ARM
CLIMATE RESEARCH FACILITY

Holistic Interactions of Shallow Clouds, Aerosols, and Land-Ecosystems

Small cotton-ball-like fair-weather clouds are common over land and oceans, including Oklahoma. These shallow clouds are known for reflecting the sun's energy back into space and under the right conditions, some of them will grow to form storm clouds and ultimately produce rain. Despite their importance, the small size of shallow clouds makes it difficult to account for processes that influence their life cycle in global climate models.

Holistic Interactions of Shallow Clouds, Aerosols, and Land-Ecosystems, or HI-SCALE, is a new campaign designed to provide a detailed set of measurements looking into coupled processes that affect the life cycle of shallow clouds. With two separate month-long intensive observational periods—one in the spring and the other in the late summer of 2016—HI-SCALE will examine the effects of different vegetation and land surface conditions on the shallow cloud life cycle in Oklahoma.

These extensive aerial measurements will be coupled with observations from the Atmospheric Radiation Measurement (ARM) Climate Research Facility's Southern Great Plains (SGP) megasite located in Oklahoma. Data will also be used to validate large-eddy simulations (LES) and cloud resolving models.

Science Objective

Airborne and ground-based observations from HI-SCALE will help scientists quantify the influence of differences in land use, vegetation, soil moisture; turbulence within convective eddies; and aerosol properties on the evolution of shallow clouds.

HI-SCALE will supply measurements needed to:

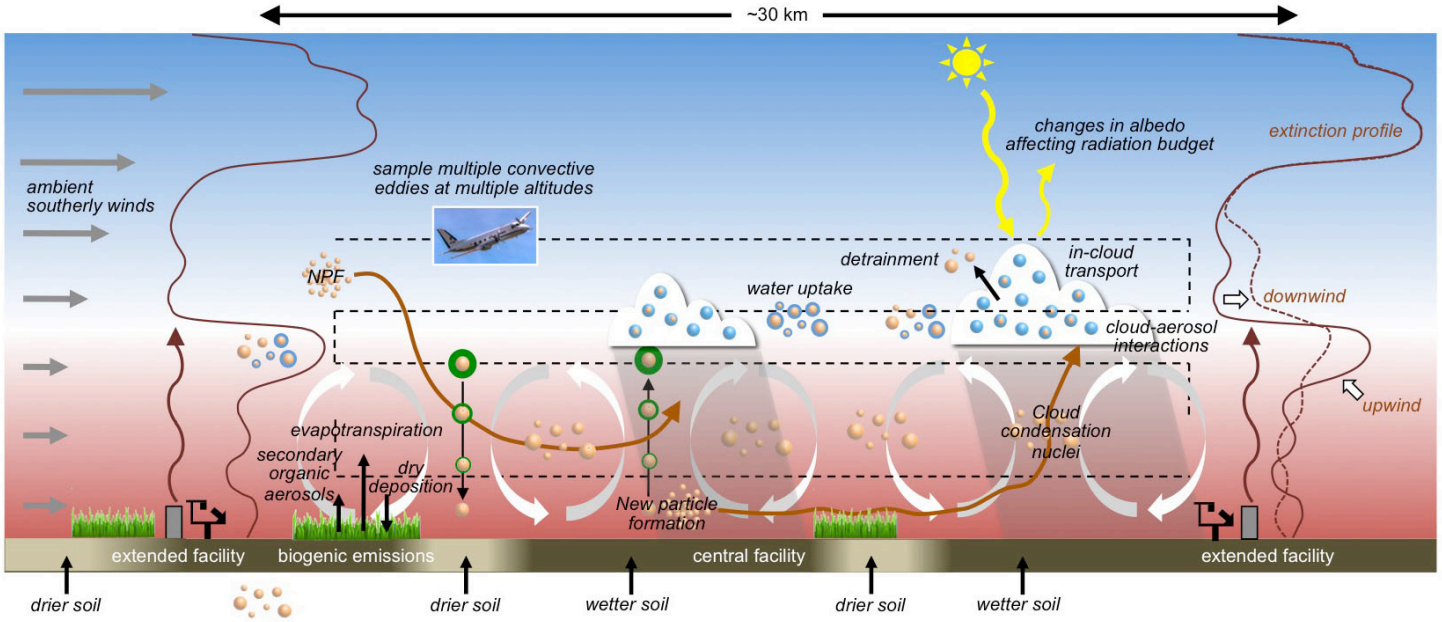
- develop improved parameterizations of land-atmospheric interactions and shallow clouds for the next generation of climate models, and
- evaluate LES and cloud resolving model predictions of heat fluxes, moisture and momentum, boundary-layer turbulence, cloud microphysics and dynamics, and aerosol properties.

The SGP site near Lamont, Oklahoma, is the world's largest and most extensive climate research facility. SGP data are providing details about cloud, aerosol, and atmospheric processes that have never before been available to improve and evaluate computer models that simulate Earth's climate.

Research Instrumentation

HI-SCALE will utilize the ARM Aerial Facility's Gulfstream-159 (G-1), as well as ground instrumentation located at the SGP megasite. The G-1 will complete transects over the site at multiple altitudes within the boundary layer, within clouds, and above clouds. The payload on the G-1 includes:

- high frequency meteorological and radiation (both up and downwelling) measurements that also permit computing sensible and latent heat fluxes
- cloud probes that characterize cloud microphysical properties, such as droplet size distribution and liquid water content
- trace gas monitors that measure carbon monoxide, mono-nitrogen oxides, ozone, and sulfur dioxide to help differentiate between urban, industrial, and other air masses
- a Chemical Ionization Mass Spectometer to characterize important trace gas volatile organic compounds needed to quantify aerosol precursor concentrations and fluxes
- a Fast Integrated Mobility Spectrometer, Ultra-High Sensitivity Aerosol Spectrometer, Passive Cavity Aerosol Spectrometer, and Cloud and Aerosol Spectrometer to characterize size distribution from fine to coarse size particles

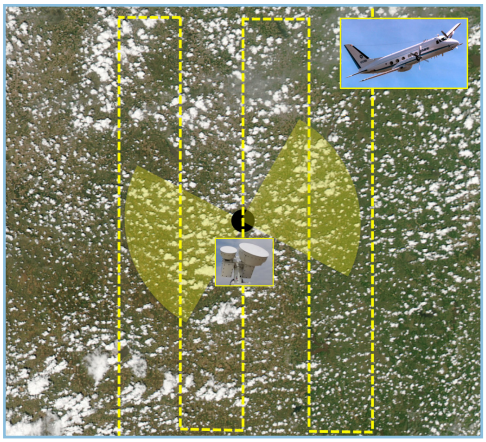


This schematic diagram depicts some of the processes to be investigated during HI-SCALE, along with the aircraft sampling.

- particle counters to quantify total aerosol number concentration
- a Dual-Cloud Condensation Nucleus Chamber to quantify cloud condensation nuclei concentrations, and
- a High Resolution Time-of-Flight Aerosol Mass Spectrometer to characterize bulk aerosol composition and a compact mini single particle mass spectrometer to characterize the composition and size of individual aerosol particles. An isokinetic inlet and a counter-flow virtual impactor inlet will be used to sample aerosols to determine the composition of aerosols in cloud droplet residuals.

The SGP site is instrumented with approximately 50 different measurement systems that operate 24-hours a day, every day. These instruments gather measurements to specifically study clouds, aerosols, precipitation, and solar and thermal energy. Data are provided free of charge online to scientists worldwide.

Aircraft and surface measurements will provide critical data that can be used to evaluate new routine LES modeling activity at the SGP site, as well as various current and new ARM retrievals.



Observed cloud distribution in the vicinity of the SGP is shown here along with an example G-1 flight pattern and spatial coverage of the Scanning ARM Cloud Radar (SACR).

Contacts

Hanna Goss
ARM Communications Team Lead and
Public Information Officer
Pacific Northwest National Laboratory
hanna.goss@pnnl.gov

Jerome Fast
Principal Investigator
Pacific Northwest National Laboratory
jerome.fast@pnnl.gov

Nicki Hickmon
SGP Facility Manager
Argonne National Laboratory
nhickmon@anl.gov

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Additional information is available on the ARM website at www.arm.gov.