants introduced themselves.

The meeting agenda is included as ***Appendix I*** and the participant list is included as ***Appendix II***.

Ro Bailey welcomed everyone to the SCOAR meeting.

A motion was made and approved to accept the minutes of the June 2011 SCOAR Meeting http://www.unols.org/meetings/2011/201106sco/201106scomi.html (McGillivary/Lenain).

Welcome to University of Alaska Fairbanks, School Activities, and R/V *Sikuliaq* Construction Update – Dr. Mike Castellini, Dean of the School of Fisheries and Ocean Science, welcomed SCOAR to UAF and provided a presentation on the University activities. His slides are included as ***Appendix III***.

Dr. Castellini discussed the marine focus for the north and the issues impacting the area:

- Changes in Arctic sea ice
- Increased economic drivers / resources
- Changes in fisheries
- Increased human marine impact / traffic
- Ocean acidification
- Social impacts on Arctic populations
- Permafrost / ocean interactions
- Public information / perception

It is a challenge studying an area as vast as the Arctic. The tools that they utilize include:

- Ocean observing systems
- Remote monitoring
- Satellite and aerial technology
- Autonomous Underwater Vehicles (AUVs) and gliders

UAF is acquiring the RV *Sikuliaq,* a Global Class vessel. The specifications include:

- Length: 260+
- Endurance: 45days
- Icebreaking capability: 2.5 ft at 2 knots
- Scientists: 26
- Under construction at Marinette Marine Corporation in Wisconsin
- Launch date: Oct 13, 2012

The deck of the ship could probably support UAV ops.

Discussion:

- Dan Schwartz - How many people are in the school. Mike – UAF has 14 locations with

about 250 faculty and staff. They have marine operations in Juneau, Anchorage, and Seward. They work closely with NOAA fisheries. The community college is also rolled into UAF.

- Phil McGillivary - Will there be a new facility in Seward when *Sikuliaq* is delivered? Mike - The city of Seward has invested in dolphins so that the ship can be moored at the old *Alpha Helix* facility. They can also use the cruise ship facility. UAF doesn't have the funds for a new marine building in Seward yet.

UNOLS and Agency Reports:

UNOLS report – Annette DeSilva provided the UNOLS Report. Her slides are included as ***Appendix IV***. The report covered the following topics:

- UNOLS Fleet Operations
- Fleet Modernization Projects
- Polar Research Vessel SMRs
- Greening the Research Fleet
- UNOLS Lectureship Program
- Early Career Initiatives
- UNOLS/SCOAR Website

Fleet Operations - Agency recommendations regarding 2013 fleet operations were provided to the UNOLS Council in late May/early June 2012. The recommendations included:

- Retire *Cape Hatteras* in 2013
- Retire *Point Sur, Knorr*, and *Melville* in 2014
- Midlife refits are under consideration for *Thompson, Revelle*, and *Atlantis*

A UNOLS Council Subcommittee is preparing a response to the agency recommendations (Deb Steinberg, Robin Muench, Vernon Asper, and Wilf Gardner).

Fleet Renewal Activities include the following:

- Ocean Class Acquisition (Navy) – The keel laying ceremony is scheduled for later this week on Friday, August 17th at Dakota Creek Shipyard. The ship deliveries are planned in 2014/2015.
- Regional Class Research Vessel (RCRV) - NSF announced an RFP for the construction of up to three Regional Class ships. Proposals are due in early September 2012. The first ship would enter the Fleet in roughly 2019.
- R/V *SIKULIAQ* - Mike Castellini provided details in his report.

Annette reviewed the recent UNOLS Goals and Initiatives:

- Antarctic Research Vessels and UNOLS – UNOLS was tasked to Review and update the 2006 Polar Research Vessel (PRV) SMRs. A workshop was held and the final report was provided to NSF in Early 2012.
- Greening the U.S. Academic Fleet: A UNOLS Workshop was held in January 2012. Over 50 participants attended with representation from Council, RVOC, RVTEC, FIC, NSF, Navy, NOAA, architects and naval designers, industry, and marine scientists. The long term goals are to promote environmental sustainability within UNOLS; provide guidelines for construction, operation and recycling of UNOLS Research Vessels; and promote environmental awareness on UNOLS ships with U.S. ocean scientists. A list of

the workshop's findings is included in the slides.

- UNOLS Speaker Series – UNOLS will establish a speaker series to highlight UNOLS ships and oceanographic research and to serve as an outreach activity to non-UNOLS colleges and universities. There will be particular attention to institutions with under-represented minorities in the marine sciences. To minimize costs, a regional approach will be taken and there will be a speaker coordinator in each region to recruit speakers and coordinate speaker series.
- Outreach - UNOLS has been working to expand their outreach and Early Career Scientist activities. The activities have included Chief Scientist Training Cruises and DESSC Early Career Workshops.

Discussion:

- The aircraft system, Altus, can be removed from the STRS form.
- UAS is the official acronym for the unmanned aircraft systems (we think).
- Phil McGillivary - Has there been more international collaboration on ship time. Annette – Much of the international collaborations are handled by the agencies. Tim Schnoor - There is also a US agency collaboration with other countries through ISOM. There are also bartering arrangements on occasion.

Office of Naval Research (ONR) – Tim Schnoor joined the meeting by teleconference and provided the ONR report.

The Navy construction of the two Ocean Class AGOR project is progressing. Dakota Creek shipbuilders started the construction phase of the project. Construction of three modules is underway. The ships have not been named yet, but the names will be coming soon. The vessels are AGOR 27 and AGOR 28 and will replace *Knorr* and *Melville*. On Friday of this week there will be the keel laying ceremony for the vessels. Delivery is scheduled for fall 2014 and early 2015.

NSF Division of Atmospheric and Geospace Sciences, Lower Atmosphere Observing Facilities – Linnea Avallone joined the meeting by teleconference and provided the NSF report. Her slides are included as ***Appendix V***.

Linnea is relatively new to NSF and has been in her office for about 9 weeks.

The NSF-Sponsored Lower Atmosphere Observing Facilities guiding principles are:

- Research facilities are available to NSF-funded PIs at no additional cost to their grants
- Projects reviewed by Observing Facilities Assessment Panel (OFAP) semi-annually
- Deployment pool (~$5.5M/yr) supports NSF- funded science in all disciplines
- Deployment possible worldwide
- Facilities available to other agencies on reimbursable cost and non-interference basis

The NCAR operated and maintained facilities include the C-130Q and the Gulfstream G-V. C130Q and the Gulfstream G-V are most requested aircraft. The NSF-sponsored/NCAR-operated facilities include:

- S-Pol radar
- ELDORA radar
- Remote Sensors:
    - High Spectral Resolution Lidar (HSRL)

    - HIAPER Cloud Radar (HCR)
- Sounding systems:
    - Surface and tower systems (fluxes) Wind profiling radars
    - GPS upper-air soundings (GAUS) Dropsondes & driftsondes

Other NSF-sponsored facilities include:
- CHILL radar - Operated by Colorado State University
- University of Wyoming King Air - State-owned and operated
- Doppler on Wheels (DOWs)

Linnea presented charts showing the Facility Utilization data including total requests and allocations (see slides). Data on requests & decisions, requestors (types of users), and project size was presented.

Recent Interagency projects are highlighted in the slides including:
- Deep Convective Clouds and Chemistry (DC3)
- NASA DC-8 from the NSF/NCAR G-V during DC3
- Ice Bridge - Antarctica 2011 and 2012

In NSF upcoming events, the Storm Penetration Aircraft, Air Force A-10, is to be transferred to the Navy. Modifications to the aircraft are planned at Zivko Aeronautics under subcontract from CIRPAS.

Discussion:
- Luc Lenain - How low can the A-10 fly? Linnea – It depends on the regulations.
- Luc Lenain - What is the issue with the P3 wings? Linnea - All P3s of a certain vintage need to be redesigned. This would cost about $20M - $30M per aircraft.
- Phil McGillivary – He is interested in oceanographic work that can be done from NSF aircraft. Luc Lenain – His group has an NSF funded proposal and will use an aircraft from the NSF pool.

Break

NOAA's UAS Program – John Coffey (JC) joined the meeting by teleconference and provided the NOAA UAS report. His presentation material is included as ***Appendix VI***. John discussed various NOAA UAS programs and provided the facility schedule spreadsheet.

Some of the programs that were carried out included work with Greg Walker (UAF). It was some of the most challenging UAS work they have been involved with. NOAA also did UAS work off Hawaii to support tsunami debris studies. They have been very busy. The NOAA UAS program office partners with USGS, NASA, and UAF.

NOAA has been putting together lessons learned form their UAS operations. They have a good set of Standard Operating Procedures (SOPs) for operations using Ravens and Pumas.

They have learned that use of small UAS is good in rough environments. During recent work in the Aleutians, the Twin Otter was grounded for the entire time. Another lesson learned is that the operators of the aircraft should be integral to the operations.

NASA UAS is located at NOAA headquarters in Silver Springs, MD.

The smallest vessel that NOAA has used to support UAS operations is a RIB-size boat. As long as you can give a good overhand throw of the UAS, it will work.

JC said that there are three things to remember during UAS operations:
- Air worthiness
- keep things simple
- Air space issues

NOAA can certify their own pilots. There is also a non-DoD Raven school. Navy is giving Puma training.

Annette DeSilva - Do you retrieve the UAS from the water? JC - Yes, but they can also land on ground.

Interagency Working Group on Facility Infrastructure – Subcommittee on Unmanned Systems (IWG-FI SUS) Activities – Brenda Mulac joined the meeting by teleconference and provided the IWG-FI report.

The SUS has become a standing committee of the IWG-FI and co-chairs are Kim Curry, John Adler, and Brenda Mulac. They are trying to improve communications of unmanned systems and they are sharing lessons learned. The committee has drafted a report that should be final soon.

As the IWG-FI SUS has conducted business, they have recognized that improved coordination is needed. Some findings and suggestions include:
- There is a lack of ability for agencies to share facilities.
- There should be an interagency MOA to more easily allow sharing.
- The UAS infrastructure requirements are demanding. They have recommended a consolidated operations center (perhaps one to be hosted at Stennis).
- Frequent utilization for these systems is often lacking. Once a system is used it is often put on the shelf.
- A definition of "utilization" is needed.
- Develop a federally recognized acquisition system for UAS. There should be more communication to avoid acquisitions that might not be needed.

The IWG-FI SUS is developing a phased implementation plan for their report recommendations.

Discussion:
- David Fisichella - Does the SUS feel that that UAS are robust enough to consider group purchases? Brenda - We are getting rather close. The technology is changing rapidly and is coming along.
- Colm Sweeney – FAA is limiting the UAS flights. Are we able to get data using UAS that cannot be acquired using manned systems? Brenda – The SUS did not dive into that subject in their report. Within NASA they try to look into this and they will consider if UAS is the appropriate vehicle for the mission that is being addressed. There are a lot of UAS applications however; such as, missions with a lot of dwell time.

- Luc Lenain - From his stand point, his group's air/sea interface studies benefit from use of both UAS and manned systems.
- Phil McGillivary - He appreciates everything that ICCAGRA has done. He doesn't feel that one centralized aircraft center is the best solution. Brenda - She totally agrees and this isn't what they are advocating. They would like a few centers as appropriate for regionalization.

Aircraft measurements of greenhouse gases by NOAA Global Monitoring - Colm Sweeney (NOAA) provided the report. His slides are included as ***Appendix VII.***

Colm's report is titled "Connecting NOAA and IAGOS." He reviewed the evolution of NOAA's Global Carbon Cycle Monitoring Networkalong with the goals for each decade. The goal in the 2000s is to estimate and track North American sources and sinks.

2012 science flights included operations to support the Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE). It was conduced on 24 July 2012 in the Yukon Flats.

Colm's presentation included data on the NOAA Flask and in-situ network (2008 measurement programs) and the current aircraft network.

The Automated Flask Sampling from Aircraft includes:
- One twelve-pack per flight
- Typical profile from 500 m AGL to 8000 m ASL
- Species: CO2, CO, CH4, N2O, SF6, stable isotopes, halocarbons, COS, hydrocarbons...

Data from these experiments are provided in the slides.

Next Colm discussed the Alaska Coast Guard (ACG) Aircraft Site. The U.S. Coast Guard conducts regular flights across Alaska for Arctic Domain Awareness (ADA); for search and rescue operations as sea ice melts. There is NOAA/USCG collaboration on flights of opportunity. It offers a test bed for instrumentation for commercial aircraft. There is unprecedented scientific opportunity for:
- monitoring Arctic response to warming and sea ice melting
- establish Baseline and monitor inter-annual variability
- stratospheric/tropospheric exchange

Additional details about the ACG and examples of the data are included in the slides.

The Passive AirCore sampling system was described. NOAA currently uses balloons, but they are working on a glider version. The payload is only a couple pounds. They use iridium for tracking since it needs to be light and withstand low temperatures.

NOAA is working with Greg Walker at UAF on an active air core sampling system. The system would allow a large area of monitoring over 4 hours.

Colm's report ended with a description of what NOAA does now for CO2 measurements and observations. There are a lot of new technologies coming on line. Satellites will all play a huge role in detecting changes to determine where the fluxes are happening and why. The aircraft are essential to these studies.

Discussion:

- Luc Lenain – The air core is a great idea. There is a new CO2 instrument coming on line. Colm - Landing is always a challenge. It would be nice if we could close the tube to allow water landings.
- Ro Bailey - There are some challenges with landing on a ship. There are strange air currents and steel ships interfere with GPS.
- It is coming to the point that they will make the facilities expendable.
- There are a lot of observing opportunities - we just need to coordinate them.

Lunch Break

OOSC Liaison Report – Annette DeSilva reported on the UNOLS Ocean Observing Science Committee. Her slides are includes as ***Appendix VIII*****. The** OOSC charge is: "The OOSC will be an essential element in the process of communicating the science user perspective to the NSF and to the project teams involved in developing, deploying and operating ocean observatories." The OOSC membership is listed in the slides.

The OOSC activities have been limited because OOI is still in the implementation phase. There is a Coastal Glider Critical Design Review meeting planned for June 29th (via Webex).

The OOI timeline is included in the slides but is subject to change.

CIRPAS Report - UNOLS National Oceanographic Aircraft Facility – Dan Schwartz presented the CIRPAS slides that were prepared by Bob Bluth. The CIRPAS material is included as ***Appendix IX*** and includes the Twin Otter Operational 2012 schedule, the CIRPAS request form, and the A-10 Storm Penetrating Aircraft Project.

The A-10 Storm Penetrating Aircraft Project is a collaborative project between CIRPAS/Naval Postgraduate School and South Dakota School of Mines & Technology (SDSM&T). The slides include a perspective on the A-10 project. In 2010 NSF selected a proposal from CIRPS with collaborative agreement from (SDSM&T) to operate an A-10 APA as a mid-size National Facility.

The A-10 is rugged and heavily armored, which minimizes needs of modification for storm penetration. A-10 has 11 hard points on its wings and belly where 8000 lbs of instruments may be suspended. It has a belly bay where 2200 lbs of stuff may be mounted. The A-10 capabilities and potential contributions to climate system science are listed in the Appendix.

The progress to date was reviewed:
- USAF A-10 program office assembles parts for regeneration.
- A Loan Agreement between USAF and US Navy was completed and signed.
- A contract was awarded to Zivko Aeronautics for conversion and certification.
- A Cooperative agreement between NPS and SDSM&T was completed and signed.
- The Statement of Work for regeneration at the USAF AMARG facility was completed but is under review.
- The leading-edge wing sections have been provided to CIRPAS for Ice-Cannon tests.
- A-10 Certified Pods are being evaluated for feasibility as instrument housings.

There are some certification issues that are being dealt with.

Update on the AGOR / UAS Scientific Demonstration Integration for Project DYNAMO and Manta Operations – Luc Lenain provided the update. His slides are included as ***Appendix X***. Luc reported on: "Development of Instrumented UAS for Air Sea Interaction Research and Ship-Based UAS Measurements of Air-Sea Interaction and Marine Atmospheric Boundary Layer Processes in the Equatorial Pacific - Update on the AGOR / UAS Scientific Demonstration Integration." The key personnel on the project are Luc Lenain, Ken Melville, and Ben Reineman.

Images of the SIO Manta UAS for Air-Sea Interaction Research and instrumentation/sensors are provided in the slides.

The SIO Manta features include:

- Fast response water vapor sensor
- Turbulence probe
- Fast response temperature sensor
- 5 hrs endurance, ~7 kg payload, 2.7-m wingspan
- Capable of stacked flight configuration
- Measures mean and turbulent wind (turbulence probe), surface topography, standard meteorological variables and air-sea fluxes

In 2011 and 2012, the SIO Manta was tested at Camp Roberts. Descriptions of the facility along with data collected are in the slides. There are data of atmospheric profiles of wind, temperature, H2O vapor.

The SIO Manta was used in Low level stacked flights. Two Manta UAVs were in stacked formation: the upper Manta was programmed to maintain a constant GPS altitude for these segments, while the lower UAV was programmed to maintain constant height above ground using measurements from the Lidar.

The SIO Manta was used to measure upwelling/downwelling radiations. A chart showing a time series of downwelling shortwave radiation, as measured with the Manta Radiometric payload and the CNR1 on the 13.5-m meteorological tower.

Next Luc discussed the SIO ScanEagle UAS for air-sea interaction research. The UAS has >12 hrs endurance with a 2 – 3 kg payload. The system is capable of ship launch/recovery with the "Skyhook" vertical line recovery. The cruise is scheduled during October 2012 on R/V *Revelle.* Luc reviewed the shipboard instrumentation.

A comparison of the SIO Manta and ScanEagle platform is included in the slides.

Originally the ship-based UAS measurements of air-sea interaction and marine atmospheric boundary layer processes in the Equatorial Pacific were planned for December 2011, but was postponed (funding delays and identifying adequate flight support group). The deployment of the instrumented ScanEagle UAVs from the R/V *Revelle* is now planned during the Papeete to Nuku Hiva, Tahiti cruise (4 - 22 Oct., 2012; Jerome Smith - SIO, Chief Scientist) EquatorMix experiment (NSF PO funded). The ScanEagles will extend the capabilities of the research vessel by measuring air-sea fluxes, marine atmospheric boundary layer (MABL) variables, and surface signatures of ocean boundary

layer (OBL) processes. There will be low level flight and stacked flight using two GCS. Measurements will include:

- Air-sea Fluxes and the Marine Atmospheric Boundary Layer
- Atmospheric Convection & Precipitation
- The Diurnal Surface Layer
- Surface Wave Processes and Mixing

Luc discussed the various payloads (Flux, Imaging, and Radiometric).

The SIO ScanEagle UAS flight tests were conducted at the Naval Surface Warfare Center Dahlgren Division on 12-16 April 2012. Video/infrared measurements of the Potomac River were taken and an example is included in the slides. Other SIO ScanEagle UAS measurements (along with examples in the slides) included:

- Nadir Lidar surface measurements
- Low-altitude wind and flux measurements (31m above MSL)
- FLUX payload
- flux measurements

The project is funded by ONR/DURAP.

Discussion:

- Luc Lenain - There have been other UAS systems deployed from ships, but this is the most extensive operation and this is a science operation. The more we do this, the better we get at it and the cheaper it gets.
- Phil - Do you have a schedule for the cruise? Luc - The Chief Scientist is Rob Pinkel. The detail cruise plan still needs to be worked out. Initial flights will be a few hours long, but eventually they hope to have 10-hour flights.
- Steve Hartz - Can the ship do other ops while the UAS is in air? Luc - Yes.
- Luc - They will take 6 aircraft on the cruise. The flight team includes three people.

Break

University of Tennessee Space Institute (UTSI) - Aircraft facilities and Research Operations - Dr. Peter Solies provided the report. His slides are included as ***Appendix XI***. The report agenda topics included:

- UTSI Location and Academic Disciplines
- UT Flight Research Laboratory
- Examples of UTSI Flight Research

UTSI is located in Martin, Memphis, Knoxville, UTSI / Tullahoma Chattanooga. UTSI offers a variety of Graduate Degree Programs. They also offer an MS degree in Engineering Science with a concentration in Flight Test Engineering.

The UT Flight Research Laboratory (UT-FRL) conducts flight research with unique UT fleet of research aircraft. It is available to support academia, government, and industry flight test / research needs.

The Av Systems Facilities include:

- Faculty and Student Offices at UTSI Main Campus

- Flight Research Laboratory - Located on Tullahoma Regional Airport (KTHA) with a 10,000 sq ft 2-bay hangar, offices, Flight Briefing room, Flight Simulator, classroom, instrumentation and Fabrication shops.
- Flight Simulation Laboratory (at Main Campus) – which includes a High fidelity Engineering Research Flight Simulator, "Desktop" flight simulators, and dedicated CFD analysis computers.
- Flight Systems Laboratory (at Main Campus) – with systems, instrumentation, avionics hardware and software.

UT-FRL Investment Areas and Customers include:
- Airborne Science - NOAA, NASA, DoD
- Aviation Safety (Icing) and Flying Qualities - NASA
- Flight Test Engineering (FTE) Education

UT-FRL Airborne Research and Education Facilities include:
- Airborne Science - Piper Navajo, Cessna 210, Piper Super Cub, Extra 300 (features are in the slides)
- Unmanned Aerial Systems (UAS) - Navion Surrogate UAV
- Flight Test Engineering Education - Piper Saratoga
- Rotorcraft Expertise - UTSI previously maintained, modified, instrumented, and operated OH-58A+ rotorcraft. The also, have experience with other rotorcraft that have been used for UTSI research.

Peter reviewed the scientific equipment integration locations and racks on the aircraft. Images and sketches are in the slides.

The airborne science sensors / instruments list is in the Appendix.

Other topics covered in Peter's report include:
- Aircraft Certification and Maintenance
- Experiment Integration
- Flight Operations
- Aircraft Modification Capability
- Examples of UTSI Flight
    - NASA MAPIR
    - NOAA Atmospheric Mercury
    - NOAA Land Surface Temperature Sensing
    - FWRI Marine Mammal Aerial Surveys

The UTSI website is http://www.utsi.edu.

United States Coast Guard (USCG) UAS Program Report – Phil McGillivary provided the report. His slides are included as ***Appendix XII.***

The report topics include:
- Staff Organization
- Concept
- Missions
- Requirements

- Cutter-Based UAS
- Land-Based UAS
- Program Challenges
- Way Ahead

The USCG is responsible for 97,000 miles of coastline and 50,000 miles of navigable waterways. There are less than 45,000 active duty augmented with reservists, civilians, and auxiliarists. The USCG is also responsible for 2 million square miles of the Exclusive Economic Zone (EEZ).

The UAS Staff Organization chart is included in the slides. The USCG UAS concept is to protect America thru the early detection of dangerous people and goods, BEFORE they can penetrate our maritime borders.

The Coast Guard UAS Missions include:
- Search and Rescue (SAR)
- Marine Safety (MS)
- Alien Migrant Interdiction Operations (AMIO)
- Ports, Waterways, and Coastal Security (PWCS)
- Marine Environmental Protection (MEP)
- Aids to Navigation (ATON)
- Drug Interdiction (DRUG)
- Defense Readiness (DR)
- Living Marine Resources (LMR)
- Other Law Enforcement (OLE)
- Ice Operations (ICE)

By 2016, manned USCG assets are predicted to be unable to achieve total required flight hours. UAS will augment manned assets to fill this gap. UAS are not intended to replace manned assets.

Phil reviewed the Cutter-Based UAS History and Cutter-Based UAS CONOPS (WMSL). The Cutter-based UAS are to provide 70% (+/-) increase in surveillance area per NSC. This equates to significant increases along all elements across the prosecution chain (surveillance, detection, classification, identification, and prosecution). Modeling/simulation indicates a potential 95% increase in prosecutions.

Interim Capabilities include use of Small UAS (sUAS). The general characteristics are provided in the slides. The sUAS are NAVAIR certified for multiple ship classes. They are portable and cost effective.

USCG ScanEagle and Raven Update – Phil McGillivary provided a report on ScanEagle, Raven, and other UAS activities. His slides are included as ***Appendix XIII***.

The Arctic Domain Awareness (ADA) uses the CG C130 Aircraft for Bi-weekly (March-Nov.) flights supporting ONR, NSF, NOAA, and NASA science. Details of the programs are included in the slides.

In 2011, Greg Walker (UAF) had insufficient time to get CG OK to fly ScanEagle off HEALY,

so the mission was delayed. Air Force CAPT Steve Wackowski (National Defense Univ) got FAA COA to fly a RAVEN UAS. It was the largest COA ever granted and the furthest north UAS flight (@88oN), @100mi from North Pole). The results of study demonstrated:

- Ice ridges best viewed in IR, but multispectral not done (sensors arrived late!)
- UAS ice ridge data useful for ship routing
- UAS ice cover data useful for ship AUV deployment/recovery

The launch of the RAVEN was from the Canadian icebreaker LOUIS S ST LAURENT. The RAVEN recovery was by CCG cadet on the flight deck of LOUIS S ST LAURENT.

Updates in 2012 include:

- New UAS Ravens with gimbaled camera and 4 zoom settings
- Innovative Automatic Technologies deploys AXO S-UAS for seabird and marine mammal studies.
- Israeli Co. Sky Sapience markets Hovermast-rotor UAS for ship deployments to 50m to provide surveillance w/o FAA COA requirement.

Near Term UAS ship ops needs include:

- Demonstrate utility of multi-/hyperspectral sensors and Interferometric SAR (ISAR) for studies of sea ice, marine mammals, search & rescue and oil detection
- Develop, implement, improve anti---icing for small UAS, including UAS & optical systems (video and still camera housings)
- Complete UAS video integration w HEALY MapServer & ship computer systems

The CG Icebreaker HEALY escort of Russian Tanker RENDA to refuel Nome after onset of heavy ice in Dec.-Jan. 2012 utilized a Quadrotor UAS to map ice ridges to determine: 1) ship best approach to harbor; and, 2) optimal locations for oil hose pathway.

Phil reviewed UAS work elsewhere (see slides). In the summer 2012, there was a successful test of omni-directional ONR-funded laser comms system.

A NASA Global Hawk UAS Hurricane study is planned in late August-early October 2012. It will use two Global Hawk UAS. Instruments on first Global Hawk UAS to study storms include: Scanning High-resolution Interferometer Sounder (S-HIS), Advanced Vertical Atmospheric Profiling System (AVAPS) (also known as Dropsondes), and Cloud Physics Lidar (CPL). The Tropospheric Wind Lidar Technology Experiment (TWiLiTE) Doppler wind Lidar is to fly in 2013. Instruments on the second Global Hawk UAS focus on interior of the storm and include High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) conically scanning Doppler radar, Hurricane Imaging Radiometer (HIRAD) multi-frequency interferometric radiometer, and High-Altitude Monolithic Microwave Integrated Circuit Sounding Radiometer (HAMSR) microwave sounder.

Other NASA programs include:

- 2012 Project ZEUS
- 2012 NASA Ames gets at $1M worth of Dragon Eye UASs from Marines.
- 2013 CARVE (Carbon in Arctic Reservoirs Vulnerability Experiment)

In 2012, Greenpeace is using UAS use in Arctic from M/V ESPERANZA.

Discussion:

- Dan Schwartz wondered if CIRPAS can integrate some of these systems into their facility.
- MBARI plans to launch an Aerovel Flexrotor. It will be used to look at fronts. It is Styrofoam.
- Ro Bailey - The Gateway is Styrofoam and is very fragile.

5:00 pm ***Adjourn Day One***

SCOAR Meeting, Day 2 – August 15 – Poker Flat Research Range

Opening Remarks – Day 2 of the meeting resumed at the Poker Flat Research Range.

Lighter than Air Platforms – Applications, operations, and issues – David Fisichella provided the report for Jim Hain. His slides are included as ***Appendix XIV*** and include images of various aerial platforms along with the types of studies that they have been utilized for. The images include:
- Twin engine AirCam (light, portable, and can fly low)
- Surveys of Ocean Life
- 30-ft aerostat
- Blimps
- Hybrid blimp RPV (concept)

The capabilities and options for the hybrid blimp RPV include:
- Low and Slow
- Station-Keeping
- Quiet
- Photography & Sensor Packages
- Cost-Effective

David explained that Jim is most interested in aerostats. They provide a stable platform.

Discussion:
- JC Coffey - The Navy has airships as well.
- Dan Schwartz - With tethered blimps, do you have the option to send power? Phil - He doesn't think that the ones in Florida have power up the tether.
- Peter – UTSI is considering a road-transportable system
- Steve Hartz - Is the air cam experimental? David - It is experimental.
- David - How do the funding agencies support work on experimental platforms? Dan - if you can get the risk managers on board at your institution, the agencies will be more supportive.
- Phil M - He wonders about the pull requirements for the blimps. What will be the requirements for winches etc. for the ships that are towing the airships? There are good applications for long term observations.

WHOI Unmanned Aircraft Vehicle Operations – David Fisichella provided a report on WHOI UAV systems, operations, and planned activities. His slides are included as ***Appendix XV***.

David reported on the WHOI UAS history, funding, and projects. He got into remote control flying a few years ago. He has been working with Hanu Singh at WHOI. Hanu partnered with a scientist who was studying penguins and the Greenland ice sheet. The Greenland scientist wanted an ice mosaic - long distance and long duration. They used a 4-stroke engine with a cranberry bottle as a gas tank. They had no idea how the system would operate in low temps. The PI expectations were very low. They were confronted with a work environment that was very challenging, but were able to get a couple flights completed. There were a lot of logistic issues. Instead of letting science drive the instrumentation, WHOI developed tools and let the scientists know what is available. It was very well received.

Projects and interest include:
- Princeton Low Alt. Gas Analysis
- Penguin Studies
- Greenland Ice Sheet
- Puerto Rico Reef Study
- Martha's Vineyard Coastal Zone
- Waquoit Bay National Estuarine Research
- Reserve Habitat/Vegetation Census

WHOI UAS Platforms include:
- Fixed wing - These vehicles are low and slow, gas or electric power, and easy to box up for shipping. The air frames are mostly disposable.
- Multi Rotor - The helicopter cost is about $700. It is quiet and easily flown.
- ADM2 - Autopilot and IMU

Future plans for the WHOI UAS include:
- Launch/Recovery from Ships
- WHOI Center for Marine Robotics – The Center is under development now. It covers the whole spectrum of robotics. Dave Mandel is the lead at MIT. Larry Madin is the lead at WHOI.
- Create Self-Sustaining Group
- Develop Operator Model - Shared-Use Pool
- Advanced Sustained Flight Experiments

Dan Schwartz suggested that we have next year's SCOAR meeting at WHOI.

Flow-field Visualization and Incorporating unique capabilities into UAS which are ideal for take-off and landing on ships - Mandyam (Srini) Srinivasan (U. Queensland) provided a report on "Insect-inspired vision guidance systems for UAVs." His slides and associated video clips are available as ***Appendix XVI***.

Srini showed an illustration of a vision system for visually guided terrain following and landing. The vision system is shown on an enlarged scale relative to the aircraft in order to clarify its configuration. The imaging properties remove perspective distortion, scales down image motion, and defines a "collision free" cylinder.

They are looking to use optic flow alone to control landing and terrain following. The ground is monitored through a curved mirror. This allows the ground terrain to be

monitored much more accurately. Optical flow data is received in real time. Srini showed a video clip of the ground terrain as seen from the camera that utilizes the optical flow data. The collision free cylinder is useful in terrain following, gorge following, obstacle avoidance and landing. At every instance in time, a measurement is being made. The system simulates the Ocelli where insects have multiple eyes for visual horizon sensing.

They conducted various flight tests:

- Guided over terrain following the mirror Collision-free cylinder.
- A closed loop flight test in manual and in auto mode.
- Test of horizon-based attitude sensing system.
- Horizon-based closed-loop control of roll and pitch

A video clip of the horizon-based attitude sensing system flight test was shown. It was tested in clouds, rain, etc. The system uses fisheye type cameras. It is similar to honey bee eyes. This is a good application for ocean flights

In 'Manual' mode a human pilot controls attitude. In 'Automatic' mode, horizon-sensing autopilot regulates attitude. A Chart showing the results of manual versus auto mode are in the slides. An extreme maneuver was accomplished autonomously by controlling the position of the horizon in the I-Eye vision system. A chart shows the comparison of the automatic versus best manual landings. The automated landing results were very good and comparable to the manual landings.

Discussion:

- Dave Fisichella - This could be integrated to Google Earth.
- Peter - Can you take an image of the ship and then program the craft to land on it? Srini - You can have a GPS target.
- Srini - At the very end of the flight, the optical flow system becomes unreliable due to the grass surface, etc. Then it is necessary to switch over to manual. I you are trying to land on still water with sunny skies, there can be problems. They system gets confused.
- Luc - This is impressive. The real-time applications are very useful.
- This technology could be applied to aircraft landings on rolling ships. The SCOAR could submit a proposal for an application.

UAF UAV Operations and Future Plans – Greg Walker provided the report on UAF UAV operations. His slides are included as ***Appendix XVII***.

UAF has worked with a variety of aircraft systems including Mavericks, Dragon Flyer, Ravens, Skylark, Pumas, Predators, etc. UAF has a research center for small, unmanned aircraft systems providing integration of unique payloads and supporting pathfinder missions within government and science communities, with a special emphasis on the arctic region. The University is focusing on evaluating unmanned system operations and identifying hurdles for a new capability to become a financially feasible enterprise.

One area that has been evaluated for the use of unmanned systems is for Ice Seal Population Study. There is a scientific need related to the Marine Mammal Protection Act mandates. They evaluate ship-based unmanned aircraft for the study. They found that the use of unmanned systems would allow safer (than manned aviation over Bering Sea) and more effective (they do not startle seals) operations as compared to manned aircraft.

Greg showed an example of data products from the University built High Resolution Payload system. It shows relaxed spotted and ribbon seals (more accurate count potential than manned aircraft).

Some other applications for unmanned systems and technology developments include:

- Shoreline Clean-up Assessment
- Technique (SCAT) Evaluation
- High Arctic Ship Piloting Experiments aboard the Canadian Cutter LOUIS S. ST. LAURENT
- Navigating Sea Ice
- During The Nome Fuel Delivery
- Augmenting Steller Sea Lion Surveys
- Steller Sea Lion Habitat Monitoring
- UAS Survey of marine debris generated by 2011 Japanese tsunami
- Sea Ice Studies
- Ice Profiling LIDAR – Technology has been deployed by NASA in Greenland and Svalbard Norway now readied for UAF ScanEagle.
- Sea Surface Temperature Measuring- Ball Experimental Sea Surface Temperature (BESST) Radiometer
- Surface Conductivity ARIEL - Airborne L-Band Radiometer
- Miniature Synthetic Aperture Radar
- Small UAS Training/Development – Approximately 160 Ravens are available for the training. This offers education and outreach opportunities
- iPASS - UAF's Portable Airspace Surveillance System,
- Designed and built by UAF for Alaska's airspace monitoring needs.

Lastly, Greg discussed the 2012 FAA Modernization and Reform Act. The Act includes Unmanned Aircraft language for the Permanent Arctic - "permanent area in the Arctic where small unmanned aircraft may operate 24 hours per day for research and commercial purposes below 2,000 feet in altitude." There is a Call for a process by August 14, 2012 to facilitate safe operations over water within all the areas identified, not a single geographical location. UAF is helping the FAA UAS Integration Office develop this process.

There is a competition to operate six test ranges - "... to integrate unmanned aircraft systems into the national airspace... to provide for verification of the safety of unmanned aircraft systems and related navigation procedures...In determining the location the Administrator shall (A) take into consideration geographic and climatic diversity; (B) take into consideration the location of ground infrastructure and research needs". Alaska will extend the University pilot program with the FAA. Alaska will compete for one of the six FAA test ranges. The University of Alaska will lead the Alaska team. Alaska is investigating partnering with Hawaii. They are looking for suitable locations where need exists in Hawaii.

Greg showed actual examples of some of the aircraft that UAF has worked with along with some video clips. A video of Puma operations was shown. It is a lot bigger than the Raven. It was used during a 3 week trip and sailed past all of the Aleutian Islands. The goal was to fly unmanned aircraft to observe the animals and to try to understand why they are leaving the habitat. An FAA official accompanied them. The aircraft could fly very low without

interrupting the mammals. The puma is designed for maritime environment. They flew 39 missions. Flights were regularly flown in rain and snow, but not in sleet. The fisheries industry paid for the operation. The video from the fixed wing was disappointing. It was not designed for maritime applications.

Greg discussed the mosaic capabilities. There is software now that allows you to dump the images into a file and it automatically correlates and mosaics. IT takes out the aircraft data. It knows how to stack the images laterally and vertically. Process can be completed overnight.

Discussion:

- Phil - The satellite images don't come in real time. It doesn't reflect what you need to know right away. Also the images are so large. The aircraft images are better and come in real time. They would like to look at oil on the ice, but are not allowed to pour oil on the ice. He expressed interest in the UAF sensors. Greg - Everything is open source.
- Phil – Is UAF working on an autopilot? Greg - Yes. The military striped the electronics from the Ravens, which was a good thing. UAF has put electronics package in that cost about $300. You can fly the aircraft in manual mode or you can fly it in auto mode.
- Phil - What are the training requirements for the Raven? Greg - The training is 2 weeks.
- Phil - Is the reason that the FAA doesn't have to certify the training because it was never required? Greg - correct.
- Greg - UAF would love to partner with WHOI on the Ravens.
- Luc - Will you be able to get more than 160 ravens? Greg - probably.
- Phil - he has a lot of groups that would like this technology, such as, fisheries applications in remote areas. Greg - UAF could partner on this.

SCOAR Action Item – It was suggested that SCOAR develop best practices for UAVs. UAF should take the lead on this as part of their Range proposal and on based on their vast experience with unmanned systems. Ro volunteered to be the lead. The best practices would be applicable to all UNOLS institutions.

Annette suggested that all interested groups such as technicians, ship captain, marine op groups, and science be involved in drafting the best practices.

SCOAR Outreach Activities - Report on SCOAR outreach activities in 2012 at the Ocean Sciences meeting **–** Annette DeSilva and Phil McGillivary discussed the SCOAR booth. Slides that include photos from the Ocean Sciences meeting are included as ***Appendix XVIII***.

- The flat screen in the booth was very worth while. It was used to show aircraft video clips.
- Phil suggested having mini talks at future venues.
- The swag was popular.
- The SCOAR town hall meeting at the Ocean Sciences two years ago was well attended.

SCOAR Membership – The current SCOAR membership list is included in Appendix XIX. One position will open in 2013. There will be a call for Nominations.

Next SCOAR Meeting – David Fisichella offered to host the 2013 SCOAR meeting at WHOI.

1:00 pm Adjourn SCOAR meeting

Afternoon **- Poker Flat Research Range Tour –** Following the meeting, participants had an opportunity to tour the Poker Flat Research Range and view a UAV flight.