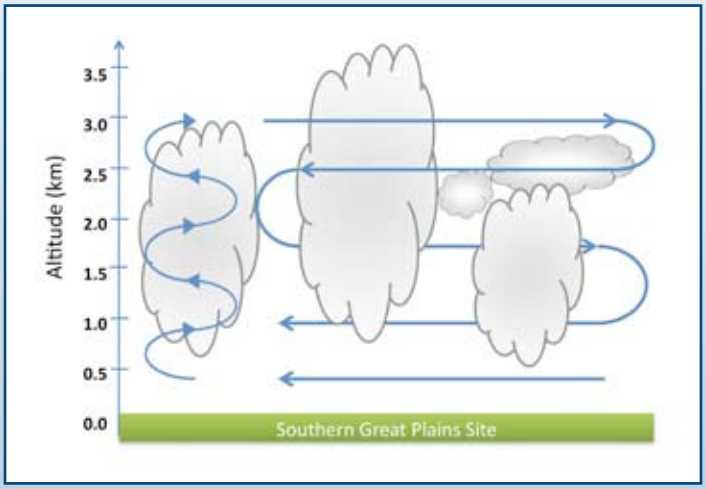
Systematic Flights Obtain Long-Term Data Set of Cloud Properties

Beginning in January 2009, the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) Climate Research Facility is sponsoring the first-of-its-kind long-term airborne research campaign to obtain data from low-level clouds above its Southern Great Plains (SGP) site. The five-month campaign is centered near Lamont, Oklahoma, a mid-latitude region that experiences a wide range of cloud types, including the "thin" clouds that are the focus of the campaign.

Thin clouds contain so little water that the sun can be seen through them. Scientists refer to such clouds as "clouds with low-optical water depth," or CLOWD. Because these clouds are often tenuous and scattered, even some of the best ground-based instruments have trouble accurately measuring their properties, such as water content and water droplet size. These properties determine the amount of sunlight that is transmitted or reflected by the cloud—an important component in modeling Earth's climate.

Conducted by the ARM Aerial Facility (AAF), the *Routine AAF CLOWD Optical Radiative Observations*, or RACORO, field campaign will obtain key measurements from these clouds through systematic science flights above the SGP site. This site is heavily instrumented with ground-based sensors that will provide comparative measurements for analysis.



Three times a week for five months, the Twin Otter aircraft will take measurements at various altitudes above the SGP site.

Discrepancies in measurements of cloud properties, such as water content, can reduce confidence in climate model results.

Science Objective

Earth's energy balance is sensitive to small changes in the amount of water in thin clouds. Because CLOWD-type clouds are very common—usually occurring between the Earth's surface up to about 2.5 kilometers throughout the globe—discrepancies in measurements of their properties can contribute a large degree of uncertainty to climate models. A better understanding of this cloud type can only be achieved by acquiring the critical in-situ data that are needed to evaluate and refine existing retrieval algorithms from ground-based instruments.

To accomplish this goal, the RACORO science team is using a Twin Otter aircraft equipped with a full payload of research instrumentation to complete routine flights over the SGP site and obtain representative statistics of cloud microphysical, aerosol, and radiative properties of the atmosphere. The data will be used to validate retrieval algorithms and support process studies and model simulations of boundary layer clouds and, in particular, CLOWD-type clouds.

Experiment Components

Twin Otter Aircraft

The CIRPAS Twin Otter is a non-pressurized turbo prop twin-engine aircraft that will operate at an air speed of about 100 knots during RACORO science flights.

Operated by the Naval Postgraduate School's Center for Interdisciplinary Remotely Piloted Aircraft Studies, or CIRPAS, the Twin Otter aircraft has flown numerous missions in support of scientific field campaigns. During the RACORO field campaign, the Twin Otter will be based out of Edmond-Guthrie Regional Airport, located 85 kilometers from the SGP site. Instrumentation on the aircraft will include probes and sensors to obtain the following measurements:

- Cloud microphysics – liquid water content and drop size distribution
- Radiometric quantities – incoming and outgoing solar and thermal energy
- Atmospheric state – water vapor concentration, temperature, and turbulence
- Aerosol properties – concentration and size distribution

Southern Great Plains Site

Cloud radars (foreground), a meteorological tower (background), and an aerosol observing system represent just a small portion of the remote-sensing instruments at the ARM Climate Research Facility's SGP site.

Fully established in 1994, this ARM Climate Research Facility 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. The SGP site meteorologist from the Cooperative Institute for Mesoscale Meteorological Studies at the University of Oklahoma will provide meteorological support throughout the campaign.

Schedule

Research flights start in late January 2009 and continue through June. Weather and cloud conditions permitting, flights will occur three times per week at different times of the day to sample diurnal variations in cloud properties. Each flight will last between four and five hours.

Collaborations

- In April, a team of scientists led by Brookhaven National Laboratory will test a linear array of scanning microwave radiometers to retrieve profiles of cloud water content at the SGP site. Data obtained during RACORO overflights may be used to validate this novel array approach for ground-based cloud property retrievals.
- In June, scientists from the National Aeronautics and Space Administration will join the RACORO campaign with an instrumented King Air B200 research aircraft. It will fly above the Twin Otter to obtain complementary measurements of aerosol and cloud microphysical properties. Measurements from both aircraft and the ground will also be used to validate a new sensor for upcoming missions by the Glory satellite.

Website: ***http://acrf-campaign.arm.gov/racoro***

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