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TECH BRIEFS

ENGINEERING SOLUTIONS FOR DESIGN & MANUFACTURING

Measurements of Radiation in the Atmosphere

These measurements are needed to understand changes in climate.

Dryden Flight Research Center, Edwards, California

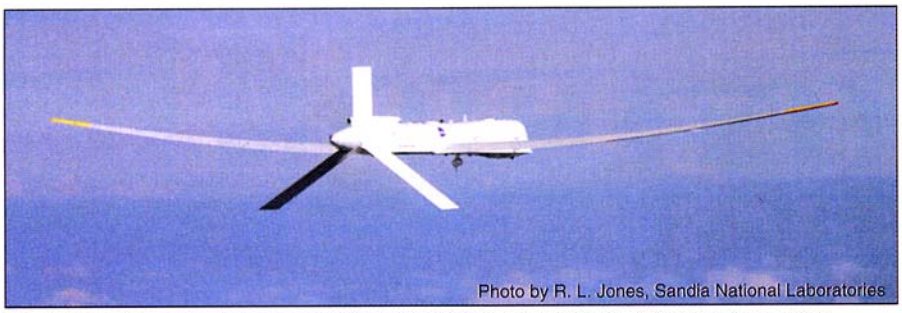
The recent summit meeting held in Kyoto, Japan, has brought world-wide attention to the issue of global climate change. For the past 5 years, the Department of Energy's Atmospheric Radiation Measurement - Unmanned Aerospace Vehicle (ARM-UAV) Program has been investigating the largest source of uncertainty in global warming; the interaction of solar radiant energy with clouds. As the program name implies, ARM-UAV is fostering the development of UAVs and developing specialized instruments for measurements related to climate research.

It was recognized from the outset that certain key parameters, such as atmospheric heating and cloud-top properties, are best measured in the atmosphere. The endurance and altitude requirements for these measurements appear to be best met by an emerging class of small, long-endurance, high-altitude UAVs, which complement, but do not eliminate the need for, piloted aircraft, satellites, and surface instrumentation.

In September 1996, ARM-UAV conducted a month-long flight series that culminated in an unprecedented scientific flight extending over a complete day-to-night-to-day cycle (26 hours, 11 minutes). For this flight series, ARM-UAV mounted its payload in the first Altus UAV (see figure), which was built for the NASA Environmental Research Aircraft and Sensor Technology (ERAST) program by General Atomics/Aeronautical Systems, Inc. The ERAST program is managed by Dryden Flight Research Center. This Altus UAV was flown in conjunction with the U.S. Navy's Center for Interdisciplinary Remotely Piloted Aircraft Studies (CIRPAS). ARM-UAV purchased the second Altus UAV for long-term use as an instrumented platform to demonstrate instruments and measurement techniques as well as to acquire initial atmospheric data. The second Altus UAV was first used in a similar month-long flight series in September, 1997, over the DOE's Cloud and Radiation Testbed site in north central Oklahoma.

The primary scientific focus of the ARM-UAV program is on radiation/cloud interactions in atmosphere of the Earth. Uncertainties in how clouds interact with solar and thermal radiation account for almost the entire factor-of-three variation in the predicted temperature rise resulting from a doubling in the carbon dioxide content of the atmosphere. An important aspect of the program is the use of UAVs as the primary airborne instrumentation platforms. UAVs are capable of extended flight at altitudes ≥ 65,000 ft (≥ 20 km), making it possible to take continuous measurements with a set of well-calibrated instruments above the tropopause, and thus above the troposphere, which is the lowest layer of the atmosphere where most clouds and weather occur.

The ARM-UAV payload consists of state-of-the-art radiometric instruments, positioned to make measurements above and below the aircraft, and instruments to make such supporting measurements as those of temperature, pressure, and concentration of water vapor. A second, similar payload with the same radiometers is typically flown in a de Havilland Twin Otter airplane, operated by Ross Aviation, flying directly below the Altus UAV. A particularly valuable flight pattern places the Altus UAV above a cloud layer and the Twin Otter below, forming a "cloud sandwich." The simultaneous measurements obtained by the Altus and Twin Otter instruments in this configuration are invaluable in understanding the role of clouds in absorbing and reflecting solar energy.



This **Altus UAV** was photographed in flight over Oklahoma during the ARM-UAV flight series.

From the outset, ARM-UAV has been a multiagency program, bringing together the best capabilities available within government agencies, universities, and private industry. Sandia National Laboratories provides overall technical direction, along with logistical planning and support, handling of data, and a multispectral imaging instrument. Other instruments are provided by Goddard Space Flight Center, Ames Research Center, Lawrence Livermore National Laboratory, Brookhaven National Laboratory, and universities, including Colorado State University and the University of California Scripps Institute. University scientists participating in ARM-UAV are also drawn from the University of Maryland, the University of California at Santa Barbara, Pennsylvania State University, the State University of New York, and others.

The next planned ARM-UAV flight series will be a joint activity with the NASA ERAST program to be conducted in September 1998, from Kauai, Hawaii. The ARM-UAV payload will be installed in the ERAST Altus UAV now being modified to enable flight to altitudes as high as 65,000 ft (20 km). This higher altitude capability will be used to investigate the properties of tropical cirrus clouds.

This article was written by W. R. Bolton of Sandia National Laboratories and describes work done in cooperation with **Dryden Flight Research Center.** *For further information, see below or access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category.*

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