Unmanned Aerospace Vehicle System Concept

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Introduction

The Atmospheric Radiation Measurement/Unmanned Aerospace Vehicle (ARM/UAV) Program has as a major mission to support the ARM Cloud and Radiation Testbed (CART) sites with an airborne measurement capability. The UAV capability will complement piloted aircraft and supplement the capabilities of ground-based CART instruments. The ARM/UAV Program strategy emphasizes meaningful scientific activity embedded in the development activities and has three phases of increasing system capability:

- Demonstration flights in the first year emphasize early scientific results and initial operational experience with UAVs in an atmospheric research role. Because of the desire for an early demonstration, this activity will be conducted with existing UAVs and instruments.
- An interim measurement capability in the second and third years will make use of improved UAV and instrument capabilities to provide sustained operations at a location in the continental United States; for example, the Southern Great Plains (SGP) CART site. The system used for interim operations will consist of near-term UAVs assumed to be capable of greater than 14-km altitude and endurance in excess of 24 hours, and existing and near-term instruments.
- The full-capability ARM/UAV system will follow in the third and fourth years, capable of sustained and autonomous operation in remote locations, for example, in the Tropical Western Pacific. The UAVs will be capable of 20 km altitude and multi-day endurance and will carry instruments tailored for UAV application.

Elements of the UAV System

In addition to the ground-based instruments, the ARM/UAV system consists of the UAV, its instrument suite, and the instrument interface and telemetry system. The UAV-borne instruments and supporting system provide a capability to obtain measurements at selected locations in the atmospheric column and transmit the data to the ground for recording and subsequent processing. The elements of this system and their functional relationships are shown schematically in Figure 1.

Demonstration Flights

The first ARM/UAV development phase is the UAV demonstration flight (UDF) series. UDF will consist of three to five flights conducted at the SGP CART site over approximately a 2-week period. The primary scientific objective of UDFs is a radiative flux divergence measurement, accomplished by measuring flux at two altitudes and subtracting to obtain the flux divergence. The lower altitude measurement will be made from the SGP tower, a tethersonde, piloted aircraft, or UAV. The higher altitude measurement will be made from a UAV, piloted aircraft, or satellite. The details of this experiment are being developed in consultation with the ARM Interim Science Team.

In addition to the scientific objectives, UDF has programmatic objectives which include obtaining operational experience with UAVs and addressing airspace and safety approval issues that must be resolved for later phases of the program.

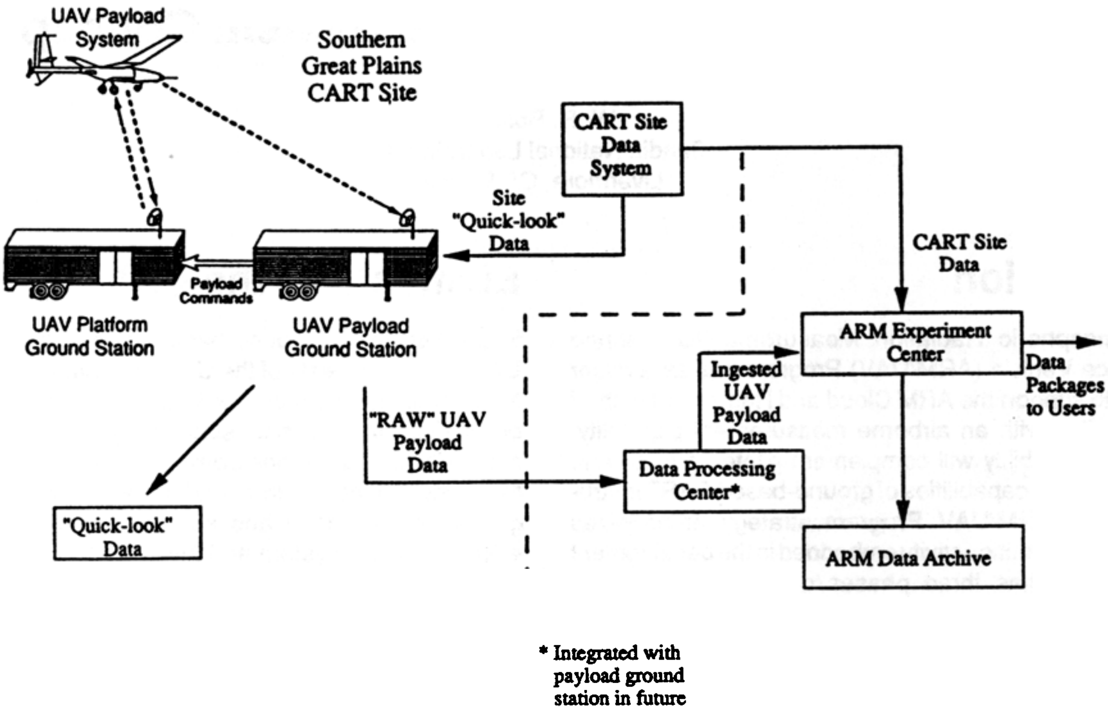

Figure 1. Functional elements of the ARM/UAV system.

The preliminary instrument list for UDF was selected to match the radiative flux divergence objective. Preliminary packaging studies indicate that useful instrument payloads drawn from the preliminary instrument list can be carried in candidate UAVs. Primary instruments include hemispherical field-of-view broadband solar and IR radiometers, and a total diffuse direct radiometer. Supporting instruments include a meteorological package (temperature, pressure, water vapor), a narrowband radiometer (solar and IR radiance), and perhaps a video camera.

UAVs suitable for UDF should have endurance in excess of 6 h; altitude of 7 km or greater; a payload capacity of at least 60 kg; and, by virtue of configuration and technology, be on the "development path" toward a full-capability UAV. Candidate UAVs that appear to be suitable include the General Atomics "Gnat 750-45" (and enhancements) and the Aurora Flight Sciences "Perseus B."

The UDF payload system will consist of the instruments, the instrument interface and signal conditioning, and radio frequency transmission to the ground station. The payload ground station will be equipped to receive and record all data, and scale and display "quick look" data. Formatting the data (ingest) will be accomplished at an existing data processing center for UDF but will be integrated into the payload ground station in the future.

Summary

UDF will provide valuable scientific data and will be an important step along the development path leading to the full-capability ARM/UAV system. Subsequent steps will develop improved instruments and fully capable ground support equipment suitable for remote deployment, as well as take advantage of improved UAV capabilities.