Atmospheric Radiation Measurement
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# Southern Great Plains Newsletter

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## CLASIC and CHAPS Campaigns

The Cloud and Land Surface Interaction Campaign (CLASIC) and the Cumulus Humilis Aerosol Processing Study (CHAPS) are major field campaigns taking place at the SGP site during June. These projects bring a host of researchers and instruments to the site in search of answers to science questions, including the following:

- What are the roles of cumulus convection and spatial variations in land cover in depleting low-level water vapor as it is advected into the SGP region?
- What are the relationships between cumulus clouds and aerosols and the soil-plant-atmosphere exchange of energy, carbon, and water at the site?
- How do soil moisture and land cover changes, such as agricultural harvesting, affect the surface energy, carbon, and water fluxes, and can they affect local and regional cumulus cloud formation at the SGP site?
- How do land surface processes at the SGP affect atmospheric aerosol loading and chemistry, and what are the resulting effects on the microphysical and macrophysical properties of cumulus cloud fields?
- How well do the local measurements of the sensible, latent, and carbon fluxes made at the SGP represent the domain average fluxes?
- How do aerosols affect the internal cloud aerosol composition and associated optical properties?

### CLASIC

The formation of clouds over land — called *continental cumulus convection* — is strongly modulated by land surface conditions. During the three-week CLASIC campaign, the ARM Climate Research Facility SGP site will be the focal point. Three primary "supersites" in the experiment domain will be heavily instrumented to generate ground-based measurements linking observed heat, moisture, and carbon fluxes to atmospheric structure (Figure 1). Data from these sites will be supplemented with data from an existing network of soil moisture instruments and additional towers for flux measurements.

The cross-disciplinary, interagency CLASIC field study will focus on the influence of land surface processes on the evolution of cumulus convection, especially the stages leading from *cumulus humilis* (fair-weather clouds) to *cumulus congestus* (storm clouds). Researchers will use instruments on aircraft, satellite, and enhanced surface platforms to obtain simultaneous ground and airborne measurements that will enable evaluation of changes in clouds and atmospheric structure — key elements of regional climate systems.

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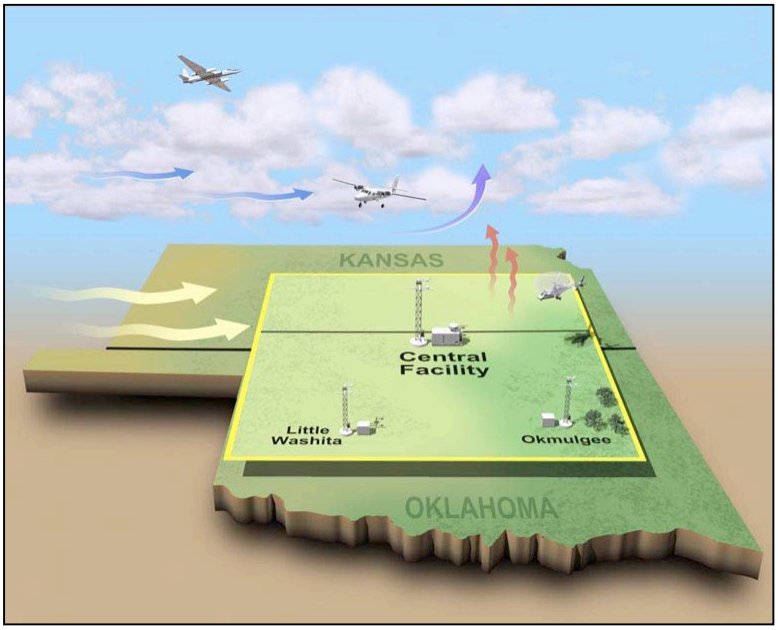


Figure 1. During CLASIC, a fleet of seven aircraft and enhanced surface instrumentation will be used to measure cloud and atmospheric properties throughout the SGP site, which covers 55,000 square miles in Oklahoma and Kansas (ARM image).

The wide range of processes involved in the formation of continental cumulus convection makes it difficult to simulate these cloud conditions in climate models. The goal of CLASIC is to obtain data about regional land surface changes that affect surface reflectivity, temperature, evapo-transpiration, and the energy balance. Scientists will use the CLASIC data to improve understanding of the way changes in land use affect clouds through alterations in surface heating and associated dynamics. The U.S. Climate Change Science Program has designated the interdisciplinary CLASIC campaign a core component of the Interagency Water Cycle Working Group.

The three CLASIC supersites are as follows:

- The SGP central facility. This heavily instrumented station, surrounded by wheat fields, will serve as the primary source of information about cloud and carbon feedbacks.
- Little Washita Watershed. This station, in mixed pastureland and winter wheat fields, will have three added carbon flux towers and associated instruments, plus two supplemental flux towers in nearby croplands at Fort Cobb.
- Okmulgee. Among the oak forests, this station will have two flux towers and additional instruments to supplement the existing flux tower. The focus will be on determining carbon dioxide sources and sinks.

Seven aircraft in coordinated flights over the experiment domain will obtain measurements below, within, and above the clouds. Several of the science missions will be coordinated with two additional aircraft — a Gulfstream-1 and King Air B200 — from the simultaneous CHAPS field campaign. All aircraft are being coordinated through the ARM Aerial Vehicles Program. Flights will be timed with routine satellite overpasses on selected days. Satellites carrying active and passive sensors will obtain measurements from space to provide spatial context and to establish connections with long-term data sets obtained from the SGP site.

**The seven research aircraft making flights during CLASIC include the following:**

- ER-2 high-altitude aircraft (National Aeronautics and Space Administration [NASA])
- P-3 (NASA) see http://science.arm.gov/clasic/factsheets/index.stm
- Twin Otter (Center for Interdisciplinary Remotely Piloted Aircraft Studies, Naval Postgraduate School, Monterey, California)
- Cessna 206 (Climate Monitoring and Diagnostics Laboratory, NOAA)
- Helicopter (Duke University)
- Twin Otter (International)
- Jetstream-31 (Sky Research)

## CHAPS

*Cumulus humilis* is the scientific term used to describe the small fair-weather clouds that dot the summer skies over Oklahoma. Scientists sponsored by the U.S. Department of Energy's Atmospheric Science Program will use aircraft- and ground-based instruments to gather information about the physical and chemical properties of the clouds and the small airborne particles — called aerosols — within and around them. Aerosols, particularly those associated with human activity, are thought to be changing the properties of clouds, including their brightness, lifetimes, and precipitation amounts.

The primary objective of CHAPS is to examine the influence of manmade aerosols on clouds and the effects that clouds have on these small particles. Though many of the issues surrounding climate change are linked to the trapping of heat by greenhouse gases such as carbon dioxide, climate change is also dependent on the amount of solar energy reflected back to space by clouds. The magnitude of changes in the effects of aerosols is a major concern to scientists trying to improve the simulation of climate change.

Two aircraft and a ground site will be used to gather data during CHAPS. Battelle's Gulfstream-1 (G-1) is a large, twin-turboprop plane capable of making measurements at altitudes approaching 30,000 feet, over ranges of 1,500 nautical miles. The aircraft is equipped with highly specialized instrumentation for characterizing the properties of the atmosphere, the intensity of solar radiation, and the amount and properties of trace atmospheric constituents.

During CHAPS, the G-1 will carry two broad categories of instruments to measure climate-relevant properties of aerosols: one set to measure the properties of aerosols found *within* individual cloud droplets and a second set to measure the same properties for aerosols *not incorporated* into cloud droplets or *outside* the larger cloudy environment.

Aerosol properties to be measured include the following:

- The number and size of aerosols both within and outside the cloud.
- The amount of solar radiation these particles can absorb and reflect.
- The propensity of the aerosols to attract water vapor.
- The chemical compositions of the aerosols.

The second aircraft flying during CHAPS will be NASA's Beechcraft King Air B200. This twin-engine turboprop aircraft will fly at altitudes of around 28,000 feet, conducting scouting missions to identify the Oklahoma City plume. It will then fly above the G-1 to make remote observations of the fields of clouds and aerosols. Its instrument payload will provide profiles of aerosol backscatter and extinction in the vicinity of clouds.

**CHAPS Participants**

- Pacific Northwest National Laboratory
- Brookhaven National Laboratory
- National Oceanic and Atmospheric Administration
- The Cooperative Institute for Environmental Research
- Harvard University
- Argonne National Laboratory
- Los Alamos National Laboratory
- National Aeronautics and Space Administration, Langley Research Center
- Aerodyne Corporation

The ground site will be located just outside of Oklahoma City. CHAPS scientists will launch daily weather balloons to monitor the temperature and moisture conditions of the lower atmosphere. Other ground-based instrumentation will make continuous measurements of climate-related properties of the aerosols coming from Oklahoma City. These measured properties will include the amount of solar energy absorbed and reflected by aerosols, as well as the aerosols' ability to serve as surfaces on which moisture condenses to form clouds.