DRAFT

Scientific Committee for Oceanographic Aircraft Research (SCOAR)
June 22 and 23, 2010
CIRPAS Facility, Marina, CA

Meeting Minutes

Executive Summary:

The Scientific Committee for Oceanographic Aircraft Research (SCOAR) met on June 22-23, 2010 at the CIRPAS Facility in Marina, CA. Dan Schwartz chaired the meeting. This was the first in-person meeting of the Committee since 2006. The meeting focused on re-familiarizing everyone with of the CIRPAS facility and mapping out the future role of SCOAR.

Appendices:

The SCOAR identified the following list of action items (short and long-term):

- Meet with agency reps at ONR and NSF. Inquire into the status of NSF's MOU – Oct 12th – Dan and Annette
- Check SCOAR broken links – UNOLS Office
- Submit a proposal for a proof-of concept experiment for a launch/recovery UAV demo on a Navy owned UNOLS Vessel – Ken Melville, Bob Bluth, Steve Hartz, Dan Schwartz, Phil M
- Update SCOAR website
- Call for SCOAR Nominations - collect names.
- Circulate revised Term of Reference to SCOAR
- Update SCOAR_Plus email lists – check for ~airborne email list~
- Sensors and Tools: (CIRPAS/SCOAR)
    - Determine the inventory of available sensors and tools.
    - Review and update the list of capabilities (sensors and tools) that should be available to oceanographers
    - Prioritize

- Draft a SCOAR/CIRPAS brochure – Dan, Erin, and Annette
- Propose an NSF workshop in relation to ocean observing systems – follow up at agency meetings, etc. – Phil and Dan

Meeting Summary Report:

Welcome and Introductions: Day 1, 22 June 2010 – Dan Schwartz, SCOAR Chair, opened the meeting. We learned that the CIRPAS Twin Otter would be leaving for a mission that afternoon, so the agenda was altered so the Committee could tour the aircraft. Haf Johnson provided the tour.

Welcome by SCOAR Chair and Introduction of Participants – Dan Schwartz reconvened the meeting and provided an opportunity for participant introductions. The agenda for the meeting is included as ***Appendix I*** and the Participant List is ***Appendix II***.

Dan provided a SCOAR Chair report. His slides are included in ***Appendix III***. He began by reviewing the SCOAR membership. SCOAR was asked to provide suggestions for members who were rotating off the Committee. Steve Ramp suggested Jack Barth (OSU).

Over the past year there have been a variety of Oceanographic Aircraft workshops and meetings of interest:

- There was the June 11, 2009 SCOAR teleconference. The minutes are available at http://www.unols.org/meetings/2009/200906sco/200906scomi.pdf.
- On Sept. 15-16, 2009 there was the 2nd Annual Alaska UAS Interest Group meeting. Steve Hartz attended the meeting and indicated that it was very well attended.
- On Nov. 9-10, 2009 the Interagency Coordinating Committee for Airborne Geosciences Research and Applications (ICCAGRA) met in Tampa, Florida. ICCAGRA has been revitalization.
- On Feb. 22-26, 2010 at the Ocean Sciences Meeting, SCOAR held a Town Hall Meeting. The Town Hall session was very well attended. Additionally Dan and Phil participated in the poster session on Ocean Technology & Infrastructure Needs for the next 20 Years.
- On Sept. 19-24, 2010 the MTS/IEEE Oceans Meeting will be held in Seattle, WA.

Dan continued his report with a brief description of the CIRPAS facilities and aircraft. CIRPAS became a UNOLS National Facility on 27 September 2002.

Next Dan highlighted the various aircraft platforms and systems that were presented at the SCOAR Town Hall meeting at the Ocean Sciences meeting in Portland, OR.

Dan showed a video clip of a launch and recovery of UAF Unmanned Aircraft from a NOAA research vessel. The aircraft was Scan Eagle.

Discussion:

- Steve Hartz – Shell Oil is using a Scan Eagle for marine mammal observations.

- Phil McGuillivary –The smallest vessel used with Scan Eagle was 34-feet
- Bob Bluth – Unmanned Aircraft Vehicles (UAVs) can also be recovered from water landings
- Phil – There can be watertight issues. To be watertight, it may also be airtight and then overheating becomes an issue.

Agency Representatives, UNOLS, and CIRPAS Reports:

UNOLS Report –Annette DeSilva provided an update on UNOLS activities and issues. Her slides are included as ***Appendix IV.***

The topics that were covered include:
- UNOLS Vessel Operations in the Gulf of Mexico
- Fleet Renewal Activities
- Ocean Class Acquisition (Navy)
- Regional Class Acquisition (NSF)
- Alaska Region Research Vessel, R/V *Sikuliaq*
- The effort to evaluate the decline in Ship Time Demand
- UNOLS Mentoring/Education/Outreach
- Ocean Observing Science Committee (OOSC)
- Antarctic Research Vessels and UNOLS
- UNOLS Charter Review
- Greening the Fleet
- Rolling deck to Repository (R2R)

CIRPAS report - Bob Bluth provided the CIRPAS report. His slides are included as ***Appendix V.***

Bob provided an overview of the CIRPAS Facilities including the Marina Facility and the Camp Roberts Facility. The Camp Roberts Facility costs about $7,500 a week to use the facility. This is restricted airspace and can be used for AUVs. They cannot fly after midnight. Getting additional access for restricted areas is very difficult and probably takes about five years to get set up.
- Phil – Another area for UAV operations that should be explored is other countries. Norway is receptive.
- Bob Bluth - Twin Otter has operated in Japan, Chile, and Barbados. To try to do this with UAVs would have been tricky. They would have had to provide airwave certificates. Operating predators is more expensive than operating manned aircraft.
- Phil – It still looks like Alaska is the best option for UAVs. Bob Bluth – Open water might be a possibility.

The characteristics and payload of the research aircraft, Twin Otter, were reviewed. There are hard points and pods for ‘research’ or ‘guest’ instruments. The cabin includes racks for ‘research’ and ‘guest’ instruments.
- Phil McGuillivary recommended posting the pod size on the CIRPAS webpage.

Some examples of CIRPAS scientific instrumentation include a 95 GHz Cloud Radar, Wind Lidar, and Smart Towed Vehicle. New instrumentation includes a stabilized radiometer platform and a micro-sized air-launched expendable meteorological sensor and chaff.

Bob described the CIRPAS Pelican Predator Surrogate that is an ideal training platform. It hasn't been used much for science.

Bob explained that CIRPAS' unmanned aircraft vehicles haven't been used in years. Their operations are limited by the FAA and must comply with the 90-mile line of sight regulation. When you remove the pilot, you still must fill the function of the pilot. Some times this means sending a second plane to observe the UAV.

CIRPAS also has Scan Eagles and these are available to the community.

Bob Bluth suggested that UNOLS could assist with the integration of NSF into the CIRPAS. The meeting participants discussed the agency contacts who might have an interest in CIRPAS. It was suggested that Dan Schwartz and Annette work to schedule a meeting with NSF representatives during the week of the UNOLS fall meetings. It might also be helpful to draft a pamphlet about CIRPAS.

Office of Naval Research (ONR) – Mike Prince provided the report for Tim Schnoor (ONR). Mike reported that Tim is a retired Navy captain at ONR in Facilities and he attended the Naval Postgraduate School (NPS). The ONR Research Facilities budget is about $10M and it hasn't changed for years.

Discussion:

- Bob Bluth – One of the big hurdles for CIRPAS is that scientists who request the aircraft must include the operating costs in their Science proposals.
- Mike – It would be good to have some or all of the CIRPAS funding included in the Facilities budget.
- Bob – Since NPS is an institution, it can have a grant with NSF. SCOAR should explore better integrating NSF with CIRPAS. Can there be an MOU.
- Mike reported that Tim Schnoor would be interested in supporting a proof-of-concept demonstration of a Scan Eagle off a Navy owned vessel. One of the reasons is that Navy is in the design process for Ocean Class ships. If SCOAR wants to coordinate this effort it would be welcome. CIRPAS has Scan Eagles that can be used.
- Mike suggested that as the Committee reviews the UNOLS Charter, the focus needs to be on the National Oceanographic Aircraft Facility, CIRPAS. We need to look at how to make to SCOAR a user facility.
- Nick Shay – What science can be carried out on the CIRPAS aircraft?
- Steve Ramp – If we want to make the facility attractive to Physical Oceanographers, we need to know what they want to use in terms of sensors.
- Bob Bluth – When CIRPAS obtains a new sensor, they need to find a mentor who will be on-board for the long term.
- Bob Bluth – If we do a demo on a Navy vessel, CIRPAS could provide the Scan Eagle and launcher, but the scientist would be needed.

- In the 2004 November SCOAR Meeting minutes – there was a list of Aircraft Flight Parameters, Appendix IX: http://www.unols.org/meetings/2004/200411sco/200411scoap09.pdf.

Ken Melville (SIO), who uses the CIRPAS aircraft, joined the SCOAR meeting and was asked for his feedback about the CIRPAS facility. Ken replied:

- His Current project is funded by ONR and uses three platforms – the Twin Otter, R/V *Sproul*, and FLIP.
- Waves are measured with marine radar and then they compare the radar data with what they see at sea. The algorithms aren't that good.
- FLIP unfortunately broke a mooring line and is out of the experiment. The core experiment is still on-going. The aircraft is a ground truth for the experiment.
- Ken had a lot of praise for the pilots.
- Air sea interactions are a big area that can be carried out with the aircraft. These facilities are essential.
- They can do sub-meter resolution.
- There has been a lot of controversy about taking gas flux measurements from a ship. As long as you can get low and into the layer, aircraft is the way to go.

Discussion:

- Mike – Are there sensors that are not readily available on the CIRPAS facilities?
- Ken – He thinks that it is best for the user to bring his/her own equipment. CIRPAS doesn't have the facilities to do this.
- Ken – There was one item that he was expecting from CIRPAS, but it was not available – "WINS." These are essential.
- Phil – Are there sensors that can measure relative humidity when flying at the surface? Ken – You would probably have to do this by modeling.
- Ken – In his opinion, turbulence and heat flux sensors are priorities. The hardware, software and user manual should be available.
- Ken – There is too much work for one person. Haf provides all of the support, science and technical service. More resources are needed.
- Bluth – The CIRPAS operating costs are based on hanger rent, people costs, etc. Haf keeps the rates low.
- Ken – Younger people who would like to use the CIRPAS facility won't have the experience to support a program. They need to rely on Haf.
- Ken – The mentoring program needs reconsideration.
- Bob – Keeping people is tough. So far CIRPAS can sustain what they have, but every cost that they have is paid through the operations. The A-10 that is coming from NSF is reimbursable. It is not burdening CIRPAS. NSF will support it for the foreseeable future.
- Mike – Some of the things that SCOAR should be considering is if the funding mechanism for the Twin Otter is a viable one. SCOAR should consider the future of CIRPAS and who is going to be supported by the facility.
- Dan –SCOAR should consider what is the optimal model for CIRPAS.
- Phil – both NOAA and NASA have moved away from the smaller aircraft. This is an area that CIRPAS can fill.
- Bob Bluth – CIRPAS has six Scan Eagles

- Mike – There would be interest in supporting a proof of concept experiment for the Scan Eagle deployment from a Navy owned vessel. This would need to be a science program.
- Ken Melville – Flying UAVs out of Australia may be less logistically complex. South Pacific would be a good area for an experiment. He would be interested in the science UAS proof-of-concept demo.
- Phil – SCOAR might want to consider organizing a workshop.
- Steve Ramp – SCOAR might want to consider someone from the National Marine Sanctuary as a workshop guest speaker and ask him or her to speak about his or her plans for their aircraft.

National Science Foundation (NSF) Report – Jim Huning could not attend the meeting, but he provided a set of slides. The slides are included as ***Appendix VI***. The slides include information about the:

- NSF Sponsored Lower Atmospheric Observing Facilities.
- The King Air is supported through Cooperative Agreements at the University of Wyoming (King Air)
- An MOA is in progress to use the CIRPAS Twin Otter at the Naval Post Graduate School. The Twin Otter would be part of the deployment pool.
- NRL P-3B integrated with ELDORA and supported through an MOA for approved ELDORA field campaigns
- There are interagency campaigns conducted in collaboration with interagency partners, e.g., NOAA, NASA, NRL, DOE, and EUFAR members.
- The flight hours for the various craft were reviewed for a grand total of 4182 NSF flight hours.
- The 2010 planning chart with proposed field campaigns for balance of 2010 and into 2011/12 was included in the slides.
- The various aircraft used by NSF are listed in the slides.
- UASs will play an increasing role – recent and extensive use is in the Antarctica.

NOAA's Hurricane Research Division - Phil McGuillivary presented a summary of the program titled, "Using the Aerosonde UAV during the 2005 Atlantic Hurricane Season." His slides are included as ***Appendix VII***. A UAS was used to help the researchers get data that they couldn't ordinarily get. The Principal Investigator for the project was Joseph J. Cione.

The project goal was to successfully fly an Aerosonde UAV into a tropical cyclone during the 2005 N. Atlantic hurricane season. Funding for the project was from NOAA/OAR, NASA, and the Aerosonde Corporation. The results are included in the slides.

Some of the lessons learned included that the UAS data was continuous and better than the dropsondes. The FAA CoA process took more than 12 months and still requires instrument flight rules.

Next Phil provided a report on "Using Aircraft-Deployed Low Altitude UAS in Tropical Cyclones: Testing in 2009 and plans for 2010-11." Phil's slides are included as ***Appendix VIII***. The PIs for the project were Joseph Cione (NOAA/Hurricane Research Division) and Nancy Ash (NOAA/AOC).

The mission plan was to launch, command, and control a Coyote using NOAA P-3 aircraft. Three Coyote UAS were brought onboard the manned aircraft. The plan was to deploy two UAS with the third to act as a back up. The third (and final) Coyote UAS launch was a success. After several minutes of controlled glide descent, the Coyote was fully operational at 5000ft. Coyote continued descent to 1,000ft. The remainder of the flight consisted of repeated ascending and descending controlled soundings between 600 ft and 1000 ft. The last 5-10 minutes of the flight included control stair-step descent from ~600ft UAS down to ~64ft. Four GPS sondes were released during the 50-minute UAS test flight. The last drop occurred as the UAS was at ~100ft altitude.

Post-mission observations and lessons learned included:

- BAE's difficulty in obtaining timely UAS pre-flight initialization. It was the first time BAE operated/worked with P-3/AOC personnel and improvement is expected next time.
- Weaker than expected P-3/UAS in-flight communications. After speaking with BAE engineers, they are confident gain can be greatly improved with a stronger antenna/receiver system. BAE says they already have a fix for this and expect no issues going forward.
- Short battery life. The 50-minute duration will be dramatically increased once a shorter pre-flight routine is established. Reducing/eliminating 'up soundings' would also increase duration. BAE also feels that increased battery power (for enhanced duration) is possible and should not be a major issue going forward.

The Primary Low Altitude UAS Tropical Cyclone Mission Objectives were to provide observations from an important region of the storm that is very difficult (and dangerous) to observe. They hoped to fully demonstrate the UAS' overall capabilities in a variety of conditions within a hurricane environment. Including operations at very low altitudes (<200ft).

Phil reviewed the 2010 and 2011 objectives and plans (details are provided in the slides).

An Interagency Hurricane Conference was held in March 2010 to discuss "Low Altitude Observing Strategies." The general guidelines for low altitude UAS hurricane missions include:

- Fill an existing critical low altitude data void in hurricanes
- Complement and support NOAA's existing research & operations
- Minimize mission and regulatory 'risk' (increase the likelihood for success)
- Minimize Cost

The pros and cons of the execution of a low altitude UAS TC flight mission was presented and included Land-launched vs. Air-deployed UAS' (see slides for details).

The pros include:

- Fill existing critical low altitude data void in tropical systems (significant benefit to both research and operations)
- Ensure safety (No need for low level manned flight in hurricanes below 5kft)
- All UAS operations now fall within NOAA's existing ORM (risk management)
- Potential to expand coverage now exists now

While the cons include:

- Limited payload capability (power/weight/endurance issues)
- Limited instrumentation options (cost ceiling- given 'expendable' nature of platform)
- Regulatory risk (land-based has higher risk but air-deployed still has some exposure)

The pros and cons of Land-launched UAS' are:

Pros:

- No 'Mother ship' required
- Obtain observations 100s of miles from TC in addition to inner core

Cons:

- To date, restrictive range limitations exist (~500mi 1-way). Mission execution determined by TC position relative to a fixed UAS deployment location.
- Significant ingress and egress mission failure risk. (Flight into and out of the storm comprise >70% of UAS mission time.)
- Significant regulatory risk. (FAA is especially leery of 'fair weather' ingress/egress portions of the proposed flight)
- Operations require very early deployment of the launch team, often days before an inherently uncertain event. (increased mission failure risk)
- Very high cost in dollars and in time. Consistent successful execution of this conop requires several pre-position deployment sites and teams. Large travel and labor costs including multiple site surveys and months of planning to coordinate. Many logistical issues need to be addressed (including: lodging, ITAR import/export regulation, securing required national and international airspace clearances, operator clearances, local media requests, etc).
- Operations potentially involve a complex chain of (required) real-time communication (e.g. ground-based UAS operators, mission scientists, manned aircraft personnel, national/international airspace operators, CARCAH)

The pros and cons of Air-deployed UAS' include:

Pros:

- If manned aircraft is within operational range of a TC, so is the UAS.
- No ingress/egress mission or regulatory risk.
- No need to establish on-the-ground mission assets or team pre-deployments (reduced mission risk, cost)
- Aircraft command and control results in streamlined communications (reduced overall mission risk)
- Leverage of existing NOAA hurricane field operations infrastructure including manned assets (AoC, HRD) and aircraft instrumentation (P-3 launch, command and control, P-3 communications, data, and expendable deployment systems)
- Potential for significant overall cost and personnel savings (pre-season: minimal logistics set-up time and cost; in-season operations: reduced travel and labor costs)

Cons:

- If manned aircraft is out of operational range, so is the UAS. (Mother ship dependent)
- To date, limited endurance/range capability (restricted storm coverage/UAS)

SCOAR Meeting, Day 2: 23 June 2010

UAV Experiment - Ken Melville kindly agreed to participate in the SCOAR meeting and provided a report on a UAV experiment that he is involved with. Ken is affiliated with the Marine Physical Laboratory and the Physical Oceanography Research Division of Scripps. His group's primary area of research is air-sea interaction, including the topics of surface wave dynamics, air-sea fluxes, and upper ocean turbulence. Many of these processes and phenomena are influenced directly by surface wave breaking.

Ken reported that a UAV system to measure air-sea fluxes of momentum and other variables in the marine atmospheric boundary layer (MABL) along with simultaneous surface wave measurements is being developed. This technology will permit measurements at low altitudes that are too dangerous for human flight. This low altitude (O(10) m) capability will result from the use of laser altimetry, differential GPS (DGPS) and inertial motion units (IMUs) to provide input to the controls for low altitude flight.

Information about Ken's experiment follows:

- The experiment uses two UAVs.
- The Manta aircraft was used initially.
- The Manta payload was suitable and it could fly in stacked formation.
- The acceptance test was in April 2009 in Tucson, AZ.
- The ground team for the UAV operations is two, but FAA will require a 3-person team.
- The UAVs have navigation lights and transponders.
- Ken's group built their own data collection system
- The system was tested on a truck.
- Images of the upper and lower UAV sensors were displayed.
- It is becoming recognized that wave measurements are essential and this can be done with the UAV.

Part of the experiment was to demonstrate that experiments can be done from manned aircraft. An Airborne LIDAR system was used. Existing lab equipment was assembled to form an Airborne LIDAR system. Research flights in a Piper Twin Comanche provided data of the Southern California coastline and near shore ocean environment. Additionally, research flights aboard a Cessna Caravan in April 2008 used scanning LIDAR to survey Lady Elliot Island (LEI) and surrounding waters, in Australia's Great Barrier Reef.

Ken also spoke about the Arctic aircraft applications. The experiments can be done with two UAVs, but he feels that the initial studies should be done with a Twin Otter. Air space issues are non-trivial even in the Arctic.

Discussion:

- Dan Schwartz – it would be good to do a comparison of costs between Twin Otter towing the CTV as compared to operations with two UAVs.
- Ken - His preference is a rational combination of manned and UAV systems.
- Luc Lenain – In a recent operation, the Twin Otter was used in Begota Bay and they were able to identify a front. The operations were joint with R/V *Sproul*. The only way *Sproul* was aware of the front was from the aircraft survey.
- Ken showed an image of the front. There was upwelling. This couldn't be seen with a satellite.
- Ken – This could offer a good science demo of a UAV operation from an AGOR.
- Mike Prince agreed. The demo could include the science demonstration and cost comparison.
- Steve Hartz showed videos of a recovery of a Scan Eagle UAV onboard a ship. The UAV was captured with a crane and the recovery was from the 01 deck. The ship length was not more than 110-ft.
- Bob Bluth - In terms of the experiment, the safety guidelines will be needed.

It was recommended that Luc and Ken draft a proposal for a UAV science demo from a Navy AGOR. They should work out the logistics with Bob Bluth.

SCOAR Terms of Reference: The UNOLS Charter requires that review of the Charter and its Annexes be preformed every three years. The SCOAR members reviewed the SCOAR terms of reference, UNOLS Charter, Annex VIII. Many suggested revisions and updates were incorporated into the terms (see ***Appendix XI***). A motion was made and passed to forward the revised UNOLS Charter Annex VIII to the UNOLS Council for consideration (Dan Reimer/Phil McGuillivary).

SCOAR Membership – The SCOAR membership and term dates were reviewed (see ***Appendix XII***). Nick Shay announced his resignation from SCOAR. When he was originally approached to serve on SCOAR, he thought it was for the broader oceanographic aircraft use. He thinks that CIRPAS is making good progress. A replacement for Nick will be needed. Suggestions were discussed.

Incorporating Aircraft into Ocean Sciences - Phil McGuillivary provided a report with examples and images of how aircraft have been conceptualized or utilized in ocean observing and oceanographic research. His slides are included as ***Appendix IX.*** The slides include:

- A Navy concept of an Ocean Observatory
- The prototype Ocean Observing System: SCCOOS
- NASA Aircraft Research, 2010, 2011
    - NASA "ICEBridge" aircraft ice studies flown out of Greenland using ice freeboard LIDAR sensors
    - ScanEagle launch, deployment, and recovery from a NOAA ship
    - NOAA Manta - shipping boxes and launch system
- NASA Aerosonde UAS:
    - Launch system
    - Melt pond mapping

    - Temperature and RH profiles
- Quadroters:
    - NOAA NMFS SWFSC Quadrotor for marine mammal counts, CCALMR (Antarctica),
    - Dragonfly COTS Quadrotor
    - Quadrotor (Nick Roy, MIT) to be mounted on Robo-kayak
- EMBLA, Coanda Effect UAS (UK Dept Defense)
- Tim Veenstra Flying Fish UAS, used off NWHI for NOAA Marine Debris / Ghost Drift Net project, 2008, restricted to 1 nmi from ship, so not particularly effective, but inexpensive.
- Ion Tiger, Navy funded UAS w fuel cell battery = quiet, good endurance
- Australian UAS program for cooperative UAS ops (2 aircraft, coordinated searching)
- U.Queensland BlimpCam for Dugongs
- Univ. Michigan relocatable buoy
- 2010 C130 Aircraft Research Plans
- Canadian Helo Ice Thickness EM, laser & video altimeter

SCOAR Action Item List – SCOAR meeting participants discussed the role of the committee and suggested activities. An action item list was generated and is included as ***Appendix X***. The list is also provided at the beginning of this meeting minutes report.

Adjourn – The SCOAR meeting adjourned at 12:00 noon.