

# ARM

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## U.S. Department of Energy North Slope of Alaska



Because the environment in the Arctic is rapidly changing, the North Slope of Alaska has become a focal point for atmospheric and ecological research. Aerosols—tiny particles in the air—and clouds have strong impacts on the Arctic's surface energy balance through absorption and reflection of shortwave and longwave radiation. In turn, changes in the surface conditions, such as melting of sea ice, snow, or permafrost, can feed back to atmospheric structure and circulation, water vapor, gas and aerosol releases, and cloud properties.

Through the U.S. Department of Energy (DOE), the Atmospheric Radiation Measurement (ARM) user facility has gathered atmospheric data since 1997 at its North Slope of Alaska (NSA) atmospheric observatory. The NSA's central facility is near Utqiagvik (formerly Barrow), the northernmost city in the United States, located on the edge of the Arctic Ocean. The Utqiagvik site has collected comprehensive data about cloud and radiative processes in the Arctic Circle using state-of-the-art ARM instrument systems. These data have been used to improve the representation of high-latitude cloud and radiation processes in earth system models.



To meet next-generation science questions about the complex interactions and feedbacks among atmospheric processes in the changing Arctic, ARM expanded its operations in the region by locating an ARM Mobile Facility at Oliktok Point in 2012. The addition of a mobile facility at this location has provided unique opportunities for operating unmanned aerial systems and tethered balloon systems for scientific research. This configuration of ARM resources has resulted in more comprehensive scientific data as well as processes and tools for scientists to more easily integrate the data into earth system models.



### North Slope Sites

**Utqiagvik** – ARM's Utqiagvik site is providing data about cloud and radiative processes at high latitudes. Many of the same instruments used at warmer ARM observatories have been hardened to withstand temperatures that drop well below negative 40 degrees Fahrenheit at the site, which is located 320 miles north of the Arctic Circle and a mile south of the Arctic Ocean.

**Oliktok Point** – Opportunities for both air and ground-based measurements at this isolated location provide a unique opportunity for the scientific research of clouds, aerosols, atmospheric conditions, sea ice, and heat exchange at the surface. In addition to the standard array of ground-based instruments deployed with the mobile facility, tethered balloon systems and unmanned aerial systems are available to sample surface fluxes, atmospheric vertical structure, and aerosol and cloud properties. Special-use arctic airspace that stretches 700 miles north is also available as a resource to conduct atmospheric research.



**Atqasuk** – While there are no longer ARM instruments at this inland arctic tundra location, it was used to collect data from 1999 to 2011. The resulting data set is available for research purposes through the ARM Data Center.

## Research Focus

ARM's NSA facilities are located in the gradient zone along the North Slope coast, where land- and ocean-surface characteristics undergo large spatial and seasonal transitions. These transitions affect fluxes of heat, moisture, and gases and aerosols. ARM's research focus is to understand how these complex interactions affect cloud properties and the energy budget.

As described in the DOE North Slope of Alaska Priorities Workshop Report, continuous data from the NSA allow scientists to:

- explore relative roles of long-range transport of aerosols, heat, and water vapor versus local processes
- examine aerosols and their impacts on the energy budget and cloud processes
- study cloud processes, including mixed-phase clouds and impacts of diverse surface conditions on cloud properties

- investigate what controls the development of the vertical structure of the thermal, water vapor, aerosol, and cloud components of the atmosphere.

Made to support a large range of scientific investigation, the NSA observatory is in the middle of a period of emphasis on studying the Arctic called the Year of Polar Prediction. NSA data will augment the upcoming Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAiC) field campaign. ARM will deploy its second mobile facility on an icebreaker-based observatory that will freeze in, and drift with, the arctic sea ice for a full annual cycle to obtain physical and chemical properties of aerosols. These instruments will be within the MOSAiC central observatory as it drifts through the central Arctic for a 13-month campaign starting in September 2019.

## Instrumentation

The Utqiagvik and Oliktok facilities support over 32 different instruments. The extended-range atmospheric emitted radiance interferometers at the two sites were built specifically for the high latitudes, where low water vapor concentrations are common. Routine observations from scanning radars detect and quantify the structure,

spatial distribution, and evolution of arctic clouds and precipitation. Other instruments provide data on surface boundary conditions and allow for characterization of the physical properties of clouds, particularly mixed-phase clouds composed of both liquid and ice.

NSA site operators fly unmanned aircraft and tethered balloons over the ARM site and over the land and sea ice as part of the ARM mission to characterize the heterogeneity of the atmospheric environment and the underlying surface around the ARM site. The Oliktok instrument suite also includes a Raman lidar, which provides vertical profiles of water vapor and information about cloud properties.

## User Information

Researchers can use the NSA's facilities and data in a number of ways:

- Access data gathered during normal operations or field campaigns through the ARM Data Center [www.arm.gov/data](http://www.arm.gov/data)
- Propose and conduct a field campaign [www.arm.gov/research/campaign-proposal](http://www.arm.gov/research/campaign-proposal)
- Make an in-person or virtual visit to the NSA site [www.arm.gov/tour/north-slope-overview.html](http://www.arm.gov/tour/north-slope-overview.html)
- Read the DOE North Slope of Alaska Priorities Workshop Report [www.arm.gov/news/publications/post/34108](http://www.arm.gov/news/publications/post/34108)

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