Implementing Scientific Data Collection across the Arctic Oceanic Region Utilizing Unmanned Aircraft Systems (UAS)

Arctic Monitoring and Assessment Programme (AMAP) Unmanned Aircraft Systems Expert Group (UASEG)

ARCTIC COUNCIL

AMAP Arctic Monitoring and Assessment Programme

Citation: AMAP, 2015. *Implementing Scientific Data Collection across the Arctic Oceanic Region Utilizing Unmanned Aircraft Systems (UAS)*. By: C. Sweatte, R. Storvold, P. Ruel, M. Wuennenberg, K. Tarr, A. la Cour-Harbo, B. Feldberg, J. Kivinen, H. Hólm, M. Raustein, E. Jangren, B. Mulac, J. Adler, D. Davis, L. Cary, S. Lesenkov. Arctic Monitoring and Assessment Programme, Oslo. 5 pp.

This is a prepublication version.

ISBN – 978-82-7971-089-9

Available as an electronic document from www.amap.no

Authors: AMAP Unmanned Aircraft Systems Expert Group (UASEG)
C. Sweatte, R. Storvold, P. Ruel, M. Wuennenberg, K. Tarr, A. la Cour-Harbo, B. Feldberg, J. Kivinen, H. Hólm, M. Raustein, E. Jangren, B. Mulac, J. Adler, D. Davis, L. Cary, S. Lesenkov.

Production management: Jan Rene Larsen (AMAP Secretariat)

Editorial support: Tonya Clayton (tclayton@nasw.org)

Layout: John Bellamy (johnbellamy@swipnet.se)

Cover photo: Boeing Insitu ScanEagle N202SE launches on the first United States beyond visual line-of-sight (BVLOS) commercial UAS flight, Chukchi Sea. Image courtesy of Insitu, Inc.

Printing:
Narayana Press, Gylling, DK-8300 Odder, Denmark (www.narayanapress.dk).

The Arctic Monitoring and Assessment Programme (AMAP) was established in June 1991 by the eight Arctic countries (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States) to implement parts of the Arctic Environmental Protection Strategy (AEPS). AMAP is now one of six working groups of the Arctic Council, members of which include the eight Arctic countries, the six Arctic Council Permanent Participants (indigenous peoples' organizations), together with observing countries and organizations.

AMAP's objective is to provide 'reliable and sufficient information on the status of, and threats to, the Arctic environment, and to provide scientific advice on actions to be taken in order to support Arctic governments in their efforts to take remedial and preventive actions to reduce adverse effects of contaminants and climate change'.

AMAP produces, at regular intervals, assessment reports that address a range of Arctic pollution and climate change issues, including effects on health of Arctic human populations. These are presented to Arctic Council Ministers in 'State of the Arctic Environment' reports that form a basis for necessary steps to be taken to protect the Arctic and its inhabitants.

AMAP gratefully acknowledges the financial support for this work provided by Norway and the United States, and the contributions of experts from the United States, Norway, Canada, Denmark, Finland, Iceland, Russia, Sweden, and the International Civil Aviation Organization (ICAO).

This document has been subject to a formal and comprehensive peer review process. The results and any views expressed in this document are the responsibility of those experts engaged in the preparation of the document.

The AMAP Secretariat is located in Oslo, Norway. For further information regarding AMAP or ordering of reports, please contact the AMAP Secretariat (Gaustadalléen 21, N-0349 Oslo, Norway) or visit the AMAP website at www.amap.no.

PREFACE

This publication presents a concise summary of the findings and recommendations of the Arctic Monitoring and Assessment Programme (AMAP) multinational Unmanned Aircraft Systems Expert Group (UASEG). This paper is intended to provide a succinct but authoritative and informative overview of barriers to UAS-based research in the Arctic and, especially, recommendations for facilitating the utilization of UAS for scientific data collection in the region.[1]

All eight Arctic countries participate in the UASEG. Group members include civil aviation authorities, experts experienced in UAS flight, and scientists interested in using UAS for Arctic environmental monitoring. The group is co-chaired by Rune Storvold, of the Northern Research Institute and the Norwegian University of Science and Technology, and Clifford Sweatte, of the U.S. Federal Aviation Administration. The ultimate goal of the expert group is to facilitate the routine use of UAS to conduct Pan-Arctic scientific observing missions.

AMAP would like to express its appreciation to the Norwegian Ministry of Foreign Affairs, the Norwegian Ministry of Climate and Environment, the U.S. Federal Aviation Administration (FAA), the U.S. Department of State, and the International Civil Aviation Organization (ICAO).

The AMAP Working Group is pleased to share here the vision of the Unmanned Aircraft Systems Expert Group and to present their recommendations to the Arctic Council and the wider public.[2]

INTRODUCTION: BRINGING A NEW TOOL TO ARCTIC SCIENCE

The Arctic represents one of the earth's harshest climates and a vast unexplored region, with many of its areas accessible only by high-risk aviation missions or by military marine vessels. The Arctic Council members desire to support UAS operations over the high seas in an effort to further scientific and search-and-rescue (SAR) missions across international flight information region (FIR) boundaries while remaining outside of sovereign airspace, in accordance with the International Civil Aviation Organization's (ICAO's) Annex 12, *Search and Rescue*, and the Arctic Council's *Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic*.

The Arctic Council's Arctic Monitoring and Assessment Programme established an Unmanned Aircraft Systems Expert Group in 2009 to identify how UAS can fulfill unmet scientific needs in Arctic regions. Since 2009, UASEG participants have utilized UAS to conduct many scientific research missions, but the flights have been limited in number and in the scope of the area of operations. All missions to date have flown within the FIRs of individual countries.

The potential for expansion of these scientific flights is limited due to the lack of:

- Knowledge of the capability of the technology
- The ability of UAS to comply with established rules of the air regulations
- Consistent application or implementation of operational approvals

[1]This report is elsewhere referred to informally as the "Arctic airspace access white paper."

[2]Also available: AMAP, 2015. *Arctic Science Remotely Piloted Aircraft Systems (RPAS) Operator's Handbook*. By: R. Storvold and coauthors. Arctic Monitoring and Assessment Programme, Oslo. 25 pp.

Ongoing scientific questions about the changing Arctic are creating a demand for access across FIRs in order to effectively monitor and assess these changes in an efficient and safe manner. The ultimate goal is to have the ability to conduct Pan-Arctic, cross-FIR scientific observations from UAS on a routine basis.

The unique characteristics of unmanned aircraft systems, also known as remotely piloted aircraft systems (RPAS), allow for the ability to measure environmental conditions that currently pose a challenge for manned aircraft. Issues such as geographically limited airport infrastructures, mission durations restricted by crew duty day or aircraft fueling requirements, and marginal low-altitude weather envelopes are overcome by UAS. These aerial platforms can be launched for missions from sea-ice camps, research ships, and remote field camps on islands or the mainland. Many of the platforms can operate nominally for 12–24 hours in duration. Each of these example conditions has posed extreme challenges for manned aircraft.

TOWARD PAN-ARCTIC SCIENTIFIC UAS OPERATIONS

Cross-FIR operations are not routine and are challenging to conduct because of the lack of understanding of how such flights can be accomplished. To achieve Pan-Arctic scientific observing capability with UAS, the ability to routinely fly across FIR boundaries must exist. Other applications utilizing UAS for emergency response, such as oil spills and SAR, are fulfilling the agreements of the Arctic Council Emergency Prevention, Preparedness and Response (EPPR) Working Group. Sharing information and lessons learned during cross-FIR operations will benefit all Arctic nations.

The first step toward a Pan-Arctic FIR agreement for UAS is establishing an understanding among the Arctic States administrating the airspace, by defining minimum safety and operational requirements and best practices for scientific UAS operations. This step would be coordinated via the civil aviation authority (CAA) and air navigation service provider (ANSP) of each Arctic Council member State.

A key challenge is ensuring that all risks to people on the ground or within the airspace are adequately considered and mitigated. In today's aviation environment, this is handled through the safety management system (SMS) process or the safety risk management (SRM) process. These processes are globally recognized in the aviation community and are captured in ICAO Annex 19, *Safety Management*.

RECOMMENDATIONS AND FLIGHT OPERATION COORDINATION

The importance of understanding the risk to manned aviation operating in the same airspace as UAS cannot be overstated. To support the safety risk assessment process that will be required by the civil regulators to substantiate operational approvals, it is recommended that each of the eight Arctic States develop an appropriate SMS guidance document for their UAS operations and associated airspace.

In order to be considered for cross-Arctic UAS scientific and SAR missions, the operator must comply with the following protocols. These protocols are an effort to encourage UAS operations in accordance with national regulations and in a manner that meets the applicable ICAO provisions to ensure the safest possible outcome of each mission.

Article 8 of the Chicago Convention stipulates that: "No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. …"

All cross-Arctic UAS operations shall be approved by each State involved, including the State of the operator, the State of Registry, and those States whose sovereign airspace is to be overflown. Prior to conducting operations in high seas airspace, the operator must coordinate the planned activities with the air traffic services (ATS) provider(s) responsible for each of the FIR(s) to be affected (see Attachment 1, "Arctic UAS Operations & Communications Plan").

RECOMMENDATIONS FOR BVLOS OPERATIONS

The UASEG has formulated a list of UAS beyond visual line-of-sight (BVLOS) recommended practices and improvements that should assist the ANSPs in mitigating risks to other aircraft operating in the Arctic:

1. Require an operations and communications plan (see Attachment 1, "Arctic UAS Operations & Communications Plan") in accordance with national regulations and in a manner that meets the applicable ICAO provisions to ensure the safest possible outcome of each mission.
2. Require the operator to file an ICAO flight plan through the appropriate CAA or ATS unit. Flight plans shall be submitted in accordance with Chapter 3 of ICAO Annex 2.
3. Recommend a common approach to safety risk assessment based on ICAO's framework.
4. Recommend the equipage of a transponder with Automatic Dependent Surveillance-Broadcast (ADS-B) in and out, or future equivalent equipment, for all flights.
5. Require that UAS used for BVLOS operation be registered in a national aircraft registry.
6. Require that each civil UAS operator provide proof of insurance in Special Drawing Rights (SDR), or equivalent, in accordance with the European Union established policy of EC785/2004, Article 7.1 Table, or each State's equivalent requirements.
7. Recommend that the CAAs approve UAS operators in a similar manner as manned aircraft operators.

8. Require the operator to ensure that each remote pilot is licensed in accordance with national regulations and in a manner that is consistent with the provisions of ICAO Annex 1, *Personnel Licensing*.

9. Require CAA-acceptable proof of proficiency of training or competency for the specific UAS to be flown. If the operator is building and flying their own manufactured UAS, include the proficiency of training and competency of the organization in their accepted operations manual.

10. Recommend CAAs establish type certification and airworthiness certification requirements to enable cross-FIR operations.

11. Any Arctic member nation reserves the right to provide additional requirement(s) for flights in its sovereign airspace at any time on a case-by-case basis.

12. Include Arctic UAS operations in Aeronautical Information Publication (AIP) supplements. Recommend charting of UAS Arctic coastal launch sites. Require deconfliction plans be coordinated with the Arctic CAAs and the operator's approval authority(ies). Attached is a suggested "Arctic UAS Operations & Communications Plan" that may be used to support this requirement.

Non-Aviation Considerations

13. Recommend States/CAAs to create and maintain an app/website for graphically displaying Notice to Airmen notifications (NOTAMs), pending operations, and other information from AIPs.

14. Develop recommendations for minimizing environmental impacts of Arctic UAS operations.

PAN-ARCTIC COLLABORATION AND DATA-SHARING

A Pan-Arctic agreement should involve steps to ensure international collaboration and sharing of data. This has two purposes:

- Build trust and confidence among the member States and observer countries
- Facilitate the creation of high-quality Pan-Arctic data sets needed for improved understanding of our changing climate and environment

Small, long-range UAS provide a relatively inexpensive tool for gathering Pan-Arctic data sets, but regular collection of data will depend on operations from the Arctic field stations established around the Arctic Ocean—and hence operations from these States' sovereign territories—to access certain parts of the Arctic High Seas. We depend on international collaboration and coordination in field activities, sensor development, intercalibration, and data analysis to obtain consistent data sets.

CROSS-ARCTIC HIGH SEAS SCIENTIFIC & SEARCH AND RESCUE
ARCTIC UAS OPERATIONS & COMMUNICATIONS PLAN

Operator Contact Information: Phone: _____ Email: _____

SATCOM or Telephone #: _____ (For Vessel Launches) Radio Call Sign: _____

Vessel #: _____ Vessel Phone: _____ VSAT: _____ Iridium: _____

A. **7 Days prior:** Distribute email, including authorization from appropriate civil aviation authorities (CAAs), to air traffic service (ATS) providers and appropriate government authorities (e.g., FAA, NavCanada, Transport Canada, U.S. Coast Guard, State Department, Defense Department, etc.). Area commercial aircraft operators shall also be notified of the pending operation.

B. **7 Days to 24 Hours in advance:** Contact appropriate ATS provider, phone # _____, to request a Notice to Airmen (NOTAM) be issued for the operation area. Emergency and National Disaster Operations authorizations may not be able to comply with standard NOTAM issuance timelines.

C. **1 Day prior (NLT 2200 hours):** Provide operation area manned aircraft operator's schedule for next day.

D. **By _____ (local time) on day of flight, prior to flight:** Participating manned aircraft operators will confirm their flight plan(s).

E. **1 Hour prior:**

1. Operator files an ICAO flight plan through appropriate CAA or ATS unit. Flight plans shall be submitted in accordance with Chapter 3 of ICAO Annex 2, *Rules of the Air*.
2. Receive weather briefing, review NOTAMs, and determine if there are any other flight plans on file for the operating area.
3. Check Receiver Autonomous Integrity Monitoring (RAIM) notices (http://www.nstb.tc.faa.gov/24Hr_RAIM.htm) or appropriate agency website.
4. Contact appropriate ATS unit via SATCOM or other acceptable means to confirm that any special use airspace or ALTRV is active.

F. **10 Minutes prior to UAS launch:** In preparation for launch, broadcast a warning announcement on Marine Common FM Ch 16 and VHF _____ MHz common traffic advisory frequency (CTAF); e.g., "UAS flight operations are commencing from LAT/LONG of research vessel or coastal launch site." Maintain a listening watch on VHF _____ MHz (CTAF) and _____ MHz for any area traffic.

G. **During flight operations:** Periodically broadcast a warning announcement on Marine Common FM Ch 16 and VHF _____ MHz (CTAF); e.g., "UAS operations are in effect between the surface and 2000 feet within 10 nautical miles of LAT/LONG."

H. **Lost Link/Lost Comms (Emergency Comms):** PIC will comply with the lost link/lost comms procedures stipulated in their authorization. Operator will immediately contact appropriate ATS unit via SATCOM and report the Lost Link condition, time, and LAT/LONG. Immediately broadcast on Marine Common FM Ch 16, VHF _____ MHz (CTAF), and VHF _____ MHz or other acceptable means; e.g., "UAS flight operations are commencing emergency return at 500 feet AGL."

I. **Coordination with Coast Guard protocols:** Operator/research vessel will maintain continuous listening watch on Marine Common FM Ch 16 and the VHF and UHF 122.5 and 243.0 guard frequencies. All UAS operations will comply with Coast Guard and any other official SAR-participating aircraft or vessel requests.

ISBN – 978-82-7971-089-9