Mobile Facility Records Annual Climate Cycle in Niger, Africa

Because dust can block incoming solar energy, and because solar energy drives weather and climate, scientists around the world are looking for ways to better understand these natural phenomena. In 2006, scientists sponsored by the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) Climate Research Facility conducted a year-long field campaign in Niamey, Niger, to provide key information for the African Monsoon Multidisciplinary Analyses, or AMMA, project.

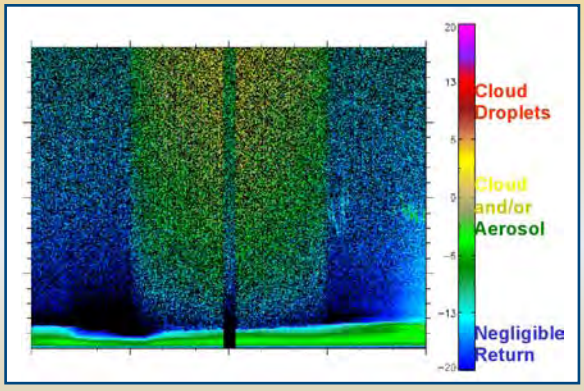
During the 12-month experiment at the airport in Niamey, researchers used a portable atmospheric laboratory, airplanes, and satellites to collect information about clouds, aerosols, and solar and terrestrial energy in the skies above the site. Measurements obtained during the "Radiative Atmospheric Divergence using ARM Mobile Facility, GERB data and AMMA Stations" project—better known by the acronym **RADAGAST**—provided the first well-sampled, direct estimates of solar and thermal radiation across the atmosphere. These data are being used by scientists to study the nature of dust storms, how far they spread, and what impact they have on incoming solar energy, outgoing thermal radiation, and generation of the monsoon.

Located near the airport in Niamey, the ARM Mobile Facility obtained measurements from January through December 2006, spanning both the wet and dry seasons. These data are allowing scientists to study radiative feedback of the Earth's atmosphere in the region, including the interaction of local clouds and the West African monsoon with dust and aerosols.

INITIAL RESULTS

Diary of a Dust Storm

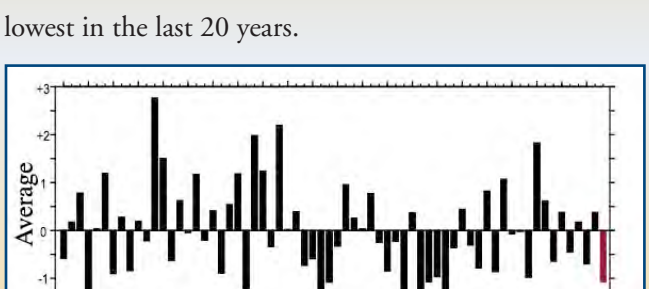
In March 2006, the ARM Mobile Facility recorded the largest Saharan dust storm in the Niamey area in the previous two years. The dust storm arrived mid-morning on March 7, quickly reducing visibility. Another dust cloud, several kilometers in height, rolled in just after noon, reducing visibility even further. Instruments from the ARM Mobile Facility recorded the onset of the dust storm and changes in optical depth throughout the next several days until the storm dissipated. This case allowed scientists to use both satellite and surface measurements to examine the total absorbed and reflected energy—or radiative energy balance—of a dust storm.



During the storm, solar radiation reaching the surface decreased by nearly 85 percent of its usual value. The dust was so thick that on March 9, 2006, the return signal from the micropulse lidar was effectively undetectable.

Rainfall Record Remains Grim

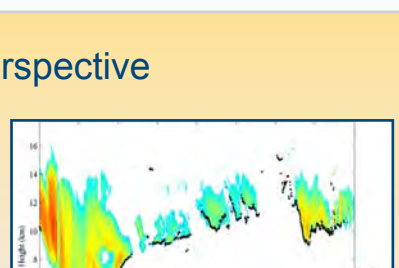
In June 2006, the annual monsoon season began. After below-average rainfall in June and July, August rainfall was slightly above the 1941-2000 mean. However, by the end of August the accumulated rainfall was even less than in 2004, which resulted in famine conditions in southern Niger, east of Niamey. September received barely half of the 1941-2000 average rainfall, and cumulative rainfall for the monsoon season was the second lowest in the last 20 years.



Cumulative rainfall records at the Niamey AMF site indicated the 2006 monsoon season was the second driest there in the last 20 years.

Cloud Profiles Add Perspective

The ARM Mobile Facility's 95-GHz W-band ARM Cloud Radar represents the newest generation of radars that provide highly detailed measurements of cloud properties that are unattainable through any other means. It was the first and only one of its kind deployed in Africa. Using a new algorithm to combine observations from the ARM Mobile Facility's cloud radar, micropulse lidar, and ceilometer, scientists have produced cloud boundaries and time-height profiles for the entire Niamey deployment in 2006. The use of multiple sensors narrows potential gaps in coverage and improves the accuracy of the various measurements, thereby enhancing the representations of clouds in climate models.



The cloud profile data set combines measurements captured by the instruments every five seconds at heights up to 42.856 meters, the range of the cloud radar.

About RADAGAST

The "**Radiative Atmospheric Divergence using ARM Mobile Facility, GERB data and AMMA Stations**" project encompassed the various components of the year-long ARM Mobile Facility field campaign in Niamey.

- **ARM Mobile Facility** – the ARM Mobile Facility is a portable atmospheric laboratory equipped with a sophisticated suite of instruments designed to collect essential data from cloudy and clear atmospheres in important but under-sampled climatic regions. At the airport in Niamey, the facility sampled absorbing aerosols from desert dust in the dry season, and deep convective clouds and associated moisture loadings during the summer monsoon. A small ancillary site was established in undisturbed grassland approximately 60 kilometers from Niamey to help decipher localized effects.
- **GERB** – the Geostationary Earth Radiation Budget (GERB) sensor is an instrument that measures incoming solar radiation, solar radiation reflected across the top of the atmosphere, and thermal radiation emitted by the Earth. This instrument is onboard a European Union geostationary weather satellite launched in December 2005; it is collecting data over Niamey and the surrounding region.
- **AMMA** – the African Monsoon Multidisciplinary Analyses (AMMA) project is an ongoing study of the interactions between West African monsoon dynamics, continental water cycle, aerosols, atmospheric chemistry, food, water, and health. To study these elements, scientists are collecting data using airplanes, satellites, and instrumented ground stations—including a station at Niamey.

Contact
Lynne Roeder, Public Information Officer
ARM Climate Research Facility
Tel: 509.372.4331
lynne.roeder@pnl.gov

Office of Science
U.S. Department of Energy

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