Land-Atmosphere Feedback Experiment

Interactions and feedbacks between the land surface and the atmosphere are important drivers of atmospheric and land processes. The atmospheric boundary layer—the lowest part of the atmosphere—controls the exchange of energy, water, and momentum. Feedback processes between the land surface and the atmosphere influence the state of the atmospheric boundary layer, as well as the formation of shallow clouds and when and where deep convection can start. Therefore, understanding influences of the land surface on the atmospheric boundary layer, and how to represent the daily evolution of the boundary layer in numerical models, is fundamental for accurate weather and atmospheric simulations.

In August 2017, the **Land-Atmosphere Feedback Experiment (LAFE; pronounced "la-fey")** at the Atmospheric Radiation Measurement (ARM) Climate Research Facility Southern Great Plains (SGP) atmospheric observatory in Oklahoma looked at the relationship between ground vegetation and atmospheric properties. By observing areas with varying vegetation—for example, native grasslands, wheat fields, and bare soil—researchers are learning more about land-atmosphere interactions and their role in large-scale systems and in small-scale local conditions.

Science Objectives

LAFE provided measurements to study core land-atmosphere feedback mechanisms determining the pre-convective state of the convective boundary layer, which is the part of the atmosphere most directly affected by solar heating of the land surface. The field campaign also provided data sets to study how land-atmosphere interactions affect the development of cumulus and shallow convection.

The results of LAFE will be used to verify simulations of land-atmosphere feedback in large-eddy simulation and mesoscale models, which are planned for the SGP site.

Research Instrumentation

Approximately 50 different ARM instruments throughout the SGP atmospheric observatory operate 24/7 to obtain measurements of clouds, aerosol, precipitation, and solar and thermal energy. SGP instruments that were a focus during LAFE included the Raman lidar and Doppler lidar.

Guest Instrumentation

For the first time, LAFE brought together a unique set of scanning active remote-sensing systems that provided boundary layer observations to be used with other instruments to characterize the land surface. This collection of remote-sensing systems measured moisture, temperature, and horizontal wind averages, gradient, and turbulence profiles, and performed coordinated range-height indicator scans (where the lidar scans only in elevation) from the surface throughout the atmospheric boundary layer up to 3,000 meters. These scanning lidar and remote-sensing instruments included:

- University of Hohenheim (Germany) 3D scanning water vapor differential absorption lidar and temperature rotational Raman lidar
- National Oceanic and Atmospheric Administration (NOAA) Earth System Research Laboratory high-resolution Doppler lidar
- University of Wisconsin-Madison Space Science and Engineering Center Portable Atmospheric Research Center (SPARC) and University of Oklahoma/NOAA National Severe Storms Laboratory Collaborative Lower Atmospheric Mobile Profiling System (CLAMPS), operating two vertically pointing atmospheric emitted radiance interferometers and two Doppler lidar systems
- National Center for Atmospheric Research (NCAR) water vapor differential absorption lidar.

NOAA's Air Resources Laboratory and the University of Hohenheim provided flux towers and soil moisture measurements. In addition, an unmanned aerial system operated by NOAA's Air Resources Laboratory measured temperature, humidity, and wind, and provided a look at how the sensible heat flux varies over the LAFE area.

Collaborations

LAFE was an international effort featuring instruments from the: NCAR Earth Observing Laboratory; NOAA Earth System Research Laboratory, Air Resources Laboratory, and National Severe Storms Laboratory; University of Hohenheim; University of Wisconsin-Madison; and University of Oklahoma.

Other contributors to LAFE were Marquette University, Cleveland State University, NASA, University of Hannover (Germany), Federal Ministry of Education and Research (Germany), and NOAA Cooperative Institute for Research in Environmental Sciences at the University of Colorado.

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