As a scientific user facility with long-term and mobile sites across the globe, the Atmospheric Radiation Measurement (ARM) user facility is used by scientists to obtain measurements of radiative fluxes, cloud and aerosol properties, precipitation interactions, and related atmospheric characteristics in diverse environments. To collect these measurements geared toward improving earth system models, long-term, continuously operating atmospheric observatories in three regions—referred to as the Southern Great Plains, North Slope of Alaska, and Eastern North Atlantic—are operated by ARM through strong collaborations between nine U.S. Department of Energy (DOE) national laboratories. These measurements are supplemented through periodic field campaigns by the ARM Aerial Facility and ARM Mobile Facility (AMF) deployments.

Consisting of several portable shelters, a baseline suite of instruments, data communications, and data systems, ARM mobile facilities are easily transported and relocated to make ideal platforms for conducting collaborative research anywhere in the world. An experienced team is deployed with each of the three mobile facilities to set up the shelters and instruments. Data from these facilities undergo quality checks and are made available in near-real time. Scientific and infrastructure staff are also available for collaborative planning activities, and systems are available to provide local onsite or virtual support for collaborating scientists using an AMF for their research.

Baseline Capabilities

An ARM AMF has instrumentation and data systems similar to the fixed atmospheric observatories. Each AMF has about 50 instruments to obtain continuous measurements of clouds, aerosols, precipitation, energy, and other meteorological variables. Instrumentation for AMF2 is, with a few notable exceptions, the same as used by AMF1 and AMF3. Because shipboard deployments of AMF2 are encouraged, the baseline suite of instruments is marine-focused.

Key instruments include vertically pointing Ka-band radars, scanning dual-frequency X- and Ka-band radars, and one scanning C-band radar to measure properties of cloud and precipitation particles. A micropulse lidar monitors elevated aerosol layers and thin clouds, while the Doppler lidar combined with an infrared spectral radiometer provides measurements of boundary layer winds, temperature, and humidity. Radiosondes on weather balloons provide wind and thermodynamic profiles throughout the troposphere. A suite of aerosol instrumentation is included with each AMF to collect measurements of aerosol optical depth, composition, size distribution, scattering, and absorption; cloud condensation nuclei; ice-nucleating particles; and trace gases.

Other instruments include a radar wind profiler to measure vertical wind and precipitation profiles, radiometers and eddy correlation flux measurement systems for monitoring surface fluxes, microwave radiometers for measuring precipitable water and liquid water path, and rain gauges and disdrometers for measuring rainfall characteristics. Digital cameras track cloud boundary location and movement.

Measurements obtained by these instruments are collected by computers inside an operations shelter. This shelter houses numerous computer stations for data and communication systems. The AMF operates 24 hours a day, seven days a week and is maintained by ARM staff. Because it is designed to collaborate with experiments from other agencies, the AMF can also host instruments other than the baseline collection. For a full list of available instruments, see www.arm.gov/capabilities/observatories/amf.
AMF Science

The purpose of an AMF is to explore research questions beyond those addressed by ARM’s fixed atmospheric observatories in Alaska, Oklahoma, and the Azores in undersampled regions around the world. The AMF produces data sets for use by the atmospheric community to improve fundamental understanding of aerosol and cloud processes that affect the Earth’s energy and water cycles and to test and improve earth system models.

Data from the AMF instruments are processed using specialized routines to produce standardized data products. These data are evaluated by scientific staff for overall quality and then processed and made available to the world, free of charge, in near-real time through the ARM Data Center, www.arm.gov/data.

Each deployment is the result of a competitive process based upon proposals submitted by teams of scientists. Details about the AMF proposal process can be found at www.arm.gov/policies/campaign-guidelines/annual-facility-call.

Recent Deployments

ARM Mobile Facility 1 (2019–2020)

From December 2019 until May 2020, the Cold-Air Outbreaks in the Marine Boundary Layer Experiment (COMBLE) aims to shed light on the dynamics and microphysical properties of clouds and precipitation in the high-latitude marine boundary layer during cold-air outbreaks. To help fill in observational gaps, ARM deployed its first mobile facility near Andenes, Norway—a town on an island in the northeastern part of the country—and a smaller set of instruments on Bear Island, located approximately midway between the Norway mainland and Svalbard. This field deployment will help researchers learn more about the properties of clouds associated with boundary layer convection, as well as air-mass transformation in cold-air outbreaks over open water.

ARM Mobile Facility 2 (2019–2020)

The Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAiC) expedition features an intricate strategy to measure the atmosphere, biosphere, ocean, and sea ice in the rapidly evolving central Arctic. It consists of:

- an intensive, icebreaker-based observatory frozen in, and drifting with, the arctic sea ice for a full annual cycle while making interdisciplinary measurements in the atmosphere, sea ice, upper ocean, and biosphere
- a distributed network of autonomous measurements to characterize spatial variability on model grid-box scales
- coordinated multiscale analysis and modeling activities.

ARM deployed its second mobile facility, along with advanced instrumentation to obtain physical and chemical properties of aerosols (tiny particles in the air) on the chief MOSAiC observatory, the Alfred Wegener Institute’s research icebreaker R/V Polarstern. ARM’s instruments are within the MOSAiC central observatory as it drifts through the central Arctic for a 13-month campaign that started in September 2019.

ARM Mobile Facility 3 (2013–2021)

Located at the North Slope of Alaska on the coast of the Arctic Ocean, Oliktok Point became the temporary home for ARM’s third ARM Mobile Facility, or AMF3, beginning in October 2013. Data are being gathered at Oliktok for an extended deployment of eight years to better understand aerosol, cloud, and radiative transfer processes that may play an important role in arctic atmospheric processes. By the end of fiscal year 2021, ARM plans to move AMF3 from Oliktok Point to a location somewhere (still to be determined) in the Southeastern United States. The Southeast is one of several high-priority science locations identified by the ARM science community in a recent workshop.

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www.arm.gov/capabilities/observatories/amf