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ARM Aerial Facility

As an integral measurement capability of the Atmospheric Radiation Measurement (ARM) user facility, ARM Aerial Facility (AAF) provides airborne measurements required to answer science questions proposed by the international research community. Ground-based instrumentation at ARM fixed and mobile atmospheric observatories provides a unique and continuous record of the components of the atmospheric state and constituents that affect the surface radiation budget. The AAF enhances the utility and information content of long-term, ground-based measurements by providing:

- in situ measurements of cloud properties for evaluating and improving ground-based remote sensing retrievals
- critical data for scaling ground-based remote-sensing retrievals to larger temporal and spatial scales detected by satellites
- aircraft measurements of clouds, aerosols, trace gases and radiation for testing and evaluating high-resolution models and model parameterizations.

Facilities and Resources

The AAF supports routine airborne observations and participates in field campaigns designed to contribute to the fundamental understanding of clouds, aerosols, and radiation. To ensure that the best airborne data set can be obtained for a given campaign or routine airborne observational time period, the AAF continually assesses the capabilities of existing instruments and instruments under development within the airborne measurement community. New instruments are integrated into the AAF suite to fill current measurement gaps, as needed.

Working with instrument developers from national laboratories, universities, and private industry, the AAF takes an active role in new instrument development, particularly in the area of miniaturization, where existing instrumentation is merged with new technology to better fit into a space/weight-constrained airborne platform.

ARM has been offering the Gulfstream-159, or G-1, research aircraft as well as contracting for other aircraft outside the U.S. Department of Energy to address the wide range of measurement requirements associated with atmospheric science. ARM is in the process of replacing the aging G-1 with a more modern plane that will be ready for science missions as early as fiscal year 2022. As flight missions are identified, a risk evaluation is performed to ensure that the aircraft and mission meet all U.S. Department of Energy aviation policy guidelines and safety protocols.

Data obtained from the aircraft are documented, checked for quality, integrated into the ARM Data Center, and made available in a timely and consistent manner for use by the scientific community through the ARM Data Center website, ***www.arm.gov/data***.

The use of unmanned aerial systems (UAS) is becoming increasingly popular among atmospheric researchers. These systems provide revolutionary scientific information through the routine measurement of atmospheric conditions, particularly properties related to clouds, aerosols, and radiation in locations not easily accessible by manned aircraft.

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As such, ARM has begun routine measurement activities with tethered balloon systems (TBS) at the third ARM Mobile Facility in Oliktok Point, Alaska. The long-term goal is for ARM to perform routine TBS flights at this site to characterize the arctic boundary layer under a range of conditions and provide routine, repeated measurements with climatological value.

The AAF's newest UAS is the ArcticShark. This UAS is a fixed-wing vehicle with a 22-foot wingspan, an empty weight of 427 pounds, and a maximum payload of 100 pounds. It can reach elevations of 18,000 feet and can be operated beyond radio line of sight via satellite link. ArcticShark test flights with a core suite of instruments have been performed in Pendleton, Oregon. This UAS is expected to be fully ready for science missions in fiscal year 2020.

Field Campaigns

The AAF provides aerial measurement platforms that can be used to support experiments at the fixed sites, in conjunction with a mobile facility, or in support of other research activities, such as maturation/hardening of instruments. Use of the aircraft and instruments must be requested through the ARM field campaign process. To learn more about the proposal process for field campaigns involving the AAF, go to ***www.arm.gov/capabilities/observatories/aaf***.

Recent Deployments

Cloud, Aerosol, and Complex Terrain Interactions Field Experiment (2018-2019)

This ARM field campaign deployed an ARM mobile observatory and the AAF G-1 to collect data in the Sierras de Córdoba mountain range from October 2018 through April 2019. North-central Argentina provided a unique opportunity to capture measurements from a large amount of individual cloud and thunderstorm life cycles and their two-way interactions with the surrounding environmental temperature, moisture, winds, surface conditions, and atmospheric particles. These data will be used to improve the understanding of thunderstorm formation and growth processes in weather and earth system models. This was the last deployment for the G-1.

Aerosol and Cloud Experiments in the Eastern North Atlantic (2017-2018)

The G-1 aircraft flew near the ARM Eastern North Atlantic (ENA) atmospheric observatory during summer (June to July) of 2017 and in winter (January to February) of 2018. The campaign studied both seasons to measure key aerosol and cloud processes under various meteorological and cloud conditions with different aerosol sources. During the summer, the Azores experience overcast stratocumulus clouds that transition to broken trade cumulus clouds, while the winter experiences maritime frontal clouds. The AAF flew the G-1 into these clouds near the ARM ENA site to collect vertical profile data of aerosols and clouds.

Green Ocean Amazon (2014-2015)

Tropical deep convection in its natural state and the underlying processes that drive it are poorly understood and modeled, with insufficient observational data sets for model constraint. The AAF Gulfstream-1 was deployed to Brazil in two phases to obtain measurements of cloud, trace gas, and aerosol properties. Phase I took place February 16 to March 27, 2014, and Phase II took place September 1 to October 10, 2014. The Gulfstream-1 flew vertical profiles to an altitude of 5 to 6 kilometers to determine changes to gases and particles within the detrainment levels of shallow cumulus clouds, to investigate properties of polluted layers, and to characterize cloud dynamics, thermodynamics, and microphysics.

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