NSF/UNOLS Fleet Improvement Committee (FIC) meeting, 3/5-6/13, La Jolla, CA
SCOAR Report: Status Update & Recommendations re: UAS inclusion into UNOLS Ship Operations

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UAS inclusion into Ship Operations

Background information:

1) Information on FAA & legal UAS ops
2) Information on UAS ops off ships
3) UAS inclusion into ship ops: Information on UAS technology and status of way forward
4) Information on UAS ops in other countries
5) Conclusions and 'way ahead' for NSF/UNOLS: recommendations and priorities

UAS inclusion into ship ops:
1) Information on FAA & legal UAS ops

- FAA is required by Congressional law to develop protocols for UAS operations off N. Slope of Alaska for summer 2013, as a primer for national UAS operations by 2015, when new GPS tracking technology for all aircraft comes online
- Development of standards for >12 nmi offshore in 'international waters' is still under FAA control, and currently still requires "Certificate of Authorization" (COA), and that aircraft be "State" (federal or federally funded) or with more paperwork, "Public" aircraft. Only Dept. of State can define "State" Aircraft: just because you are a federal agency does NOT mean you are a State Aircraft. This requires specific paperwork (eg NOAA UAS do not now qualify as "State" because their paperwork has not been approved, so they are not now allowed to operate in intl. waters under "Due Regard" rules (more later on that)).
- FAA was, as of exactly one year ago, required to draft new requirements on what constituted "hobbyist" unmanned aircraft: they are well over a year away from drafting these new regulations … requirements will be UAS < 50 lbs, and ops at <400' altitude
- Current federal inter-agency regulations are being developed by the Inter-agency FAA UAS Remote Operating Area Working Group (headed by USCG), whose priority is to get N. Slope of Alaska UAS ops protocols in place for summer 2013.
- FAA existing regulations are both unclear and complicated: at present either a chase plane, or at least a ship-mounted radar is required…however these regulations are in flux…FAA has not yet determined what rules will actually apply….which is part of the 'problem'. Things are being worked out NOW however.

UAS inclusion into ship ops:

2) Information on UAS ops off ships

- L. Lenain has provided background on SIO ops to date for Melville group. Ramanathan group at SIO has also operated multiple UAS at different altitudes off UNOLS vessels, but in international waters
- Other US groups have operated off foreign RVs and in foreign airspace due to FAA restrictions
- MBARI and WHOI have operated UAS in recent months from ships; they have done this as 'hobbyists' which legal certification is, um, 'questionable' in eyes of FAA, and by their admission unsustainable into the future. MBARI used UAS to locate fronts and direct AUVs to them, saving batteries. WHOI is still developing UAS use scenarios, but is keenly interested in using UAS for COASTAL (ie <12mi) operations, not just >12mi ops. SIO ops and WHOI ops to date have been mostly coordinated with DoD/NAVY management… which will not be relevant to a path forward for NSF-funded and other operations… We have work to do here re how to achieve NSF/ UNOLS goals

UAS inclusion into ship ops:
2) Information on UAS ops off ships (contd)

Upcoming UNOLS UAS ops off ships:

1) @May 2012 ONR/DoD ScanEagle ops off KNORR (Melville group, ONR will handle paperwork
2) SIKULIAQ, UAF Quadrotor UAS ops, @March 2014 ops in ice, for ice recon
3) Navy AGOR vessels (NEIL ARMSTRONG and TBD) at WHOI and SIO: will want UAS inclusion also
4) HEALY dedicated 6-day UAS cruise Aug. 15-21, 2013 (assuming no cruise cancellation due to sequestration) involving NOAA PUMA and USCG R&D Center personnel off N. Slope

UAS inclusion into ship ops:
3) Info on UAS technology & status of way forward

Key issues for UAS ops off UNOLS vessels are threefold:

1) Launch & Recovery
2) UAS Video data ingestion, geo-referencing, archiving, and computer & bridge integration, and 'search-ability': including issue of computer systems to accomplish this
3) Technology development & integration with OOS and other research (eg Ocean Acidification, marine mammal studies, ocean color studies, air-sea flux, ie integration with AUVs & ASVs & OOS)

UAS inclusion into ship ops:
3) Info on UAS technology & status of way forward

Three current methods of UAS LARS (Launch And Recovery Systems):

1) Shipboard LARS: eg ScanEagle UAS: compressed air hydraulic launch, 'tetherball' aka SkyHook recovery
2) PUMA UAS: air hydraulic launch, small boat/ water recovery
3) Hand launch, net or hand recovery 'on deck' eg RAVEN, Quadrotor UAS, or 'transition' UAS (which do LARS vertical but transition to horizontal after launch)

UAS inclusion into ship ops:

3) Info on UAS technology & status of way forward

- You have seen Luc Lenain info re ScanEagle LARS via air pressure hydraulic launch & Skyhook recovery…. Disadvantages: (1) relatively expensive system; (2) launcher has significant deck space requirements, and safety issues related to air hoses and cables across deck; (3) launch includes @30-40G's…a lot of acceleration requiring 'tough' sensors… this is more acceleration than crash landing!

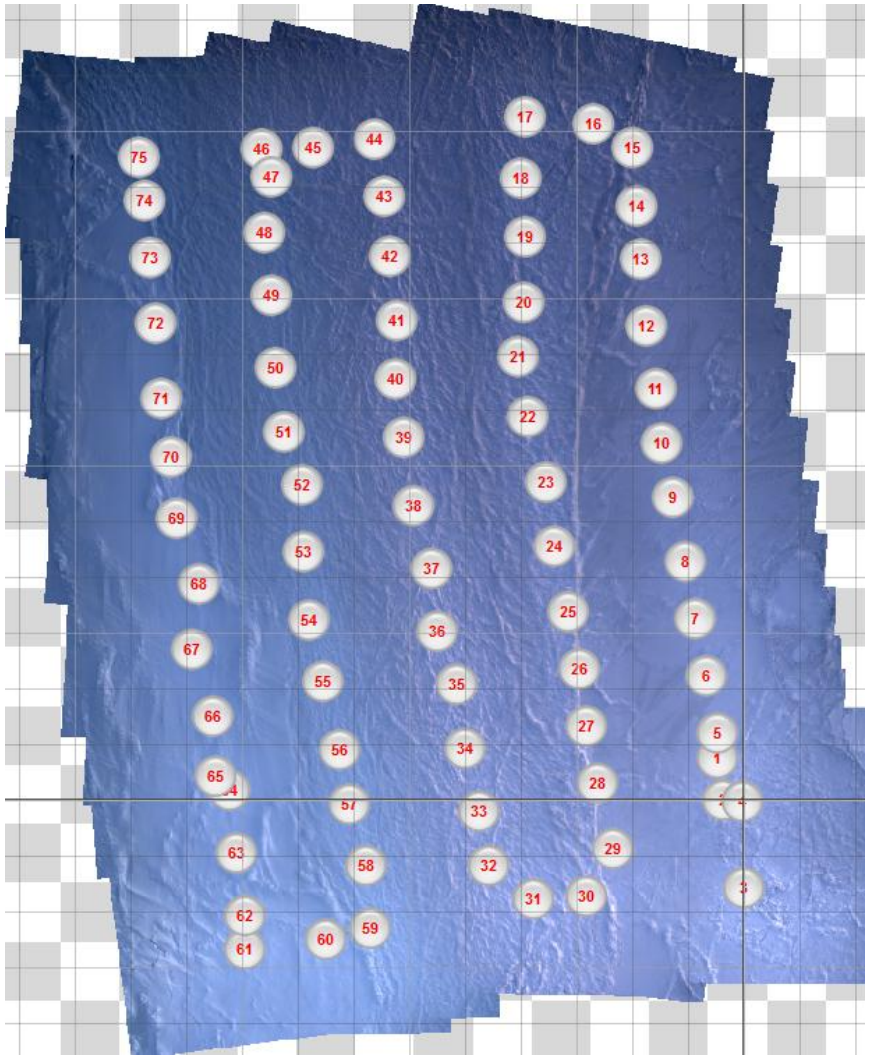
UAS inclusion into ship ops:
3) Info on UAS technology & status of way forward

Five alternatives to ScanEagle:

1) Quadrotor (eg Aeryon Scout, see next slide): simply program GPS waypoints, hit a button and off it goes: automated launch and recovery. Disadvantages: not so good in winds >20 knots, and limited range/ endurance. Advantage: cheap, >$5K, easy to use, provides vertical view of fronts, etc., easily.
2) Transition Robotics and Aerovel Flexrotor UAS: these UAS launch & recover vertically, then fly horizontally (see pix next slides). This appears to be the main system of the future for ships: pay attention!
3) Propulsive Wing design UAS: can operate at extremely high angle of incidence, operated by fan within wing which can be turned off when over ship, and simply drop to deck. Huge sensor payload capability, but endurance and wind speed limits unclear ATT. (See pix next slides)
4) NOAA PUMA: launch via air hydraulics, recovery in water. Disadvantages: need small boat ops to recover: time consuming
5) 'Regular' UAS w hand (or hydraulic) launch and net recovery. Advantage: easy to use w trained operators; disadvantage: need to mount nets on ship, potential for UAS damage on net recovery. OK for S-UAS. EU nets more flexible than those used in US, better recovery, less damage.

UAS inclusion into ship ops:
3) Info on UAS technology & status of way forward:
Aeryon Scout Quadrotor UAS

UAS inclusion into ship ops:
3) Info on UAS technology & status of way forward:
Aeryon Scout Quadrotor Pre-programmed Flight Path, Nome, Jan. 2012



UAS inclusion into ship ops:

3) Info on UAS technology & status of way forward:

Aerovel Flexrotor: takes off & land vertically (LARS resembles a horizontal 'comb' w 'slots' for landing, transitions to horizontal, ONR contract, May 2012:

http://www.aerovelco.com/Flexrotor.html

UAS inclusion into ship ops:

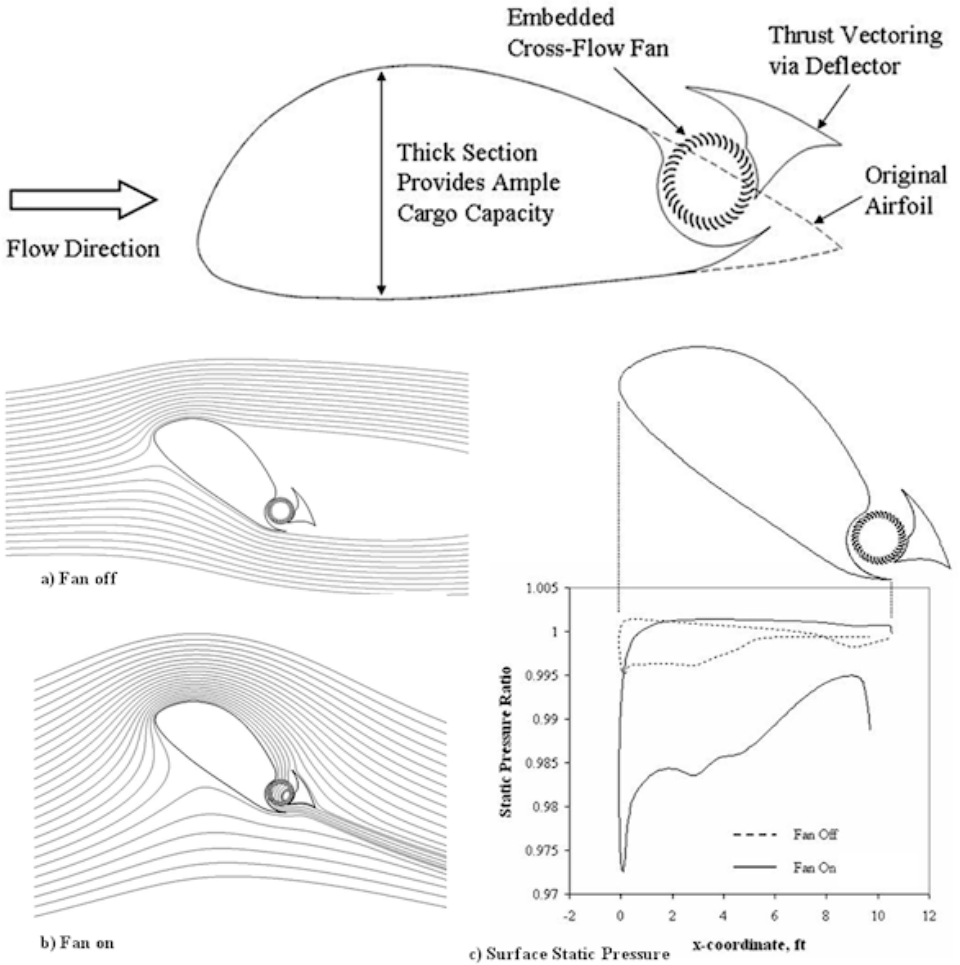
3) Info on UAS technology & status of way forward:

NOAA PUMA air-hydraulic launch, water landing…

advantage: if you don't make ship deck, you don't lose UAS, and certified MilOps, which FAA likes; disadvantage: ship time, and small boat ops

UAS inclusion into ship ops:

3) Info on UAS technology & status of way forward: Propulsive Wing…great payload, easy launch (no high G hydraulic takeoff, near-vertical) , stalls to land on deck- turn fan off



UAS inclusion into ship ops:

3) Info on UAS technology & status of way forward:

Info on UAS technology & status of way forward - Shipboard net recovery, note very flexible EU nets

UAS inclusion into ship ops: 3) Info on UAS technology & status of way forward:

- Key point: UAS Technology is still VERY rapidly evolving, do NOT assume technology today is technology of tomorrow!
- E.g.: battery developments already allow SUAS to remain aloft at least 40 hrs.
- New battery technologies in existence NOW will increase endurance/range when applied to UAS
- UAS sensor systems are rapidly shrinking, also increasing range/ endurance
- Ability to beam energy to battery powered UAS from ship/ground to keep them aloft indefinitely without landing exists NOW; not been tested off ships yet, but we seek to test ASAP.
- Goal will be to keep UAS aloft WITHOUT deck landings. This IS achievable in near future.
- Hi-altitude persistent UAS are being tested now; will interface w ship-based or shore-based UAS. These will be VERY important.

UAS inclusion into ship ops:
3) Info on UAS technology & status of way forward:

So far we have discussed UAS technology, including re launch & recovery (LARS).

The other issue is computer systems on ship.

This is a non-trivial and key issue for SIKULIAQ and two NAVY TAGOS.

What is involved?....

UAS inclusion into ship ops:
3) Info on UAS technology & status of way forward:

Ships must have computers that can ingest video…from both AUVs/ROVs and UAS! This NEEDS TO BE DONE! Not done yet: all UNOLS and NOAA ships handle video separately from ship science computer systems!

Even NAVY ships do not ingest UAS video as part of ship science systems: we have to do this ourselves!

UAS inclusion into ship ops:
3) Info on UAS technology & status of way forward:

- The issue of ingesting, geo-referencing and archiving (search-ably) HD video involves a couple of approaches:
- The HEALY MapServer is currently a 'one-off' but is being 'ported' to other ships (initially POLAR STAR) under NSF funding via STARC contract to SIO. It allows geo-referencing of imagery and overlay on ship science station and bridge navigation systems. This effort is underway
- R-2-R (Rolling Deck to Repository) personnel should probably be involved in discussion, but generally the issue of video geo-referencing is regarded as beyond current R2R personnel time/capabilities.
- RECOMMEND: workshop to address issues, convened with SIO, WHOI, and R2R, as well as UAF (re SIKQULIAQ).

UAS inclusion into ship ops:
3) Info on UAS technology & status of way forward:

- Cost of hardware to ingest, geo-reference and archive HD video data, whether from UAS or AUV is estimated at <$50K/ship, potentially only @ $20K, which includes some training costs.
- Recommend: getting this going on POLAR STAR per existing requirement to coordinate into MapServer system, then port to other ships. This program is underway, needs more work.

UAS inclusion into ship ops: 3) Info on UAS technology & status of way forward:

- CIA, Nat. Geospatial Mapping Center, military use HADOOP software for archive, search of UAS HD video data. This is Open Source software which may prove extremely useful. Would allow automatic archiving of data in NGDC as is.
- Google Oceans has capability and has offered to store UNOLS HD video data using HADOOP, which should (I think) save NSF a LOT of money in archiving video data. Just an option, to be eval'd.

UAS inclusion into ship ops:

4) Information on UAS ops "elsewhere"

2012 Greenpeace using UAS use in Arctic from M/V ESPERANZA

2012 M/V ESPERANZA in Chukchi w 2 Deepworker manned subs filming abandoned oil drilling holes & benthic hotspots. Alan Grieg using 2 "Flying Wing" UAS <400' ("to avoid FAA COA requirement") for ice surveillance to assist ship ops & submersible launch/recovery.

UAS similar but different: One fully autonomous, other Remotely Controlled w video link from onboard camera.

UAS from Ritewing Zephyr: wingspan 56"; weight @3 kilo, depending on payload, battery, etc.; speed to 60-70 mph, usually 30-40mph; range @20-30 min depending on battery.

UAS inclusion into ship ops:

4) Information on UAS ops in other countries

- China: establishing 11 stations for UAS coastal surveillance; already planning on inclusion on RVs, starting w icebreaker XUE LONG
- Korea, no capability now on icebreaker ARAON, seeking partnership w US UAS operators
- Canada: UAS centers at Dalhousie and U.Victoria. Plan to begin routine UAS ops off Vancouver in 2013
- Norway: has funded routine UAS coastal surveillance program in 2013 using PENGUIN UAS
- Portugal, Spain, France, Italy: proceeding w NATO-funded UAS ops on ever-increasingly routine ops
- Bottom line: due to FAA restrictions, US is not just behind in ship UAS ops, but seriously behind. (McG. Opinion only!) Good news: we are working to catch up. However EU is still way ahead in legislative initiatives for routine UAS ops. No time to be wasted however. UAS are key to air-sea flux and other oceanographic studies.

UAS inclusion into ship ops:

5) Conclusions and 'way ahead' for NSF/UNOLS: recommendations and priorities

1) Need to convene workshop on ship video ingestion (whether from AUVs or UAS)
2) Workshop needs to include focus on MapServer due to ability to geo-reference, which is critical
3) Ship computer hardware needs should be evaluated, prepared for
4) Data archiving should include R2R personnel, evalute cloud-related storage (eg Google Oceans using HADOOP software already in use elsewhere in government for similar purpose)