UNOLS SCOAR: Scientific Committee for Oceanographic Aircraft Research

Christopher Zappa (LDEO, SCOAR chair; zappa@ldeo.columbia.edu*)*
and
Alice Doyle (UNOLS office; alice@unols.org*)*

2021 UNOLS Annual Meeting

SCOAR Membership

SCOAR - Scientific Committee for Oceanographic Aircraft Research

SCOAR Website: Briefs from past annual meetings, currently undergoing update to include more resources to users

https://www.unols.org/committee/scientific-committee-oceanographic-aircraft-research-scoar

Current Membership:

Name	Institution	Role	Rep Of	Term Start	Term End
Dr. Christopher Zappa	LDEO	Chair		9/1/2021	Sep-24
Dr. Luc Lenain	SIO	Past-Chair		4/1/2015	Apr-21
Dr. Armin Sorooshian	UA	Member		10/1/2021	Oct-24
Dr. Michael Starek	TAMU	Member		9/1/2017	Sep-23
Dr. Britton Stephens	NCAR	Member		4/1/2019	Apr-22
Dr. Hanumat Singh	NEU	Member		2/1/2017	Feb-23
Dr. Roni Avissar	Miami	Member		11/1/2020	Nov-26
Andrew Woogen	OSU	Committee-Rep	RVTEC	11/1/2020	Nov-23
Dr. Debbie Bronk	Bigelow	Ex-Officio		11/1/2020	Nov-22
Dr. Dennis Hansell	RSMAS	Ex-Officio		10/1/2020	Oct-22
Dr. Anthony Bucholtz	NPS	Ex-Officio		3/1/2019	

→ (new head of NPS research aircraft facility, formerly CIRPAS)

Annual meeting: Generally in the summer, 1 1/2 day, remotely available. Report to the UNOLS council three times a year.

Goal

- To inform broader community on the use of airborne assets in support of ocean sciences, in particular in coordination with Academic Research Vessels.

- SCOAR is available as a resource to those PIs, RVTECs, etc. who are interested adding such capability to future field programs.

- Receive community input and feedback on implementation? Follow-up discussions about all UAS are welcome.

- On-going SCOAR activity:
  - Develop a roadmap to make uncrewed/unoccupied aerial vehicles (UAVs) a standard capability of the Academic Research Fleet.
  - UAS Operator's Handbook.
  - Operator/User input is needed!

Please contact us if you are interested!

"This Committee shall provide advice and recommendations to the National Oceanographic Aircraft Facility managers and supporting federal agencies on aspects of operations, sensor development, fleet composition, utilization and data services as appropriate.

In addition, SCOAR and the UNOLS Office shall provide the ocean science user community with valuable information and advice concerning experiment design, facility usage, scheduling and capabilities.

The Committee shall also promote collaborations and cooperation between facility operators, funding agencies and the scientific community to improve the availability, capabilities and quality of aircraft facilities supporting the ocean sciences. By promoting collaboration between the ocean science community, the atmospheric science community and other science communities using aircraft in support of their research, the Committee shall work to improve utilization and capabilities for all of these communities.

The SCOAR shall also recommend the designation of aircraft facilities as National Oceanographic Facilities to the UNOLS Council and membership as described in paragraph 4 below."

Promote the use of Uncrewed/Unoccupied and piloted aircraft in support of atmospheric and oceanographic research

- Inform the scientific community on the benefit of airborne remote sensing capabilities
  - AGU Ocean Sciences Town Halls in 2020 and upcoming 2022: *Expanding the Reach of the Research Fleet: Autonomous (and Piloted) Airborne Systems in Support of Ocean Sciences*

- Developed the Uncrewed/Unoccupied Aerial Systems (UAS) Operations from the U.S. Academic Research Fleet: Operator's Handbook: *A roadmap to using Uncrewed Aerial Vehicles on Academic Research vessels.*

- Explore various approaches to make UAS a standard capability of the Academic research fleet.

The handbook is designed to provide detailed guidance on how to operate UAS from the Academic Research Fleet (ARF)

Status: Handbook endorsed by UNOLS council, available on the UNOLS website

Motivation is to develop UAS Policy and guidance documents for Shipboard Operations on UNOLS ships

UNOLS
Uncrewed Aerial Systems (UAS) Operations from the U.S. Academic Research Fleet: Operator’s Handbook

A publication from the UNOLS Scientific Committee for Oceanographic Aircraft Research

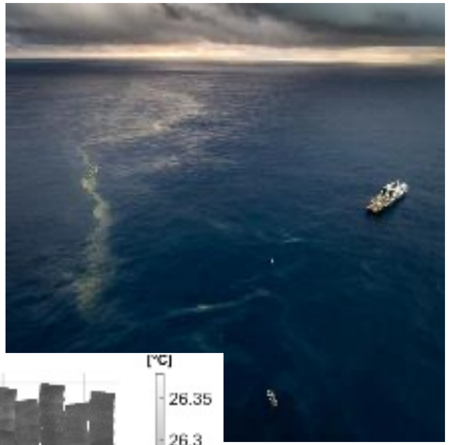
Photos courtesy of Luc Lenein, Chris Zappa and NSF/USAP

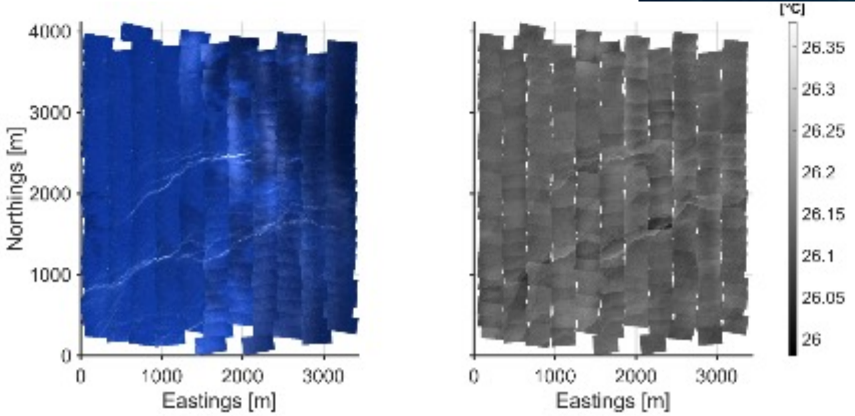
https://www.unols.org/sites/default/files/UNOLS_SCOAR_UAS_Operator_Handbook_V1.0.pdf

- General information (regulatory, size, classification etc)
- Flowchart for decision-making
  - Used by science party and operator institution as a tool to assist them with safe UAS operations in a range of situations. It recommends appropriate steps to take in the pre-planning stages of the activity.
- Timeline – When should a PI start planning UAS operations?
- Requirements broken down into three sections:
  - Planning and preparation
  - Shipboard procedures
  - Post-cruise actions
- Extensive Appendices, covering risk assessment and management, communication plans, NOTAMs, report and record-keeping, environmental review, operators and center of excellence point of contacts, etc.

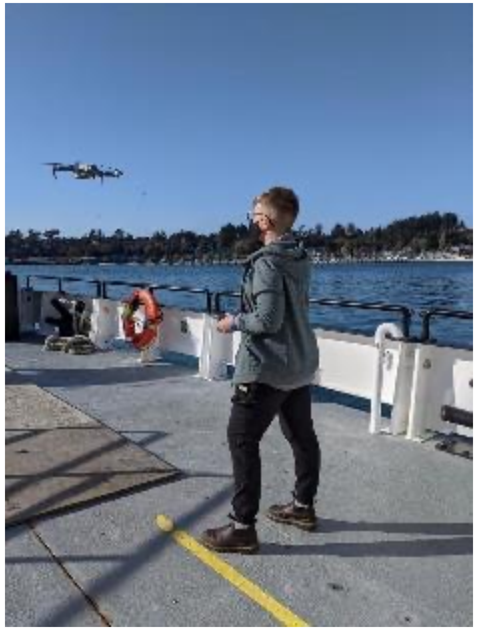
Andrew Woogen (OSU) and Zappa (LDEO) invited RVTECs to work more closely with SCOAR and to engage PIs to facilitate the use of UAVs on ships as more the "norm" or routine

High-Endurance UAVs





Quad-Copter UAVs



NOAA/NMFS research permit #21678

Naval Postgraduate School (NPS)
CIRPAS Airborne Research Facility
Twin Otter DH-6

Twin Otter-primary research aircraft

- **Research Capacity:** 1500 lbs
- **Research Power (DC):** 7000W at 28VDC
- **Research Power (AC):** 4000W 110VAC/60Hz
- **Speed:** 100-140 kts
- **Practical Ceiling:** 18,000 ft
- **Floor:** 100 ft over ocean (weather dependent)
- **Duration:** 3-5 hours (6-8 hrs w extra fuel tanks)
- **Base of Operation:** Marina, CA
- **Deployable:** CONUS, OCONUS
- **Recent Field Studies:** CO, FLA, Iceland

In-house Instrumentation

Cabin: Nephelometer, Sootphotometer, CPCs, UFCPC, Data System Racks for 'Research' and 'Guest' Instruments. Satcom system

Dropsonde: standard/AXBT

Fuselage: Solar/IR radiometers

Nose: Temperature, Dew Point, Pressure (Static, Dynamic Sideslip Attack angle), GPS/INS, IR Temperature, Liquid Water Content, Aerosol Inlet

Towed Platform: High rate T/RH/winds, SST

Wings: CAPS, FSSP, PCASP, CIP, PIP ... Hard points and pods for 'research' or 'guest' instruments

Inlet

Naval Postgraduate School (NPS)
CIRPAS Airborne Research Facility
Twin Otter DH-6

Coherent Wind LIDAR System
Mentor: Dr. David Emmitt,
Simpson Weather Associates

Controlled Towed Vehicle (CTV)
Mentor: Ryan Yamaguchi, NPS

Stabilized Radiometer Platform (STRAP)
Mentor: Anthony Bucholtz, CIRPAS

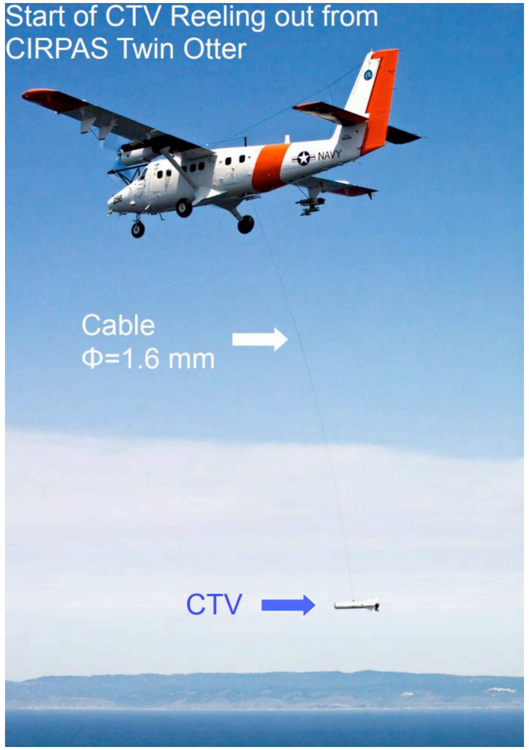
ALE 47 Dispensor Pod
Chaff/Sonde Dispenser

Dropsonde Tubes

Extended Range Fuel Tanks

Wind LIDAR

STRAP



CTV

Extended Range Fuel Tanks

Dispensor Pod

Dropsonde Tubes

Currently Planned FY22 Twin Otter Missions

1. **C-HARRIER:** (October 2021 - 1 week)
    - **PI:** Liane Guild, NASA Ames
    - **Location:** Marina, CA
    - **Goal:** Measure coastal and inland water radiance for satellite validation over relevant aquatic targets – supports coastal and inland water quality science
    - **Sponsor:** NASA

2. **CALICO: (**February-March 2022 - 6 weeks)
    - **PI:** Scott Powell, NPS
    - **Location:** Marina, CA
    - **Goal:** Study of post-frontal convection and interactions with the boundary layer
    - **Sponsor:** ONR

3. **SWEX: (**April-May 2022 - 6 weeks)
    - **PI:** Leila Carvalho, UC-Santa Barbara
    - **Location:** Santa Barbara, CA
    - **Goal:** Study downslope windstorms, ‘Sundowners’, along the Santa Barbara coast
    - **Sponsor:** NSF

Questions?

GORDON AND BETTY MOORE FOUNDATION

frontiers in Marine Science

TECHNOLOGY REPORT
published: 21 January 2020
doi: 10.3389/fmars.2019.00777

Check for updates

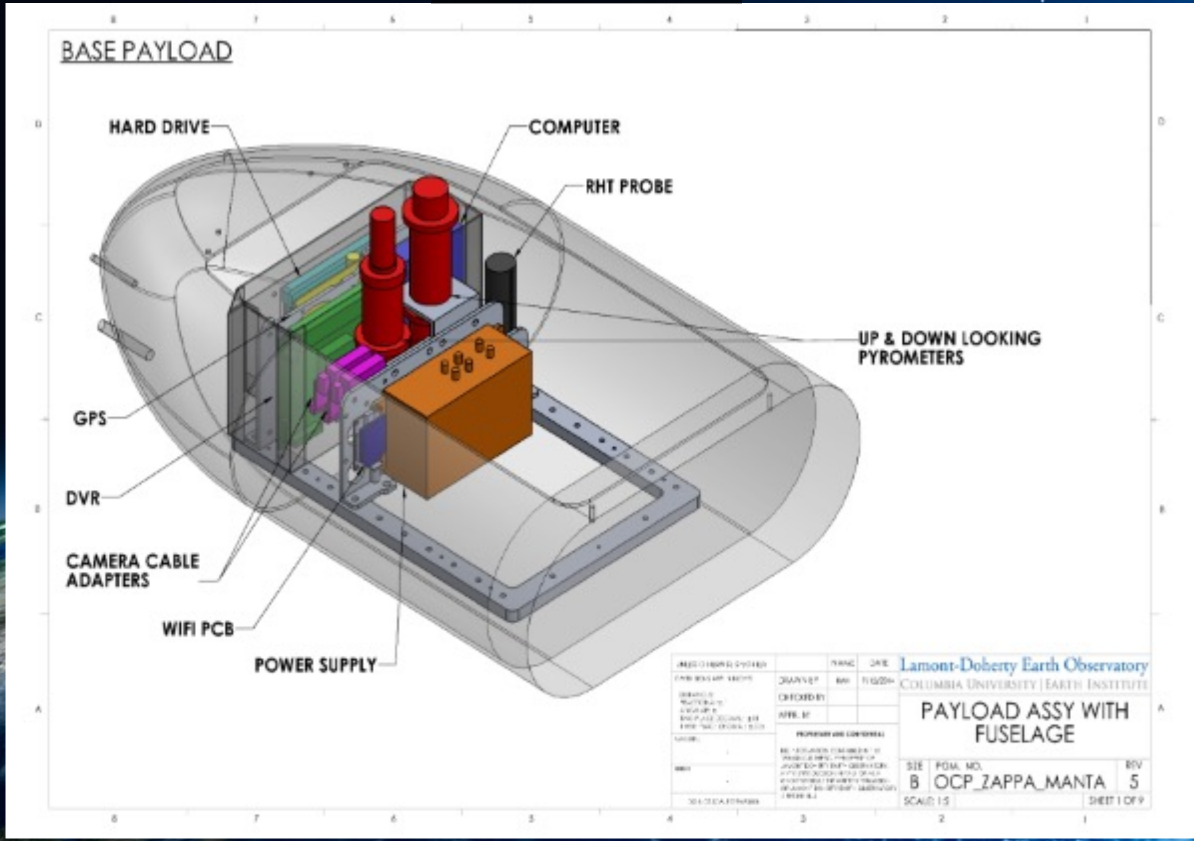
Using Ship-Deployed High-Endurance Unmanned Aerial Vehicles for the Study of Ocean Surface and Atmospheric Boundary Layer Processes

Christopher J. Zappa[1], Scott M. Brown[1], Nathan J. M. Laxague[1], Tejendra Dhakal[1], Ryan A. Harris[1], Aaron M. Farber[2] and Ajit Subramaniam[1]*

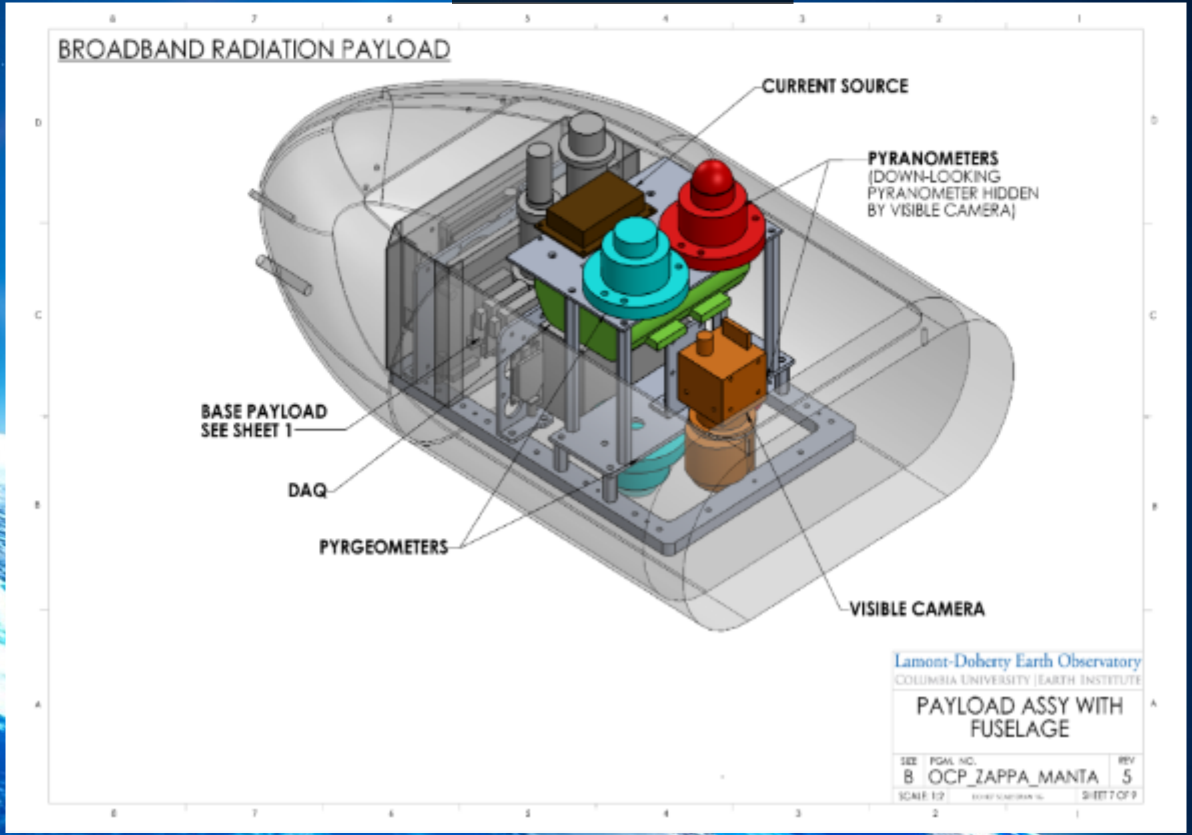
[1] Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY, United States, [2] L3 Latitude, Tucson, AZ, United States

UAS Payload Development

BASE Payload



Sensor Module



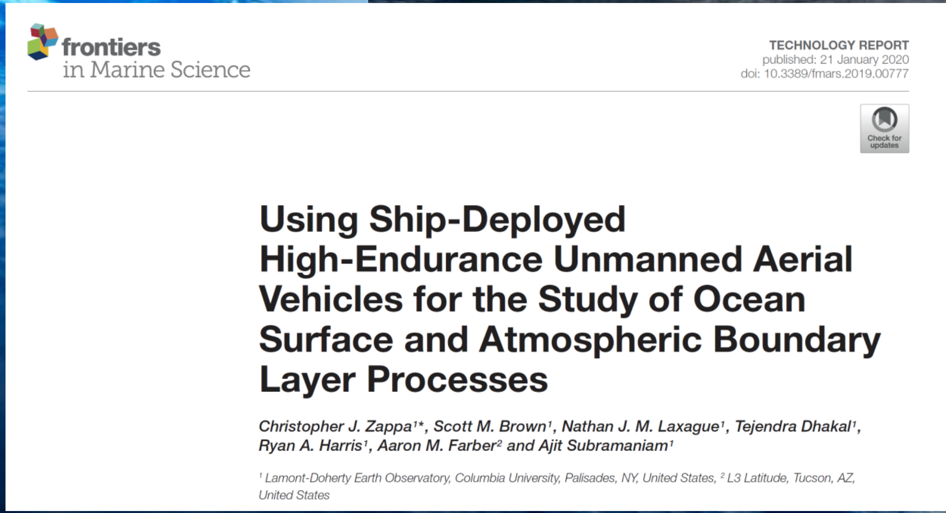
BASE payload allows for quick change between sensor payloads

GORDON AND BETTY MOORE FOUNDATION

UAS from Ships – Accomplishments

- 1st Complete autonomous takeoff, flight and landing from ships
- Dual-UAV aircraft continuous flight operations.
  - 3 aircraft utilized
- 42 Flights with Payloads (242 hours)
  - MET, RAD, ATOM, VNIR payloads
- High endurance flights for > 8-hours.
- Long-range capability (50+ nm) with high bandwidth data link for real-time mission control and tasking.
- Demonstrated 24-hour operations.

SCHMIDT OCEAN INSTITUTE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UAS Mission Control on R/V Falkor

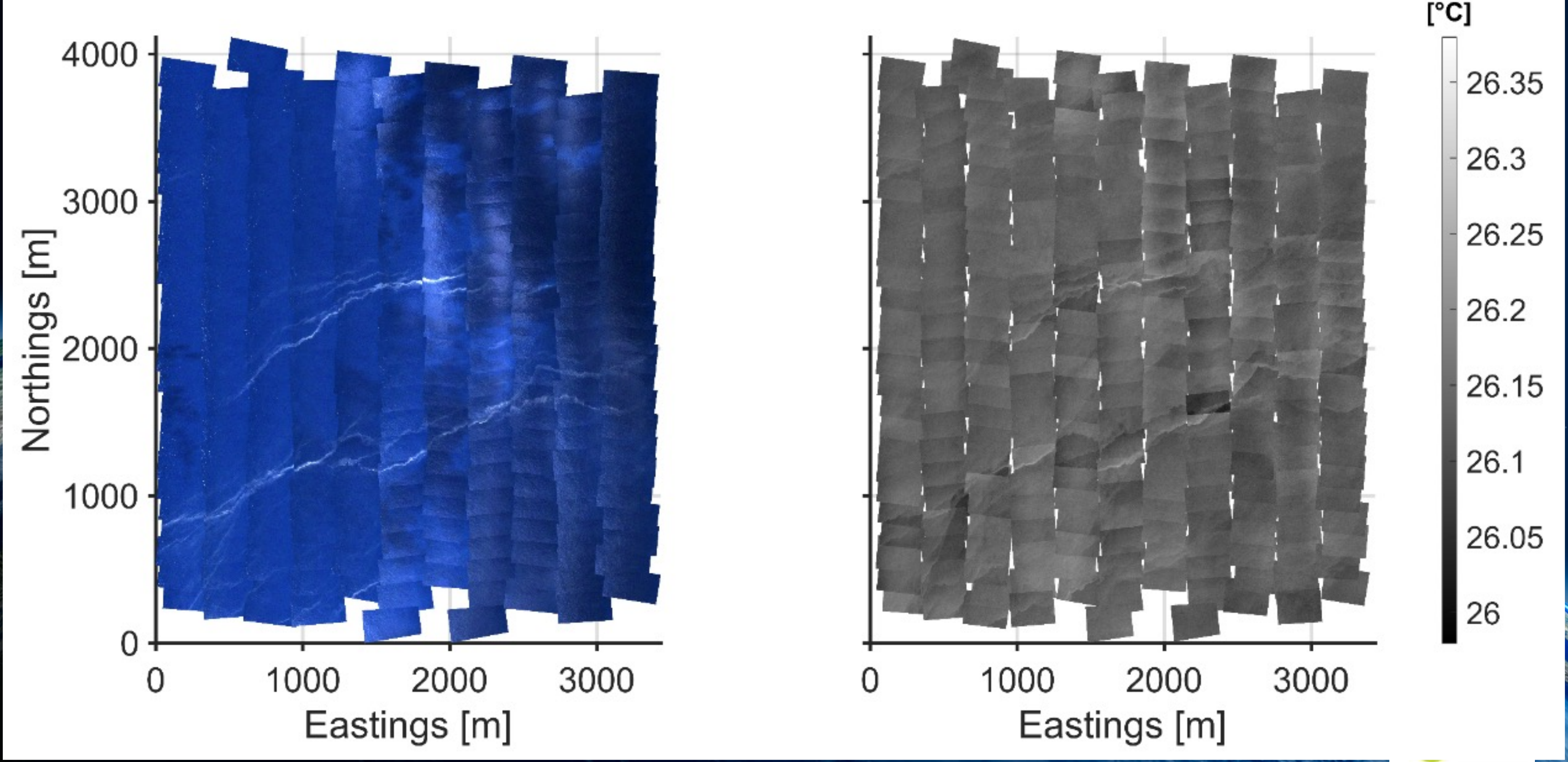
SCHMIDT OCEAN INSTITUTE

UAS from Ships (Latitude HQ-90B)

UAS from Ships (Latitude HQ-90B)

SCHMIDT OCEAN INSTITUTE

Observing Cyanobacteria Streaks in Infrared and Visible



Email: zappa@ldeo.columbia.edu

R/V Falkor Air-2-Sea Project Website:
https://schmidtocean.org/cruise/studying-the-sea-surface-microlayer-2/

More Cool Videos: https://vimeo.com/oasisthezappalab

Twitter: @CJZappa, @TheZappaLab

And outreach

The handbook is designed to provide detailed guidance on how to operate UAS from the Academic Research Fleet (ARF)

UAS Policy (endorsed by the UNOLS Council in summer 2016):

With the recent publication of the FAA small UAS rule, a policy for academic research vessels has become necessary. Effective immediately, operation of Uncrewed Aircraft Systems (UAS), or drones, from or over academic research vessels may not take place without demonstrated compliance with national or international regulations (ICSA, FAA) and specific approval of the ship's captain or designee, as a minimum. This applies to crew, techs and members of the science party, and refers to all operations, whether recreational, educational, or professional. Obtaining national approvals, such as FAA's Sec 333 exemption or Certificate of Authority or Waiver (COA), as well as pilot qualifications, are not a guarantee the operations will be approved by the ship's captain. Recreational or hobbyist freedom of use over land is not available at sea, so the importance of contacting the ship's operator ahead of time is critical. Detailed policies and processes are in development by SCOAR to provide guidance and training.

Status: Handbook endorsed by UNOLS council, available on the UNOLS website

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Photos courtesy of Luc Lenein, Chris Zappa and NSF/USAP

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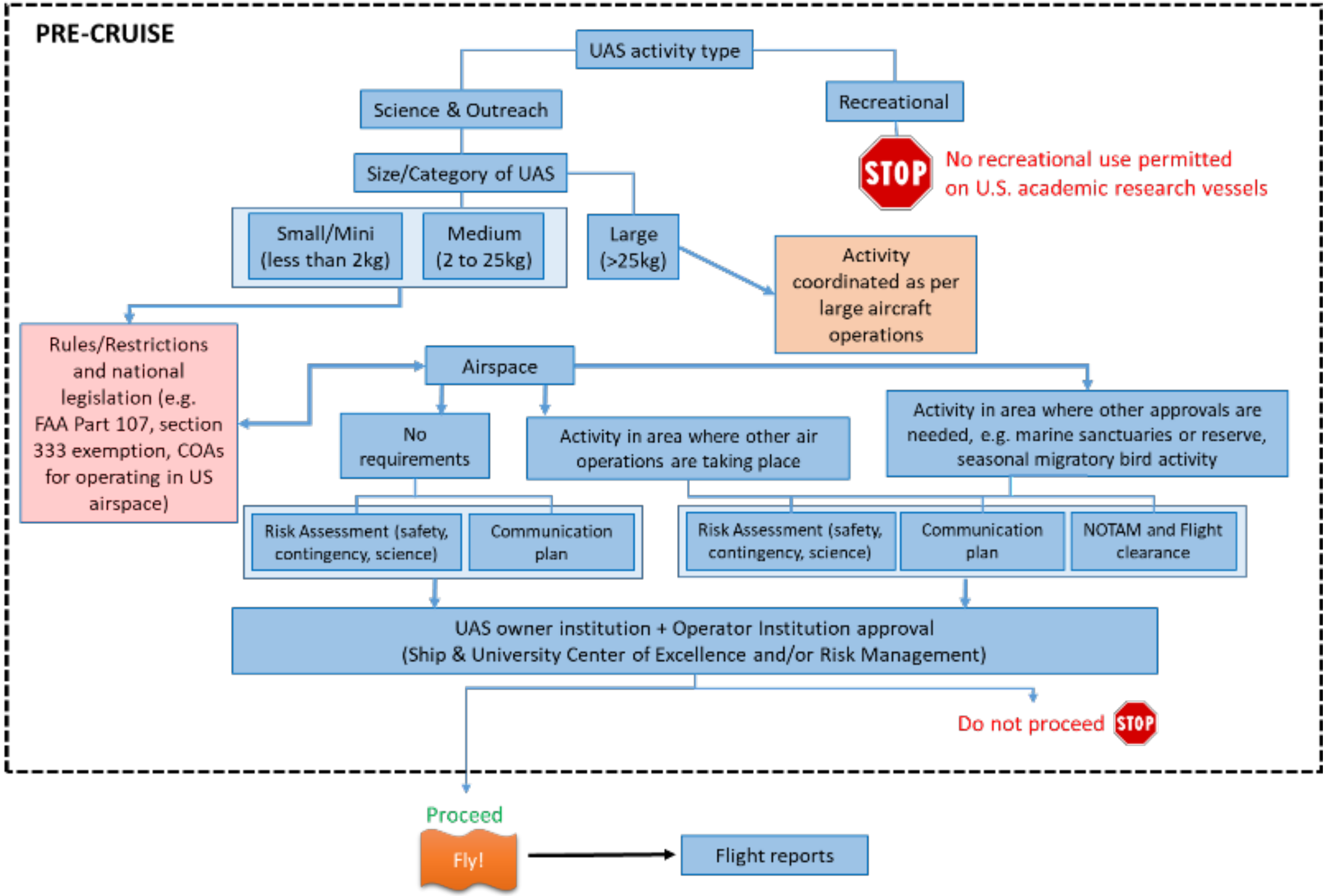
Published: March 2019 – Version 1.0

https://www.unols.org/sites/default/files/UNOLS_SCOAR_UAS_Operator_Handbook_V1.0.pdf

Decision-making flowchart

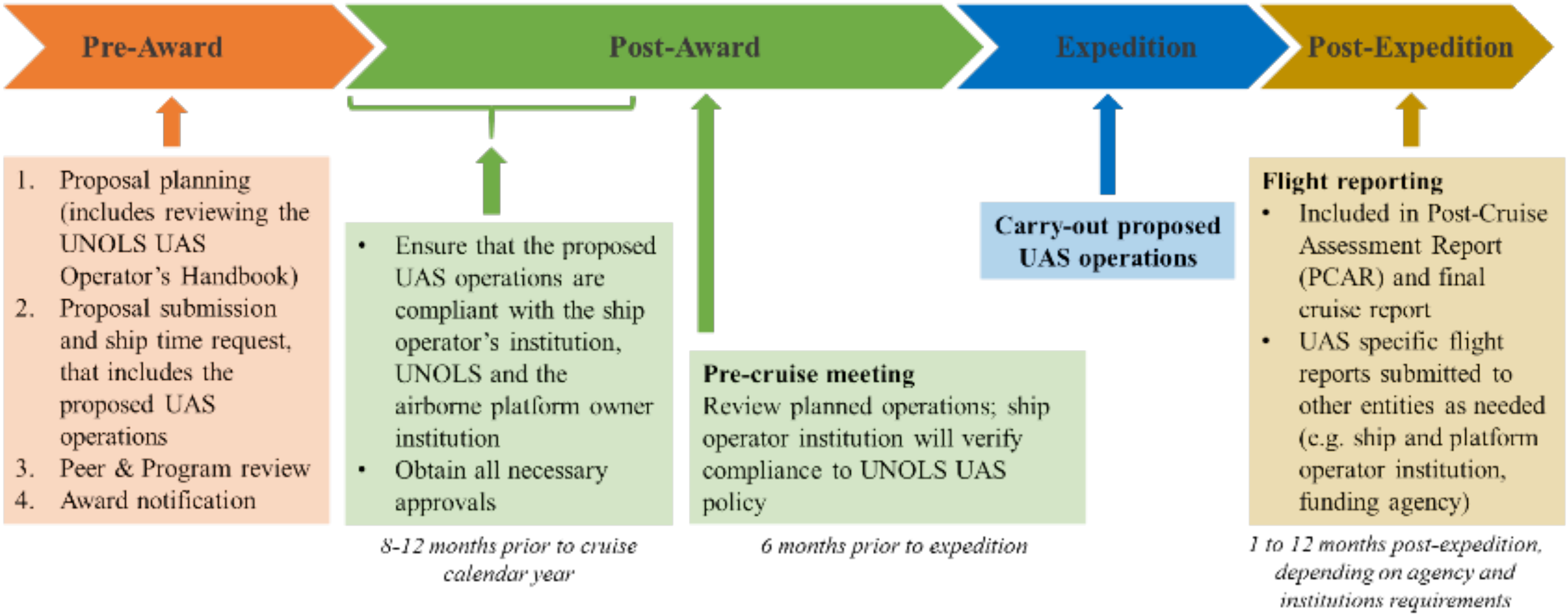
Used by science party and operator institution as a tool to assist them with safe UAS operations in a range of situations. It recommends appropriate steps to take in the pre-planning stages of the activity.



Timeline – When should a PI start planning UAS operations?

UNOLS
UNIVERSITY-NATIONAL OCEANOGRAPHIC LABORATORY SYSTEM

SCOAR - Scientific Committee for Oceanographic Aircraft Research



Requirements: Planning and preparation

1) All UAS deployments are to be conducted for support of science, including science support, ship logistics and operations, outreach/documentation of research, and for use in emergency and search and rescue situations. Recreational use is not permitted on U.S. academic research vessels.

2) All proposed UAS operations conducted from an academic research vessel must be approved by the oversight entity of the ship (vessel operator) and UAS operator institution. A number of institutions now have a flight request system in place to check FAA compliance of the proposed effort. The research vessel must have an approved shipboard UAS operations policy tailored to the specific ship.

3) All UAS operational plans must be covered in pre-cruise planning meetings with the research vessel crew.

4) Liability insurance coverage must be compliant with the requirements imposed by the ship operator institution and the institution that owns the UAS or RPA.

5) A reciprocal waiver agreement is required to address the potential liability of the ship operator if the UAS is damaged while in storage, transit, or while being handled by the ship's crew.

6) Recognizing that there are many regions of the world where no manned air operations take place and that there are areas that require detailed coordination with range operators (restricted and warning airspace along the coast of continental United States). In these areas, advanced communication of planned UAS operations, emplacement of UAS restrictions (height and radius around manned air operations locations and facilities) or emplacement of technologies such as "geo-fences" is required.

Requirements: Planning and preparation

7) If operations are conducted in waters or airspace where no local regulations are in place, or in high seas, it is recommended to follow the general guidance of the Convention on International Civil Aviation Organization (ICAO). Note that it is the responsibility of the UAS operator to determine that the proposed operation area is clear of any controlled airspace or Air Defense Identification Zones (ADIZ).

8) Where practical, all major components of any UAS must carry identification marks, including any national registration and identification information, in order to identify the pilot and operator for record keeping or in the event of an accident, incident or near-miss. Any such marks, especially on medium and large RPA should be placed on the deployed aircraft in a manner that can be clearly visible during flight. Brightly colored RPAs might be appropriate for over the water use, for retrieval/recovery purposes.

9) Ship operator institutions are to take a common approach to safety risk assessment based on a recognized and commonly accepted air operations framework so that RPA operations can be carried out in as safe a manner as manned aircraft operations and not present a hazard to persons, property or the ocean environment that is any greater than that attributable to the operation of manned aircraft preforming the same or similar activity.

10) Each RPA pilot must produce proof of appropriate training and certification, and the ship operator institution must ensure that each RPA pilot is appropriately trained in accordance with national regulations and in a manner that is consistent with, for example, the provisions of Annex 1 to the Convention on International Civil Aviation (ICAO) Personnel Licensing, and provides proof of proficiency of training or competency for the specific category and type of RPA to be flown. If the pilot is flying his/her own manufactured RPA, specific airworthiness certification must be required.

Requirements: Planning and preparation

11) Ensure that proposed UAS or RPA operations is in compliance with Department of Defense (DoD) requirements if the project or airborne platform is funded by DoD.

Requirements: Shipboard Procedures:

1) A pre-flight plan must be developed prior to the start of a field experiment using UAS. A standard ship-specific checklist must be used.

2) Risk assessment must be part of a pre-flight check-list to be completed prior to UAS flight operations. All UAS deployments conducted from research vessels must involve appropriate notifications (see Appendix 2). In areas with manned air operations, use of a communications plan and the NOTAM (or similar) system may be required.

3) Prior to UAS launch, a safety brief must be held for all personnel involved with the operation.

4) All UAS operations conducted from research vessels must contain provisions for safe and appropriate retrieval of waste in the event the UAS suffers an accident as part of its operations.

5) Any UAS accident, incident or near miss must be reported immediately in accordance with Appendix 6.

Requirements: Post-Cruise Actions

1) It is strongly recommended that as enabling technology develops, on attributes such as search and avoid capabilities or perception and avoidance systems, that ship and UAS operators consider routine integration of such technologies, after maturation, in UAS deployments.

2) All ship operator institutions must routinely share operational and certification information and any documentation developed, in support of the sharing of best practices and to facilitate the establishment of national accreditation and operational programs.

3) A flight record for each UAS flight should be submitted to the operator institution and UNOLS SCOAR, in accordance with Appendix 5.

The handbook is now available on the UNOLS website (SCOAR).

It contains requirements and recommendations for safe UAS operations on academic research vessels, along with various UAS technical information, templates of common forms, such as communications plans and UAS pilot logs, provided as examples that can be modified to suit a specific UAS activity.

We expect for this handbook to be viewed as a living document which, as UAS technology evolves, and as published research on the use of UAS from research vessels is made available, its contents will also evolve. Comments, on any aspect of this handbook, are welcomed.

Questions?