EXPLORATORY MINI-WORKSHOP SUMMARY REPORT

Utilization of Unmanned Aircraft Systems for Environmental Monitoring

May 2011
FCM-R32-2011

Office of the Federal Coordinator for Meteorological Services and Supporting Research

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Cover images (Top to Bottom)
- Artist's rendition of a Global Hawk UAS over Hurricane Elena (1985). – Credit: NOAA UAS Program
- The 2006 Esperanza wildfire in California, above which NOAA flew an Altair UAS for monitoring. – Credit: CalFire
- Global Hawk UAS operated by NASA's Dryden Flight Research Center – Credit: NOAA UAS Program
- Lightning – Credit: NOAA Photo Library
- NASA Aerosonde on low altitude mission – Credit: NOAA UAS Program
- NASA's Ikhana UAS (Modified MQ-9) on Fire Patrol mission in Feb 2010 - Credit: NASA Airborne Science Program, UAS Program

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UTILIZATION OF UNMANNED AIRCRAFT SYSTEMS FOR ENVIRONMENTAL MONITORING

Office of the Federal Coordinator for
Meteorological Services and Supporting Research

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FOREWORD

The idea for a mini-workshop to explore the use of unmanned aircraft systems (UAS) evolved from an awareness of the increasing capabilities and efforts within several Federal organizations to use UASs for a wide variety of missions. The OFCM proposed conducting an exploratory mini-workshop on the Federal use of UASs to the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR) and gained ICMSSR's support. We believe UASs will revolutionize Federal environmental observing strategies in the near future in a manner not seen since the introduction of weather satellites and Doppler weather radars assets decades earlier. There is a clear need to ensure our efforts are coordinated and transparent to the administration and the public.

As various agencies continue to develop their strategic plans and roadmaps for UAS programs and applications, I encourage them to seek convergence so that they can share assets, operators, sensors, logistics, etc. I believe the currently established working groups, like the Interagency Working Group-Facilities & Infrastructure Task Force on Unmanned Systems (IWG-FI TFUS), the Interagency Coordinating Committee for Airborne Geoscience Research and Applications (ICCAGRA), and the U.S. Army UAS External Program, together with OFCM assistance, will help agencies leverage work already accomplished and lessons already learned. Effective communications and coordination are the keys to future success.

Appendix A to this summary report provides a background paper on the UAS Mini-Workshop. Appendix B provides the mini-workshop agenda. Appendix C contains a list of questions which were provided to the participants to both guide development of the presentations and to stimulate discussion.

The success of the mini-workshop rested with the diligent efforts of the participants involved, and I want express my deepest gratitude to them for a job well done. Section III of this report provides a summary of results from the workshop, together with potential government actions to provide a way forward, and I urge your support in addressing and implementing the actions and recommendations documented in this report.

// Signed //
Samuel P. Williamson
Federal Coordinator for Meteorological Services
and Supporting Research

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SECTION I: OVERVIEW

1. Purpose, Theme and Objectives

The Exploratory Mini-Workshop, led by the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM), examined the use of unmanned aircraft systems (UAS) for meteorological operations, services, and research. OFCM convened the mini-workshop in response to a growing interest in the meteorological operational and research communities' use of UAS technologies and solutions to address difficult environmental monitoring issues.

The Exploratory Mini-Workshop objectives were as follows:

Objective 1: Share information among active and interested agencies.

Objective 2: Identify opportunities to collaborate and leverage activities.

Objective 3: Identify roadblocks to success and identify potential courses of action to eliminate or mitigate them.

Objective 4: Identify community direction and support for next steps.

A "UAS Background Paper" given to all participants prior to the meeting is at Appendix A. The agenda for the 2-day Exploratory Mini-Workshop is at Appendix B. A set of discussion questions, included in this report at Appendix C, was developed and provided to the participants to help focus the discussion sessions on key issues. Section II of this summary report is structured to coincide with the agenda. Section III captures the lessons learned and key actions. It also provides a proposal to move forward with the mini-workshop's actions and recommendations.

2. Key Takeaways

Key takeaways are defined as the overarching impressions formed by those engaged in the mini-workshop. We summarize these impressions below.

- Technology has progressed to the point where UAS should be considered a viable approach to accomplish a wide variety of environmental monitoring missions. They are particularly appropriate for those "dull, dirty, denied, or dangerous" applications not well suited for manned aircraft.

- The development of UAS capabilities and programs within agencies should be approached from a "Program of Record" point of view and consider full life cycle costs.

The majority of life-cycle costs are incurred during the operation and maintenance phase of the program. "Hobby-shop" approaches are not viable for long-term mission satisfaction.

- UAS technologies are adaptable for a wide variety of missions and transferable between organizations. There's no need to reinvent a system when you can leverage the investment already made by other agencies. The DOD can be a particularly useful partner for leveraging technology, systems, procedures, etc.

- The need for interagency communication and transparency is paramount. Numerous UAS activities that have taken place, are in-progress, or are planned can benefit other organizations.

- The Federal agencies must present a coherent, coordinated approach to the development and utilization of UASs in order to mutually support UAS initiatives and programs. This must fit within an overall construct of all unmanned systems (including ground, sea surface, and undersea systems) for environmental monitoring.

- A number of challenges to the implementation of UAS solutions for environmental monitoring exist including routine access to the National Airspace System (NAS), UAS infrastructure and support, interagency/international coordination, and data and system standards.

3. Highlights of Potential Government Actions

Although no formal actions stemmed from the mini-workshop, several common needs emerged during the presentations and subsequent discussions. We list the highlights of potential government actions below:

- Coordinate the efforts of several organizations and interagency groups interested in UAS and unmanned systems development and utilization for environmental monitoring and related missions. In order to ensure effectiveness and efficiency, these Federal efforts should be centrally coordinated.
- Find or establish a data/metadata clearinghouse for UAS missions so that information can be shared across agencies. NOAA's National Data Centers, like the National Climatic Data Center (NCDC) and the National Geophysical Data Center (NGDC), may be the best organizations to consider.
- Crossfeed information about miniaturized sensor development for UAS platforms amongst the community as much as possible.
- Crossfeed information about the Joint Center for Satellite Data Assimilation (JCSDA) to the UAS community to serve as a model for interagency development and exploitation of UAS capabilities.
- Establish data standards to maximize use of data obtained from UAS missions.
- Establish instrument and sensor calibration standards. The UAS community could leverage examples from other systems (radar, balloon, surface observation, etc.)

SECTION II: MINI-WORKSHOP PRESENTATIONS

1. Introductory Comments and Presentations

Section II presents a synopsis of each invited presentation from the different agencies and stakeholders as indicated in the agenda (see Appendix B). Briefing slides for all of the presentations that were given at the mini-workshop can be found at http://www.ofcm.noaa.gov/uas/workshop/index.htm.

PRESENTATION TITLE: *EXPLORATORY MINI-WORKSHOP - UTILIZATION OF UNMANNED AIRCRAFT SYSTEMS FOR ENVIRONMENTAL MONITORING* - MR. SAMUEL P. WILLIAMSON, FEDERAL COORDINATOR FOR METEOROLOGY

SYNOPSIS: The OFCM has conducted mini-workshops in the past as a means to examine particular issues regarding meteorological services and supporting research. Growing interest among our interagency partners seeking to capitalize on opportunities to share hard-earned experiences, while investigating cooperative efforts to move forward, generated the need for a mini-workshop on environmental applications of UASs.

The objectives of the Exploratory Mini-Workshop were as follows:

1. Share information among active and interested agencies.
2. Identify opportunities to collaborate and leverage activities.
3. Identify roadblocks to success and identify potential courses of action to eliminate or mitigate them.
4. Identify community direction and support for next steps.

2. Session I: Unmanned Aircraft System Applications for Environmental Research and Monitoring

This session addressed the UAS activities and interests of Federal government agencies; explored their needs, requirements, and priorities; and identified gaps and leveraging opportunities.

PRESENTATION TITLE: *OVERVIEW OF THE NOAA UNMANNED AIRCRAFT SYSTEM PROGRAM* - ROBBIE HOOD, NOAA UAS PROGRAM MANAGER, OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH

SYNOPSIS: According to NOAA's new UAS Strategic Plan, UASs will revolutionize NOAA observing strategies by 2014 comparable to the introduction of satellite and radar assets decades earlier. Goals of the NOAA program are to:

- Increase access to UAS technologies for the NOAA science community by 2013 (in preparation for the first operational implementation of UASs by 2014).
- Develop comprehensive UAS mission strategies for high-impact weather monitoring, polar monitoring, and marine monitoring.

- Foster new conceptual demonstrations for additional science topics, like fire weather, flood, marine debris, fishery law enforcement, and rapid-response monitoring.

Ms. Hood described the UAS observing campaigns over the past few years and a variety of encouraging results.

PRESENTATION TITLE: *USING UAS FOR EARTH SCIENCE - AN OVERVIEW OF NASA UAS ACTIVITIES* - BRENDA L. MULAC, AIRBORNE SCIENCE PROGRAM UAS PROGRAM LEAD, EARTH SCIENCE DIVISION, SCIENCE MISSION DIRECTORATE, NASA HEADQUARTERS

SYNOPSIS: NASA has developed and leveraged a number of UAS systems ranging in size and capability. The UAS systems primarily used for airborne science include SIERRA, Ikhana, and Global Hawk. These systems have clearly demonstrated the potential of UASs for environmental monitoring and airborne science research. NASA uses UASs to augment current manned fleet capabilities. Ms. Mulac described a series of successful UAS airborne science missions. She concluded with the following thoughts:

- Unmanned aircraft will not replace manned aircraft but will augment existing fleets, filling gaps in observing capabilities.
- Unmanned aircraft technology will continue to mature, driving more instrument development and expanding science application options.
- New platforms, such as the Global Observer, will challenge the traditional relationship between satellites and aircraft.
- Organizations will create observing networks using all sizes of unmanned aircraft.

PRESENTATION TITLE: *DEPARTMENT OF ENERGY'S UTILIZATION OF UNMANNED AERIAL SYSTEMS FOR ENVIRONMENTAL MONITORING* - RICKEY PETTY, ARM AERIAL FACILITY PROGRAM MANAGER, OFFICE OF SCIENCE, DEPARTMENT OF ENERGY (DOE)

SYNOPSIS: Mr. Petty opened his presentation by describing the mission of DOE's Office of Science. He explained that DOE's climate research is interested in understanding the "Energy Nexus," the interrelationship between energy production and climate change. UASs have unique capabilities and have been used since 1993 on several observing campaigns to collect data relevant to this question. He described how UAS capabilities have been integrated with DOE's Atmospheric Radiation Measurement Program. Finally, Mr. Petty emphasized the need for interagency and international cooperation on UAS activities, citing the Interagency Coordinating Committee for Airborne Geoscience Research and Applications (ICCAGRA) as a key U.S. Government organization, which coordinates the science programs flown on aircraft in the different agencies.

PRESENTATION TITLE: *FOREST SERVICE UAS ACTIVITIES* - EVERETT A. HINKLEY, NATIONAL REMOTE SENSING PROGRAM MANAGER, U.S. FOREST SERVICE

SYNOPSIS: The U.S. Forest Service Aviation owns and operates 27 aircraft and helicopters and contracts with over 800 aircraft and helicopters annually to conduct missions, supporting fire surveillance, aerial reconnaissance, air attack, delivery of smoke jumpers, firefighter and cargo

transport, aerial delivery of retardant and water, natural resource management, and research. Their UAS strategy is to augment rather than replace manned aircraft, work with partners to identify niche applications that are underserved by current technology, keep the approach simple, and provide unified systems that are affordable. Over several years, they have learned that integrating UASs into fire operations is complicated but not impossible. UAS systems are considered part of the tool kit needed to achieve mission success. Spatial, spectral, and temporal resolution, as well as data delivery and dissemination, are important considerations.

PRESENTATION TITLE: *U.S. GEOLOGICAL SURVEY UNMANNED AIRCRAFT SYSTEMS PROJECT OFFICE - LESSONS LEARNED AND OPPORTUNITIES* - MICHAEL E. HUTT, UAS PROGRAM MANAGER, USGS, DEPARTMENT OF THE INTERIOR (DOI)

SYNOPSIS: Much like the Global Positioning System and the internet have changed the way we do business, UASs will transform DOI and USGS methods and techniques to conduct assigned missions. Cost-effective UAS technology is currently available to support a wide variety of applications including:

- Managing Federal lands.
- Monitoring environmental conditions and natural resources use.
- Analyzing dynamic earth processes.
- Supporting global and climate change investigations (carbon trade).
- Supporting law enforcement actions.
- Aiding search and rescue teams.
- Inventorying wildlife.
- Generating mapping, charting, and geodesy products.
- Conducting environmental impact assessments.
- Developing an archive of observations.
- Preventing, preparing for, responding to, and recovering from disasters.

Starting from small beginnings, the USGS UAS program has conducted a number of aerial observing programs and operates a number of small UASs with 13 planned observing campaigns. They are partnering with other agencies to conduct these campaigns and to develop a roadmap for UAS utilization in the future.

3. Session I Discussion

Following the Session I presentations, Mr. Rickey Petty, DOE, facilitated a discussion session based on the questions provided to the group prior to the mini-workshop. He methodically reviewed these five questions (Appendix C) to ensure the briefings had thoroughly addressed each. We noted the following items during the discussion:

- There is a potential need to find or establish a data/metadata clearinghouse from UAS missions so that information can be shared across agencies. It was suggested that the NCDC and NGDC may be the best organizations to consider.
- It's important to raise awareness and transparency of UAS initiatives, capabilities, and observing campaigns across the community.

- We must share information about miniaturized sensor development for UAS platforms amongst the community as much as possible.
- The UAS community should leverage Small Business Innovation Research (SBIR) opportunities.
- We need data standards to maximize use of systems.
- The Joint Center for Satellite Data Assimilation (JCSDA) could serve as a model for interagency development and exploitation of UAS capabilities.
- We should employ unmanned systems to fill gaps in a seamless Earth System Prediction capability.

4. Session II: Challenges to the Development and Use of UASs for Environmental Monitoring

PRESENTATION TITLE: *UNMANNED AIRCRAFT SYSTEMS IN THE NATIONAL AIRSPACE SYSTEM* - RANDY WILLIS, AIR TRAFFIC CONTROL SPECIALIST, FAA UNMANNED AIRCRAFT SYSTEMS GROUP

SYNOPSIS: The FAA Unmanned Aircraft System Group and Unmanned Aircraft Program Office play key roles in the development of regulations and approval of Certificates of Authorization (COA) to use the National Airspace System (NAS) for UAS operations. Over the past few years, requests for COAs have come from more than a dozen Federal and state agencies, industry, and universities. These organizations are flying a wide variety of missions across the NAS on a daily basis. Mr. Willis clearly explained the process for submitting COA requests for UAS operations. Nearly 300 COAs have been approved since 2010, and that number is expected to increase rapidly in the near future. The FAA is working hard to make the COA and all associated certification processes as efficient as possible, while ensuring the safety and integrity of the NAS.

PRESENTATION TITLE: *U. S. CUSTOMS AND BORDER PROTECTION, UNMANNED AIRCRAFT SYSTEMS NATIONAL RESPONSE* -MR. TOM FALLER, NATIONAL DIRECTOR, UAS OPERATIONS, U.S. CUSTOMS AND BORDER PROTECTION (CBP), DEPARTMENT OF HOMELAND SECURITY (DHS)

SYNOPSIS: The CBP operates one of the world's largest law enforcement air and marine forces utilizing more than 270 aircraft and 270 maritime vessels. The CBP Office of Air and Marine (OAM) conducts a variety of missions, including port security, counter-narcotics, law enforcement, and crisis and disaster relief. CBP UASs deliver enhanced national response posture and domain awareness across land and maritime regions. CBP air and marine operations centers control missions around the country and feed data through Processing Exploitation Dissemination (PED) cells to serve their end users. The CPB OAM operates the Predator-B and Guardian UASs, significantly expanding their reach and endurance for many kinds of missions, and the office has a wealth of operational experience.

PRESENTATION TITLE: *COAST GUARD UAS PROGRAM* - LCDR JEFF VAJDA, UAS PLATFORM MANAGER, USCG OFFICE OF AVIATION FORCES (CG-711)

SYNOPSIS: The USCG is beginning to use fixed- and rotary-wing UASs from the cutters and land bases to fulfill their search and rescue, marine environmental protection, living marine

resources monitoring, and ice operations missions. The USCG estimates that cutter-based UASs will contribute up to 54,000 hrs/year by 2025 to address currently unmet needs. Similarly, their land-based MQ-9 Guardian UAS will contribute 9,200 hrs/year by 2021. Together with an integrated concept of operations for cutter-based and land-based UAS operations, it is expected that the USCG will be able to better perform these and other missions, realizing significant cost savings and freeing manned aircraft for missions for which they are uniquely capable.

PRESENTATION TITLE: *RPA / UAS SUPPORT TO ENVIRONMENTAL MONITORING* - LT COL PETER "PEPE" LEHEW, HEADQUARTERS USAF A2Q RPA INNOVATIONS

SYNOPSIS: Without question, the USAF has the most experience flying large UAS aircraft on operational missions, but they also operate many other UASs throughout the full spectrum of size and capabilities. Given this experience and the size of the UAS programs, the USAF has been an excellent partner for other Federal organizations on UAS programs. Lt Col LeHew described the many components that make up a UAS—it's not just the aircraft. He emphasized the three "triads" of UAS operations:

- Who—Remotely Piloted Aircraft Crew, Users, Support Unit.
- What—Voice, Data, Video.
- Where—Aircraft, Ground Control Center, and the Squadron Operations Center.

Finally, he offered the following lessons learned, emphasizing the importance of advanced planning to:

- Resolve airspace access issues.
- Resolve communications details.
- Determine data retrieval requirements.
- Plan data exploitation needs and capabilities.
- Determine training needs—CONOPs, tactics, terminology, limitations.
- Consider all legal aspects—Title 10 vs. 32, Posse Comitatus, Intelligence vs. Situational Awareness.
- Detail preparation requirements—equipment, websites, inject nodes, checklists.

PRESENTATION TITLE: *PM UAS, EXTERNAL PROGRAMS INFORMATION BRIEF* - LTC TREY KELLEY, DIRECTOR, EXTERNAL PROGRAMS, U.S. ARMY PROJECT MANAGERS OFFICE, UAS, REDSTONE ARSENAL, AL

SYNOPSIS: One tenet of Department of Defense (DOD) support to civil authorities is to assist the civil sector's development and procurement of new technologies and equipment. For that reason, the U.S. Army UAS Program runs an External Programs Office. This office is specifically chartered to assist other U.S. government agencies with leveraging the DOD's investment and experience with UASs. The U.S. Army PM UAS has already provided assistance to USGS, NOAA, and several law enforcement agencies. With a wide variety of UAS systems and capabilities at their disposal, the U.S. Army PM UAS could play a critical role in getting UAS programs up and running for environmental monitoring missions which across many agencies.

5. Session II Discussion

Following the session II presentations, Mr. Michael Bonadonna, OFCM, facilitated a discussion session based on the questions provided to the group prior to the mini-workshop. He reviewed the discussion questions (Appendix C) and asked for additional comments. We noted the following items during the discussion:

- UASs are capable of collecting a vast amount of complex data. It is important to find ways to "package" the data for various users so it can be used for maximum effect.
- Information security measures and IT architectures must allow data sharing with time delays short enough to be useful to the end users.
- Data and instrument calibration standards need to be established. The UAS community could leverage examples from other systems (radar, balloon, surface observation, etc.)
- Be sure to think of the UAS as a system and not just an aircraft. Functionality can exist in different parts of the system rather than on the unmanned aerial vehicle (UAV).
- Communications requirements are all too often overlooked and cobbled together at the last minute. Approval for the communications links to operate and collect data from the UAS can take many months to secure. One must also carefully consider and plan communications and data dissemination between the UAS and the end users.
- Documentation and progress made through interagency coordination will help keep individual programs funded.
- UASs are more expensive than we originally planned and a lot more difficult to operate in the NAS. It is important not to underestimate the challenges.
- The business model, accessibility, and relevancy are also key to keeping programs funded.
- UAS technology is often cutting edge and therefore evolving rapidly. We must incorporate Change Management processes into UAS programs.
- The development of UAS capabilities and programs within agencies should be approached from a "Program of Record" point of view and consider full life-cycle costs. The majority of life-cycle costs are incurred during the operation and maintenance phase of the program. "Hobby-shop" approaches are not viable for long-term mission satisfaction.

6. Session III: Interagency Coordination and Strategic Planning for the Use of UASs to Support Environmental Monitoring

PRESENTATION TITLE: *STRATEGIC DIRECTION OF NOAA UNMANNED AIRCRAFT SYSTEMS (UAS) PROGRAM* - REAR ADMIRAL PHILIP M. KENUL, DIRECTOR, MARINE AND AVIATION OPERATIONS CENTERS, NOAA

SYNOPSIS: NOAA is in the process of developing a strategic plan for their UAS program which will define a clear vision and mission for UAS environmental monitoring, define current and planned UAS capabilities, document observational requirements and standards, and provide a strategic analysis and an acquisition strategy for achieving the vision. The UAS Strategic Plan aligns with other planning documents, including the NOAA Next Generation Strategic Plan, the

NWS Strategic Plan, the National Ocean Policy, and NOAA's Arctic Plan. Rear Admiral Kenul described NOAA's vision for UAS and unmanned systems which included a number of different platforms operating worldwide while being centrally controlled and managed.

PRESENTATION TITLE: *IWG-FACILITIES & INFRASTRUCTURE (IWG-FI), TASK FORCE ON UNMANNED SYSTEMS (TFUS) OVERVIEW* - DR. REGINALD BEACH, SENIOR SCIENTIST, NOAA/OAR/OER

SYNOPSIS: The Interagency Working Group – Facilities & Infrastructure (IWG-FI) Task Force on Unmanned Systems (TFUS) was established in January 2010 to provide advice to the National Science and Technology Council Committee on Environment and Natural Resources, regarding the use of unmanned systems for environmental monitoring. This advice focuses on policies, procedures, and plans related to the use of unmanned systems, as well as future investments and upgrades. Since its inception, the TFUS has completed an inventory of unmanned systems used for monitoring environmental conditions throughout the ocean, on land, and in the atmosphere. This seamless approach to environmental monitoring is the cornerstone of the TFUS. In February 2011, the TFUS provided a letter to IWG-FI identifying four challenges to UAS utilization:

- FAA resources.
- Airspace access.
- UAS infrastructure and personnel training.
- Interagency coordination.

The TFUS serves as the single Federal point of contact for coordinating between operating agencies and legal entities at the state or Federal level, involving unmanned system(s) usage with regular participation by 11 Federal organizations.

PRESENTATION TITLE: *OVERVIEW OF THE NOAA UAS REQUIREMENTS AND CAPABILITIES DATABASE* - MATT LUCAS, NOAA UAS PROGRAM, TRIVECTOR SERVICES, INC.

SYNOPSIS: One goal for interagency coordination of UAS operations and programs is the development of observing requirements that not only serve the needs of one organization, but can also benefit other users as well. Mr. Lucas described how NOAA developed their observing requirements and matched them to needed UAS capabilities. The structured approach and resulting database can serve as a model for other organizations. NOAA's UAS observational requirements may also benefit other organizations and reduce the needless duplication of efforts and capabilities. Currently, the NOAA database has captured performance data for 70 UAS vehicles, cost data for 22 vehicles, sensor capabilities for 47 instruments and 354 mission requirements from 29 categories. It has also captured metadata on 16 demonstration missions. The presentation concluded with a demonstration of the database.

7. Session III Discussion

Following the session II presentations, Mr. Kim Curry, Deputy Technical Director, Oceanographer of the Navy, facilitated a discussion session based on the questions provided to

the group prior to the mini-workshop. He reviewed the discussion questions (Appendix C) and asked for additional comments. We noted the following items during the discussion:

- UAS missions for environmental monitoring applications should focus on the "dull, dirty, denied, and dangerous" missions to augment (not replace) manned systems.
- NOAA has provided a model process to determine observing requirements, establish priorities, and analyze alternatives to bring the organizations and agencies together to make progress toward finding solutions.
- International issues are important considerations. International airspace management, data sharing, and technology transfer are but a few issues to consider.
- The Interagency Coordinating Committee for Airborne Geoscience Research and Applications (ICCAGRA) is a key U.S. Government organization, which coordinates the science programs flown on aircraft in the different agencies.
- Funding stability is critical to program development. Agencies must develop solid, long-term UAS program plans and actively advocate for their initiatives.
- Interagency coordination is a must. The IWG-FI TFUS addresses this coordination for unmanned systems with the Office of Science and Technology Policy (OSTP).
- Coordination needs to be "top – down" directed. Connectivity with OSTP and the Office of Management and Budget (OMB) is crucial.
- We must combine the efforts of many interagency coordinating activities including: IWG-FI (TFUS), OFCM, U.S. Army UAS External Programs, ICCAGRA, etc. Each group seems to fill an important niche yet fails to reach across the entire UAS and Unmanned Systems community. Central coordination is needed to ensure the effectiveness and efficiency of the Federal effort.

SECTION III: OUTCOMES

1. Closing Remarks

Mr. Williamson provided informal closing remarks at the conclusion of the mini-workshop and deferred the presentation of the summary briefing. He emphasized the need for continuing dialog and coordination among the agencies and offered assistance to the established coordinating groups. He reaffirmed OFCM's interest in facilitating collaboration and enhancing communication and transparency across the environmental monitoring UAS community. Finally, he thanked the participants for the time and effort in making the mini-workshop a great success.

PRESENTATION TITLE: *CLOSING REMARKS: UTILIZATION OF UNMANNED AIRCRAFT SYSTEMS FOR ENVIRONMENTAL MONITORING* - MICHAEL F. BONADONNA, SENIOR STAFF METEOROLOGIST, OFCM

SYNOPSIS: Mr. Bonadonna claimed and the group agreed that the mini-workshop had met all of its stated objectives. He reminded the participants that the briefings and support materials were posted on the OFCM's website. He then explained the process and timeline for documenting the proceedings from the mini-workshop in a summary report to be reviewed by the participants, approved by OFCM, and sent to OSTP and OMB for their review and consideration. OFCM will also post the summary report on the OFCM's website for public use.

2. Lessons Learned from Existing Agency Initiatives

- It's important to raise awareness and transparency of UAS initiatives, capabilities, and observing campaigns across the community.
- UASs are capable of collecting a vast amount of complex data. It is important to find ways to "package" the data for various users so it can be used for maximum effect.
- Information security measures and IT architectures must allow data sharing with time delays short enough to still be useful to the end users.
- Think of the UAS as a system and not just an aircraft. Functionality can exist in different parts of the system rather than on the UAV.
- Communications requirements are all too often overlooked and cobbled together at the last minute. Approval for the communications links to operate and collect data from the UAS can take many months to secure. One must also carefully consider and plan communications and data dissemination between the UAS and the end users.
- Documentation and progress made through interagency coordination will help keep individual programs funded.
- UASs are more expensive than originally planned and a lot more difficult to operate in the NAS. It's important to not underestimate these challenges.
- UAS technology is often cutting edge and therefore evolving rapidly. Change management processes must be incorporated into UAS programs.

- The development of UAS capabilities and programs within agencies should be approached from a "Program of Record" point of view and consider full life-cycle costs. The majority of life-cycle costs are incurred during the operation and maintenance phase of the program. "Hobby-shop" approaches are not viable for long-term mission success.
- UAS missions for environmental monitoring applications should focus on the "dull, dirty, denied, and dangerous" missions to augment (not replace) manned systems.
- International issues are important considerations. International airspace management, data sharing, and technology transfer are but a few issues to consider.
- The Interagency Coordinating Committee for Airborne Geoscience Research and Applications (ICCAGRA) is a key U.S. Government organization that coordinates the science programs flown on aircraft in the different agencies.

3. Potential Government Actions

- Find or establish a data/metadata clearinghouse from UAS missions so that information can be shared across agencies. NOAA's National Data Centers (NCDC, NGDC) may be the best organizations to consider.
- Crossfeed information about miniaturized sensor development for UAS platforms amongst the community as much as possible.
- The UAS community should leverage SBIR opportunities.
- Establish data standards to maximize use of data obtained from UAS missions. ICCAGRA is working with the international S&T aviation community to establish standards to maximize use of data obtained from manned aircraft and UAS operations.
- Crossfeed information about the Joint Center for Satellite Data Assimilation (JCSDA) to the UAS community to serve as a model for interagency development and exploitation of UAS capabilities.
- Establish data and instrument calibration standards. The UAS community could leverage examples from other systems (radar, balloon, surface observation, etc.)
- We must combine the efforts of many interagency coordinating activities including: IWG-FI (TFUS), OFCM, U.S. Army UAS External Programs, ICCAGRA, etc. Each group seems to fill an important niche yet fails to reach across the entire UAS and Unmanned Systems community. Central coordination is needed to ensure effectiveness and efficiency of the Federal effort. As NOAA, NASA, DHS and others continue to develop their strategic plans and roadmaps, the hope is that we can all find convergence so that we can share assets, operators, sensors, logistics, etc. Working groups like this, ICCAGRA and others help us to leverage work already accomplished and lessons already learned. The importance of doing an analysis of alternatives (AOA), market research, systems engineering, cataloging of our research assets (both aircraft and sensors), and cataloging of our data will lead us to the best mission solutions at the best value across the federal government.

4. The Way Forward

- Lessons learned from operational experience, employing UASs for various applications and missions, will be shared among the agencies and should lead to more effective and efficient use of UASs for environmental monitoring.
- Given the funding and scheduling constraints on each individual agency, coordination of missions and flight opportunities will become a key part of UAS program success. By showing the combined utility of UASs across several agencies, increased national investment in these capabilities will more likely materialize. The current administrative barriers (long and unstandardized methods of exchanging funds for services and hardware between government entities) must be eliminated to fully realize the timely upward spiral in utilization, mission satisfaction and benefit to the public.
- Organizations like the U.S. Army UAS External Programs, and established interagency groups like IWG-FI TFUS and ICCAGRA will play important roles in developing and maintaining broad support for individual or joint agency UAS programs. Enhanced coordination and cooperation among these organizations are keys to the future success of UAS programs for environmental monitoring.

APPENDICES

Appendix A – UAS Background Paper

EXPLORATORY MINI-WORKSHOP

USE OF UNMANNED AIRCRAFT SYSTEMS FOR ENVIRONMENTAL MONITORING

BACKGROUND:

Unmanned Aircraft Systems (UAS) entered the national consciousness with military operations in Southwest Asia following the attacks on September 11, 2001, and, in the decade that followed, UASs have become an important capability for both military and homeland security operations. UASs have also seen limited testing and research activity for environmental monitoring and have the potential to revolutionize our Nation's ability to monitor and understand the environment from a localized area up to a global scale. A key information gap exists today between data from instruments on the Earth's surface and data from satellites — UASs can bridge that gap. Operated autonomously or by remote pilots with wingspans, ranging from less than 6 feet to more than 115 feet, UASs can also collect data from dangerous or remote areas such as the arctic, the open oceans, in and around tropical cyclones, near erupting volcanoes, and over wildland fires. Better data and observations can improve scientific understanding and lead to better forecasts to save lives, property, and resources and aid several U.S. Government agencies in achieving their mission goals.

The Department of Defense operates a wide variety of UASs for operational intelligence, surveillance, and reconnaissance missions but their use for environmental applications appears to be limited or not openly available. Similarly, the Department of Homeland Security's Customs and Border Protection and U.S. Coast Guard have been operating UASs for various missions, but environmental data collection appears limited or not openly available.

In civil environmental applications, the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the Department of Energy (DOE) have been actively operating or preparing to operate UASs. NOAA collaborated with NASA to conduct a number of demonstration projects applying UASs for tropical cyclone reconnaissance, maritime monitoring for law enforcement in protected areas, and arctic monitoring, and NASA used the Ikhana UAS to monitor a wildland fire during an emergency situation in California earlier in the decade. The DOE is in the final stages of approval to operate a UAS overwater along the North Slope of Alaska for climate data collection. DOE is also currently working with NOAA to renew a Memorandum of Understanding (MOU) on UASs and is working with other agencies to make use of their Alaska capability (via a proposal process) or to partner in other ways. Other Federal agencies with interests in UAS environmental monitoring capabilities include the U.S. Forest Service (USFS) and the U.S. Geological Survey (USGS).

Each year, the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) organizes and hosts the Interdepartmental Hurricane Conference (IHC) to

review the Nation's end-to-end tropical cyclone research, observing, forecasting, and warning program. The results of the 59th IHC in 2005 included an action item to develop a strategic plan for improved tropical cyclone reconnaissance systems, which included manned, unmanned, and space-based systems. This action item was subsequently incorporated as a task in the *Interagency Strategic Research Plan for Tropical Cyclones: The Way Ahead* in February 2007. UAS applications in tropical cyclone observing have been expanding with NASA and NOAA tests and field programs and have demonstrated the potential to address the needs identified in the 59th IHC.

Although the preceding discussion has been meteorologically focused, UAS and Autonomous Underwater Vehicle (AUV) operations with an ocean focus are also underway. Under the White House's National Science and Technology Council, the Committee for Environment, Natural Resources, and Sustainability has established the Subcommittee for Ocean Science and Technology (SOST, formerly the separate Joint Subcommittee on Ocean Science and Technology). Under SOST, the Interagency Working Group on Facilities and Infrastructure (IWG-FI) has established the Task Force on Unmanned Systems (TFUS). Chartered in January 2010, the TFUS advises, assists, and makes recommendations to the working group on policies, procedures, and plans related to unmanned system uses, upgrades, and investments. The OFCM joined the TFUS in 2010 to provide the interagency meteorological focus for the group. In 2011, the TFUS plans to develop a strategic plan for unmanned systems development and utilization for environmental monitoring and the OFCM, with information from its participating agencies and from this mini-workshop, will provide the meteorological input.

DISCUSSION

Building on a history of interagency leadership in developing aerial weather reconnaissance capability and recognizing the emerging UAS capability for civil environmental monitoring, the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) has organized an exploratory mini-workshop. Now is the time to open an interagency dialogue to share information, identify opportunities to collaborate, and assess potential to improve the nation's return on investment in this area. The OFCM has successfully used the mini-workshop approach in the recent past to address hydrometeorology needs and priorities, potential science and technology skill shortfalls, and the integration of social sciences into meteorological operations and services. These mini-workshops serve as models for this effort.

The Exploratory Mini-Workshop on the Use of Unmanned Aircraft Systems will be held on February 4, 2011, at the OFCM conference room in Silver Spring, MD. The workshop will consist of three primary sessions addressing the following environmental monitoring topics: UAS applications for environmental research and monitoring; challenges to the development and use of UASs; and interagency coordination and strategic planning for the use of UASs. The complete agenda will be provided separately.

OBJECTIVES:

The objectives of the mini-workshop are to:

- Share information among active and interested agencies.
- Identify opportunities to collaborate and leverage activities.
- Identify roadblocks to success and identify potential courses of action to eliminate or mitigate them.
- Identify community direction and support for next steps.

Appendix B: Workshop Agenda

Utilization of Unmanned Aircraft Systems for Environmental Monitoring

February 4, 2011

9:00 AM	Administrative Information	**Mr. Michael F. Bonadonna** Senior Staff Meteorologist, OFCM
9:05 AM	Welcome	**Mr. Samuel P. Williamson** Federal Coordinator for Meteorology
Session 1: Unmanned Aircraft System Applications for Environmental Research and Monitoring The use of Unmanned Aircraft Systems (UASs) has the potential to substantially contribute to U.S. scientific research and operational forecasting by enabling the collection of atmospheric, oceanic, and remote land data in ways either not possible, or not prudent, by manned aircraft or other systems. *This session will describe the UAS activities and interests of federal government agencies; explore their needs, requirements, and priorities; and identify gaps and leveraging opportunities.* **Facilitator: Mr. Rick Petty, Program Manager, Climate and Environmental Science Division, Office of Biological and Environmental Research, Dept. of Energy**		
9:15 AM	National Oceanic and Atmospheric Administration (NOAA) UAS Program	**Ms. Robbie Hood** UAS Program Manager NOAA
9:30 AM	National Aeronautics and Space Administration (NASA) UAS Program	**Ms. Brenda Mulac** UAS Program Lead Goddard Space Flight Center NASA
9:45 AM	Department of Energy (DOE) UAS Program	**Mr. Rick Petty** Program Manager, Climate and Environmental Science Division, Office of Biological and Environmental Research, Dept. of Energy
10:00 AM	U.S. Department of Agriculture (USDA) U.S. Forest Service (USFS) UAS Program	**Mr. Everett Hinkley** National Remote Sensing Program Manager U.S. Forest Service
10:15 AM	U.S. Geological Survey (USGS) UAS Program	**Mr. Michael Hutt** UAS Program Manager U.S. Geological Survey
10:30 AM	**Session 1 Discussion**	
11:30 AM	**LUNCH BREAK**	

Session 2: Challenges to the Development and Use of UASs for Environmental Monitoring

Full utilization of civil UASs is currently limited by several challenges, including securing sufficient resources, developing and approving standards for UAS operations, routine access to the National Airspace System, sustaining UAS infrastructure, and training. Our ability to address these and other challenges will determine the long-term effectiveness of UASs for environmental monitoring.

This session will review the key challenges to fully utilizing UASs for research and operational environmental monitoring.

Facilitator: Mr. Michael F. Bonadonna, Senior Staff Meteorologist, OFCM

1:00 PM	Federal Aviation Administration (FAA) UAS Policies and Procedures	**Mr. Randy Willis** Air Traffic Control Specialist, Unmanned Aircraft Systems Group, Headquarters, FAA
1:15 PM	Customs and Border Protection UAS Program Lessons learned	**Mr. Tom Faller** National Director, UAS Operations, U.S. Customs and Border Protection, Department of Homeland Security
1:30 PM	U.S. Coast Guard UAS Program Lessons Learned	**LCDR Jeffrey Vajda** Unmanned Aircraft Systems Joint Program Office U.S. Coast Guard
1:45 PM	USAF UAS Infrastructure and Training	**Lt Col Peter "Pepe" LeHew**, USAF Deputy Director ISR Innovations HQ USAF – A2
2:00 PM	U.S. Army UAS Program Lessons Learned	**LTC Trey Kelley** Chief External Programs, Cooperative Programs Integration Program Manager Unmanned Aircraft Systems U.S. Army
2:15 PM	**Session 2 Discussion**	
3:00 PM	**BREAK (15 min)**	

Session 3: Interagency Coordination and Strategic Planning for the Use of UASs to Support Environmental Monitoring

Several U.S. civil government agencies have UAS programs or plans and other agencies have potential applications, but we lack broad awareness of capabilities, needs, requirements, and priorities and an awareness of associated gaps and leveraging opportunities. Improved coordination among U.S. government agencies would increase the effectiveness and efficiency of UAS environmental monitoring operations and planning and maximize the national investment in these capabilities.

This session will explore efforts to coordinate the use of UASs across the federal government and how this coordination may be improved.

Facilitator: Mr. Kim Curry, Deputy Technical Director, Oceanographer of the Navy

3:15 PM	NOAA Unmanned Systems Strategy	**Rear Admiral Philip M. Kenul** Director, Marine and Aviation Operations Centers NOAA
3:30 PM	Interagency Working Group – Facilities and Infrastructure Task Force for Unmanned Systems (IWG-FI TFUS)	**Dr. Reginald Beach** Senior Scientist Office of Ocean Exploration and Research NOAA
3:45 PM	Collecting, Validating, and Documenting UAS Requirements for Environmental Monitoring	**Mr. Matt Lucas** NOAA UAS Program Office TriVector Services, Inc.
4:00 PM	**Session 3 Discussion**	
4:45 PM	**Mini-Workshop Wrap Up and Action Items**	**Mr. Michael F. Bonadonna** Senior Staff Meteorologist, OFCM
4:55 PM	**Closing Remarks**	**Mr. Michael Babcock** Deputy Federal Coordinator for Meteorology
5:00 PM	**ADJOURN**	

Appendix C: Discussion Questions

A series of questions were compiled to help the presenters focus their briefings on key areas of interest and concern. The discussion periods following each session began with a recap of these questions to ensure the presenters had addressed each topic. These, in turn, stimulated other topics of discussion.

Session 1 – Unmanned Aircraft System Applications for Environmental Research and Monitoring

The use of Unmanned Aircraft Systems (UAS) has the potential to substantially contribute to U.S. scientific research and operational forecasting by enabling the collection of atmospheric, oceanic, and remote land data in ways either not possible, or not prudent, by manned aircraft or other systems.

This session will describe the UAS activities and interests of federal government agencies; explore their needs, requirements, and priorities; and identify gaps and leveraging opportunities.

1. What has your agency done to explore, develop, and/or use Unmanned Aircraft Systems (UAS) for environmental monitoring for research or operational use?

2. What are the capabilities of UAS platforms that are available for use or planned for acquisition?

3. What environmental data could UASs provide that would address your agency's unmet observing requirements?

4. How do you see UAS capabilities fitting in with other unmanned systems like Autonomous Underwater Vehicles (AUV), Unmanned Surface Vehicles (USV), and Lagrangian platforms?

5. How do you see UAS capabilities fitting in with environmental satellites, radiosondes/rawinsondes, and manned weather reconnaissance aircraft?

Session 2: Challenges to the Development and Use of UASs for Environmental Monitoring

Full utilization of civil UASs is currently limited by several challenges, including securing sufficient resources, developing and approving standards for UAS operations, routine access to the National Airspace System, sustaining UAS infrastructure, and training. Our ability to address these and other challenges will determine the long-term effectiveness of UASs for environmental monitoring.

This session will review the key challenges to fully utilizing UASs for research and operational environmental monitoring.

1. What gaps exist between current or planned UAS capabilities and a desired "end state" employment of UASs for environmental monitoring?

2. What environmental impact and safety issues have you encountered or anticipated in UAS operations?

3. What are the national airspace access challenges and the prospects and processes to achieve appropriate access? Today and in the future airspace system?

4. What acquisition strategies and timelines have you pursued in the development of UAS environmental sensing capabilities? What lessons learned can be passed to other agencies? What would work best in developing a nationally coordinated capability?

5. How have you secured and protected funding lines for UAS development, operations, and maintenance? What lessons learned can be passed to other agencies or a coordinated national effort?

6. What data standards and data exchange protocols have you applied to UAS observations? What are the problems you have encountered or anticipate? What lessons learned can be passed to other agencies?

7. What information technology and information system security issues need to be considered? What lessons learned can you share?

Session 3: Interagency Coordination and Strategic Planning for the Use of UASs to Support Environmental Monitoring

Several U.S. civil government agencies have UAS programs or plans and other agencies have potential applications, but we lack broad awareness of capabilities, needs, requirements, and priorities and an associated awareness of gaps and leveraging opportunities. Improved coordination among U.S. government agencies would increase the effectiveness and efficiency of UAS environmental monitoring operations and planning and maximize the national investment in these capabilities.

This session will explore efforts to coordinate the use of UASs across the federal government and how this coordination may be improved.

1. How can we best leverage or jointly operate UAS missions in support of multiple agency needs?

2. What efforts are planned or underway to coordinate Federal UAS activities?

3. How can the nation best coordinate the use of UASs for environmental research and operational services?

4. What strategic and/or implementation planning activities for UAS development and utilization are ongoing or planned? What are the potential benefits of a national strategy?

5. How can a national strategy support agency acquisition, operation, and maintenance of UASs?

6. What federal or national data standards and data exchange standards or protocols are needed to maximize the use of UAS environmental data across user agencies? For the private and academic sectors?

7. How should UASs fit into the Network of Weather and Climate Observing Networks initiative with the OFCM-sponsored Committee for Integrated Observing Systems?

8. What is the role of the international community in UAS planning, operations, and data exchange?

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