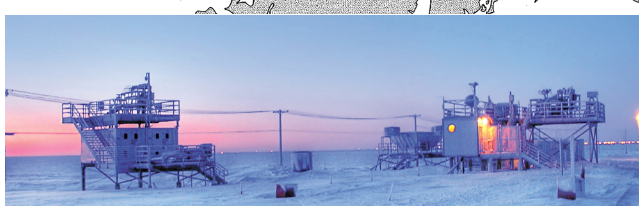
Understanding Climate Change

Sandia Researchers Travel to the North Slope of Alaska

Sandia researchers are members of a global research team whose work on the cold tundra in northern Alaska is helping to transform scientists' understanding of what the future may hold for Earth's climate.

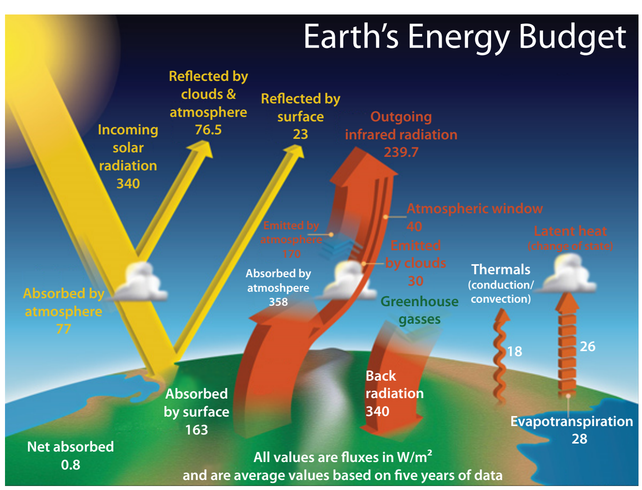
A Centerpiece of DOE Climate Research

Sponsored by DOE's Office of Science and managed by its Office of Biological and Environmental Research, the Atmospheric Radiation Measurement (ARM) Climate Research Facility operates research sites on the North Slope of Alaska and adjacent Arctic Ocean, providing researchers with a rare, ground-based window into the cloud and radiative processes that take place in Earth's atmosphere at high latitudes. Centered at Barrow and extending to the south (to the vicinity of Atqasuk), west (toward Wainwright), and east (toward Oliktok), this area has become a focal point for atmospheric and ecological research activity on the North Slope.



Instrument clusters (near Barrow, Alaska) gather data used to refine global climate models.

The ARM program is the DOE's largest global climate-change research effort. It was created in 1989 to help resolve scientific uncertainties related to global climate change, focusing on the role of clouds and aerosols. Designated as a DOE scientific user facility in 2003, ARM provides the national and international research community with climate data from three permanent facilities—Southern Great Plains (Oklahoma), Tropical Western Pacific (Australia), and North Slope of Alaska (Barrow)—and supplemented by aerial and mobile facilities. The ARM sites continuously collect massive amounts of atmospheric measurements needed to improve climate models through better understanding of cloud and aerosol processes.



The Arctic is important to climate science because it exhibits a large change in seasonal surface albedo, high-latitude cloud processes are poorly understood, and Arctic warming is expected to be roughly two times the global average. *(Image courtesy of Loeb et al., J. Climate, **22**(3), 748–766, 2009.)*

Aerosol Life Cycle. ARM's heavily instrumented sites provide data to help scientists determine the characteristics and properties of aerosols throughout their life cycle. Improved observation of aerosol particles results in more accurate projections of how aerosols affect the global climate.

Cloud Life Cycle. ARM data collections assist scientists who are studying the various stages of cloud evolution in order to relate cloud observation to climate model development and evaluation. These data provide information to improve cloud parameterizations in global climate models.

Cloud Aerosol Interactions. Data from fixed, mobile, and aerial ARM climate research facilities provide information to help quantify the impact of aerosols on the radiative balance of Earth's climate system, both directly and indirectly, through their influence on clouds.

Radiative Processes. To help improve and test radiation parameterizations at the accuracy required for climate studies, ARM contributes to this research with continuous data collections of long-wave to short-wave radiation. These data have made significant contributions in improving climate prediction models, particularly with respect to radiative heat transfer and radiation absorption.

Why Study Climate at the Top of the World?

The North Slope of Alaska site provides data about cloud and radiative processes at high latitudes. Climate researchers have focused attention on high latitudes to better understand the interactions of the atmosphere-land-ocean system. These data are used to refine models and parameterizations as they relate to the Arctic. The Arctic has a significant impact on climate all over the world. The Arctic, specifically, is predicted to undergo more intense change relative to global averages than any other region on Earth because water undergoes a specific seasonal phase change there. Other compelling scientific reasons to study climatic change at high latitudes are

- Ice (including snow) is the predominant form of condensed water most of the year, both in the air and on the surface. Ice and snow scatter, transmit, and absorb sunlight and radiant heat much differently than water
- The Arctic atmosphere contains very little water vapor, changing the impact of the atmosphere on the propagation of radiant energy, particularly radiant energy propagating upwards from the surface, and on the performance of some atmospheric remote sensing instruments.
- The major "pumps" for the global ocean currents are at high latitudes, and there is good reason to believe that those pumps will be affected by climate-related changes in the atmosphere.
- High-latitude atmospheric processes over both land and sea must be characterized for incorporation into global climate models.

The arid cold during winter at the North Slope provides a 'window' into space. Under these conditions, infrared radiant energy can escape more easily through the atmosphere. This is one of the ways that high latitudes are quite different from temperate or tropical regions, and reinforces the importance of this research. Because the North Slope site is fairly cold year-round, scientists often observe clouds that are composed of ice or ice and water in mixed phases.

The value of these different regional factors is that the researchers have the chance to study how long-wave energy gets trapped to varying degrees inside the atmosphere by different conditions from chemical constituents that include water vapor, carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, and liquid water droplets that absorb the energy emitted by the surface of Earth.

Barrow Arctic Research Center, proposed location of some of the new Recovery Act-funded sensors.

Recent Funding Has Increased Facility Capabilities

Sandia's North Slope climate study project got a boost in 2009 with the help of $2.5M from the American Recovery and Reinvestment Act—the stimulus package—which will be used to prepare the ARM site near Barrow, Alaska, for several new instruments, including scanning cloud and precipitation radars, improved balloon sounding systems, carbon flux instruments, and several new lidar (light detection and ranging) systems. Lidar is an optical remote-sensing technology that measures properties of scattered light to find range and/or other information of a distant target. It operates much like radar but measures light pulses instead of radio waves.

An instrumented tethered balloon is one way to gather atmospheric data. With Recovery Act funding, the ARM program can lease time on unmanned aerial vehicles.

The new high-resolution spectral lidar system will allow the researchers to take better measurements of clouds and aerosols and help them build better climate change models. In addition to profiling atmospheric water vapor, the systems developed for the ARM program also profile temperature, clouds, and aerosol particles.

The Recovery Act funding allows the research in Barrow to take atmospheric measurements to a new level. The improved radar and lidar equipment will strengthen the facility's standing as a world-class atmospheric observatory—continuing the research and obtaining a more thorough understanding of clouds and their role in climate change in the Arctic.

Sandia has managed the ARM sites on the North Slope of Alaska since its inception in 1998. Staff from Sandia also played key roles in development of the Atmospheric Cloud and Radiation Stations used at the ARM sites in the Tropical Western Pacific. They also work closely with ARM staff at Los Alamos National Laboratory on operations in the Tropical Western Pacific and the first ARM mobile facility, which deploys for a few months to a year at a time at sites around the world.

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