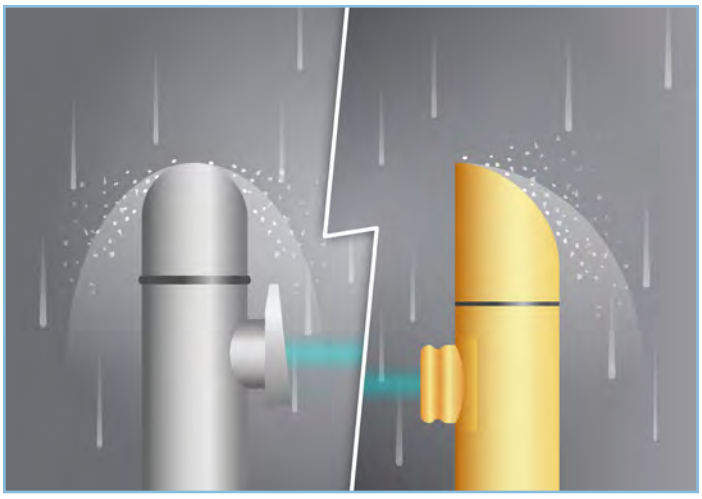
ARM
CLIMATE RESEARCH FACILITY

Small Particles in Cirrus

Because the reflective properties of ice crystals in cirrus clouds can greatly influence the amount of solar energy that reaches the Earth, scientists use information about the shape and size of ice crystals as input to climate models. These data are obtained by satellite instruments, ground-based sensors, and research aircraft equipped with probes. However, notable discrepancies among these measurements have led to considerable uncertainty in how to represent these properties in climate models.

From December 2009 through Aoril 2010, the Atmospheric Radiation Measurement (ARM) Climate Research Facility will sponsor the use of an instrumented aircraft to obtain the most comprehensive set of measurements of ice crystals in cirrus clouds yet obtained. In conjunction with concurrent data from ground-based instruments at the ARM Southern Great Plains site, the Small Particles in Cirrus, or SPARTICUS, field campaign will help resolve discrepancies between both ground-based and in-situ measurements. SPARTICUS will use new probes designed to minimize potential problems with shattering of larger crystals on the inlets of the older probes. By using both new and old probes to obtain the airborne data, scientists hope to balance the new information against the legacy measurements and evaluate past data sets. Ultimately, this will lead to a better understanding of the radiative effects of cirrus clouds on global climate.



Newer aircraft probe designs could minimize the shattering effect that previously resulted in a disproportionate amount of smaller particles being measured by the sensor beam.

Science Objective

Understanding the microphysical properties—ice water content, ice crystal size, shape, density, concentration, etc.—of cirrus clouds is a critical factor in determining how they affect energy transfer in the atmosphere and how the clouds are coupled with atmospheric motions. Previous research has shown that measurements of the number and size of ice crystals smaller than 50 microns in diameter from the same cirrus cloud can vary greatly depending on the probe used to acquire the data.

Data from SPARTICUS will allow scientists to move forward with greater confidence in answering the following questions:

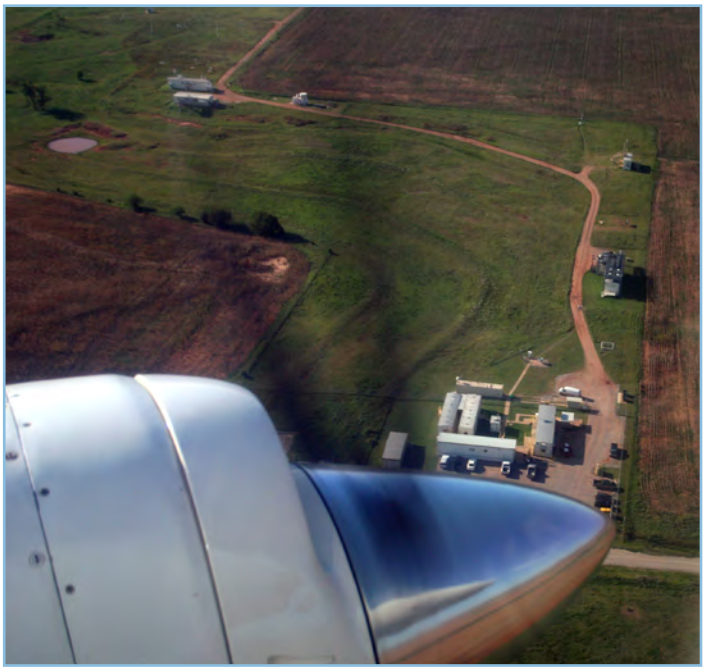
- How much do the smallest ice crystals contribute to the reflection of solar energy from cirrus clouds?
- What types of physical processes influence the lifecycle of cirrus clouds?
- What is the optimum method for inferring cloud properties using ground-based measurements?

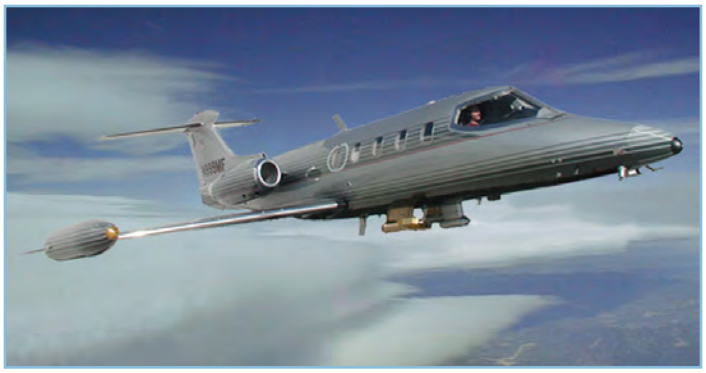
Research Instrumentation

Learjet Aircraft

Using an instrumented Learjet 25 operated by Stratton Park Engineering Company, Inc., researchers are focusing their flights primarily in cirrus clouds between 9 and 12 kilometers above the ARM Southern Great Plains site. During the campaign, the Learjet payload is carrying both new and legacy probes for measuring the size, shape and water content of ice particles in the clouds, as well as a variety of instruments for measuring the vertical profile of the atmosphere.

Research flights start in December 2009 and continue through April 2010. Each flight will last between four and five hours, weather permitting, and some flights will be timed to correspond with satellite overpasses for additional comparative measurements. Once collected, this will be the most comprehensive data set on the microphysical properties of cirrus yet obtained, and should provide the statistically representative data needed to evaluate the measurements from ground-based and satellite instruments. Forecasting for the campaign is provided by the site meteorologist at the Southern Great Plains site.





Southern Great Plains Site

Fully established in 1994, this ARM site covers an area of about 43,000 square kilometers in north-central Oklahoma and south-central Kansas. It consists of a heavily instrumented Central Facility, plus numerous smaller facilities positioned throughout its domain. Remote-sensing instruments at each location collect data 24/7, delivering a continuous record of ground-based atmospheric measurements ideally suited to climate studies.

Key ground-based instruments that will provide critical comparative data for the SPARTICUS campaign include the following:

- Raman Lidar - vertical profiles of water-vapor and several cloud- and aerosol-related quantities
- Atmospheric Emitted Radiance Interferometer – infrared energy
- Micropulse Lidar – cloud bases and tops, and aerosols
- Millimeter Wavelength Cloud Radar – cloud boundaries, reflectivity, and vertical velocity

http://acrf-campaign.arm.gov/sparticus

Contacts

Jay Mace, Principal Investigator
University of Utah
801.585.9489
mace@met.utah.edu

Lynne Roeder, ARM Public Information Officer
Pacific Northwest National Laboratory
509.372.4331
lynne.roeder@pnl.gov

DOE/SC-ARM-09-018

U.S. DEPARTMENT OF ENERGY | Office of Science

The ARM Climate Research Facility is funded through the U.S. Department of Energy's Office of Science.
Additional information is available on the ARM website at www.arm.gov.