

All in the Name of Fire Science

Unmanned Aircraft Battle Flames and Smoke During RxCADRE 2011

By Lindsay Voss



RxCADRE at Eglin Air Force Base relied on UAS to convey controlled burn information on up to 2,000 acres a day. All photos courtesy Tom Zajkowski and Mark Bauer, U.S. Forest Service.

Unmanned systems are becoming popular research tools for widespread applications. Unmanned maritime systems are being operated to study the effects of climate change in the world's oceans, unmanned ground vehicles are capturing environmental data in locations unfit for humans and unmanned aircraft systems are compiling information from tornadic thunderstorms. When it comes to research, unmanned systems can get the job done in high winds or arctic temperatures, thousands of feet under water or miles above in the air.

This February, UAS once again became valuable tools for the research community by providing data to scientists studying wildland fire behavior and dynamics as a part of the Prescribed Fire Combustion-Atmospheric Dynamics Research Experiments (RxCADRE) exercise held 4-13 Feb., 2011 at Eglin Air Force Base in northwest Florida. Three different UAS platforms flew during the exercise, including the Maveric UAS, manufactured and operated by Prioria Robotics; a U.S. Forest Service/U.S. Geological Survey Raven A system; and a G2R UAS operated by the 46th Test Wing of Eglin Air Force Base.

RxCADRE is an exercise conducted every two years in conjunction with the U.S. Forest Service and the Eglin Air Force Base Natural Resources Branch commonly known as the Jackson Guard. At these exercises, fire researchers representing agencies and universities from across the country gather to conduct a number of research assessments on controlled burns. The 2008 exercise featured prescribed burns in Florida and Georgia, but this year's exercise was limited to large acreage burn blocks at Eglin.

This is not the first time UAS have been used during a staged wildland fire exercise. Last September, several systems were operated during AUVSI's Firefighting Table Top Exercise 2010 (FF-TTX 10) at Dugway Proving Ground in Utah, including the Prioria Maveric and a Lockheed Martin Stalker system. These aircraft were utilized

to survey a small acreage grassfire and a structural fire to demonstrate how UAS could be integrated into a wildland fire scenario to support incident managers and firefighters on the ground. Unlike FF-TTX 10, where the spotlight was on integrating unmanned systems into firefighting activities to increase public safety, RxCADRE was a much larger exercise focused on studying wildfire behavior and dynamics utilizing various tools including UAS, manned aviation assets and weather analysis instruments.

The Jackson Guard routinely conducts prescribed fires at Eglin, typically burning more than 100,000 acres a year to manage the growth of non-indigenous trees and shrubs that threaten the area's longleaf pine forests and the native wildlife habitat. Unlike the controlled burns conducted during the 2010 TTX exercise at Dugway Proving Ground, the prescribed burns during RxCADRE totaled several thousand acres, averaging approximately 1,600-2,000 acres on days with favorable burn conditions. These large fires allowed researchers to collect information on fire behavior, atmospheric dynamics and fire effects in a controlled setting.

"RxCADRE is the cutting edge of fire measurements," said Kevin Hiers, prescribed fire program manager from the Jackson Guard. "We have leading scientists from around the nation collecting data on the same burn to both test methods and advance our understanding of fire behavior. Studying fire behavior and smoke transport on a prescribed fire allows us to have much more predictable conditions to validate our models."

"By burning at a large scale, the data collected at RxCADRE are at similar scales of western wildfires and push the models to their limits under conditions where validation data are possible," Hiers added.

Major objectives for the 2011 RxCADRE exercise included implementing prescribed burn ignition and contingency actions in a safe

manner to support ecosystem management and fire research objectives, providing a collaborative training environment for the Eglin Fire and Emergency Services team and the Jackson Guard, and evaluating the protocols and functionality of UAS and associated sensor systems in a wildfire environment. From a research perspective, several data points were of interest including pre-burn fuel loads, post burn consumption, ambient weather, in-situ convective dynamics, smoke plume dynamics, radiant heat release, fire behavior and select fire effects. UAS operations were able to assist with several of these data collection objections by providing persistent time on station.

Each unmanned aircraft flew missions one at a time on 30-minute rotations, providing continuous aerial coverage of the fires. The Maveric was equipped with either a short-wave infrared camera (SWIR) or an electro-optical camera for its missions, while the Raven A provided surveillance using an infrared sensor. The G2R was equipped with cameras as well as a carbon sensor and an instrument to determine relative humidity. A video feed from all three UAS was streamed to the Mobile Emergency Operations Center (MEOC) so firefighters and researchers on hand could see the data collection in real time. In addition to the UAS, a manned helicopter carried a delayed aerial ignition device (DAID) to drop ping-pong ball sized spheres filled with potassium permanganate and ethylene glycol to ignite the fire. A manned Cessna aircraft also flew overhead during the exercise with a lidar sensor for mapping.

According to Hiers, the fire research community is enthusiastic about the use of unmanned aircraft as investigative tools for smoke plume sampling and other atmospheric research related to fire. Researchers



This year's RxCADRE used smaller UAS, like this Raven A, but next year, demo planners hope to see larger UAS in the sky, like ScanEagle.

at RxCADRE were positive about the ability of the deployed UAS to constantly measure ignition patterns and fire lines from an orbiting view. The acquisition of atmospheric data within and around the smoke plume, such as temperature, humidity and wind speed, was also valuable. A notable success from the UAS operations included deploying a mini-aethalometer in the nose cone of the G2R platform to collect concentrations of particulate matter in the fire plume. This type of sampling and data collection will assist fire researchers to better understand the impact of fire on the local weather environment, and conversely, the impact the local environment has on wildland fire.

Though the focus of RxCADRE was on fire science, UAS operations went beyond sampling and surveillance. The systems also provided real-time situational awareness that assisted fire managers in predicting and assessing fire behavior during the exercise, increasing overall safety for researchers in the field and attendees in the exercise staging area. For future exercises, unmanned aircraft could be used to maintain researcher accountability, provide further smoke plume analysis, assess fuel loads prior to the burn and monitor lingering hot spots post burn.

Hiers and others in the fire community are already planning for future RxCADRE events by exploring different UAS platforms, sensors and instruments that could be valuable for these research efforts. Operating a larger, long-endurance aircraft such as a ScanEagle above smaller, hand-launched systems is a key priority for the next RxCADRE exercise. There is also interest in collecting wind and temperature data from start to finish across the burn, which can be achieved with a larger UAS system and simultaneous aircraft operations. Longer term unmanned helicopters could be used to transport the DAID fire ignition system, and larger UAS could be brought in to carry lidar sensors and other technologies of interest such as synthetic aperture radar. There is also interest in deploying unmanned ground components in future exercises for applications including search and rescue, fire retardant dispersal, and brush clearance.

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Request for Information (Sources Sought)

Unmanned Aerial Systems (UAS) for University Use

ISR Group is requesting information from interested sources in order to acquire Unmanned Aerial Systems (UAS) to support a prominent University's UAS Program. This program will include Associates, Undergraduate and Graduate studies in UAS Operations, Maintenance, Management, as well as Payloads and will be a requirement in the immediate future.

The primary objective of the UAS is to support University, along with ISR Group related initiatives in:

- Degree Studies
- Training Certifications
- UAS Research, Development, Test & Evaluation (RDT&E) Projects
- Payload Testing
- National Airspace (NAS) Integration Studies
- Next Generation Air Transportation System research

Interested suppliers can download the full RFI from our website at isrgroup.com or contact Perry Ratliff at 731.926.4188 or e-mail pratliff@isrgroup.com for more information.