Cloud Properties and Life Cycle

Millimeter wavelength radars are used to obtain measurements of the horizontal and vertical distributions of clouds, as well as the sizes and shape of the water and ice that compose the clouds.

Scanning Cloud and Precipitation Radars

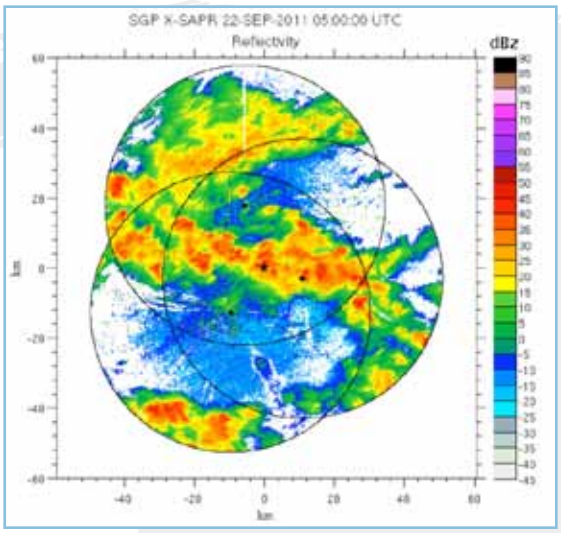
An unprecedented assortment of 19 new scanning radars provides a unique capability for high-resolution delineation of cloud evolution, morphology, and characteristics. All these radars are equipped with dual-polarization technology which, combined with multiple frequencies, provides improved retrievals of cloud properties, including better discrimination of liquid from ice.

- 35/94-gigahertz (Ka/W-band) scanning ARM cloud radars at SGP, NSA, and with AMF1
- 35/10-gigahertz (Ka/X-band) scanning ARM cloud radars at TWP sites (2) and with AMF2
- 10-gigahertz (X-band) and 5-gigahertz scanning ARM precipitation radar at SGP (3) and NSA
- 5-gigahertz (C-band) scanning ARM precipitation radar at SGP and TWP-Manus

Cloud Probes for In Situ Measurements

In situ data is critical for validating measurements obtained from both ground-based and satellite remote sensing instruments. Six new cloud probes, all with the newly designed tips and faster electronics, reduce the effects of particle shattering to provide more accurate measurements for model development and validation studies.

- Fast forward scattering spectrometer
- 2-dimensional imaging probe
- High-volume precipitation spectrometer
- Cloud spectrometer and impactor
- Fast cloud droplet probe
- Liquid ice water sensor



Overlapping precipitation radars surround the cloud radars (star in center) at the SGP site

3-Channel Microwave Radiometer

A new 3-channel microwave radiometer at all the ARM sites provides improved sensitivity to liquid water when the liquid water path is less than 100 grams per square meter, offers improvements in the spatial and temporal resolution of the measurements, and matches as closely as possible the field of view for all channels.

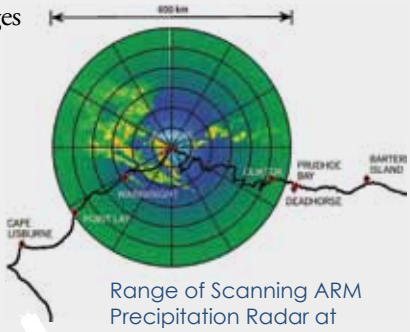
The high-volume precipitation spectrometer (front) measures the number and size of precipitation particles, including snowflakes, from 150 microns to 1.92 centimeters in size. This is the only aircraft research instrument of its kind that provides complete digital images of precipitation particles up to nearly 2 centimeters in size.




Scientific Impact

Recovery Act enhancements throughout the ARM Facility reflect the need for detailed measurements of key atmospheric processes—particularly those involving clouds and aerosols. These measurements provide the essential building blocks for climate models, which are currently the only tools available to anticipate the climate of future decades and centuries.

North Slope of Alaska



Range of Scanning ARM Precipitation Radar at the North Slope of Alaska.

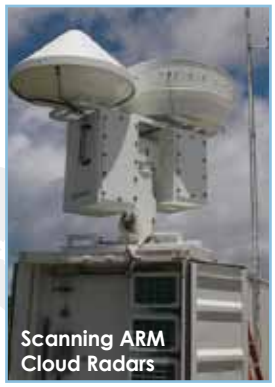
Dramatic changes in the Arctic—which appear to be driven primarily by increasing clouds and precipitable water vapor—are occurring at rates greater than predicted. Routine observations from three new scanning radars greatly expanded the NSA site's ability to detect and quantify the structure, spatial distribution, and evolution of Arctic clouds and precipitation. Other new instruments close a gap in observations of surface boundary conditions and allow for characterization of the physical properties of clouds over Barrow, particularly those associated with mixed-phase clouds composed of both liquid and ice.

Southern Great Plains

Due to its relatively homogeneous geography and continental locale, the SGP site serves as a good testbed for single-column models and cloud-resolving models. Now, the simultaneous operation of multiple radar and lidar systems within the SGP domain provides an unparalleled capability for "interrogating" the growth and decay of individual clouds and their interactions with the larger associated weather systems.

Tropical Western Pacific

Detailed measurements from the tropical warm pool regime—Earth's "heat engine"—are essential to fully understand and model the planet's atmospheric circulation and climate. New scanning cloud radars at the TWP sites allow far better characterization of the complex convective cloud fields than is possible with traditional vertical-pointing cloud radars. Meanwhile, the new scanning precipitation radar provides an important constraint for model simulations of the equatorial tropical climate regime.



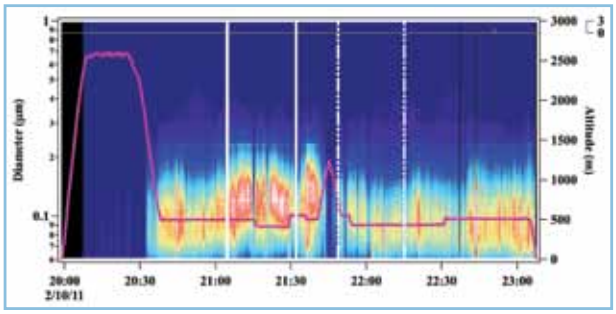
Scanning ARM Cloud Radars

ARM Mobile Facilities

The two AMF provide the means to apply the comprehensive array of ARM measurements to diverse climatic regimes. New instruments from the Recovery Act will allow scientists to better explore cloud and aerosol properties in under-sampled regions around the world.

ARM Aerial Facility

Recovery Act funding more than tripled the number of instruments available in the AAF—ARM's "site in the sky." State-of-the-art instrumentation measures in situ atmospheric state parameters, cloud and aerosol properties—including particle-size detection from 15 nanometers to 2 centimeters—and concentrations of numerous climate-relevant gases. New cloud probe designs provide unbiased measurements of the size distribution of ice particles, which equates to more accurate model input. In addition, faster electronics and data processing software have greatly increased the sensitivity of the probes to detect very low concentrations of both aerosols and cloud particles.



Aerosol size and concentration from the Ultra High Sensitivity Aerosol Spectrometer.