

# Technical Progress in the Atmospheric Radiation Measurement Instrument Development Program

J. W. Griffin, Technical Monitor  
ARM Instrument Development Program  
Pacific Northwest Laboratory  
Richland, Washington

## Goals of the Instrument Development Program

The primary goal of the Atmospheric Radiation Measurement (ARM) Instrument Development Program (IDP) is to develop fieldable atmospheric sensing systems which 1) provide a needed atmospheric observation/measurement requisite to the success of the ARM Program and 2) are adaptable for sustained deployment at one or more of the ARM Cloud and Radiation Testbeds (CART). In this sense, the ARM IDP more closely resembles an engineering development activity than a basic sensor system research and development effort. In fact, instruments selected for IDP funding support were purposely chosen for 1) their relatively high degree of maturity and 2) the likelihood that they could actually be fabricated, installed, and maintained at one of the ARM CART sites at a reasonable cost. Inherent in the second criterion is the requirement that the instrument will be operable and maintainable by CART Site Operations staff following a minimal amount of training (i.e., "principal investigator" instruments and/or those requiring a covey of graduate students for operation are excluded from consideration). Without exception, instrument projects that were terminated before completion of the first 3-year funding cycle did not demonstrate the potential to meet the "fieldability" criteria within the first two years.

## Summary of Projects

A summary of ARM IDP project status including project titles, principal investigators, institutions, and current instrument status appears in Table 1. Projects that have been terminated or had their work scope modified before

the end of FY93 are noted. Fiscal Year 1993 is the third and final year of the initial (3-year) funding cycle for ARM-funded instrument development projects. That is, IDP principal investigators will be required to submit a new proposal in order to be considered for funding beyond September 30, 1993. As for the first funding cycle, continuation proposals will be peer-reviewed and funding awarded on a competitive basis.

## Deployment of IDP Instruments

Over the past 30 months, six IDP-developed instruments have emerged as likely near-term contributors to the ARM CART instrument suite. These include the Multi-Filter Rotating Shadowband Radiometer (MFRSR), the Atmospheric Emitted Radiance Interferometer (AERI), the Polarization Diversity Lidar (PDL), the Raman Water Vapor Lidar (RWVL), the Micro-Pulse Lidar (MPL), and the Cloud Profiling Radar System (CPRS). Status of these instruments is summarized below.

### MFRSR

The first MFRSR prototype was deployed at the Southern Great Plains (SGP) CART in June 1992. A brief description of this instrument, its measurement capabilities, and representative data are summarized later in this document

### AERI

Plans are currently being made to deploy and test the first AERI prototype (designated AERI00) at the SGP CART in

**Table 1.** IDP Project Status

IDP Project Title	Principal Investigator(s)	Institution(s)	Status (December 1993)
"Development of Rotating Shadowband Spectral Radiometer in Support of the ARM Program" (MFRSR)	Michalsky/Harrison	SUNY Albany	Presently deployed at SGP CART
"High Spectral Resolution Measurements for the ARM Program" (AERI, AERI-X, and SORTI)	Revercomb/Murcay	Univ of Wisconsin and Univ of Denver	AERI00 and SORTI prototypes presently deployed at SGP CART
"Micro-Pulse Lidar " (MPL)	Spinhirne	NASA Goddard	Prototype presently deployed at SGP CART
"Laser Remote Sensing of Water Vapor" (also denoted Raman Water Vapor Lidar or RWVL)	Goldsmith/Melfi	Sandia National Laboratory (SNL) and NASA Goddard	Hybrid lidar design and fabrication presently in progress. Delivery of system to SGP CART anticipated in Fall, 1994
"Polarization Diversity Lidar" (PDL)	Sassen	University of Utah	Prototype PDL presently operational at Univ of Utah
"Ground-Based Millimeter-Wave Cloud Profiling Radar System" (CPRS)	McIntosh	University of Massachusetts	Prototype CPRS tested at SGP CART in July 1993. Prototype is currently operational at Univ of Mass.
"Development of a Short-Wave Infrared Spectral Radiometer for the ARM Program"	Murcay	University of Denver	Development in progress at Univ of Denver
"Passive Cloud Dynamics Measurement - A Flow Field Registration Approach"	Thorne and Kegelmeyer	Sandia National Laboratory (SNL)	Some cloud image analysis products to be implemented at SGP CART using Scripps Whole-Sky-Imagers
"Tethered Balloon Sounding System for Vertical Radiation Profiles"	Whiteman	Pacific Northwest Laboratory (PNL)	Prototype presently undergoing testing at PNL
1) "Widely-Deployable Low-Cost Radiometer for the ARM Extended Observing Stations " and 2) "Pointing Shortwave / Near-Infrared Radiometer for ARM"	Kryter and Simpson	Oak Ridge National Laboratory (ORNL)	1) Project redirected during FY92 to topic (2) 2) Instrument presently resides at ORNL (less tracker)
"Precise Narrow-Beam Filter Infrared Radiometer and Its Use with LIDAR in the ARM Program" (LIRAD)	Platt	CSIRO Division of Atmospheric Research Melbourne, Australia	Radiometer demonstrated in Tropical Western Pacific during TOGA COARE

**Table 1. (contd)**

"Development of an Integrated Data Assimilation and Sounding System"	Dabberdt / Gage and Westwater	NCAR Applied Technology Laboratory and NOAA Wave Propagation (WPL) and Aeronomy (AL) Laboratories	Integrated Sounding Systems (ISS) deployed and tested in Tropical Western Pacific during TOGA COARE. Non-hydrostatic version of four-dimensional data assimilation code ready for deployment at SGP CART
1) "Photometric Studies of Clouds from an ARM Site" and 2) "Aerosol Characterization Using Stellar Imagery"	Buchwald (1) and Weber (2)	Los Alamos National Laboratory (LANL)	1) Terminated at the end of FY92 2) Re-scoped project topic
"Spectral Inversion of Solar Radiation Measurements to Recover High-Resolution Spectral Information, Constituent Concentrations, and Particle Sizes"	Spratlin	Oak Ridge National Laboratory (ORNL)	Work performed in collaboration with Harrison at SUNY Albany to support analysis of MFRSR data
"Development of High Spectral Resolution LIDAR Technology for the DOE ARM Program" (HSRL)	Eloranta	University of Wisconsin	Project terminated at end of FY92
"Develop a Radiation Measurement System (RAMS) for the Atmospheric Radiation Measurement Program (ARM)"	Valero	NASA Ames	Project terminated at end of FY92

March 1993. A brief description of this instrument, its measurement capabilities, and representative data are summarized later in this document.

### **PDL and RWVL**

The designs for these two instruments, scheduled for field demonstrations in 1993, will likely be combined to form an ARM "hybrid lidar design" capable of measuring/detecting aerosol extinction/backscatter coefficients, cloud boundaries, cloud phase, and vertical water vapor profiles. Pending successful completion of these two IDP projects in FY93, design and procurement of the ARM hybrid lidar is anticipated early in FY94. A brief description of the RWVL instrument and its measurement capabilities are summarized later in this document.

### **MPL**

This instrument development effort, funded for two years beginning in FY92, will likely result in an eye-safe, fieldable

laser ceilometer capable of detecting thin cirrus cloud layers at high altitudes. Such measurements are not currently possible with commercially-available laser ceilometers. Initial testing of the MPL will occur during the Tropical Ocean Global Atmosphere/Coupled Ocean Atmosphere Response Experiment (TOGA/COARE) field campaign in the Tropical Western Pacific during the first-quarter of 1993. Assuming initial MPL field performance is satisfactory, testing at the ARM SGP CART is anticipated early in FY94.

### **CPRS**

This instrument is scheduled for initial field testing at the SGP CART in the summer of 1993. Because of the anticipated high capital cost of this remote sensing system, the CPRS is expected (pending successful field trials) to be deployed at the SGP CART only during intensive observation periods. A brief description of this instrument, its measurement capabilities, and representative data are summarized later in this document.