

ARM

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U.S. Department of Energy North Slope of Alaska



Because of the importance of the Arctic to the nation's security and energy production, and the potential for changes in the region, the North Slope of Alaska has become a focal point for atmospheric research. Aerosols and clouds have strong impacts on the Arctic's surface energy balance through absorption and reflection of shortwave and longwave radiation. In turn, shifts in the surface conditions, such as melting of sea ice, snow, and 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. Data from the ARM site's state-of-the-art instrument systems have been used to improve the representation of high-latitude cloud and radiative processes in earth system models. These models in turn are important for understanding environmental threats to the nation's energy supply.

To meet next-generation science questions about the complex interactions and feedbacks among atmospheric processes in the changing Arctic, ARM temporarily expanded its operations in the region with an ARM Mobile Facility at Oliktok Point from 2013 to 2021. The addition of a mobile facility at this location provided unique opportunities for operating uncrewed aerial systems and tethered balloon systems for scientific research. This configuration of ARM resources resulted in more comprehensive scientific data as well as processes and tools for scientists to more easily integrate the data into earth system models.

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, gases, and aerosols. ARM's research focus is to understand how these complex interactions affect cloud properties and the energy budget.

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 processes of clouds, including mixed-phase clouds, which are composed of both liquid and ice, and impacts of different 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 contribute to a large range of scientific investigation, the NSA observatory has supported approximately 80 field campaigns. The site recently supported field campaigns led by investigators at the University of Alaska Fairbanks and U.S. Air Force Research Laboratory to learn more about the effect of snowmelt on surface reflectivity and the extinction of laser light in arctic haze, respectively. Other uses for the NSA include validating satellite measurements, tracking sea-ice breakup with radar, augmenting data from other high-latitude areas, and testing new instruments, such as low-cost optical sensors for space domain awareness of low Earth orbit satellites.

North Slope Sites

Utqiagvik – ARM’s Utqiagvik site provides comprehensive 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 1 mile south of the Arctic Ocean.

Oliktok Point – ARM ended operations at Oliktok in 2021 to prepare the mobile facility for relocation to the Southeastern United States. Resources for aerial and ground-based measurements at this isolated location, such as special-use airspace stretching 800 miles north, enabled new opportunities for the research of clouds, aerosols, atmospheric conditions, sea ice, and heat exchange at the surface. Data from Oliktok remain available through the ARM Data Center.

Atkasuk – This inland arctic site, which hosted instrumentation including meteorological sensors and radiometers, operated from 1999 to 2011. Data from its tundra location (about 70 miles south of Utqiagvik) provide contrast to Utqiagvik’s mixed land-and-sea influences. The data are still available through the ARM Data Center.

Instrumentation and Data

The Utqiagvik facilities support about 50 different instruments. The extended-range atmospheric emitted radiance interferometer was built specifically for the high latitudes, where low water vapor concentrations are common. Routine scanning radar observations detect and quantify the structure,

spatial distribution, and evolution of arctic clouds and precipitation. A set of instruments measures the chemical composition and size of aerosol particles, including those that are biogenic, or naturally occurring. Other instruments provide data on surface boundary conditions and allow for characterization of the physical properties of clouds, particularly mixed-phase clouds. Snow instruments operating just south of the NSA’s central facility provide details on coastal-to-inland gradients.

ARM flew uncrewed aircraft and tethered balloons over the Oliktok site and over the land and sea ice as part of the ARM mission to characterize the heterogeneity of the atmosphere and the underlying surface. The Oliktok instrument suite also included a Raman lidar for 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
- Propose and conduct a field campaign www.arm.gov/research/campaign-proposal
- Visit the NSA in person or virtually www.arm.gov/capabilities/observatories/nsa

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