

ARM

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U.S. Department of Energy ArcticShark Uncrewed Aerial System

Some studies of atmospheric processes benefit from specialized instrumented observation platforms, including towers, crewed aircraft, tethered balloon systems, and uncrewed aerial systems (UAS). The ArcticShark UAS, managed by the U.S. Department of Energy's (DOE's) Atmospheric Radiation Measurement (ARM) User Facility, has emerged as a vital scientific platform, providing comprehensive measurements to expand the horizons of atmospheric research and ARM data.

The ArcticShark focuses on small-scale, accurate, and repetitive flight patterns over areas of scientific interest, including ARM's ground observatories in Alabama and Oklahoma. When used in concert with data from ground-based instruments and other aerial platforms, UAS observations help deliver a complete picture of atmospheric processes, helping scientists evaluate and improve the accuracy of earth system models needed to inform energy infrastructure planning.

Performance, Precision, and Flexibility

The ArcticShark features a 22-foot (6.7-meter) wingspan and maximum gross weight of 650 pounds (295 kilograms). Flights are generally conducted within these ranges:

- payload capacity: 100 pounds (45.3 kilograms)
- minimum altitude: 500 feet (~152 meters) above ground level
- maximum altitude: typically 15,000 feet (~4,572 meters) above sea level
- flight duration: 5 to 8 hours
- cruise speed: ~60 miles (~97 kilometers) per hour
- climb and descent rate: 50 to 1,500 feet (15 to 457 meters) per minute.

In addition to overseeing flight operations, ARM staff work with researchers to customize instrument packages to meet their specific atmospheric data collection needs. They also collaborate with manufacturers to miniaturize instruments while maintaining data accuracy.

Smaller, lighter instruments enable a flexible payload configuration, allowing a wide range of instruments to be carried internally or externally.

ArcticShark data are available to the ARM user community in four broad categories:

- meteorological variables, such as humidity, temperature, ambient pressure, and three-dimensional wind components
- aerosol properties, including absorption, concentration, size distribution, and chemical composition
- atmospheric gases and water vapor concentration
- infrared temperature and multispectral imagery, which can be used for surface and cloud characterization.

ARM staff evaluate the overall data quality of the ARM instruments flown on the ArcticShark. The data are then processed and made available free of charge through the ARM Data Center.



A Focus on Safety

Stringent maintenance and safety protocols are followed before, during, and after missions. In the air, the ArcticShark flies remotely under strict safety protocols and in coordination with the Federal Aviation Administration and local authorities. Depending on the location and mission, each flight is tracked by visual observers on the ground or a chase plane.

UAS-Enabled Research and Field Campaigns

ArcticShark field campaigns around ARM's atmospheric observatories in Alabama and Oklahoma have gathered critical observations of new particle formation, aerosol-cloud interactions, and boundary-layer dynamics. ArcticShark flights around Alabama's Bankhead National Forest are also providing new details on atmospheric processes above forested regions.

In addition to providing ArcticShark data to the scientific community, ARM issues periodic calls for researchers to propose their own ArcticShark field campaigns.

Researchers may also propose joint access to ARM and DOE Environmental Molecular Sciences Laboratory (EMSL) user facility capabilities through DOE's Facilities Integrating Collaborations for User Science (FICUS) program. EMSL and ARM are working together to collect aerosol samples from the ArcticShark for subsequent offline analyses using multimodal microscopy, spectroscopy, and advanced mass spectrometry techniques at EMSL.

User Information

Researchers can use the ArcticShark platform and its data in a number of ways:

- Access data through the ARM Data Center www.arm.gov/data
- Propose and conduct a field campaign www.arm.gov/research/campaign-proposal



For more information:

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