Sandia National Laboratories

Fact Sheet

Global Climate Research:

Atmospheric Radiation Measurement-Unmanned Aerospace Vehicle (ARM-UAV)

The Department of Energy's Atmospheric Radiation Measurement-Unmanned Aerospace Vehicle (ARM-UAV) program uses unmanned aerospace vehicles (UAVs) and piloted aircraft to make key climate measurements that cannot be made by other means.

ARM-UAV is developing UAV compatible sensor payloads and measurement techniques and using those payloads and capabilities in UAV and piloted aircraft science flights to acquire important climate-related data.

ARM-UAV has flown unique science missions with a variety of piloted and remotely piloted aircraft.

UAVs are remotely controlled aircraft that were originally developed for defense surveillance and are now being used in a variety of applications. Because they are unmanned, they can fly higher and longer than manned aircraft. Their long endurance at high altitudes is important in studying how clouds interact with the earth's solar and thermal radiation to heat or cool the earth.

An appropriately instrumented UAV can directly measure the atmosphere's rate of heat absorption by flying at different altitudes. At high altitudes, the UAV payload can provide calibration for satellite-based measurements. When combined with ground-based measurements, these UAV-based measurements reduce the uncertainty of predictions about greenhouse warming, a key element in global climate research.

The Department of Energy, Office of Biological and Environmental Research provides funding for the ARM-UAV program.

Capabilities

ARM-UAV is a multi-laboratory program. Sandia National Laboratories is responsible for overall technical direction of the program. Over the life of the program, other key team members have included:

- NASA Ames, UCSD Scripp's Institute of Oceanography, and Colorado State University, which provided radiometric instruments;
- NASA Goddard, which provided a microwave radiometer;
- NASA Langley, which conducts satellite data comparisons;
- Los Alamos National Laboratory, which provided a scientific instrument calibration capability;
- Brookhaven National Laboratory, which provided meteorological instruments;

SAND2004-1364P
June 2004

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories
AY5572

- Pacific Northwest Laboratory, which provided data management;

- University of Maryland and Florida State University, which provided the mission scientist for UAV missions; and

- Sandia, Lawrence Livermore, and Los Alamos National Laboratories, which are developing highly accurate climate instrumentation, designed for UAVs.

Resources

The ARM-UAV team has developed compact, highly accurate instrumentation for the ARM-UAV program. These instruments include:

- A wide field-of-view, imaging cloud radiometer for retrieving cloud reflectivity, for resolving the phase of cloud droplets (ice or water) and their effective size, and for calibrating various satellite measurements (SNL);

- A fully eye-safe lidar for detecting and profiling thin cirrus clouds, which are difficult to measure by other techniques, but which may contribute significantly to the earth's radiation balance (LLNL); and

- Net flux radiometer for accurately measuring the difference between the upwelling and down-welling radiation (LANL); additional instrumentation will be developed as needs are identified.

Accomplishments

The ARM-UAV program is being accomplished in three phases:

- The first phase, to establish the utility of UAVs as an atmospheric measurement platform, has been completed. An existing UAV (the General Atomics Gnat 750) and modified versions of radiometers, which were originally developed for manned aircraft, were used in eight highly successful flights at the DOE ARM climate site in Oklahoma. The instrumentation measured atmospheric heating under a variety of clear-sky atmospheric conditions up to an altitude of 7 km. Analysis showed excellent agreement between the resulting measurements and computational models.

- The second, interim measurement phase demonstrated important system growth capabilities through sustained operations (endurance/high altitude). This phase used existing and near-term instruments on the General Atomics "Altus" UAV, which flies at altitudes up to 20 km for more than 24 hours. Payloads for these flights consisted of instruments tailored for UAV application, to study radiation-cloud interactions, especially the recently identified enhanced cloud absorption. The highlights of this phase include an unprecedented 26+ hour science flight and an altitude record of 57,000 feet, both accomplished by the "Altus" UAV.

- The third phase is demonstrating a transition to more routine operations, which will provide airborne measurement capabilities for long periods of time in remote locations. The payload system that has been developed includes in situ as well as remote sensing instruments. This payload has been flown over the Oklahoma Cloud and Radiation Testbed (CART) site and will be demonstrated on missions over the DOE ARM sites at the North Slope of Alaska and in the tropical western Pacific at Darwin, Australia. The ultimate goal in the tropics is to use the payload system to study water vapor and radiation-cloud interactions in the upper troposphere above the Pacific warm pool, the region many call "nature's greenhouse laboratory."

ARM-UAV payloads use instruments provided by many organizations.

Learn more at:
http://armuav.ca.sandia.gov

For more information contact
Sandia National Laboratories
Will Bolton at (925) 294-2203
wrbolto@sandia.gov