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Site Scientific Mission Plan for the Southern Great Plains CART Site

July-December 1996

Prepared for the U.S. Department of Energy
under Contract W-31-109-Eng-38

Site Program Manager Office
Environmental Research Division
Argonne National Laboratory
Argonne, IL 60439

MASTER

ARM
Atmospheric Radiation Measurement

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NOTATION

ABRFC	Arkansas Basin Red River Forecast Center
AERI	atmospherically emitted radiance interferometer
ANL	Argonne National Laboratory
AOS	aerosol observation system
ARESE	ARM Enhanced Shortwave Experiment
ARM	Atmospheric Radiation Measurement
AVHRR	advanced very-high-resolution radiometer
BBSS	balloon-borne sounding system
BF	boundary facility
BLC	Belfort laser ceilometer
BLX	Boundary Layer EXperiment
BSRN	Broadband Solar Radiation Network
CAR	Corrective Action Report
CART	Cloud and Radiation Testbed
CASES	Cooperative Atmosphere-Surface Exchange Study
CASH	commercial aviation sensing humidity
CCN	cloud condensation nuclei
Cimel	Cimel sunphotometer
CIMMS	Cooperative Institute for Mesoscale Meteorological Studies
CIRA	Cooperative Institute for Research in the Atmosphere
CLEX	Cloud Layer EXperiment
CSU	Colorado State University
DA	data assimilation
DOE	U.S. Department of Energy
DQR	Data Quality Report
DSIT	Data and Science Integration Team
EBBR	energy balance Bowen ratio
ECOR	eddy correlation
EF	extended facility
ETL	Environmental Technology Laboratory
EVAC	Environmental Verification and Analysis Center
FDDA	four-dimensional data assimilation
FTP	file transfer protocol
GBRS	Ground-Based Remote Sensing (IOP)
GCIP	GEWEX Continental-Scale International Project
GCM	general circulation model
GCSS	GEWEX Cloud System Study
GEWEX	Global Energy and Water Cycle Experiment
GIST	GEWEX Integrated System Test
GMS	general measurement strategy
GOES	geostationary orbiting Earth satellite
GPS	global positioning system
GSFC	Goddard Space Flight Center
GVaP	GEWEX Water Vapor Project

NOTATION (Cont.)

GVFA	geophysically variable focus area
HD	hierarchical diagnosis
IDP	Instrument Development Program
IF	intermediate facility
IOP	intensive observation period
IPM	instrument performance model
IR	infrared
IRF	instantaneous radiative flux
IRT	infrared thermometer
ISLSCP	International Satellite Land-Surface Climatology Project
ISS	integrated sounding system
IT	Instrument Team
KSU	Kansas State University
LBL	line by line
LBLRTM	line-by-line radiative transfer model
LLJ	Low-Level Jet
LMS	Lockheed Missile and Space
MAPS	Mesoscale Analysis and Prediction System
MFR	multifilter radiometer
MFRSR	multifilter rotating shadowband radiometer
MMCR	millimeter cloud radar
MPL	micropulse lidar
MSX	Midcourse Satellite Experiment
MWR	microwave radiometer
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NCSU	North Carolina State University
NDVI	nondimensional vegetative index
NEPA	National Environmental Policy Act
NGM	nested grid model
NIP	normal-incidence pyrheliometer
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory
NSSL	National Severe Storms Laboratory
NWS	National Weather Service
OCS	Oklahoma Climatological Survey
OKM	Oklahoma Mesonet
Ops	operations
ORR	Operational Readiness Review
OU	University of Oklahoma
PAR	photosynthetically active radiometer

NOTATION (Cont.)

PARABOLA	portable appartus for rapid acquisition of bidirectional observations of the land and the atmosphere
PARC	Palo Alto Research Center
PBL	planetary boundary layer
PBLF	Planetary Boundary Layer Facility
PC	personal computer
PIF	Problem Identification Form
PNNL	Pacific Northwest National Laboratory
PRB	Problem Review Board
PRR	Pre-Readiness Review
PSU	Pennsylvania State University
QME	quality measurement experiment
RASS	radio acoustic sounding system
RCF	radiometer calibration facility
RLID	Raman lidar
RUC	rapid update cycle
RWP	radar wind profiler
S	solar
SAC	Site Advisory Committee
SCM	single-column model
SDS	site data system
SGP	Southern Great Plains
SI	International System of Units
SIROS	solar and infrared radiation observing system
SITAC	Spectral Imagery Technology Applications Center
SMOS	surface meteorological observation station
SNL	Sandia National Laboratories
SORTI	solar radiance transmission interferometer
SOW	statement of work
SPM	site program manager
SST	Site Scientist Team
SUCCESS	Subsonic Aircraft: Contrail and Cloud Effects Special Study
SUNY	State University of New York
SVC	sky video camera
SWATS	soil water and temperature system
TBD	to be determined
T/RH	temperature and relative humidity sensor
UAV	unmanned aerospace vehicle
UBC	University of British Columbia
UIR	upwelling infrared radiometer
UM	University of Massachusetts
UNAVCO	University NAVSTAR Consortium
USDA	U.S. Department of Agriculture
USR	upwelling solar radiometer

NOTATION (Cont.)

UTC	universal time coordinated
UU	University of Utah
UV	ultraviolet
UV-B	ultraviolet B
UW	University of Wisconsin
VAPs	Value-Added Products (Working Group)
Vceil	Vaisala ceilometer
VORTEX	Verification of the Origins of Rotation in Tornadoes Experiment
WPDN	Wind Profiler Demonstration Network
WPL	Wave Propagation Laboratory
WSI	whole-sky imager

SITE SCIENTIFIC MISSION PLAN FOR THE SOUTHERN GREAT PLAINS CART SITE JULY-DECEMBER 1996

1 INTRODUCTION

The Southern Great Plains (SGP) Cloud and Radiation Testbed (CART) site is designed to help satisfy the data needs of the Atmospheric Radiation Measurement (ARM) Program Science Team. This document defines the scientific priorities for site activities during the six months beginning on July 1, 1996, and looks forward in lesser detail to subsequent six-month periods. The primary purpose of this *Site Scientific Mission Plan* is to provide guidance for the development of plans for site operations. It also provides information on current plans to the ARM functional teams (Management Team, Data and Science Integration Team [DSIT], Operations Team, Instrument Team [IT], and Campaign Team) and serves to disseminate the plans more generally within the ARM Program and among the members of the Science Team. This document includes a description of the operational status of the site and the primary site activities envisioned, together with information concerning approved and proposed intensive observation periods (IOPs). The primary users of this document are the site operator, the Site Scientist Team (SST), the Science Team through the ARM Program science director, the ARM Program Experiment Center, and the aforementioned ARM Program functional teams. This plan is a living document that is updated and reissued every six months as the observational facilities are developed, tested, and augmented and as priorities are adjusted in response to developments in scientific planning and understanding.

To facilitate access to this report and cut down on publication costs, this report can also be found on the SGP CART site World Wide Web home page at

http://www.arm.gov/docs/sites/sgp/sgp.html .

In the future, the routine availability of this report will be limited to the home page, with hard copies available only upon request.

2 SUMMARY OF SCIENTIFIC GOALS

2.1 Programmatic Goals

The primary goal of the SGP CART site activities is to produce data adequate to support significant research addressing the objectives of the ARM Program. These overall objectives, as paraphrased from the *ARM Program Plan, 1990* (U.S. Department of Energy 1990), are the following:

- To describe the radiative energy flux profile of the clear and cloudy atmosphere
- To understand the processes determining the flux profile
- To parameterize the processes determining the flux profile for incorporation into general circulation models

To address these scientific issues, an empirical data set must be developed that includes observations of the evolution of the radiative state of the column of air over the central facility, as well as the processes that control that radiative state, in sufficient detail and quality to support the investigations proposed by the ARM Science Team. To address the entire 350-km × 400-km SGP CART site, the ARM Program relies on models to compute the processes or properties that affect radiative transfer. This set of data includes measurements of radiative fluxes (solar and infrared [IR]) and the advective and surface fluxes of moisture, heat, and momentum occurring within the column and across its boundaries. Other entities to be described are cloud types, composition, and distribution (depth, fractional coverage, and layering); thermodynamic properties of the columnar air mass (temperature, pressure, and concentrations of all three phases of water); the state and characteristics of the underlying surface (the lower boundary condition); processes within the column that create or modify all of these characteristics (including precipitation, evaporation, and the generation of condensation nuclei); and radiatively significant particles, aerosols, and gases. Basic continuous observations must be made as often as is feasible within budgetary constraints. For limited periods of time, these observations will be supplemented by directed IOPs providing higher-resolution or difficult-to-obtain *in situ* data.

Beyond simply providing the data streams, determining their character and quality as early as possible in the observational program is imperative. This evaluation will provide the basic operational understanding of the data necessary for an ongoing program of such scope. Although both reason and ample opportunity will exist to develop a further understanding of the ARM observations over the course of the program, the task of investigating and ensuring the data quality is extremely important. In this regard, definitive quality measurement experiments (QMEs) will help establish confidence in the measurements.

The SGP CART site is the first of several global locations chosen and instrumented for data collection. As summarized in the *Science Plan* for the ARM Program (U.S. Department of Energy 1996), the scientific issues to be addressed by using data from a midlatitude continental CART observatory include the following:

- Radiative transfer in cloudless, partly cloudy, and overcast conditions
- Cloud formation, maintenance, and dissipation
- Nonradiative flux parameterizations
- The role of surface physical and vegetative properties in the column energy balance
- Other complications in the radiative balance in the atmosphere, particularly those due to aerosols, cloud condensation nuclei (CCN), and cloud-aerosol radiative interactions
- Feedback processes between different phenomena and different domains

The variety, surface density, and atmospheric volumetric coverage of the SGP instrumentation will be more comprehensive than those at any other ARM site, and the SGP site will experience a wider variety of atmospheric conditions than will any other ARM site. The resulting data will accordingly support a greater range and depth of scientific investigation than data from any other location, making it imperative for the ARM Program to develop and maintain a high-quality, continuous data stream from the SGP site.

The measurements required by Science Team proposals, the DSIT, and the science director have in the past been incorporated into a set of general measurement strategies (GMSs) representing groups of experiments requiring measurements with similar characteristics. The

GMSs were originally designed to quantify the instantaneous radiative flux (IRF) and to support the requirements of the single-column model (SCM), data assimilation (DA), and hierarchical diagnosis (HD) research. The DSIT and other teams coordinated activities to develop integrated, well-focused data sets. During this six-month period, the ARM Program will continue embarking on an evolution of GMSs into what is now called geophysically variable focus areas (GVFAs)—radiation water vapor, longwave radiation, aerosols, clouds, surface fluxes, and SCM—rather than the original GMSs. The goal is to move toward algorithm development that prescribes these geophysical phenomena as products of multiple data streams rather than focusing on individual data streams. This transition is addressed in more detail in Section 5.6.

2.2 Priorities for Site Activities

With the construction of the SGP CART site near completion, the primary scientific goal has shifted from the establishment of routine observations to addressing the specific science issues related to the site. In descending order, we rank the priorities of site activities for July through December 1996 as follows:

1. Support all data quality assurance efforts, including implementation of QMEs.

2. Plan and implement key IOPs.

3. Plan and implement campaigns.

4. Complete establishment and sustain high quality of routine site operations.

5. Support the Instrument Development Program (IDP).

Within this ranking, the differences in relative importance between adjacent items are not large. The categorization is also somewhat artificial because many site activities have multiple purposes. For example, IOP activities can simultaneously support Science Team, IDP, and campaign requirements. Even so, this ranking reflects our scientific assessment of the activities that should receive the most support during this period.

The IOPs will focus on providing critical data sets on an episodic basis to the Science Team, as well as field support for instrument development and testing and for collaborative campaigns. The IOPs scheduled for this six-month period are detailed in Section 5.1. To assist the site scientist with scientific issues, a Site Advisory Committee (SAC), consisting of seven scientists (approximately half from outside the ARM Program), provides scientific guidance for the SGP CART site. The SAC works directly with the site scientist and the site program manager. A second meeting was held on June 11 and 12, 1996, in Norman, Oklahoma, and a report from that meeting will become available during this six-month period. This meeting followed up on an earlier SAC meeting (November 27-29, 1995) that included a visit to the SGP CART site.

Budgetary constraints and site scientific issues have forced management of the SGP CART site to reevaluate the radiosonde launch schedule continually. The cost of radiosondes is the single largest expense for the SGP CART site. Routine radiosonde observations will continue to include five daily balloon-borne sounding system (BBSS) launches on Monday through Friday (including holidays) at the central facility. One routine daily launch will continue on Monday through Friday (including holidays) at the four boundary facilities. Three SCM IOPs, each lasting for three weeks, are now conducted each year; a summer SCM IOP is scheduled for July 1996. Three SCM IOPs will continue to be scheduled each year. Spring and summer SCM IOPs are scheduled annually, while fall and winter SCM IOPs alternate between years. No SCM IOP is scheduled this fall. However, the first of at least three new Water Vapor IOPs has tentatively been scheduled for September 1996. This IOP series will help define the water vapor properties above the SGP CART site, especially in the lowest few hundred meters, a critical need of the IRF Working Group.

Although more instrumentation will be added, the SGP site central facility and boundary facilities are nearly complete, and routine operations have been established for most platforms. Construction was completed for the radiometer calibration facility, and personnel from the National Renewable Energy Laboratory (NREL) will be setting up the facility for operations in time for some level of support of the July 1996 SCM IOP. The emphasis in this six-month period will be on completing the installation of the remaining extended facilities and implementing one auxiliary and three intermediate facilities.

Although budgetary limitations have somewhat slowed the development and completion of the site, 22 permanent extended facilities will be in place at the end of this six-month period. Only the forested Okmulgee site will remain to be completed. Activities to develop boundary facilities were completed in April 1996. At the central facility, the aerosol facility has been established, and the calibration facility was completed in June 1996. Establishment of one auxiliary facility will be needed to accommodate the installation of a second day-night whole-sky imager (WSI). During this six-month period, we will continue to address additional measurement needs with the procurement of 915-MHz profilers with radio acoustic sounding systems (RASSs) to be deployed at locations between the central and boundary facilities; these profilers will enhance the boundary layer monitoring across the total SGP CART site. This deployment requires additional leasing of property and environmental assessments at the new locations, which will be referred to as "intermediate facilities." This work began during the last six-month period and will be completed during this six-month period.

The IDP instruments expected to be accepted as CART instruments during this period are an atmospherically emitted radiance interferometer (AERI X) and a solar radiance transmission interferometer (SORTI 02). The IDP millimeter cloud radar is expected to become a CART instrument during this six-month period. In addition, a Vaisala 75-km ceilometer, a whole-sky cloud video camera, and a Cimel sunphotometer are expected to complete the process of Pre-Readiness Review (PRR) and Operational Readiness Review (ORR) and become CART instruments sometime during the next six months.

All solar and infrared radiation observing systems (SIROSs) have been upgraded with SciTec solar tracking and shading assemblies. These upgrades will improve measurements of the direct and diffuse broadband solar radiation and the diffuse hemispheric broadband IR radiation, which are important elements in the IRF measurements. All eddy correlation (ECOR) instruments installed at the SGP CART site were upgraded by the vendor in May 1996, and more reliable performance is expected. In addition, ECOR sensors were installed on the 60-m tower at the central facility at the 25- and 60-m levels. The physical infrastructure at all extended facilities except Okmulgee was completed during the last six-month period. The central facility Broadband Solar Radiation Network (BSRN) was upgraded with a SciTec assembly in January 1996. A data quality investigation was performed to track this successful upgrade.

A unique opportunity to supplement the existing CART instrumentation was proposed by the SST and has been funded by the GEWEX Continental-Scale International Project (GCIP), housed within the National Oceanic and Atmospheric Administration (NOAA) Office of Global Programs. (GEWEX is the Global Energy and Water Cycle Experiment.) This support will permit additional sensors for the profiling of soil moisture and temperature to be installed at the central facility and the extended facilities during this period, with the network to be completed by the spring of 1997. These additional sensors will support water and energy budget analyses, diagnostic studies, and model validation efforts of ARM and GCIP investigators. Installation of the first seven systems was completed last period, and an additional seven systems will be installed during this six-month period.

During IOPs, site operations staff will continue to support activities necessary for the IDP. Remaining IDP-related efforts will be dedicated to either configuring systems for permanent deployment at the CART site (e.g., the millimeter cloud radar) or evaluating the operational requirements for a few remaining instruments in need of field verification (e.g., Raman lidar). These activities will continue during the next six months.

In summary, our goals for this six-month period are to provide the Science Team with a suite of measurements that will support a wide range of research, to establish solid procedures for instrument calibration and maintenance, to continue the series of QMEs, and to provide input for the GVFAs. Quality assurance efforts are central to the success of the entire program. Section 4 reflects this increased emphasis.

3 ROUTINE SITE OPERATIONS

3.1 Overview

The overwhelming majority of the measurements with the highest priority, on which the existing experimental designs are based, are regular (i.e., routine) observations, as specified in the *ARM Program Plan, 1990* (U.S. Department of Energy 1990). Scientifically and logistically, routine operations will also serve as the basis and background for all nonroutine operations, including instrument development activities, IOPs, and collaborative campaigns directed toward obtaining difficult-to-gather or expensive *in situ* data. Consequently, development and validation of the basic observations remain high priorities. Site development has progressed sufficiently to support three IOPs addressing key scientific questions during this six-month period. In addition, the IOPs are an opportunity to provide more focused data sets to the Science Team and the scientific community at large.

The SST will continue to work to ensure the scientific productivity of the site by providing guidance to the site operations manager and his staff on scientific matters related to the data stream, by answering questions from operations personnel concerning potential instrument problems, by reviewing schedules and procedures for instrument maintenance and calibration, by reviewing designs for infrastructure supporting new instruments, by contributing to the design of the standard operating procedures, by reviewing and developing plans for special operations, and by helping to obtain additional weather forecasting support for special operations. The SST, in cooperation with instrument mentors and others, will continue to lead the data quality control effort at the CART site, an ongoing activity that includes monitoring of the CART data streams in collaboration with the staff at the central facility and the development of quality assurance performance metrics and graphic tools that will address the data originating at the SGP site. These activities are discussed in more detail in Section 4 of this report.

By the end of this period, development of the SGP CART site will be nearly complete, except for the wooded extended facility. Routine operations are considered to be the activities related to the operation and maintenance of instruments, the gathering and delivery of the resulting data, and the planning for scientific investigations, including IOPs, campaigns, and QMEs. Although the site is nearly complete, instrumentation will be evaluated continuously to assess the need for possible elimination of instruments or replacement with updated or new sensors. The process that leads to implementation of CART instruments continues to be the PRR. The PRR includes the identification of requirements for instrument design and installation and the development of the documentation, procedures, and training needed to maintain CART instrumentation and integrate data streams into the site data system. The PRR also provides a forecast of when these instruments will be fully operational and delivering data to the Experiment Center and the Archive.

The current expectation for the routine operation of instruments is that they will require servicing by site operators only once every two weeks. The exception to this is the central facility and the boundary facilities, which are staffed. If an instrument fails during a two-week period at an extended facility, data streams could be lost. Such loss of data is unfortunate but acceptable to the ARM Program because of manpower and budget constraints. The data collected at all extended and boundary facilities by the end of this period are expected to be polled frequently each day by the site data system at the central facility and then packaged and delivered to the Experiment Center and the Archive once daily. The Experiment Center generally delivers data to Science Team members and other data requesters once weekly.

Site operations staff conduct instrument triage during IOPs and campaigns. The triage plan calls for identifying instruments, individual sensors, and communication links that are critical to the operation and goals of the IOP and will receive more frequent servicing than that prescribed by routine operation requirements mentioned above. The priority of triage efforts is determined by the SST and IOP scientists and the site program manager, who take into consideration the scientific importance of a particular data stream and its expense. The triage plan has been very successful, as demonstrated during the recent IOPs for the ARM Enhanced Shortwave Experiment (ARESE) and for the Subsonic Aircraft: Contrail and Cloud Effects Special Study (SUCCESS). The triage plan will continue to be an ongoing effort during the upcoming six months.

Handling of instruments that must be returned to the vendor for calibration and servicing is also part of routine operation. Replacement instruments and sensors will be rotated regularly to meet these requirements. A comprehensive, integrated plan for calibration and maintenance is being compiled by the SST in conjunction with the site program manager, site operations manager, and instrument mentors; this work should be completed during this six-month period. Changeouts of all sensors and instrumentation are recorded in the site operations log.

The initial checks on data quality after instrument installation are provided by the instrument mentors. After the mentor reviews the data stream to ensure that the acquired instrument is performing properly and that the data are identified accurately by the Experiment

Center, the mentor approves a "beta" release of the data. The beta release provides data to selected Science Team members who have requested them and are willing to work with the instrument mentor on data quality issues. Beta releases are established after the instrument mentor and an appropriate member of the DSIT create a general statement on data quality for the Experiment Center. Beta releases are also available to other Science Team members who are willing to work in conjunction with the instrument mentor. When the data quality relative to proper instrument functionality is consistently acceptable and well documented, the mentor approves a full release of the data.

3.2 Routine Operations

3.2.1 Functional Instruments and Observational Systems

Accomplishments in the area of site development are most evident at the central facility, with its functioning power, fiber-optic infrastructure, and near-complete array of instruments. Of the 26 planned extended facilities, 21 (including 1 at the central facility and 1 at the Cement location) are operational at the beginning of this period, 2 (Seminole and Ft. Cobb) are expected to be operational by the end of this six-month period, 1 (Okmulgee, the wooded location) is to be developed by the spring of 1997, and 2 are placeholder sites for possible expansion, if required. In addition, three intermediate facilities will be installed and become operational during this six-month period. "Operational" means that the instruments are installed and collecting data, but the data collection may not yet be fully automated. If the data are not ingested, data are downloaded every two weeks onto laptop computers by site operators and transported back to the central facility for transmittal to the Experiment Center.

Four boundary facilities are also in full operation. Data are now transferred from the boundary facilities by T-1 lines installed at all boundary facilities in April 1996. Figure 1 is a map of the SGP site showing the locations of the developed extended and boundary facilities. The status of the systems and instruments anticipated by December 31, 1996, is summarized in Tables 1-5.

3.2.2 Launch Schedule for Balloon-Borne Sounding Systems

Until the full suite of remote sensing systems is deployed to perform deep, detailed soundings of the wind, temperature, and moisture of the troposphere under a wide range of

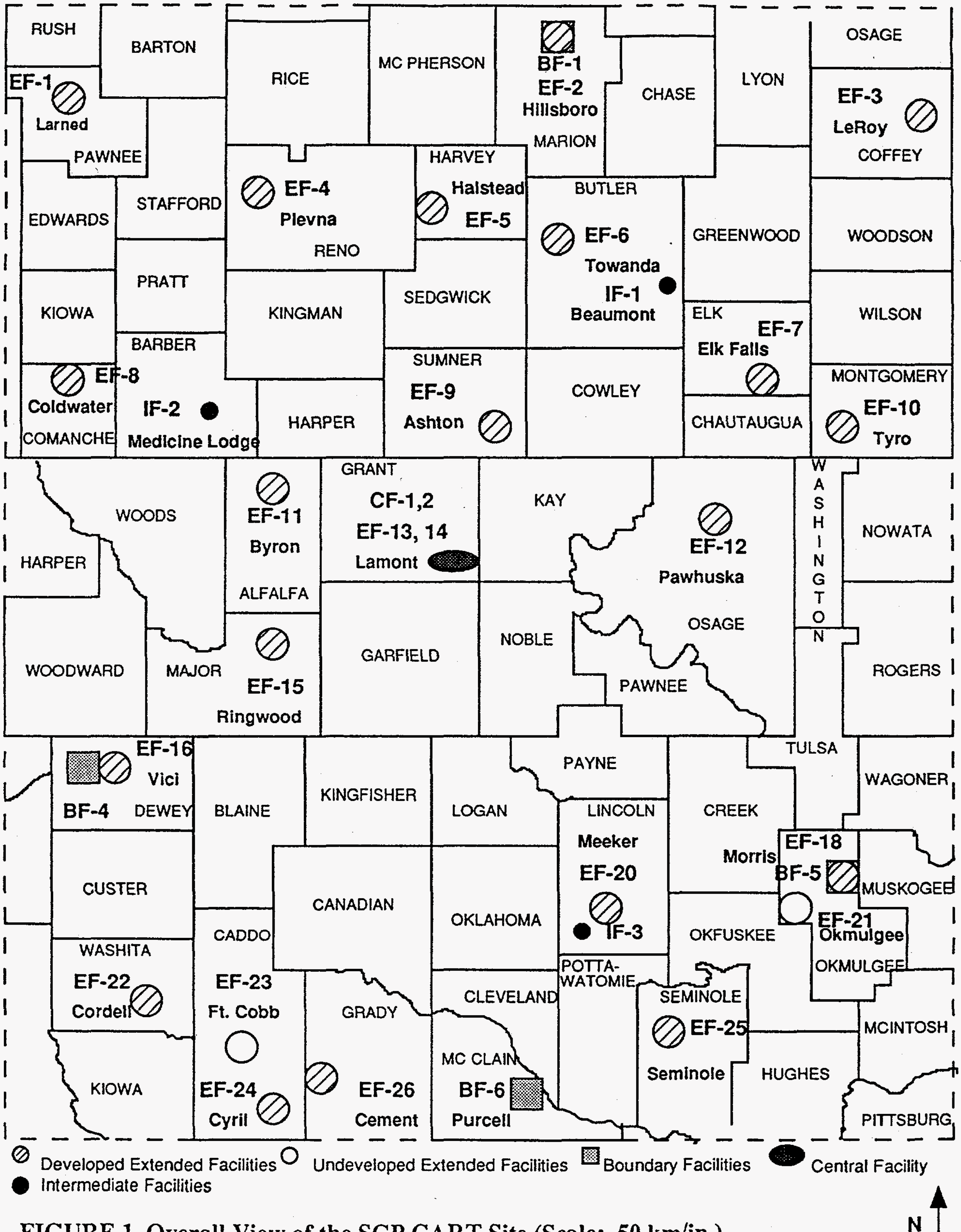

FIGURE 1 Overall View of the SGP CART Site (Scale: 50 km/in.)

TABLE 1 Actual and Planned Locations of Instruments at the Central Facility[a]

Instrument	Latitude, Longitude (deg)	Surface Type	Location	Comments
AERI	36.967 N 97.528 W	Pasture	Optical trailer	—
AERI X	36.967 N 97.528 W	Pasture	Optical trailer	Not installed
SORTI	36.967 N 97.528 W	Pasture	Optical trailer	—
BSRN	36.993 N 97.708 W	Pasture	Central cluster	—
SIROS	36.993 N 97.708 W	Pasture	Central cluster	—
UV-B	36.993 N 97.708 W	Pasture	Central cluster	Not installed
PAR	36.993 N 97.708 W	Pasture	Central cluster	Not installed
10-m MFR	36.785 N 97.665 W	Pasture	Central cluster	—
25-m USR	36.932 N 97.916 W	Wheat	60-m tower	—
25-m UIR	36.932 N 97.916 W	Wheat	60-m tower	—
25-m MFR	36.932 N 97.916 W	Wheat	60-m tower	—
Cimel	36.967 N 97.528 W	Pasture	Optical trailer	Not installed
BBSS	37.012 N 98.120 W	Grass	Central compound	—
915-MHz RWP	36.677 N 97.686 W	Shale, pasture	Profiler trailer	—
50-MHz RWP	36.630 N 97.706 W	Shale, pasture	Profiler trailer	—

TABLE 1 (Cont.)

Instrument	Latitude, Longitude (deg)	Surface Type	Location	Comments
MWR	37.105 N 97.765 W	Pasture	Optical trailer	—
RLID	38.052 N 97.741 W	Pasture, wheat	IDP 3	—
WSI	36.842 N 97.608 W	Pasture	Optical trailer	—
BLC	36.697 N 97.528 W	Pasture	Optical trailer	—
MPL	36.967 N 97.528 W	Pasture	Optical trailer	—
MMCR	36.885 N 97.591 W	Pasture, wheat	IDP 2	Not installed
Vceil	37.105 N 97.765 W	Pasture	Optical trailer	Not installed
SVC	37.105 N 97.795 W	Pasture	Optical trailer	Not installed
25-m T/RH	36.932 N 97.916 W	Wheat	60-m tower	—
60-m T/RH	36.932 N 97.916 W	Wheat	60-m tower	—
ECOR	36.857 N 97.631 W	Wheat, pasture	Aerosol trailer	—
25-m ECOR	36.932 N 97.916 W	Wheat	60-m tower	—
60-m ECOR	36.932 N 97.916 W	Wheat	60-m tower	—
EBBR	36.887 N 97.531 W	Pasture	Central cluster	—
SMOS	36.785 N 97.665 W	Pasture	Central cluster	—

TABLE 1 (Cont.)

Instrument	Latitude, Longitude (deg)	Surface Type	Location	Comments
AOS	36.927 N 97.828 W	Pasture, wheat	Aerosol trailer	—
RCF	36.958 N 97.653 W	Pasture, wheat	Calibration trailer	—

[a] AERI, atmospherically emitted radiance interferometer; AOS, aerosol observation system; BBSS, balloon-borne sounding system; BLC, Belfort laser ceilometer; BSRN, Broadband Solar Radiation Network; Cimel, Cimel sunphotometer; EBBR, energy balance Bowen ratio; ECOR, eddy correlation, MFR, multifilter radiometer; MMCR, millimeter cloud radar; MPL, micropulse lidar; MWR, microwave radiometer; PAR, photosynthetically active radiometer; RCF, radiometer calibration facility; RLID, Raman lidar; RWP, radar wind profiler; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station; SORTI, solar radiance transmission interferometer; SVC, sky video camera; T/RH, temperature and relative humidity sensor; UIR, upwelling infrared radiometer; USR, upwelling solar radiometer; UV-B, ultraviolet B; Vceil, Vaisala ceilometer; WSI, whole-sky imager.

TABLE 2 Locations and Status of Extended Facilities[a]

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	Flux Station[c]	SWATS[c]	SMOS[c]	SIROS[c]	Comment
Larned, KS EF-1	632	38.202 N 99.316 W	Wheat	ECOR 9/1/95	Yes 6/96	Yes 9/1/95	Yes 9/1/95	Power and communication center installed 10/95
Hillsboro, KS EF-2	450	38.306 N 97.301 W	Pasture	EBBR 10/96	Yes 6/96	No	Yes 9/7/95	Power and communication center installed 8/95
LeRoy, KS EF-3	338	38.201 N 95.597 W	Wheat and soybeans (rotated)	ECOR 12/7/95	Yes 9/96	Yes 12/7/95	Yes 12/7/95	Power and communication center installed 9/95
Plevna, KS EF-4	513	37.953 N 98.329 W	Rangeland (ungrazed)	EBBR 4/4/93	Yes 3/5/96	Yes 3/28/95	Yes 3/28/95	Power and communication center installed 3/95
Halstead, KS EF-5	440	38.114 N 97.513 W	Wheat	ECOR 1997	Yes 9/96	Yes 5/31/96	Yes; broad-band only 5/31/96	Power and communication center installed 11/95
Towanda, KS EF-6	409	37.842 N 97.020 W	Alfalfa	ECOR 12/14/95	Yes 9/96	Yes 12/14/95	Yes 12/14/95	Power and communication center installed 8/95
Elk Falls, KS EF-7	283	37.383 N 96.180 W	Pasture	EBBR 9/8/93	Yes 3/12/96	Yes 3/9/95	Yes 3/9/95	Power and communication center installed 2/95
Coldwater, KS EF-8	664	37.333 N 99.309 W	Rangeland (grazed)	EBBR 12/8/92	Yes 6/96	Yes 3/4/93	Yes 5/9/95	Power and communication center installed 5/95

TABLE 2 (Cont.)

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	Flux Station[c]	SWATS[c]	SMOS[c]	SIROS[c]	Comment
Ashton, KS EF-9	386	37.133 N 97.266 W	Pasture	EBBR 12/10/92	Yes 2/27/96	Yes 3/13/90	Yes 10/5/93	Power and communication center installed 10/93
Tyro, KS EF-10	248	37.068 N 95.788 W	Wheat	ECOR 7/21/95	Yes 7/96	No	Yes 7/21/95	Power and communication center installed 6/95
Byron, OK EF-11	360	36.881 N 98.285 W	Alfalfa	ECOR 6/26/95	Yes 6/96	Yes 6/26/95	Yes 6/26/95	Power and communication center installed 6/95
Pawhuska, OK EF-12	331	36.841 N 96.427 W	Native prairie	EBBR 9/11/93	Yes 9/97	No	Yes 6/30/95	Power and communication center installed 6/95
Lamont, OK EF-13, 14	318	36.605 N 97.485 W	Pasture, wheat	EBBR 8/24/92 ECOR 5/30/95	Yes 2/5/96	Yes 4/9/93	Yes 10/15/93 BSRN 5/15/92	Power and communication center installed 6/93
Ringwood, OK EF-15	418	36.431 N 98.284 W	Pasture	EBBR 9/25/92	Yes 2/21/96	Yes 3/29/93	Yes 10/12/93	Power and communication center installed 10/93
Vici, OK EF-16	602	36.061 N 99.134 W	Wheat	ECOR 5/30/95	Yes 7/96	No	Yes 5/30/95	Power and communication center installed 5/95
EF-17	—	Unspecified	—	—	—	—	—	—

TABLE 2 (Cont.)

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	Flux Station[c]	SWATS[c]	SMOS[c]	SIROS[c]	Comment
Morris, OK EF-18	217	35.687 N 97.856 W	Pasture (ungrazed)	EBBR 1/96	Yes 9/96	No	Yes; broad-band only 5/24/96	Power and communication center installed 10/95
EF-19	—	Unspecified	—	—	—	—	—	—
Meeker, OK EF-20	309	35.564 N 96.988 W	Pasture	EBBR 4/3/93	Yes 2/8/96	Yes 4/2/93	Yes	Power and communication center installed 10/94
Okmulgee, OK EF-21	—	Location identified	Forest	ECOR 4/97	Yes 4/97	Yes 4/97	Yes 4/97	No lease agreement
Cordell, OK EF-22	465	35.354 N 98.977 W	Rangeland (grazed)	EBBR 4/4/93	Yes 2/15/96	No	Yes 4/26/95	Power and communication center installed 3/95
Ft. Cobb, OK EF-23	415	35.153 N 98.461 W	Peanuts (irrigated)	ECOR 12/96	Yes 12/96	No	Yes 12/96	No lease agreement
Cyril, OK EF-24	409	34.883 N 98.205 W	Wheat (gypsum hill)	ECOR 8/25/95	Yes 7/96	Yes 8/25/95	Yes 8/25/95	Power and communication center installed 7/95
Seminole, OK EF-25	277	35.245 N 96.736 W	Pasture	EBBR 9/96	Yes 9/96	Yes 9/96	Yes 9/96	Power and communication center planned installation 9/96

TABLE 2 (Cont.)

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	Flux Station[c]	SWATS[c]	SMOS[c]	SIROS[c]	Comment
Cement, OK EF-26	400	34.957 N 98.076 W	Pasture	EBBR 9/20/92	—	No	No	Phone line (only) installed 10/92

[a] BSRN, Broadband Solar Radiation Network; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; EF, extended facility; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station; SWATS, soil water and temperature system.

[b] Above sea level.

[c] Date indicates actual or scheduled installation date.

TABLE 3 Locations and Status of Intermediate Facilities[a]

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	915-MHz Profiler and RASS[c]	Comment
Beaumont, KS IF-1	525	37.626 N 96.538 W	Rangeland	Yes 8/96	Power and communication planned installation 7/96
Medicine Lodge, KS IF-2	585	37.280 N 98.933 W	Rangeland	Yes 8/96	Power and communication planned installation 7/96
Meeker, OK IF-3	300	35.550 N 96.920 W	Grass	Yes 9/96	Power and communication planned installation 8/96

[a] IF, intermediate facility; RASS, radio acoustic sounding system.

[b] Above sea level.

[c] Date indicates actual or scheduled installation date.

TABLE 4 Locations and Status of Boundary Facilities[a]

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	BBSS[c]	MWR[c]	AERI[c]	Comment
Hillsboro, KS BF-1	441	36.071 N 99.218 W	Grass	Yes 1/18/94	Yes 1/18/94	No	Temporary power and communication installed 12/93
Hillsboro, KS BF-1	447	38.305 N 97.301 W	Grass	Yes 9/28/94	Yes 9/28/94	No	Relocation and temporary power and communication installed 9/94; permanent power, communication, and grounding mat installed 3/96; T-1 line installed 4/96
BF-2	—	Unspecified	—	—	—	No	—
BF-3	—	Unspecified	—	—	—	No	—
Vici, OK BF-4	648	36.071 N 99.218 W	Grass	Yes 1/18/94	Yes 1/18/94	No	Temporary power and communication installed 12/93
Vici, OK BF-4	622	36.071 N 99.204 W	Grass	Yes 10/3/94	Yes 10/3/94	No	Relocation and temporary power and communication installed 9/94; permanent power, communication, and grounding mat installed 3/96; T-1 line installed 4/96
Morris, OK BF-5	18	35.682 N 95.862 W	Grass	Yes 1/18/94	Yes 1/18/94	No	Temporary power and communication installed 12/93

TABLE 4 (Cont.)

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	BBSS[c]	MWR[c]	AERI[c]	Comment
Morris, OK BF-5	217	35.688 N 95.856 W	Grass	Yes 10/6/94	Yes 10/6/94	No	Relocation and temporary power and communication installed 9/94; permanent power, communication, and grounding mat installed 3/96; T-1 line installed 4/96
Purcell, OK BF-6	344	34.969 N 97.415 W	Grass	Yes 9/23/94	Yes 9/23/94	No	Permanent power, communication, and grounding mat installed 3/96; T-1 line installed 4/96

[a] AERI, atmospherically emitted radiance interferometer; BBSS, balloon-borne sounding system; BF, boundary facility; MWR, microwave radiometer.

[b] Above sea level.

[c] Date indicates actual or scheduled installation date.

TABLE 5 Instruments and Observational Systems in Place at the Central, Boundary, Extended, and Auxiliary Facilities on December 31, 1996[a]

Central Facility

Radiometric Observations

- AERI
- AERI X
- SORTI
- BSRN
  - Pyranometer (ventilated)
  - Pyranometer (ventilated, shaded)
  - Pyrgeometer (ventilated, shaded)
  - NIP on tracker
  - MFRSR
- SIROS
  - Pyranometer (ventilated)
  - Pyranometer (ventilated, shaded)
  - Pyrgeometer (ventilated, shaded)
  - NIP on tracker
  - MFRSR
  - Pyranometer (upwelling, above pasture at 10 m)
  - Pyrgeometer (upwelling, above pasture at 10 m)
- UV-B
- PAR
- MFR (upwelling, above pasture at 10 m)
- Pyranometer (upwelling, above wheat at 25 m on 60-m tower)
- Pyrgeometer (upwelling, above wheat at 25 m on 60-m tower)
- MFR (upwelling, above wheat at 25 m on 60-m tower)
- Cimel sunphotometer

Wind, Temperature, and Humidity Sounding Systems

- BBSS
- 915-MHz profiler with RASS
- 50-MHz profiler with RASS
- MWR
- Heimann IR thermometer
- Raman lidar

Cloud Observations

- WSI (daytime/nighttime)
- BLC (interim)
- MPL (IDP) ceilometer
- Millimeter cloud radar
- Vaisala ceilometer
- Sky video camera

Others

- Temperature and humidity probes at 25-m and 60-m levels on tower
- Heat, moisture, and momentum flux at 25-m and 60-m levels on tower
- EBBR
- ECOR
- SMOS
- AOS (samples at 10 m)
- RCF

TABLE 5 (Cont.)

Extended Facility Components	
	SIROS
	Pyranometer (ventilated)
	Pyranometer (ventilated, shaded)
	Pyrgeometer (ventilated, shaded)
	NIP on tracker
	MFRSR
	Pyranometer (upwelling, at 10 m)
	Pyrgeometer (upwelling, at 10 m)
	EBBR or ECOR
	SMOS
	SWATS
Auxiliary Facilities	
	None in preparation
Boundary Facilities	
	BBSS
	MWR
Intermediate Facilities	
	915-MHz profiler and RASS

[a] AERI, atmospherically emitted radiance interferometer; AOS, aerosol observation system; BBSS, balloon-borne sounding system; BLC, Belfort laser ceilometer; BSRN, Broadband Solar Radiation Network; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; IDP, Instrument Development Program; IR, infrared; MFR, multifilter radiometer; MFRSR, multifilter rotating shadowband radiometer; MPL, micropulse lidar; MWR, microwave radiometer; NIP, normal-incidence pyrheliometer; PAR, photosynthetically active radiometer; RASS, radio acoustic sounding system; RCF, radiometer calibration facility; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station; SORTI, solar radiance transmission interferometer; SWATS, soil water and temperature system; UV-B, ultraviolet B; WSI, whole-sky imager.

conditions, the BBSS will continue to be an expensive workhorse owing to the cost of the expendables and manpower associated with an ambitious schedule of radiosonde launches. The number of BBSS launches sitewide should eventually be reduced to a minimum needed to support routine cross-checks on the remotely sensed measurements, but we are a number of years from that goal. The frequency of routine launches at the central facility during this six-month period will be the same as in the previous six months. Routine operations (see Table 6) will include five daily launches at the central facility and one daily launch at each of the four boundary facilities.

TABLE 6 Radiosonde Launch Schedule for July 1-December 31, 1996 (Times in UTC)[a]

Central Facility	Boundary Facilities
Routine Operations, July 1-July 14, Monday-Friday	
0600	
1200	
1500	1800
1800	
2100	
SCM IOP Operations, July 15-August 4, Monday-Sunday	
0300	0300
0600	0600
0900	0900
1200	1200
1500	1500
1800	1800
2100	2100
2400	2400
Routine Operations, August 5-December 30, Monday-Friday	
0600	
1200	
1500	1800
1800	
2100	

[a] IOP, intensive observation period; SCM, single-column model; UTC, universal time coordinated. Launch time is 30 min earlier; the stated time represents the approximate midpoint of the flight.

The current routine radiosonde launch times at the central facility were chosen to facilitate IRF and IDP research, and the launch times at the boundary facilities were chosen to support the microwave radiometer (MWR) and the nearby NOAA 404-MHz profilers with their recent/imminent RASS deployment and to complement the wider network of National Weather Service (NWS) radiosonde launches. Remote sensing of virtual temperature profiles at all boundary facilities is provided by the nearby NOAA profilers, which are being outfitted with ARM-provided RASS units. RASS units have already been installed at the Purcell, Oklahoma, and at the Haviland, Kansas, NOAA profilers. The Lamont, Oklahoma, NOAA profiler will not receive a RASS unit because it would be located too close to a residence, but the nearby SGP CART site central facility collects a relative abundance of thermodynamic data. The NOAA profilers located at Vici and Morris, Oklahoma, and Hillsboro, Kansas, are expected to have RASS installed during this six-month period. In addition, global positioning system (GPS) instruments were recently installed at the Purcell, Vici, Morris, and Hillsboro NOAA profiler locations to provide estimates of precipitable water. This information is expected to become available to the ARM Program during this period as external data, along with the NOAA profiler data.

The four boundary facilities routinely launch radiosondes once daily at 1800 universal time coordinated or noon local time. Boundary facilities will continue to be staffed only during the period of 1030-1430 local time, Monday through Friday (including holidays). During appropriate IOPs, the boundary facilities will be staffed 24 hours per day for 21 consecutive days (including holidays) to facilitate releases every 3 hours (Table 6).

The central facility will be staffed from 0430 to 1630 and from 2230 to 0230 local time, Monday through Friday (including holidays). During SCM IOPs, the central facility will be staffed 24 hours per day, 7 days per week (including holidays) to facilitate round-the-clock radiosonde releases every 3 hours. Hours vary for other IOPs or campaigns, depending on the operational requirements for the central facility.

3.3 Instruments

A CART instrument is any instrument that is approved by the ARM Program and for which the site operations management has accepted responsibility for operation and maintenance. The PRR and ORR forms are requests for information that facilitates the installation and operation of instruments or facilities at the SGP CART site. The purpose of these reviews is to achieve an efficient handoff of instruments and facilities from instrument mentors to site operators. Figure 2, the SGP CART instrumentation implementation flowchart, contains information obtained from the PRR and ORR documentation. When all procedures, operation manuals, and training pertaining to an instrument have been completed, the instrument is accepted by the site operations management. If sufficient documentation is available to operate an instrument, even though more will ultimately be required for full acceptance, the instrument may be operated in a degraded mode. The status of the instruments is summarized in Table 7.

Recent instrument additions include the following:

- The soil water and temperature system (SWATS) is a joint venture between the GCIP and ARM. The GCIP has provided the SWATSs and data loggers, and ARM is contributing half of the salary of the soil physicist working on the project and is installing and will operate the system. Phase I SWATS installations completed during the last six-month period included installation at the central facility, three Kansas extended facilities (Plevna, Elk Falls, and Ashton), and three Oklahoma extended facilities (Ringwood, Meeker, and Cordell). Phase II SWATS installations will occur at three Kansas extended facilities (Larned, Hillsboro, and Coldwater) and five Oklahoma extended facilities (Tyro, Byron, Pawhuska, Vici, and Cyril) during this six-month period. The remainder of the SGP CART site extended facilities will be outfitted with SWATSs in the spring of 1997.

- An additional level of temperature and humidity observations was added at the 25-m level of the 60-m tower at the central facility. These new sensors duplicate those at the 60-m level. This addition addresses the need for more complete measurements of temperature and humidity profiles at the central facility. Also, ECOR sensors for sensible heat, latent heat, and momentum fluxes were added to the 25-m and 60-m levels of the tower in May 1996.

Installation of sensors to measure the downwelling hemispheric solar radiation in the ultraviolet B (UV-B) and photosynthetically active radiation bands at the central facility is planned for this six-month period. Requests for such observations have come from U.S. Department of Energy (DOE) offices, the ARM Program Office, and ecologists. Implementing these observations is an efficient means of increasing collaborations with other programs.

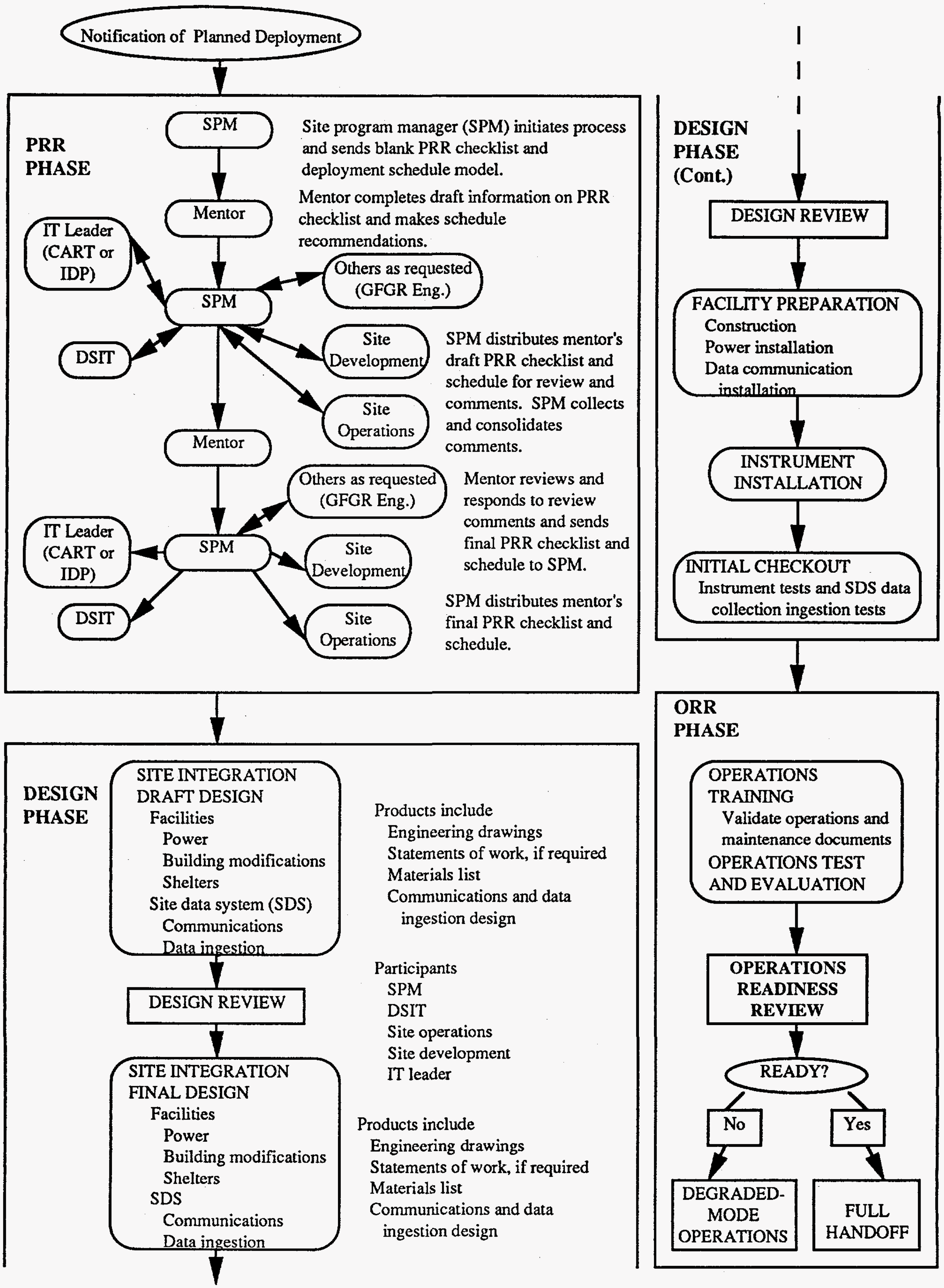

FIGURE 2 SGP CART Instrumentation Implementation Flowchart

TABLE 7 Status of SGP CART Instrumentation by December 31, 1996[a]

Instrument System	Instrument Class	Installation Date	ORR Date	Full Handoff	Degraded Operations
AERI 00	IDP prototype	3/18/93	3/18/93	No	Removed 4/95
AERI 01	CART	5/1/95	5/17/95	No	No (preliminary documents received 12/95)
Aerosol facility	CART	10/23/95	1/19/95	No	Yes
BBSS Digi-Cora	CART	3/15/93	4/15/93	Yes	—
BBSS PC Cora	CART	3/15/92	1/27/93	Yes	—
BLC	CART	3/15/93	5/19/95	Yes	—
EBBR	CART	11/24/92	11/24/92	Yes	—
C1 (60-m tower) ECOR	CART	Pending	—	—	—
C2 (3-m tower) ECOR	CART	5/16/95	5/18/95	No	Yes
C3 (mobile system) ECOR	CART	3/15/95	10/12/95	No	No
10-m MFR	CART	9/15/93	5/22/95	Yes	—
25-m MFR	CART	9/15/93	5/22/95	Yes	—
MMCR	IDP/CART	1/30/96	—	—	—
MPL 00	IDP prototype	9/15/93	5/22/95	No	Yes
MPL 02	CART	9/13/95	10/12/95	No	No
MWR	CART	11/2/92	5/17/95	Yes	—
Raman lidar	IDP/CART	9/15/95	4/3/95	No	Yes
RCF	CART	5/24/96	—	—	—
SIROS	CART	9/15/93	5/17/95	Yes	—

TABLE 7 (Cont.)

Instrument System	Instrument Class	Installation Date	ORR Date	Full Handoff	Degraded Operations
SMOS	CART	6/10/93	6/10/93	Yes	—
SORTI 00	IDP	1/15/93	1/15/93	No	Yes
SORTI 01	CART	1/15/96	—	—	—
WSI 00	IDP loaner	10/18/93	5/22/95	No	Removed 9/95
WSI 01	CART	9/18/95	3/11/96	Yes	No
25-m upwelling IR/S radiometer	CART	9/15/93	5/22/95	Yes	—
50-MHz profiler with RASS	CART	1/30/94	1/30/94	Yes	—
915-MHz profiler and RASS	CART	1/30/93	1/30/93	Yes	—

[a] AERI, atmospherically emitted radiance interferometer; BBSS, balloon-borne sounding system; BLC, Belfort laser ceilometer; CART, Cloud and Radiation Testbed; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; IDP, Instrument Development Program; IR, infrared; MFR, multifilter radiometer; MMCR, millimeter cloud radar; MPL, micropulse lidar; MWR, microwave radiometer; ORR, Operational Readiness Review; PC, personal computer; RASS, radio acoustic sounding system; RCF, radiometer calibration facility; S, solar; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station; SORTI, solar radiance transmission interferometer; WSI, whole-sky imager.

Plans are proceeding to place three or more infrared thermometers (IRTs) at the central facility, one pointing downward at the central facility, one pointing downward on the 10-m mast in the pasture, and one pointing downward at the 25-m level above the wheat field. The purpose of these IRTs is to establish (1) boundary conditions for calculations of cooling rate; (2) boundary conditions for calculations of spectral radiance and flux, for comparison with data from airborne radiometers; and (3) ground truth for satellite verification and calibration.

A second day-night WSI is scheduled for delivery to the SGP CART site this fall for installation at an auxiliary site for studies of cloud structure and motion. This addition will provide a more complete three-dimensional view of clouds at the central facility. Acquisition of additional WSIs for auxiliary stations to enable more complete three-dimensional views of clouds will be considered after evaluation of the usefulness of the data from the first two WSIs.

During the immediately past six-month period, the construction of the radiometer calibration facility (RCF) was completed. When fully operational, the facility will include a calibration deck; a reference spectroradiometer (300-1,100 nm); a site reference cavity radiometer; a program reference cavity radiometer; a site working-standard cavity radiometer; automatic solar trackers for direct and diffuse solar measurements; reference diffuse pyranometers; working-standard pyranometers, pyrheliometers, and pyrgeometers; National Institute of Standards and Technology (NIST) standard lamps; blackbody circulators; and computer hardware and software support. The RCF will greatly aid the ARM Program in its ability to collect the best radiometric data possible.

The current status of and plans for acquisition and deployment of all instruments are summarized in Tables A.1-A.3 in Appendix A.

Much of the SGP CART site installation is now complete as originally planned. However, CART instrument performance, the availability of new commercial instruments, and additional data stream requirements result in a list of potential new instruments that is reviewed by ARM infrastructure staff. Recommendations are then made to the Science Team Executive Committee for approval. The instrument modifications and additions that have been suggested and are now under discussion within the ARM infrastructure staff include the following:

- *Occasional Tethersonde Measurements of Humidity Profiles at the Central Facility as Needed, with Trial Efforts Being Planned for September 1996.* A tethersonde system with a high-quality humidity sensor could be used to make repeated measurements of temperature and relative humidity profiles in the lower 150 m of the atmosphere over periods of about one hour. Probing to greater altitudes is probably not possible at the CART central facility because of restrictions associated with aircraft operations. Operation of a tethersonde system requires continuous effort by experienced researchers. Nevertheless, occasional tethersonde soundings to make observations between about 100 m and 150 m would provide several points of reference and potential calibration for the Raman lidar. A tethersonde system will be borrowed from one of the DOE laboratories, and special chilled-mirror sensors are being acquired. Carrying out several soundings every 3-6 months might suffice. The lidar-derived estimates of water vapor could then be used more effectively to examine the performance of the BBSS and other sources of temperature and humidity data.

- *Upgrades to the BBSS System Currently in Progress* (using GPS for tracking instead of Loran-C and using the new Vaisala RS-90 radiosondes, reported to have faster-response temperature and humidity sensors). Switching the BBSS to GPS- rather than Loran-based tracking for determining position and winds might be necessary during the next few years as Loran-C trransmitters are phased out. In addition, the humidity sensor on the RS-90 sondes is reported to have a faster response and to recover more quickly after emerging from clouds than the RS-80. The temperature sensors are smaller and thus probably considerably faster in response and less susceptible to the effects of heating by solar radiation. A thorough evaluation of the RS-80 versus the RS-90 sondes would be beneficial for ongoing and subsequent studies of atmospheric radiation transfer. Although some comparisons can be made at the CART site with sequential flights of each type of sonde, a better means of evaluating both types of sondes would rely on flying both types attached to the same balloon. This may be attempted in September 1996.

- *An Extra High-Resolution AERI X*. A need was stated during early phases of CART planning to have at least two infrared interferometers running routinely at the central facility. Two systems were said to be needed to improve evaluation of the uncertainties of the radiance observations. Because the AERI X has a resolution about 10 times greater that the AERI and would provide the best available emission observations for comparison with line-by-line calculations, the AERI X could be considered an enhancement or new observation, in addition to contributing to completion of the SGP CART site instrumentation. The high-resolution system provides a more independent check of radiance readings than would a second AERI of standard resolution because a different type of interferometer is used. A prototype AERI X ran at the SGP central facility in 1995. Acquisition of an AERI X for routine operation at the CART central facility is currently being considered.

- *Vaisala Ceilometer for the Central Facility, which Has Entered the PRR Process*. The present Vaisala ceilometer system could be enhanced by the addition of a stepping motor and motor control that would allow mechanized scanning of the ceilometer along one axis. Software would have to be developed and tested to use this function. The enhancement would allow the ceilometer to make three measurements that at present would require manual rotation of the ceilometer: (1) scan the sky, and analyze the return as a performance check on the cloud decision algorithm of the WSI; (2) periodic rotation of the ceilometer from the vertical to increase the optical path length in the boundary layer, thereby increasing the possibility of observing mixing depths from boundary layer aerosol returns, and (3) calibration of the ceilometer by rotating the system to a horizontal position and observing the return from a target a known distance away.

- *Zenith Sky Radiance in the Near IR at the Central Facility* (i.e., an uplooking near-IR shortwave radiance instrument with a field of view overlapping or nearly coincident with that of the MWR), being investigated. The wavelengths detected should be in a fairly narrow band near 0.9 μm, and the field of view should coincide with the MWR field of view as much as possible. Such a device is needed to improve understanding of the relationships between liquid water path and shortwave radiation. A specially designed device for this purpose could probably be obtained from commercial sources at a modest cost. At the SGP central facility, the sensor could be mounted next to the UV-B radiometer and PAR and use the same data logger.

- *A Commercially Available Optical Transmissometer to Detect Particles like Fog, Dust, and Drizzle Too Light to Be Recorded by Rain Gauges at the Central Facility, Being Investigated.* Such phenomena are best detected by open-path devices rather than through a large sampling stack such as being used with the SGP aerosol observation system (AOS). The data would be useful for evaluation of signals from radars, lidars, and the MWR.

- *A Cimel Sunphotometer for Measurements of Aerosol Optical Depth at the Central Facility and of Sky Irradiance along the Solar Almucantar and along the Solar Principal Plane, Including the Solar Aureole, for Use in Research on Inferring Aerosol Size Distribution and the Scattering Phase Function, in the PRR Process.* This instrument has been suggested to supplement the multifilter rotating shadowband radiometer (MFRSR) and to tie in with a global network of such sunphotometers supported in part by the National Aeronautics and Space Administration (NASA). A sunphotometer system manufactured by Cimel, a private company in France, has been recommended.

- *Valero Radiometers at the Central Facility and at Extended or Boundary Facility Locations to Be Identified, Being Investigated.* The ARM Program acquired several radiometers designed by Francisco Valero and associates. These radiometers were deployed at three ground stations in the SGP CART site during experiments in October and November 1995. Further information on the quality and nature of the data produced during the experiments, the design of the radiometers, their characteristics, and calibration procedures is being compiled to consider them for routine operations. Issues such as weatherization and thermal control need to be addressed.

- *Solar Spectral Radiometer Observations at the Central Facility for a Wavelength Range of 350-1,100 nm, Being Investigated.* Early attempts have failed to find a commercially available spectroradiometer that is suitable for routine operation. Portable field spectroradiometers for a wavelength range of 350-1,100 nm are available but require considerable attention during operation and are not fully weatherized. One possible approach is to arrange for modification by the commercial source or by scientists in DOE or NOAA laboratory facilities. Another consideration is whether solar wavelengths beyond about 1,100 nm in wavelength need to be measured. A spectroradiometer with this capability would require a directed development effort, which is feasible but probably would have a significant cost. Also, a rotating shadowband spectroradiometer might be developed successfully as part of an ongoing IDP effort.

- *A Sky Video Camera for Cloud Pictures at the Central Facility, in the PRR Process.*

- *UV-B and Photosynthetically Active Radiation Sensors, in Progress.* Installation of sensors to measure the downwelling hemispheric solar radiation in the UV-B and photosynthetically active radiation bands at the central facility is planned for 1996. Data will be recorded continuously with a Campbell Scientific, Inc., data logger. Sensor and data logging costs are minimal. Requests for carrying out some type of UV-B observations at the CART site have been received from DOE offices and the ARM Program office. Requests for photosynthetically active radiation data from the CART site have come mostly from ecological scientists who are not supported directly by the ARM Program but are involved in programs or projects that are or could be collaborative with ARM. Implementing these observations is an efficient means of increasing collaborations with other programs.

- *Addition of Rain Gauges at Six SWATS Locations Where No Surface Meteorological Observation Station (SMOS) Exists.* These rain gauges are needed in proximity to SWATS to learn more about the flux of water from the near surface atmosphere through the layers of soil measured by SWATS for realistic soil water balance estimations. These rain-gauge data are necessary for determining soil moisture characteristics for distributed surface models and for building empirical relationships between soil water status and surface energy and water partitions. Studies have shown that antecedent precipitation is a dominant cause of spatial variation in surface exchanges across a wide area like the CART site, working its way through into a convective response in the atmosphere, perhaps influencing cloud formation.

Measurement issues currently unresolved by the ARM infrastructure include the following:

- *Evaluation of the Feasibility and Costs of Improving the SIROS Data Logging at All Extended Facilities by Converting to a Campbell Data Logger, Being Investigated.* This change would reduce the complexity and increase the reliability of data acquisition from the broadband radiometers. Another reason for this change is that the MFRSR data logger has inadequate data storage for more than 2-4 hours when electronic communications fail at the extended facilities; at least two weeks of data storage are needed to allow retrieval of data during routine site visits. In addition, the MFRSR data logger samples only once every 20 s, which is too infrequent for obtaining statistically sound estimates of broadband radiation for averaging periods of less than 15 minutes under skies with broken cloud cover.

- *Installation of Ceilometers at Boundary Facilities to Decrease the Uncertainties in Estimates of Temperature and Humidity Profiles Based on Data from AERIs.* Ceilometers at the boundary facilities would assist sitewide evaluation of cloud conditions. Vaisala ceilometers are now capable of detecting cloud base to a height of about 7.5 km. Two to three months of effort would be needed by an instrument mentor to have such ceilometers acquired and installed at the four boundary facilities, and effort by site operations personnel and site data system (SDS) personnel would be significant.

- *Local Observations of Surface Vegetative Conditions at Extended Facilities, Specifically Commercially Available Devices that Measure the Nondimensional Vegetative Index (NDVI) and the Leaf Area Index.* Recent discussions about measurements that would assist in the interpretation of data on, and modeling of, surface latent and sensible heat fluxes at SGP extended facilities have centered on measurements of the leaf area index and surface optical reflectance properties represented by the NDVI. Local measurements of the leaf area index were considered usually to be too variable to be of much use, but local measurements of NDVI were believed to be particularly important for interpretation of NDVI values derived from remote sensing data from satellites. Satellite data could then be used to help infer the values and variability of surface heat fluxes for the overall CART site. Relatively simple devices that obtain a measure of the NDVI can be obtained at a modest cost and are currently being investigated.

- *Addition of a Passive MWR (Radiometrics) for Obtaining Profiles of Temperature through Clouds, to Augument or Supplant Profile Measurements Made with the AERI at the Central or Boundary Facilities.* Vertical resolution appears to be about 100 m near the surface and increases gradually to over 2 km at a height of about 10 km near its maximum range. A passive system for water vapor profiling might also be successfully developed. The primary advantage of microwave profiling is that it penetrates through clouds, which is not accomplished with any of the water vapor remote sensing systems currently in operation at the SGP CART site. A question that needs to be considered is whether such temperature and water vapor profiling is required for radiative transfer studies that is not provided by other sources (e.g., the Han-Westwater data fusion algorithms that are currently being implemented as value-added products).

- *Surface Bidirectional Reflectance.* Measurements of surface bidirectional reflectance have been suggested at times for both the SGP and North Slope of

Alaska experimental areas, and a commercial source is available for the portable appartus for rapid acquisition of bidirectional observation of the land and the atmosphere (PARABOLA). Such observations would be quite useful in the interpretation of solar reflectances seen from satellites. A commercial system is available but is not suitable for routine observations. The need for measurements of surface bidirectional reflectance should be considered in greater detail by ARM Science Team members; the effort costs could be fairly high and would depend on the frequency of observations possibly required.

- *Ozone Profiles*. Measurements of vertical profiles of atmospheric ozone content above the SGP central facility were made during experiments in October and November of 1995. An assessment of the suitability and potential costs of making ozone sonde measurements routinely can be made by the SGP CART site operations personnel. When the ozone data become available, the importance of ozone concentration variability in research on infrared radiative transfer can be reevaluated, and recommendations can be provided by Science Team members on the need for routine and further campaign measurements.

3.4 Observations, Measurements, and External Data

The observations being delivered to the Experiment Center from the SGP CART site as of June 30, 1996, are summarized in Table B.1 in Appendix B. The availability of data from a particular platform on any given day is a function of quality control, with some segments temporarily unavailable during evaluation or correction of problems. Instruments operating at the site that are not in Table B.1 either are still under evaluation by the instrument mentors or are awaiting the creation of the data ingestion modules required to add their data to the SGP data stream.

The measurements being produced at the Experiment Center as of June 30, 1996, for distribution to the Science Team are listed in Table B.2 in Appendix B. This summary includes both the measurements derived from the SGP CART data and data streams from sources external to ARM (e.g., the gridded data from the National Meteorological Center's ETA Model). Table B.3 in Appendix B lists the external data that currently supplement the SGP CART data.

The Experiment Center will continue to prepare software to produce measurements from the available observations. Table B.4 in Appendix B lists the measurements, organized by type, derived from the SGP CART site and external data that are anticipated to exist by the end of this period (December 31, 1996).

3.5 Site Development Activities

3.5.1 Facilities

The infrastructure at the central facility is complete, including the power, telephones, and fiber-optic data network, along with three IDP pads that have continued to support visiting instruments. A fiber-optic upgrade was completed in December 1995, and major upgrades to the SDS at the central facility were completed in June 1996. In anticipation of the arrival of two daytime-nighttime WSIs, the first of six planned auxiliary facilities will need to be located. Auxiliary facilities are to be 5-10 km distant from the central facility and at approximately the same elevation as the central facility. At least one auxiliary facility is expected to be located and leased during this period.

To accommodate the new T-1 lines at the boundary facilities, a new trailer (10 $\times$ 30 ft) was procured for installation in April 1996. The new trailer, a new SDS changeout, and increased work space to accommodate delivery of a future AERI and perhaps other equipment will finalize the boundary facilities.

On the basis of a recommendation from a subset of the Science Team, new locations for the three intermediate facilities with the new 915-MHz profilers and RASS units were identified during the last six-month period of 1995. The National Environmental Policy Act (NEPA) approval process was completed in April 1996, and land agreements have been approved. Subsequently, support infrastructure (utilities, cement pads, housing structures for computers, etc.) will be implemented, and the instruments will be installed by the vendors at staggered monthly intervals beginning in July 1996. The sites are located at Beaumont and Medicine Lodge, Kansas, and at Meeker, Oklahoma. The 915-MHz profiler and RASS instruments will be installed in response to the need of boundary layer information by Science Team members for scales smaller than previously provided by instruments at the central and boundary facilities and the NOAA Wind Profiler Demonstration Network locations.

As new IDP and CART instruments arrive at the central facility, special support structures are required. For example, the optical trailer was modified to accept the CART AERI 01 and AERI X, and the pad for the Raman lidar was constructed at IDP location 3 in October 1995. Installation of the millimeter cloud radar, which was delayed, should be completed during this six-month period.

3.5.2 Development of the Site Data System

Several of the installed instruments and all new instruments will require creation of software to transfer the data from the instrument platforms to the SDS. Transfer of data by coded switches from the extended facilities has been established. Because the telephone lines cannot support data transfer from the boundary facilities, T-1 lines were installed at these locations in time for the SCM IOP in April 1996. Most of the ARM SGP instruments have their data collected (or delivered) to the SDS regularly, with data processed (i.e., ingested) and passed on to the Experiment Center and the ARM Archive. Some exceptions to this pattern will continue to occur during the next six months. These exceptions are as follows:

- *SORTI*. The SORTI data are retrieved directly by the instrument mentor and do not enter the SDS computers.

- *WSI*. The WSI is connected to the network.

- *AERI 01*. The AERI 01 data are retrieved by the Experiment Center, and ingestion of the data occurs there. The data do not enter the SDS computers.

- *Micropulse Lidar (MPL)*. The MPL data are received by the SDS computers but are not processed (because no ingestion module has been developed), except that the raw data files are renamed to the ARM file-naming standard.

- *Belfort Laser Ceilometer (BLC)*. The BLC data are collected by the SDS computers, but the processing (ingesting) of the data currently takes place at the Experiment Center.

- *ECOR*. The 3-m ECOR systems recently installed at the central facility and extended facilities currently write data files to an optical drive unit that stores data for 11.7 days. After this time, new data are written over the last existing data files, and so the last 3.5 days are lost until the communications module is completed. The optical data tapes are sent to the instrument mentor for data processing until the SDS communication file is complete. Data are retrieved only every two weeks from extended facilities.

- *Raman Lidar*. Data are expected to be retrieved from the Raman lidar in an automated fashion by the instrument mentor, until ingestion can be completed.

- *SWATS*. The SWATS data will be retrieved automatically by the instrument mentor until the ingestion module is in place.

- *AOS*. The AOS data are being retrieved automatically every hour.

- *RCF*. How data will be retrieved from the RCF is not clear at this time.

- *Intermediate Facility 915-MHz Profilers and RASS*. The spectral data from the 915-MHz profilers and RASS will be retrieved manually every two weeks. The consensus data will be retrieved automatically each day.

- *Millimeter Cloud Radar*. How data will be retrieved from the millimeter cloud radar is not clear at this time.

- *Cimel Sunphotometer*. How data will be retrieved from the Cimel sunphotometer is not clear at this time.

- *Vaisala Ceilometer*. How data will be retrieved from the Vaisala ceilometer is not clear at this time.

- *Sky Video Camera for Clouds*. How data will be archived is not clear at this time.

Further work is being undertaken to facilitate routine operations and particularly to assess instrument performance, including a broader suite of data display capabilities. Once the SDS is near completion, procedures for system management and maintenance need to be written and transferred to site operations staff. During the previous six-month period, site operations management hired a site computer systems administrator, who will facilitate local SDS development, operation, and maintenance. In addition, the SDS continues to address the ongoing need to make near-real-time data available for selected scientists during IOPs and campaigns and for educational outreach efforts in conjunction with the Oklahoma Climatological Survey's EARTHSTORM project.

3.6 Limiting Factors

The most basic of limiting factors is the amount of resources available to continue site development, expand operations, and provide necessary support for the IT and DSIT. Shortfalls result in delays in implementation. Shortfalls in vendor supplies, delays in obtaining information for PRRs, and budgeting problems have also been hindrances. Other significant limiting factors are the time lags inherent in the procurement process and the calibration of radiometers before installation, though the latter should be relieved by the presence of the new calibration facility.

All systems awaiting construction or installation go through a formal design review of structural and mechanical systems. These reviews frequently identify deficiencies in plans and drawings related to engineering requirements, procurement details, safety, and quality control. This review activity was recently expanded to include large or complex IOPs (e.g., the ARESE IOP in September 1995) in an effort to integrate the exceptionally wide variety of IDP instrument support requirements for cost-effective and safe implementation. Neither construction nor installation can begin until the design review process has been successfully completed.

The costs associated with BBSS launches (primarily expendables) will continue to be a burden on the operations budget until these systems are replaced by continuous, unmanned remote sensing systems. These expenses are a strong constraint on the total number and frequency of launches, making impossible the routine provision of all of the requested launches (eight per day at the central and boundary facilities) defined as the optimal sounding strategy for SCM requirements by the DSIT (M. Bradley and R. Cederwall, unpublished information). A potential BBSS system upgrade tested during the previous six-month period using directional antennas and new sondes proved quite effective. This upgrade helps reduce interference, produce higher-quality moisture profiles, and allow longer tracking of the sondes. In addition, Vaisala is working on its next-generation radiosonde (RS-90), which will yield faster response humidity information (dual sensors; one is heated) and includes an improved, lower-mass thermistor for faster temperature response. The RS-90 sondes are expected to be tested and evaluated at the SGP CART site during this six-month period, before implementation.

4 DATA QUALITY

Data quality issues are addressed at several levels within the ARM Program and at the SGP CART site. One of the goals of the ARM Program is to provide data streams of known and reasonable quality. Maintaining data quality for a program of this size and complexity is a significant challenge. Data quality assurance within the ARM Program infrastructure has matured over the past few years and will continue to evolve, with the SST continuing to develop the stronger role that it assumed during the previous six-month period.

4.1 Instrument Mentors

Instrument mentors are charged with developing the technical specifications for instruments procured for the ARM Program. The instrument mentor then tests and operates the instrument system (either at his or her location or at the SGP CART site). In addition, the mentor works with SDS personnel on ingestion software requirements. Data ingestion involves the conversion of data streams to the International System of Units (SI), as well as the acquisition of parameters that can be used to monitor instrument performance (e.g., monitoring an instrument's output voltage for a 5-V power supply or the continuity of the wire in a hot-wire anemometer). Data collection and ingestion, then, are the focus of the first level of data quality assurance. Quality at this level is monitored routinely by site operators and instrument mentors.

The next level of data quality assurance involves beta release of data streams from individual instruments. The mentor receives the data from the instrument to determine whether the technical specifications of the instrument are being met. When the mentor is satisfied that the instrument is functioning properly and that the technical specifications have been met, the data are formally released to the Science Team and other data users. The instrument mentor is also charged with reviewing the instrument data streams at least once every two weeks, an action monitored at the Experiment Center.

Instrument mentors also provide all operations and maintenance documents and lists of spare parts to site operations. Typically, the mentor provides additional detailed documentation and hands-on training so that appropriate support can be provided by site operators. This activity is part of the ORR process.

4.2 Site Scientist Team

The SST helps to ensure that the scientific productivity of the SGP CART site is maximized by both the routine and special (IOP) operations at the site. The SST acts a resource for the site operations manager and his staff on scientific matters related to instrument data streams by doing the following:

- Fielding and answering questions from site operations personnel concerning potential instrument problems
- Reviewing proposed instrument siting and deployment strategies, including the needs of the instrument mentors and instrument requirements for IOPs and campaigns
- Reviewing schedules and procedures for instrument calibration and maintenance (to be reported in a *Calibration and Maintenance Plan* currently being drafted)
- Providing an initial confirmation of suspected instrument or data problems through the use of both graphic display techniques and systematic monitoring of data performance

These activities require constant communication with site operations staff, including routine visits to the central facility and occasional trips to extended, intermediate, and boundary facilities. These activities are also highly coordinated with the site program manager. Ongoing focus activities of the SST will contribute to the goals of data quality assurance for the SGP CART site and ensure that the operation of the site meets, as nearly as possible, the overall scientific goals of the ARM Program.

In the past, data quality assurance efforts of the SST largely involved evaluation of individual and multiple sets of data streams as needed, on an exploratory or developmental basis (data quality investigations); participation in QMEs; and participation in the creation and workings of the Value-Added Products (VAPs) Working Group.

Now that operational activities have shifted from deployment to support of ongoing, continuous operation of a wide variety of instrumentation at many locations, a more comprehensive, systematic data quality assurance effort is being initiated by the SST. This effort is manifested not only by the *Calibration and Maintenance Plan* being drafted but also by the development and use of automated, graphic display modules for use by site operators in monitoring data quality (beginning in October 1995) that plot multiple data streams for visual inspection by site operations and (beginning in early 1996) the development of performance metrics that systematically determine what percentage of the collected data falls within given quality tolerances. Data quality display modules have been developed for the broadband radiometer data (SIROS), MFRSR channels 1-6, sitewide albedo, and comparisons of BSRN and SIROS data. Although a Web site has been dedicated for the program-wide viewing of these display modules, at this time they are primarily intended as the site operator's first line of defense.

The development of performance metrics began in February 1996 and to date has concentrated on the MWR, BBSS, energy balance Bowen ratio (EBBR), SIROS, and EBBR/SIROS net radiation comparisons. This effort is aimed at systematically determining the data "health" of the site via time series (numerical and graphic) of the metrics. The ultimate format of this presentation is under development. Plans for this six-month period and beyond include development of display modules for more data streams (as yet undetermined), the development of explicit guidance materials to allow site operations staff to use the display modules effectively, continued development of performance metrics (including AERI, SMOS, and 60-m tower parameters), and continued drafting of the *Calibration and Maintenance Plan.* Thus, with the assistance of the site operations staff, the SST will be able to serve the ARM Program goals better by laying a foundation for improving data credibility.

4.3 Quality Measurement Experiments

As part of the data quality assurance effort, the focus goes far beyond the calibration of instruments and analysis of individual data streams to intercomparisons of data streams and evaluations of our ability to capture an accurate representation of the state of the atmosphere (through QMEs). The QMEs are investigations designed to evaluate and enhance ARM data quality. They are suggested by the instrument mentors, the DSIT, and the SST. These efforts are expected to lead to peer-reviewed publications, a result strongly encouraged by the ARM Program. Such publications would allow data quality to be documented in the open literature. Specific QMEs are listed in Section 5.4.

4.4 Data Quality Problems

Suspect data can be reported to the ARM Program by anyone via the Problem Identification Form (PIF) shown in Figure 3. The PIF is submitted electronically to the Problem Review Board (PRB), which is made up of representatives of all ARM Program functional groups and meets weekly. The PRB's function is to review PIFs and assign the problems to appropriate personnel for resolution. The PIF remains open until the problem has been officially addressed by a Corrective Action Report (CAR); the CAR form is shown in Figure 4. In addition, Data Quality Reports (DQRs) are generated by an instrument mentor (and others) during his or her routine inspection of an instrument data stream; the DQR form is shown in Figure 5. The forms can also be entered via the ARM World Wide Web page at

http://www.arm.gov/docs/data.html .

The PIFs, CARs, and DQRs are archived as a data quality information database.

Problem Identification Form

PIF No.

(PIF No. will be assigned by PIF Manager)

Subject:
Date submitted:

Submitted by:
Organization:
Telephone:
E-mail:

Problem description/change description: (Give a brief explanation with details. Attach samples and any supporting information. This should include a description of analysis leading to identification of problem and, if known, recommended action.)

Submitter's prioritization: (circle one) Critical-1
Very Important-2
Important-3
Inconvenient-4
Interesting-5

Where was this problem identified? (circle one) SGP Site Data System-SGPSDS
Experiment Center-EC
Archive-A
TWP Site Data System-TWPSDS
Field Instrument-FI
During Data Analysis-DA
Other (list location)

Does this problem affect data values or cause data loss? (circle one) Yes/No

Which platform(s)?

Specify (or estimate) begin and end dates for data loss:
Begin Date: Time (UTC):
End Date: Time (UTC):

Does this PIF result in a Software Change Request? (circle one) Yes/No

Where? (circle one) SGPSDS, TWPSDS, EC, A

Type (circle one) Developmental-1, Problem-2, Enhancement-3

Suggested distribution:

FIGURE 3 The Problem Identification Form

Corrective Action Report Form

CAR No.

(CAR No. will be assigned by PIF Manager)

Subject:

PIF number(s):

CAR submitted by:

Date CAR submitted:

How may we contact you?
E-mail:
Phone:

Classification of this CAR: (check one)

____ Information only, problem cannot be fixed
List reference PIF(s) in PIF closed section.
____ Software modification
Implemented by:
Date Time Local/UTC (circle one)
Tested by:
Date Time Local/UTC (circle one)
Installed by:
Date Time Local/UTC (circle one)
____ Other (list)

PIFs addressed: (List all PIFs closed or addressed by the CAR. In the solution comments section below, list the details of the corrective action that has taken place.)

PIF closed (circle one) Yes/No

Solution comments/technical actions taken:

FIGURE 4 The Corrective Action Report Form

The Data Quality Report Form

DQR No.: Platform:

Subject:

Date submitted:
Submitted by:

____

Submitter's affiliation:
____ Instrument Mentor
____ Experiment Support Team Member
____ Science Team Member
____ Other ________________________

For questions or problems, please contact the ARM Experiment Center at 509-375-6898 or via e-mail at DQR@arm.gov.

Platform/measurement:

Level of data (raw, a0, a1, b1, c1, etc.):

Location of data collection:

Period of questionable data:

Begin Date: Time (UTC):
End Date: Time (UTC):

Data should be labeled:
____ Questionable
____ Incorrect
____ Wrong calibration
____ Other

Extent of problem:
____ All data fields affected
____ Only some data fields affected

Discussion of problem:

Other observations/measurements affected by this problem:

Suggested corrections for the problem (e.g., change calibration factor and recompute, flag data with this comment):

Data processing notes:

FIGURE 5 The Data Quality Report Form

5 SCIENTIFIC INVESTIGATIONS AND OPPORTUNITIES

In 1994, the ARM Program identified a need for the creation of a SAC to provide assistance to the ARM Program Science Team, the SGP CART site scientist, and the SGP CART site program manager. The SAC's charter is to

- Evaluate the SGP CART site scientific mission,
- Provide scientific mission guidance for SGP CART site operations,
- Evaluate the research program of the site scientist,
- Evaluate the potential for collaboration with other research programs, and
- Provide recommendations for the SGP CART site educational outreach program.

The seven-member SAC is composed of ARM and non-ARM Program scientists who meet formally at least once per year. The first such meeting was held in November 1995 at the University of Oklahoma, and a second follow-up meeting was held in June 1996. A written report summarizing the SAC's recommendations on the basis of the first meeting was distributed in early 1996 to the ARM Management Team, the SST, the site operations manager, and the site program manager and was responded to in writing by the SST. The report from the June meeting is expected during this six-month period. Individual committee memberships last for three years.

5.1 Intensive Observation Periods

The foundation of the ARM Program at the SGP CART site is the suite of continuous, routine observations, but some critical observations either can be too expensive to be made continuously or require instrumentation that cannot be deployed continuously. In addition, some questions concerning data accuracy or representativeness (for either established instruments or prototypes) can be answered only during periods of more intense observations. Acquiring these observations requires special efforts and arrangements by the SGP site staff. Such efforts are categorized as IOPs because they include activities beyond the routine observations and operations. The IOPs can be held in support of the needs of the Science Team, QMEs, IDP, campaigns, and even field tests of non-ARM instruments. Table 8 lists IOPs that have occurred, are in progress, or are in the design stage.

The SCM IOPs form the foundation for the IOP program. The scheduling of other IOPs during SCM IOPs has a significant benefit in keeping costs manageable. The SGP site has shown that it can support scientific investigations on relatively short notice (e.g., ARESE, Cloud Layer EXperiment [CLEX] IOPs), but budgetary impacts must be considered. The scientific prioritization of IOPs and their effects on routine operations are evaluated continuously.

The IOPs and campaigns are, in general, proposed to the DSIT by Science Team members, ARM infrastructure staff, the SST, the SAC, and other agencies. The DSIT integrates and develops specific requirements into a document that is passed on to the site program manager for evaluation, assessment, and budgetary consideration.

Data from guest instruments collecting data during IOPs can generally be located and acquired by contacting the DSIT.

The IOPs of key scientific interest during this upcoming six-month period are discussed in the following paragraphs.

The Summer 1996 Single-Column Model IOP. An SCM is a physical parameterization package extracted from a general circulation model (GCM) or other large-scale model. The SCM is a primary test of our current understanding of clouds and radiative transfer. The SCM IOPs are designed to provide, as boundary conditions, the advective tendencies and vertical velocities that are the dynamic forcing normally calculated with a GCM. The BBSS is the only technology currently capable of providing the range and resolution of observations of winds and thermodynamic quantities necessary to estimate these boundary conditions. Because derivatives are needed in both horizontal directions, BBSS data from the central facility and the four boundary facilities are the minimum required for reliable estimates. This IOP will be held from July 15 to August 5, 1996.

The Cloud Layer Experiment IOP. The CLEX IOP will be conducted by the Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, during the period of June 20 to July 3, 1996, to investigate middle-level, complex layered cloud systems, under funding from the U.S. Department of Defense. The investigation includes observation of the cloud layer systems from satellites, aircraft, and surface platforms.

TABLE 8 Intensive Observation Periods

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
11/92	Field Test of NCAR Flux Profiler	D. Parsons (NCAR)	R. Cederwall	Enhanced soundings at the central facility and profiler site were made 11/10-11/19; boundary layer flights were also conducted on a few days.	Completed; data available summer 1993
4/93	AERI Field Test	H. Revercomb (UW)	J. Liljegren	Enhanced soundings at the central facility were requested during the field acceptance test of the AERI instrument.	Completed 4/29/93
5/93-6/93	Using the GPS for the Measurement of Atmospheric Water Vapor	Collaborative (UNAVCO and NCSU)	J. Liljegren	The purpose was to test the investigators' technique for inferring total precipitable water vapor in the atmosphere column by using GPS signals.	Completed 6/8/93; data available
6/93	Warm-Season Data Assimilation and ISS Test	D. Parsons (NCAR)	R. Cederwall	This test was an enhanced sampling (in time and space) of the SGP domain for a 10-d period with profilers and sondes. The primary goals of the IOP were (1) to study the performance of FDDA under thermodynamic conditions typical of the continental warm season and (2) to evaluate the estimates of divergence and vorticity from the prototype NCAR ISS with interferometric techniques, the triangle of three 915-MHz profilers, and the results of FDDA.	Completed; all data available at the Experiment Center except for FDDA, which is available upon request at NCAR

TABLE 8 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
1/94; 4/94; 7/94; 10/94; 4/95; 7/95; 9/95; 4/96; 7/96	Seasonal SCM IOP	D. Randall (CSU)	M. Leach	Seasonal IOP with enhanced frequency of observations, particularly vertical soundings of temperature, water vapor, and winds at central facility and boundary facilities for periods of 21 d; the required sounding frequency is 8/d. The data are required for quantifying boundary forcing and column response.	IOP being planned for 7/96
4/94; 9/95-10/95; 9/96	ARM UAV	J. Vitko (SNL); G. Stokes (PNNL)	D. Rodriguez	Measurements of clear-sky flux profiles acquired by a UAV and surface support data are to be used to understand clear-sky heating rates and the ability of models to reproduce the observations.	First IOP conducted successfully in 4/94; flight for ARESE IOP in 9/95-10/95
4/94-5/94; 4/95-5/95	Remote Cloud Sensing Field Evaluation	R. McIntosh (UM); B. Kropfli (NOAA); T. Ackerman (PSU); K. Sassen (UU); A. Heymsfield (NCAR); J. Goldsmith (SNL); and others	C. Flynn	The primary purpose was the field evaluation and calibration of several remote sensing cloud-observing instruments (some from the IDP project). *In situ* cloud observations were critical to the success of this IOP. Enhanced soundings were required at the central facility.	Completed; data analysis in progress
5/94	WB-57 Overflight for the Measurement of Atmospheric Water Vapor at High Altitude	Collaborative (Visidyne and Lockheed PARC)	J. Liljegren	The purpose was to attempt to infer the vertical distribution of water vapor at high altitudes from solar transmission spectra.	Completed; preliminary transmission spectra delivered to ARM
5/94	VORTEX IOP	E. Rasmussen (NSSL)	D. Slater	Special launches were made in support of VORTEX, testing hypotheses on the development and dissipation of severe storms.	Completed 5/31/94

TABLE 8 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
8/94	GEWEX/GCIP/GIST IOP	Collaborative	T. Cress	Special launches were made in support of the GCIP and GIST as part of an effort to improve climate models by improving parameterizations of hydrologic and energy cycles.	Successfully conducted in 8/94
9/94-10/94; 6/95-7/95	Sampling of Coherent Structures with the 915-MHz Profiler	R. Coulter (ANL)	R. Cederwall	Fluctuations in the vertical wind and index of refraction were observed by operating the 915-MHz profiler with RASS in a special mode during the afternoon hours to sample convective plume structures.	Completed
4/95-5/95	Simultaneous Ground-Based, Airborne, and Satellite-Borne Microwave Radiometric and *In Situ* Observations of Cloud Optical Properties and Surface Emissivities	W. Wiscombe (NASA-GSFC); E. Westwater (NOAA-ETL)	D. Slater	Observations of cloud optical properties were obtained over the CART site simultaneously from ground-based, *in situ*, and satellite-borne sensors; spatial variability of surface emissivities was assessed to attempt retrieval of total precipitable water and cloud liquid water from the special sensor microwave imager.	Completed; involved collaboration between Wiscombe and L. Fedor at NOAA
4/95-5/95	VORTEX-ARM	E. Westwater (NOAA-WPL); W. Wiscombe (NASA-GSFC); G. Stephens and P. Gabriel (CSU); J. Schneider (CIMMS/NSSL)	D. Slater	A joint VORTEX-ARM proposal was approved for 45 h of P-3 aircraft time to study stratocumulus clouds. Work was coordinated with Remote Cloud Sensing IOP.	Data exchange completed 12/95

TABLE 8 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
6/95-7/95	Surface Energy Exchange IOP	C. Doran (PNNL); R. Coulter (ANL); R. Stull (UBC)	R. Cederwall	Detailed observations of the temperature and moisture profiles in the PBL obtained within a radius of 75-125 km of the central facility by using airsondes and profilers to evaluate the variations of the PBL structure in relation to underlying surface fluxes.	Completed; airsonde data available as beta release from C. Doran
9/95-10/95	ARESE	Collaborative	T. Cress	The purpose was to study the anomalous absorption of solar radiation by clouds. The phenomenon was first noticed when satellite measurements of solar radiation absorbed by the surface atmosphere were compared with solar radiation measured at collocated surface sites.	Completed; data are available
2/96-6/96	Sensible Heat Flux IOP	Unspecified	R. Cederwall	This IOP is a data evaluation for sensible heat flux, comparing data from one or two scintillometers with data from EBBR and ECOR at the central facility.	Design in progress
4/96-5/96	SUCCESS	Collaborative	R. Peppler	The purpose is to determine the impact of the current and the future subsonic aircraft fleet on Earth's radiation budget and climate.	Design in progress
6/96	Atmospheric Emission Sounder Overflights	S. Clough (Atmospheric and Environmental Research, Inc.)	D. Slater	Special ozone sonde launches will support these flights.	Pending airborne platform

TABLE 8 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
6/96	MSX Satellite Overflights	Collaborative	H. Foote	The purpose is to provide ground truth support for the MSX satellite. Nine MSX sensors operate in the range of 0.12-0.9 µm. A spectral IR imaging telescope also operates.	Launched on 4/24/96; CART site flyovers on 6/17, 7/15, 8/12, and 9/9/96
6/96-7/96	CLEX IOP	G. Stephens (CSU/CIRA) J. Davis (CSU/CIRA)	R. Cederwall	Intensified satellite data collection (by CSU), airborne cloud radar and *in situ* microphysical observations, and an array of ground-based measurements will be carried out for better understanding of the nature and role of middle-level, nonprecipitating cloud systems.	Planning in progress; operation dates 6/20-7/2/96
7/96-8/96	BLX IOP	R. Stull (UBC)	R.Cederwall	Remote sensing surface fluxes with instrumentation on the University of Wyoming King Air; CASES site and NCAR mobile profiler involved; in conjuction with 7/96-8/96 SCM IOP.	Planning completed
7/96-8/96	LLJ IOP	D. Whiteman (PNNL)	R. Cederwall	The purpose is to investigate oscillations in the characteristics of the LLJ over the SGP.	Planning completed

TABLE 8 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
9/96	Water Vapor IOP	H. Revercomb (UW)	R. Peppler/ M. Splitt	First of a series of IOPs to take measurements of water vapor profiles using many instrument systems to attempt to define water vapor profile of the site in support of IRF research efforts.	Planning underway
9/96	LMS/SITAC IOP	B. Dillman (Lockheed)	Unassigned	To analyze approaches to atmospheric compensation on hyperspectral and ultraspectral image data obtained from satellite platforms.	Under discussion

[a] Affiliations: ANL, Argonne National Laboratory; CIMMS, Cooperative Institute for Mesoscale Meteorological Studies; CIRA, Cooperative Institute for Research in the Atmosphere; CSU, Colorado State University; ETL, Environmental Technology Laboratory; GSFC, Goddard Space Flight Center; NASA, National Aeronautics and Space Administration; NCAR, National Center for Atmospheric Research; NCSU, North Carolina State University; NOAA, National Oceanic and Atmospheric Administration; NSSL, National Severe Storms Laboratory; PARC, Palo Alto Research Center; PNNL, Pacific Northwest National Laboratory; PSU, Pennsylvania State University; SNL, Sandia National Laboratories; UBC, University of British Columbia: UM, University of Massachusetts; UNAVCO, University NAVSTAR Consortium; UU, University of Utah; UW, University of Wisconsin; and WPL, Wave Propagation Laboratory.

[b] Other definitions: AERI, atmospherically emitted radiance interferometer; ARESE, ARM Enhanced Shortwave Experiment; ARM, Atmospheric Radiation Measurement (Program); BLX, Boundary Layer EXperiment; CART, Cloud and Radiation Testbed; CASES, Cooperative Atmosphere-Surface Exchange Study; CLEX, Cloud Layer EXperiment; DSIT, Data and Science Integration Team; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; FDDA, four-dimensional data assimilation; GCIP, GEWEX Continental-Scale International Project; GEWEX, Global Energy and Water Cycle Experiment; GIST, GEWEX Integrated System Test; GPS, global positioning system; IDP, Instrument Development Program; IOP, intensive observation period; IR, infrared; IRF, instantaneous radiative flux; ISS, integrated sounding system; LLJ, Low-Level Jet; LMS, Lockheed Missile and Space; MSX, Midcourse Satellite Experiment; PBL, planetary boundary layer; RASS, radio acoustic sounding system; SCM, single-column model; SGP, Southern Great Plains; SITAC, Spectral Imagery Technology Applications Center; SUCCESS, Subsonic Aircraft: Contrail and Cloud Effects Special Study; UAV, unmanned aerospace vehicle; VORTEX, Verification of the Origins of Rotation in Tornadoes Experiment.

The surface component of the research will consist of a field observation campaign to provide ground truth for the aircraft and satellite observations. The ARM SGP CART site was deemed the ideal location for the surface campaign.

The goals of the investigation are threefold: (1) to develop and test methods for inferring cloud tops and especially cloud bases from satellite and supporting observations; (2) to study the role of radiative energy transfer in the overall energy budget of these clouds; and (3) to analyze the potential for increasing the forecasting skill of medium-range models by including satellite-inferred parameters of middle-level clouds in the initial data field, with the focus on nonprecipitating cloud systems. For ARM, this IOP presents a potentially fruitful opportunity for collecting cloud-radiation data.

The CIRA ground-based instrumentation to be deployed includes an MPL of Spinhirne design; Bomem MB-155 solar near-IR interferometer; Bomem MB-100 emission interferometer; Belfort ceilometer; AIR Inc. radiotheodolite at 1,680 MHz; Aerotech optical mount; a portable rawinsonde system; Barnes radiometer system; 10-channel spectral sunphotometer; four Eppley pyranometers (total solar, near IR both up and down); two Eppley pyrgeometers (upward and downward); R.M. Young wind monitor; and all-sky camera. An incomplete guest instruments list includes the Pennsylvania State University (PSU) cloud radar and the Desert Research Institute microwave mobile radiometer. The ARM CART site central facility surface instruments of interest for this IOP include the WSI, SIROS, MFRSR, MWR, SORTI, and AERI, while the NOAA wind profiler network is expected to yield useful regional information. Aircraft support will be provided by the NASA DC-8 carrying airborne cloud radars, with initial ground support from the NASA/Jet Propulsion Laboratory Airborne Cloud Profiling Radar. The DC-8 flights will be conducted at altitudes in excess of 10 km, providing broad coverage of the cloud liquid water and cloud morphology. The King Air aircraft will provide more localized radar probing and cloud liquid water/microphysical distribution measurements during coordinated flight tracks with the DC-8. Satellite data will be gathered from the geostationary orbiting Earth satellite (GOES) and the Defense Military Satellite Platform.

The Boundary Layer Experiment IOP. The Boundary Layer EXperiment (BLX) IOP will be conducted July 15-August 11, 1996, in conjunction with the summer 1996 SCM IOP. The primary driver for the BLX IOP will be the remote sensing of surface fluxes by instruments carried on the University of Wyoming King Air aircraft. The King Air will traverse four basic tracks during 15 flights totaling 60 hours. Mean and flux profiles of the lower and middle troposphere will be constructed from the measurements. Issues to be addressed by the IOP data collection include convective transport theory, definition of joint frequency distributions of lifting condensation level and buoyancy, and the relation between the top of the mixed layer and topography. Added ground support will be provided by 915-MHz wind profilers and minisodars at the Cooperative Atmosphere-Surface Exchange Study (CASES) site in Kansas and by an advanced mobile multiple-antenna profiling system provided by the National Center for Atmospheric Research (NCAR).

The Low-Level Jet IOP. The Low-Level Jet (LLJ) IOP will be conducted during the SCM IOP period and will take advantage of the frequency of radiosonde launches and the 915-MHz profiler. The goals of the LLJ IOP are to investigate oscillations in the LLJ characteristics (primarily wind speed and height of the jet max) and to compare radiosonde and wind profiler data for the lower levels of the troposphere. The 915-MHz profiler will operate in the high-resolution mode only for this IOP.

The Water Vapor IOP. The Water Vapor IOP is to be held on September 10-30, 1996, in conjunction with a concurrent unmanned aerospace vehicle (UAV) IOP, and will be the first in a series of three IOPs that will attempt to define the water vapor profile over the SGP CART central facility site to help support IRF research efforts. The primary goal of the first of these IOPs will be to determine how well water vapor can be quantified in the lowest few hundred meters, perhaps up to 1,000 m, using a wide array of instrumentation. A secondary goal will be to establish a calibration for the Raman lidar. A need has been recognized from both within and outside the ARM community to advance the state-of-the-art science for columnar water vapor measurements (both range-resolved and column-integrated), and this series of IOPs will attempt to address that critical issue.

The Lockheed Missile and Space IOP. The Lockheed Missile and Space (LMS) IOP is proposed during the same time frame as the Water Vapor IOP, but the detailed planning is still being developed. The primary goal is to analyze approaches to atmospheric compensation on hyperspectral and ultraspectral image data obtained from satellite platforms. A need exists for a uniform and consistent data set over varied climatic and vegetative types that can be used to verify atmospheric correction models. Seasonal differences are also important in understanding the wide range of atmospheric structure, moisture, and particles. Seven sites will be used to obtain a wide range of optical depth levels and air-mass types; one of the locations selected is the SGP CART site.

A core group of sensors achieving hyperspectral coverage of 0.4 μm to 14 μm will be flown on aircraft at altitudes required to produce nadir ground spatial resolutions of 1 m, 3 m, 6 m, and 20 m. A standard suite of ground signature targets would be placed at a surface location, and atmospheric truth data will be collected.

Future IOPs (i.e., beyond this six-month period) that can be identified thus far include the second in a series of Water Vapor IOPs and a Hydrology IOP. Planning for each is under discussion. While no firm season has been selected for the second Water Vapor IOP, the Hydrology IOP, a soil moisture mapping experiment at satellite temporal and spatial scales in and near the SGP CART site, is being planned for the spring of 1997.

The key remote sensing instrument will be the L-band electronically scanned thinned-array radiometer aboard a P-3 aircraft. An attempt will be made to carry out a daily soil moisture mapping of the SGP (10,000-km × 10,000-km area) over a period of one month. Crucial to the project are the extensive *in situ* observing programs of the U.S. Department of Agriculture (USDA) Micronet, the Oklahoma Mesonet (OKM), and the DOE SGP CART site. In addition, data will be validated by a gravimetric sampling program. Furthermore, a possibility of joint experiments with CASES is being explored. A three-day planning workshop is being scheduled for August 26-28, 1996, at the USDA facility located in Beltsville, Maryland. Please contact Tom Jackson for details at (202) 358-0771.

With the recent delivery of the CART Raman lidar to the SGP central facility, the originally planned suite of instruments that measure water vapor is now complete; hence the time has arrived to implement the first of the planned Water Vapor IOPs that will focus on optimizing the capabilities of CART instrumentation for characterizing atmospheric water vapor under all atmospheric conditions (clear/cloudy, day/night, etc.) from a fusion of the variety of measurements. Relevant CART instrumentation to be emphasized includes the CART Raman lidar, the 60-m tower, the central facility and boundary facility BBSSs (with boundary facility instruments brought to the central facility for the IOP), AERI, the central facility and boundary facility MWRs, the central facility and boundary facility MFRSRs, and SMOS. Special instrumentation to be utilized during at least the first of these IOPs includes the NASA/Goddard Space Flight Center (GSFC) Raman lidar (which can be operated in a tipping mode), a tethersonde, NCAR GPS, NASA/Langley lidar system, Cimel sunphotometer, UAV aircraft overflights, and available satellite information. A key sensor to be housed on the tethersonde, and perhaps at ground level and on the 60-m tower, is the chilled mirror hygrometer, a device that offers the lowest practical absolute calibration uncertainties. This sensor should provide accurate point measurements to be used to transfer calibration to the high-spatial-resolution profiling instrument, the Raman lidar, and the BBSS sondes.

The resulting water vapor profiles will allow testing of other hypotheses important to improving absolute water vapor accuracies for when a lesser, more typical array of instrumentation is available, namely, that radiation observations can be used to constrain the overall absolute calibration of both the sondes and the Raman lidar. Planning for this first Water Vapor IOP continues as of this writing.

The satellite overflights of the Midcourse Satellite Experiment (MSX) will occur at the CART site on June 17-July 15, August 12, and September 9, 1996. The satellite was launched on April 24, 1996. The plan for ARM CART site coordination is to schedule at least one "staring" experiment during the first date of each MSX operating month (listed above), when the recorders are clean. This observation may be supported by one or more "limb" scans and one or more "pushbroom" scans. The ARM ground support measurement activities were still being planned as of this writing.

5.2 Potential Collaborative Investigations

Argonne National Laboratory is developing a new research facility within the existing boundaries of the SGP CART site, to be devoted to studies of the planetary boundary layer (PBL). The Argonne Planetary Boundary Layer Facility (PBLF) will cover an area approximately 50 km × 50 km within the Walnut River watershed in Butler County, Kansas, about 50 km (30 mi) east of Wichita and near the Towanda extended facility. New techniques of observation and data fusion will be developed and used to study the nocturnal low-level wind maximum and its relation to the synoptic jet features; to develop methods for spatial integration of air-surface exchange of heat, gases, and momentum; and to study horizontal and vertical dispersion in the PBL. The initial set of instrumentation available at the PBLF will include two 915-MHz profilers with RASS, three minisodars, one lidar ceilometer, one BBSS, five surface ECOR flux stations, five soil moisture and temperature stations, and one satellite data receiver processor. One central location will house data collection equipment and instrumentation and will provide accommodations for visiting scientists. The data obtained will be provided in real time to a user community of atmospheric scientists and ecologists.

The 915-MHz profilers with RASS and the minisodars are planned for installation within the PBLF at Oxford and Whiteface, Kansas, by August 1996. In addition, a minisodar will be added to the ARM Program's Beaumont, Kansas, intermediate facility, which will be shared by and provide data streams for both the ARM Program and the PBLF.

CASES is a collaborative effort to obtain measurements over the entire Walnut River watershed (approximately 100 km × 100 km) in and around Butler County, Kansas, about 50 km (30 mi) east of Wichita. The CASES initiative will obtain measurements over a somewhat larger domain than the PBLF. CASES will include hydrologic, ecological, and atmospheric chemistry studies, in addition to PBL research.

5.3 Design of Intensive Observation Periods

The initial design of most of the special operations is in the hands of the DSIT. Prototype procedures to facilitate the design, review, and implementation processes are specified for the planning of IOPs. Examples of such plans were included in Appendices A and B of Schneider et al. (1993). Similar documents are prepared by Campaign Team leaders to facilitate interagency collaborations and by Operations Team leaders to facilitate the use of guest instruments. The SST and the site program manager assist the DSIT in the generation of plans for special operations, including the plans for newly approved QMEs, IOPs, and campaigns in the *Site Scientific Mission Plan,* and assist in the execution of special operations. With the many-month lead time necessary to schedule research aircraft, the design of special operations involving aircraft should begin more than a year before the projected operation and should be sufficiently complete to be included in collaborative proposals.

5.4 Quality Measurement Experiments

As discussed in Section 4.3, QMEs are investigations designed to enhance the ARM data quality by providing information derived from a continuous intercomparison of alternative measurements or models of observed geophysical quantities. During this six-month period, a high priority will again be given to comparisons of similar data streams from different instrument packages, a natural and obvious complement to the efforts of the instrument mentors. A number of QMEs developed by instrument mentors, the SST, or the DSIT will be conducted by employing routine observations.

Examples of QMEs include the ongoing comparisons of (1) the AERI spectral radiances with the values calculated via the line-by-line radiative transfer model (LBLRTM) and (2) the integrated columnar water vapor measured by the MWR with that calculated from the vertical integration of water vapor estimates from the BBSS and Raman lidar. Prospective QMEs include comparison of (1) water vapor profiles retrieved from the MWR with the BBSS and Raman lidar moisture profiles; (2) the brightness temperatures observed by the MWR with values calculated by using the LBLRTM at the specific wave numbers at which the MWR operates; (3) cloud base heights derived from the BLC, MPL, and Raman lidar with cloud base heights derived from other cloud radars as available; (4) the observed to calculated broadband radiative surface fluxes; (5) virtual temperature and velocity profiles from the BBSS with data from the 915- and 50-MHz profilers and Raman lidar; (6) temperature, humidity, and pressure measurements from the SMOSs with those from the 25-m and 60-m levels on the 60-m tower and the EBBR system; and (7) momentum, heat, and moisture fluxes derived from the EBBR with those from ECOR systems. Many such studies under consideration would help to evaluate the vendor-specified operating ranges, as well as the precision and accuracy of the CART instruments.

5.5 Value-Added Products

The VAPs Working Group provides a mechanism for generating scientifically useful data sets (including products from QMEs) of geophysical quantities that are important to the ARM Program, including the SGP site. Value-added products are second-generation data streams derived by applying algorithms to existing data streams. The VAPs Working Group is composed of scientists from the DSIT, IT, and SST. The group is dedicated to data quality issues. Its tasks are to prioritize the creation of products focused on key geophysical quantities and to facilitate the implementation of procedures to generate such products. The results of these efforts, including the results of QMEs, will have both short- and long-term effects on the ARM data stream and on site management, including advisories to the Science Team concerning data quality, modifications in strategies for data acquisition, and reassessments of measurement algorithms. The most important and unique of the instrument comparisons will be distributed as internal ARM reports and submitted for publication in appropriate peer-reviewed journals.

5.6 Geophysically Significant Phenomena

The ARM Program has transitioned toward the GVFA, a focus on the study of geophysically significant phenomena (e.g., water vapor profiles, aerosols, clouds, temperature profiles, and radiation). Algorithm development that describes these phenomena is a current primary focus.

The algorithm products represent a merging of appropriate instrument measurements into a cohesive product defining a particular geophysical state, for use by the Science Team. These products specifically address problems posed in the *Science Plan* and by various working groups. A product currently under discussion is one prescribing water vapor over the SGP CART site sought by the IRF Working Group. As noted above, such an effort will involve three IOPs obtaining multiple water vapor measurements at the central facility (e.g., additional measurements on the 60-m tower; use of a tethersonde system; use of guest instruments and additional instruments, such as chilled mirrors and frost-point hygrometers) and comparison of these measurements with routine BBSS, Raman lidar, MWR, and 915- and 50-MHz RASS water vapor profiles. The end result of such comparisons will be the generation of an ensemble, site-representative water vapor profile for use in GCMs. The first such Water Vapor IOP will occur in September 1996.

5.7 Campaign Planning

Table 9 summarizes potential campaigns and cooperative projects that have been called to the attention of CART site management. Plans for these activities are in various stages of development, and the topics are listed briefly in Table 9 to generate further discussion. Inclusion in this list does not imply any endorsement of these activities by the ARM Program.

5.8 Educational Outreach

The educational outreach program for the SGP CART site, coordinated by Dr. Ken Crawford, Director of the Oklahoma Climatological Survey (OCS), combines a range of resources available at the University of Oklahoma. Outreach efforts are focused at the precollege, undergraduate, and graduate levels. Efforts in this six-month period continue to be focused on integration of ARM and NWS data (as nearly in real time as possible) into the EARTHSTORM project, a program conducted by the OCS to integrate real-time data into classroom activities in kindergarten through grade 12 (McPherson and Crawford 1996). The EARTHSTORM project currently accesses data from the OKM, a high-density network of surface meteorological stations, and provides the data to students in real time. EARTHSTORM has created learning modules and has provided teacher workshops to enhance the use of OKM data. Extension of these activities to include SGP ARM data is now beginning to occur at a significant level. Further extension of these efforts to the Tropical Western Pacific and North Slope of Alaska ARM sites will be investigated.

TABLE 9 Collaborative Campaigns and Cooperative Activities in Progress or under Discussion

Title[a]	Proponent/Contact[b]	Projected Date
GEWEX		
GCIP	J. Leese	1995-1996
ISLSCP	P. Sellers	1995-1996
GVaP	H. Melfi	Spring 1996
GCSS	M. Moncrieff	To be determined
Soil Moisture and Temperature Profiling	J. Schneider (NSSL)	1995-1997
WB-57 Overflight IOP	J. Liljegren	As requested
Argonne PBLF	R. Coulter	1996
MSX Satellite Overflights	T. Cress	1996
SUCCESS IOP	T. Cress/D. McDoughal	1996
GBRS IOP	J. Griffin	1996
ARM UAV IOP	J. Vitko	1994-1996
University of Wyoming King Air Flights	R. Stull (UBC)	1996
CLEX IOP	J. Davis (CSU)	1996
EVAC	M. Morrissey (OU)	1996

[a] ARM, Atmospheric Radiation Measurement (Program); CLEX, Cloud Layer EXperiment; EVAC, Environmental Verification and Analysis Center; GBRS, Ground-Based Remote Sensing; GCIP, GEWEX Continental-Scale International Project; GCSS, GEWEX Cloud System Study; GEWEX, Global Energy and Water Cycle Experiment; GVaP, GEWEX Water Vapor Project; IOP, intensive observation period; ISLSCP, International Satellite Land-Surface Climatology Project; MSX, Midcourse Satellite Experiment; PBLF, Planetary Boundary Layer Facility; SUCCESS, Subsonic Aircraft: Contrail and Cloud Effects Special Study; UAV, unmanned aerospace vehicle.

[b] Affiliations: CSU, Colorado State University; NSSL, National Severe Storms Laboratory; OU, University of Oklahoma; UBC, University of British Columbia.

6 DISTRIBUTION OF DATA

Most of the data being requested are received from the SGP CART site or external data sources and are then repackaged for daily and weekly distribution to individual users. In some cases, users can log into the Experiment Center and extract data by anonymous file transfer protocol (FTP). The Experiment Center has developed a method to track the progress of data streams. This method is summarized on the World Wide Web (http://www.arm.gov/stdocs/dst) in a table that has been partially reproduced in Table 10. The information provided includes the name of the instrument base or the source of the external data set, the name of the data stream, the status of data availability, whether the individual data stream is ingested, the number of people who have requested the data, and the person responsible for releasing the data and periodically checking the data stream quality. A yes (Y) in the "Ingested" column means that data streams are available, that an ingestion program has been written for the data stream, and that the data are of sufficient quality to be releasable.

The status of data streams from CART instruments or external sources has been classified as releasable (released upon request for the data stream), developmental (released only to SDS personnel for development of ingestion programs), under evaluation (released to an investigator for an initial data quality check), beta release (for releasable data of known and reasonable quality), collecting (when raw data are being collected for future processing and distribution), mentor only (when the data stream is provided only to the instrument mentor at the request of the mentor), analysis (if the data stream is released for further processing and/or analysis, such as for graphic display), or defunct (due to replacement of a prototype instrument data stream with the CART instrument data stream).

The Web site discussed above includes further information about the dates and status of ingestion software development, when data streams were first released, and when data streams were last reviewed by the person responsible for the data stream quality.

TABLE 10 Data Stream Availability as of June 30, 1996

Base[a]	Data Stream	Avail-ability[b]	Ingested[c]	Requests	Quality Contact
Currently Operating Platforms					
ABRFC	sgpabrfcpcpX1.c1	R	Y	6	Cederwall
AERI	sgpaeri01ch1C1.a1	R	Y	19	Flynn
AERI	sgpaeri01ch2C1.a1	R	Y	19	Flynn
AERI	sgpaeri01engineerC1.a1	R	Y	6	Flynn
AERI	sgpaeri01summaryC1.a1	R	Y	22	Flynn
AERI	sgpaeriprofC1.c1	E	Y	3	Turner
AERI	sgpqmeaeriprofC1.c1	E	Y	2	Turner
AERI/LBL	sgpaerilblcloudsC1.c1	E	Y	8	Turner
AERI/LBL	sgpaerilbldiffC1.c1	E	Y	16	Turner
AERI/LBL	sgpqmeaerilblC1.c1	E	Y	14	Turner
AERI/LBL	sgpqmeaerimeansC1.c1	E	Y	19	Turner
AERI/LBL	spglblcloudech1C1.c0	D	N	0	Shippert
AERI/LBL	sgplblcloudech1C1.c1	D	N	0	Shippert
AERI/LBL	sgplblcloudech2C1.c0	D	N	0	Shippert
AERI/LBL	sgplblcloudech2C1.c1	D	N	0	Shippert
AOS	sgpaosC1.a1	D	N	0	Leifer
AVHRR	sgpavhrr12radX1.a1	R	Y	2	Minnett
AVHRR	sgpavhrr12X1.a1	R	Y	4	Minnett
AVHRR	sgpavhrr14radX1.a1	R	Y	1	Minnett
AVHRR	sgpavhrr14X1.a1	R	Y	4	Minnett
BLC	sgpblcC1.a1	R	Y	68	Flynn
BSRN	sgpbsrnC1.a1	R	Y	65	Wesely
CASH	sgp07mcashX1.a1	D	N	0	Leach
EBBR	sgp30ebbrE12.a1	B	Y	33	Cook
EBBR	sgp30ebbrE13.a1	R	Y	41	Cook
EBBR	sgp30ebbrE15.a1	R	Y	34	Cook
EBBR	sgp30ebbrE20.a1	R	Y	34	Cook
EBBR	sgp30ebbrE22.a1	B	Y	34	Cook
EBBR	sgp30ebbrE26.a1	B	Y	33	Cook
EBBR	sgp30ebbrE4.a1	B	Y	34	Cook
EBBR	sgp30ebbrE7.a1	R	Y	34	Cook
EBBR	sgp30ebbrE8.a1	B	Y	34	Cook
EBBR	sgp30ebbrE9.a1	R	Y	34	Cook
EBBR	sgp5ebbrE*.a1	B/R	Y	0	Cook
EBBR	sgp15ebbrE*.a0	B/R	Y	0	Cook
ECOR	sgp30ecorE*.a1	D	N	8	Hart

TABLE 10 (Cont.)

Base[a]	Data Stream	Avail-ability[b]	Ingested[c]	Requests	Quality Contact
Currently Operating Platforms (Cont.)					
ETA	sgpalleta90X1.00	R	—[d]	0	Cederwall
ETA	sgpalleta90X1.c1	D	N	4	Cederwall
ETA	sgpeta90X1.c1	D	N	6	Cederwall
ETA	sgpetaderivX1.c1	D	N	5	Cederwall
GOES	sgpgoes8visX1.a1	R	Y	6	Minnett
GOES	sgpgoes8visX1.a1	R	Y	4	Minnett
GOES	sgpgoes8minnisX1.c1	—	—	—	Minnett
GOES	sgpgoes8minnis_acfX1.c1	—	—	—	Minnett
KSU	sgp1440ksumesoX1.a1	R	Y	12	Cederwall
KSU	sgp60ksumesoX1.a1	R	Y	13	Cederwall
LBL	sgplblcrC1.c0	D	N	0	Shippert
LBL	sgplblcrC1.c1	D	N	0	Shippert
LBL	sgplblch1C1.c0	E	Y	17	Shippert
LBL	sgplblch1C1.c1	E	Y	17	Shippert
LBL	sgplblch2C1.c0	E	Y	18	Shippert
LBL	sgplblch2C1.c1	E	Y	17	Shippert
MFR	sgpmfr10mC1.a1	R	Y	22	Barnard
MFR	sgpmfr25mC1.a1	R	Y	17	Barnard
MFRSR	sgpmfrsrN1.a0	M	Y	14	Barnard
MMCR	sgpmmcrC1*.a1	D	N	0	Widner
MPL	sgpmplC1.00	M	—	4	Flynn
MPL	sgpmplC1.a0	R	Y	21	Flynn
MWR	sgp1mwravgC1.c1	R	Y	2	Liljegren
MWR	sgp5mwravgB1.c1	R	Y	27	Liljegren
MWR	sgp5mwravgB4.c1	R	Y	27	Liljegren
MWR	sgp5mwravgB5.c1	R	Y	27	Liljegren
MWR	sgp5mwravgB6.c1	R	Y	18	Liljegren
MWR	sgp5mwravgC1.c1	R	Y	69	Liljegren
MWR	sgpmwrcalC1.c0	A	N	0	Liljegren
MWR	sgpmwrirtC1.a1	D	N	0	Liljegren
MWR	sgpmwrlosB1.a0	M	Y	2	Liljegren
MWR	sgpmwrlosB1.a1	R	Y	21	Liljegren
MWR	sgpmwrlosB4.a0	M	Y	2	Liljegren
MWR	sgpmwrlosB4.a1	R	Y	21	Liljegren
MWR	sgpmwrlosB5.a0	M	Y	2	Liljegren
MWR	sgpmwrlosB5.a1	R	Y	21	Liljegren
MWR	sgpmwrlosB6.a0	M	Y	2	Liljegren
MWR	sgpmwrlosB6.a1	R	Y	13	Liljegren
MWR	sgpmwrlosC1.a0	M	Y	2	Liljegren
MWR	sgpmwrlosC1.a1	R	Y	53	Liljegren

TABLE 10 (Cont.)

Base[a]	Data Stream	Avail-ability[b]	Ingested[c]	Requests	Quality Contact
Currently Operating Platforms (Cont.)					
MWR	sgpmwrprofC1.c1	R	Y	27	Turner
MWR	sgpmwrtipB1.a0	M	Y	5	Liljegren
MWR	sgpmwrtipB4.a0	M	Y	5	Liljegren
MWR	sgpmwrtipB5.a0	M	Y	5	Liljegren
MWR	sgpmwrtipB6.a0	M	Y	2	Liljegren
MWR	sgpmwrtipC1.a0	M	Y	1	Liljegren
MWR	sgpqmemwrprofC1.c1	R	Y	2	Turner
MWR/LBL	sgpmwrlblC1.c0	E	Y	2	Shippert
MWR/LBL	sgpqmemwrlblC1.c1	E	Y	3	Shippert
MWR/sonde	sgpqmemwrcolB1.c1	R	Y	7	Turner
MWR/sonde	sgpqmemwrcolB4.c1	R	Y	7	Turner
MWR/sonde	sgpqmemwrcolB5.c1	R	Y	7	Turner
MWR/sonde	sgpqmemwrcolB6.c1	R	Y	6	Turner
MWR/sonde	sgpqmemwrcolC1.c1	R	Y	22	Turner
NWS	sgp06snwsupaX1.00	R	—	0	Tichler
NWS	sgp06snwsupaX1.a1	A	N	0	Tichler
NWS	sgp60nwssurfX1.a1	R	Y	1	Cederwall
NWS	sgpnwssurfX1.00	R	—	5	Cederwall
NWS	sgpnwsupaX1.00	R	—	5	Cederwall
OKM	sgp05okmX1.a1	R	Y	30	Cederwall
OKM	sgp15okmX1.a1	R	Y	11	Cederwall
Raman	sgpr1C1.a0	D	N	1	Turner
Raman	sgprlprofC1.c1	D	N	0	Turner
Reference	refMLSspecmapX1.c1	R	—	11	Turner
RUC	sgpf00allruc60X1.00	R	—	0	Cederwall
RUC	sgpf00allruc60X1.c1	A	N	0	Cederwall
RUC	sgpallruc60X1.00	R	—	0	Cederwall
RUC	sgpallruc60X1.c1	A	N	0	Cederwall
RWP	sgp50rwptempC1.a1	R	Y	7	Coulter
RWP	sgp50rwptempC1.a2	R	Y	22	Coulter
RWP	sgp50rwpwindC1.b1	R	Y	3	Coulter
RWP	sgp50rwpwindC1.a1	R	Y	6	Coulter
RWP	sgp50rwptempC1.a2	R	Y	18	Coulter
RWP	sgp50rwptempC1.b1	R	Y	3	Coulter
RWP	sgp915rwpwindC1.a1	R	Y	12	Coulter
RWP	sgp915rwpwindC1.a2	R	Y	30	Coulter
RWP	sgprwptempC1.b1	R	Y	3	Coulter
RWP	sgp915rwpwindC1.a1	R	Y	10	Coutler
RWP	sgp915rwpwindC1.a2	R	Y	25	Coulter

TABLE 10 (Cont.)

Base[a]	Data Stream	Avail-ability[b]	Ingested[c]	Requests	Quality Contact
Currently Operating Platforms (Cont.)					
RWP	sgp915rwpwindC1.b1	R	Y	3	Coulter
RWP	sgprwptempC1.c1	R	Y	2	Turner
SIROS	sgpsirosE1.a1	B	Y	15	Barnard
SIROS	sgpsirosE10.a1	B	Y	15	Barnard
SIROS	sgpsirosE11.a1	B	Y	21	Barnard
SIROS	sgpsirosE12.a1	B	Y	15	Barnard
SIROS	sgpsirosE13.a1	B	Y	77	Barnard
SIROS	sgpsirosE15.a1	B	Y	45	Barnard
SIROS	sgpsirosE16.a1	B	Y	21	Barnard
SIROS	sgpsirosE2.a1	B	Y	15	Barnard
SIROS	sgpsirosE20.a1	B	Y	18	Barnard
SIROS	sgpsirosE22.a1	B	Y	18	Barnard
SIROS	sgpsirosE24.a1	B	Y	16	Barnard
SIROS	sgpsirosE3.a1	B	Y	15	Barnard
SIROS	sgpsirosE4.a1	B	Y	16	Barnard
SIROS	sgpsirosE6.a1	B	Y	15	Barnard
SIROS	sgpsirosE7.a1	B	Y	16	Barnard
SIROS	sgpsirosE8.a1	B	Y	20	Barnard
SIROS	sgpsirosE9.a1	B	Y	38	Barnard
SIROS	sgpsirosopdepthE13.c1	E	N	20	Barnard
SIROS	sgpsirosopdepthE15.c1	E	N	7	Barnard
SIROS	sgpsirosopdepthE9.c1	E	N	6	Barnard
Site Operations	sgpsologB1.a1	R	Y	23	Tichler
Site Operations	sgpsologB4.a1	R	Y	24	Tichler
Site Operations	sgpsologB5.a1	R	Y	24	Tichler
Site Operations	sgpsologB6.a1	R	Y	21	Tichler
Site Operations	sgpsologC1.a1	R	Y	46	Tichler
Site Operations	sgpwxlogB1.a1	R	Y	24	Tichler
Site Operations	sgpwxlogB4.a1	R	Y	25	Tichler
Site Operations	sgpwxlogB5.a1	R	Y	24	Tichler
Site Operations	sgpwxlogB6.a1	R	Y	22	Tichler
Site Operations	sgpwxlogC1.a1	R	Y	47	Tichler
Site Operations	siteopsC1.a1	A	N	0	Tichler
SMOS	sgp1smosE1.a0	R	Y	3	Hart
SMOS	sgp1smosE11.a0	R	Y	3	Hart
SMOS	sgp1smosE13.a0	R	Y	13	Hart
SMOS	sgp1smosE15.a0	R	Y	4	Hart
SMOS	sgp1smosE20.a0	R	Y	4	Hart
SMOS	sgp1smosE24.a0	R	Y	3	Hart
SMOS	sgp1smosE3.a0	R	Y	3	Hart
SMOS	sgp1smosE4.a0	R	Y	3	Hart
SMOS	sgp1smosE6.a0	R	Y	3	Hart
SMOS	sgp1smosE7.a0	R	Y	3	Hart
SMOS	sgp1smosE8.a0	R	Y	4	Hart
SMOS	sgp1smosE9.a0	R	Y	4	Hart

TABLE 10 (Cont.)

Base[a]	Data Stream	Availability[b]	Ingested[c]	Requests	Quality Contact
Currently Operating Platforms (Cont.)					
SMOS	sgp30smosE1.a1	R	Y	14	Hart
SMOS	sgp30smosE11.a1	R	Y	17	Hart
SMOS	sgp30smosE13.a1	R	Y	64	Hart
SMOS	sgp30smosE15.a1	R	Y	36	Hart
SMOS	sgp30smosE20.a1	R	Y	35	Hart
SMOS	sgp30smosE24.a1	R	Y	14	Hart
SMOS	sgp30smosE3.a1	R	Y	14	Hart
SMOS	sgp30smosE4.a1	R	Y	21	Hart
SMOS	sgp30smosE6.a1	R	Y	14	Hart
SMOS	sgp30smosE7.a1	R	Y	22	Hart
SMOS	sgp30smosE8.a1	R	Y	34	Hart
SMOS	sgp30smosE9.a1	R	Y	35	Hart
Sonde	sgpobjsondprof.c1	E	N	2	Leach
Sonde	sgpsondewndcalcB1.c1	R	Y	6	Leach
Sonde	sgpsondewndcalcB4.c1	R	Y	6	Leach
Sonde	sgpsondewndcalcB5.c1	R	Y	6	Leach
Sonde	sgpsondewndcalcB6.c1	R	Y	6	Leach
Sonde	sgpsondewndcalcC1.c1	R	Y	6	Leach
Sonde	sgpsondewrpnB1.a1	R	Y	46	Lesht
Sonde	sgpsondewrpnB4.a1	R	Y	45	Lesht
Sonde	sgpsondewrpnB5.a1	R	Y	46	Lesht
Sonde	sgpsondewrpnB6.a1	R	Y	33	Lesht
Sonde	sgpsondewrpnC1.a1	R	Y	85	Lesht
Sonde/LBL	sgplblsondeC1.c1	E	Y	3	Shippert
SORTI	sgpsortiC1.a1	D	N	0	Flynn
SWATS	sgpswatsE*.a1	D	N	0	Schneider
Tower	sgp1twr25mC1.a0	R	Y	3	Cook
Tower	sgpltw60mC1.a0	R	Y	3	Cook
Tower	sgp30twr25mC1.a1	R	Y	7	Cook
Tower	sgp30twr60mC1.a1	R	Y	7	Cook
WPDN	sgp06wpdnmmtsX1.a1	R	Y	7	Leach
WPDN	sgp06wpdnrassX1.a1	D	N	1	Leach
WPDN	sgp30wpdngpsX1.c1	R	Y	7	Liljegren
WPDN	sgp60wpdnmmtsX1.a1	S	N	1	Leach
WPDN	sgp60wpdnrassX1.a1	D	N	2	Leach
WPDN	sgp60wpdnsurfX1.b1	R	Y	7	Leach
WPDN	sgp30wpdnwndsX1.c1	R	Y	11	Leach
WSI	sgpwsicloud01C1.00	D	—	0	Thorne
WSI	sgpwsicloudC1.b1	D	N	10	Thorne
WSI	sgpwsicloudC1.c1	D	N	20	Thorne

TABLE 10 (Cont.)

Base[a]	Data Stream	Availability[b]	Ingested[c]	Requests	Quality Contact
Defunct Platforms					
AERI	sgpaerich1C1.a1	DR	N	NA[e]	Turner
AERI	sgpaerich2C1.a1	DR	N	NA	Turner
AERI	sgpaerisummaryC1.a1	DR	N	NA	Turner
AERI	sgpaerich1C1.a2	DR	N	NA	Turner
AERI	sgpaerich2C1.a2	DR	N	NA	Turner
AERI	sgpaerisummmaryC1.a2	DR	N	NA	Turner
AERI	sgpaeridqflagC1.c1	DND	N	NA	Turner
AVHRR	sgpavhrrX1.b1	DU	N	NA	Liljegren
AVHRR	sgpavhrr9radX1.a1	DU	N	NA	Minnett
AVHRR	sgpavhrr9X1.a1	DU	N	NA	Minnett
BSRN	sgpbsrncalcC1.c1	DU	N	NA	Shippert
Cess algorithm	sgp1toacessC1.c1	DU	N	NA	Shippert
GOES	sgpgoesirX1.b1	DR	N	NA	Liljegren
GOES	sgpgoesvisX1.b1	DR	N	NA	Liljegren
GOES	sgpgoes7ir8X1.a1	DR	N	NA	Minnett
GOES	sgpgoes7minnisX1.c1	DU	N	NA	Minnis
GOES	sgpgoes7minnis_acfX1.c1	DU	N	NA	Minnis
GOES	sgpgoes7rad8X1.a1	DR	N	NA	Minnett
GOES	sgpgoes7radX1.a1	DR	N	NA	Minnett
GOES	sgpgoes7visX1.a1	DR	N	NA	Minnett
KSU	sgpksudlymesoX1.b1	DNR	N	NA	Tichler
KSU	sgpksuhrlymesoX1.b1	DNR	N	NA	Tichler
MAPS	sgpmaps60derivX1.c1	DU	N	NA	Cederwall
MAPS	sgpmaps60X1.c1	DU	N	NA	Cederwall
MAPS	sgpmapsall60X1.c1	DU	N	NA	Cederwall
MPL	sgpmplcbhC1.c1	DR	N	NA	Scott
MWR	sgpmwrtipC1.a1	DU	N	NA	Liljegren
NGM	sgpngm250derivX1.c1	DU	N	NA	Cederwall
NGM	sgpngm250X1.c1	DU	N	NA	Cederwall
Sonde	sgpsondeB1.a1	DR	N	NA	Lesht
Sonde	sgpsondeB4.a1	DR	N	NA	Lesht
Sonde	sgpsondeB5.a1	DR	N	NA	Lesht
Sonde	sgpsondeB6.a1	DR	N	NA	Lesht
Sonde	sgpsondeC1.a1	DR	N	NA	Lesht
Sonde	sgpsondenogcwrpnC1.c1	DU	N	NA	Shippert

TABLE 10 (Cont.)

Base[a]	Data Stream	Availability[b]	Ingested[c]	Requests	Quality Contact
Currently Operating Platforms (Cont.)					
Tower	sgp1twr21xC1.a0	DR	N	NA	Cook
Tower	sgp30twr21xC1.a1	DR	N	NA	Cook

[a] Bases: ABRFC, Arkansas Basin Red River Forecast Center; AERI, atmospherically emitted radiance interferometer; AOS, aerosol observation system; AVHRR, advanced very-high-resolution radiometer; BLC, Belfort laser ceilometer; BSRN, Broadband Solar Radiation Network; CASH, commercial aviation sensing humidity; Cess, R. Cess, State University of New York; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; ETA, National Centers for Environmental Prediction model; GOES, geostationary orbiting Earth satellite; KSU, Kansas State University; LBL, line by line; MAPS, Mesoscale Analysis and Prediction System; MFR, multifilter radiometer; MFRSR, multifilter rotating shadowband radiometer; MMCR, millimeter cloud radar; MPL, micropulse lidar; MWR, microwave radiometer; NGM, nested grid model; NWS, National Weather Service; OKM, Oklahoma Mesonet; RUC, rapid update cycle; RWP, radar wind profiler; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station; SORTI, solar radiance transmission interferometer; SWATS, soil water and temperature system; WPDN, Wind Profiler Demonstration Network; WSI, whole-sky imager.

[b] Availability: A, analysis; B, beta release; C, collecting; D, developmental; DND, defunct, no data; DR, defunct, releasable; DU, defunct, unknown; E, evaluation; M, mentor only; R, releasable; S, suspended.

[c] Y, yes; N, no.

[d] Information unavailable.

7 LOOKING AHEAD

By December 1996, the SGP CART site will be essentially complete as originally envisaged. As such, it will be providing the full range of data streams needed to support the DSIT's algorithm development effort, which is now drawing on multiple data streams to focus strongly on geophysically significant phenomena (water vapor profiles, clouds, aerosols, temperature profiles, radiation). The operational challenges that will be of the greatest importance during 1997 and 1998 will therefore include maintaining the performance of the basic instrumentation suite at the highest possible level and enhancing the original CART design through the addition of new instruments to address evolving scientific requirements, challenges, and opportunities.

The anticipated late-1996 completion of the basic instrumentation suite and related facilities, along with the likely addition of several new instruments, is expected to significantly benefit the Science Team's pursuit of the ARM goals and objectives during 1997 and 1998. Most of the key developments are occurring at the central facility and include the achievement of the routine, unattended, continuous operation of the Raman lidar; the installation of the IDP millimeter cloud radar (MMCR); the operation of the newly constructed RCF; and the installation of several new instruments (AERI X, Cimel sunphotometer, Vaisala 75,000-ft ceilometer, sky video camera, SORTI 01, UV-B sensor, and photosynthetically active radiometer). These developments will support a more complete specification of the radiative state of the lower atmosphere, particularly if (1) the planned series of three Water Vapor IOPs (beginning in September 1996 and extending into 1997 and 1998) yields procedures to independently make accurate measurements of the water vapor distribution in the lowest kilometer of the atmosphere and (2) a counterpart temperature profiling capability is also produced.

During the Water Vapor IOPs, the tropospheric water vapor profile will be intensively quantified, especially in the lowest kilometer, by using a full range of state-of-the-science instrumentation including a second Raman lidar, multiple MWRs, BBSSs, a tethersonde system, additional sensors on the 60-m tower at the 25-m level, and fixed-sensor temperature, relative humidity, and surface pressure measurements near the BBSS launch point. The first of these IOPs will focus on the atmosphere's lowest few hundred meters in particular, and its results will be used to guide the development of the envisaged two follow-up IOPs during 1997 and 1998. The temperature and humidity profiles that have recently begun to be routinely generated by the

AERI instrumentation at the central facility will also contribute to the needed enhanced specification of the lower atmosphere during 1997 and 1998.

The utility of the Raman lidar in this context—to characterize the atmosphere (e.g., water vapor, clouds, aerosols) more accurately and with finer vertical resolution than is possible with the existing suite of instruments (radiosondes, MWRs)—has been strongly advocated by the IRF Workshop Reports of the last two years. The routine, unattended, continuous operations of the Raman lidar, following initial shakedowns during the past six-month period (particularly during the April 1996 IOP), is therefore eagerly anticipated, especially by IRF Science Team members. Various challenging issues pertaining to the unattended operation of the Raman lidar continue to be dealt with at the time of this writing but are expected to be resolved by December 1996. Also, the addition of the IDP millimeter cloud radar during the upcoming six months will subsequently enhance the ongoing efforts of the VAPs Working Group to improve the definition of cloud characteristics (fractional coverage, as well as base and top heights) above the central facility in coordination with key Science Team members. This cloud radar will be equipped to map the vertical extent of cloud boundaries up to a height of approximately 20 km. Measurements of vertical wind speed will be made by Doppler analysis. The system will operate in the vertically pointing position.

Additional recent and future developments of the central facility will also enhance its ability to monitor land-atmosphere interactions that contribute to cloud development and affect cloud characteristics. For example, the expected improved performance of the ECOR system there (following a spring 1996 upgrade) will permit more complete characterization of the turbulent transfers of sensible heat and moisture. Characterization of the latter may also benefit from the additional information that will accrue from the possible future uses of scintillometers to measure directly the sensible heat flux. The EBBR-based turbulent flux estimated for the central cluster is representative of the pasture conditions, whereas the direct ECOR measurements are characteristic of the wheat fields there. In addition, the delivery of the portable ECOR system in late 1996 will establish a capability to compare independent flux measurements by a single system. The aforementioned addition of instrumentation to measure photosynthetically active radiation and UV-B radiation will provide the basis for supporting probable future ecological studies capitalizing on the other ARM CART instrumentation.

By the end of 1996, the basis for the spatial integration of the turbulent and radiative fluxes over the entire SGP CART site will have been firmly established through the completion (according to their original design) of all but 1 of the 23 extended facilities. Note that the

Seminole, Oklahoma, extended facility will be completed during this six-month period (late summer or early fall 1996). The remaining extended facilities are being equipped with recently calibrated SIROS units, EBBR or ECOR systems, and SMOS. Beginning in January 1996 and extending through mid-1997, all extended facilities are being enhanced through the addition of SWATS. The SWATS data will contribute to completing the characterization of the land-atmosphere interactions that form the context for surface heat exchanges. Furthermore, approximately 40 additional identical SWATS systems will be installed at OKM sites within the SGP CART site domain during a two-year period beginning in mid-1996. These SWATS systems will be the focus of a USDA/NASA Hydrology IOP that is now being planned for mid-1997, which will also make use of satellite data and probably involve other federal agencies. The capability for monitoring land-atmosphere interactions will be further enhanced during the summer of 1996 with the establishment and operation of three ARM intermediate facilities containing 915-MHz profilers with RASS, which will be used to quantify structures and processes in the PBL. Significant scientific dividends from these substantial surface and boundary layer measurement enhancements will begin to accrue in 1997 and 1998.

The SGP CART site activities during 1997 and 1998 will also capitalize on the 1996 installation of the aerosol instrumentation and the RCF. The data from the associated suite of aerosol instruments will fill a significant gap in the specification of the radiative state of the near-surface atmosphere. The establishment of the RCF is a key element in the total quality control effort addressing the wide variety of radiometers at the central facility. Establishment of the RCF will be accompanied during the latter half of 1996 by the development and implementation of the comprehensive integrated *Calibration and Maintenance Plan* that is required as the SGP CART site moves from establishment of routine operations to the maintenance of routine operations, with inherent instrument-aging problems. The SST will continue to play a major implementation role concerning the above *Calibration and Maintenance Plan* during 1997 and 1998, when the SST will also contribute to the quality control and assurance of every expanding SGP CART data bank through the further development and use of data quality display modules and performance metrics. As noted in earlier chapters, the display modules, which plot actual data against modeled expectations, are intended for use by the site operations staff (and the SST) to aid in their efforts to perform "first-line-of-defense" near-real-time quality assurance relative to instrument operation. The performance metrics are intended to give a broader view of instrument performance and data quality over the CART site relative to how data fall within or outside of specified quality tolerances, such as range and consistency checks, and ultimately will include platform intercomparisons. Both efforts represent a major step forward toward achieving a comprehensive end-to-end quality control system for instrument performance and data.

During 1997 and 1998, the SGP CART site observational capabilities are expected to continue to benefit from ongoing interactions between the ARM Program and several other federal and state research programs having an interest in the SGP CART site. These interactions, which now particularly involve the GCIP component of GEWEX, have already resulted in the formation and functioning of a joint ARM-GCIP-ISLSCP Working Group (on which ARM is represented by J.C. Doran, R.G. Ellingson, and P.J. Lamb), the funding by GCIP of additional SGP CART radiosonde observations during August 1994, and the currently ongoing implementation of the SWATS (partially funded by GCIP) at the SGP CART site extended facilities. The Joint Working Group will be concerned not only with fostering the most cost-effective and efficient observational strategies for the SGP CART site for 1997 and subsequent years, but also with formulating the best possible scientific use of resulting data among their programs. The Joint Working Group is expected to meet twice annually in the foreseeable future, with its upcoming December 1996 focus on "Value-Added Science" being consistent with the above goal of achieving the optimum exploitation of the available data. Interactions with the OKM, which has been an important source of external data for the SGP for several years, are expected to increase with the OKM's parallel deployment of approximately 40 SWATS systems. A joint effort between the NWS and ARM will, from late 1996 onward, result in ARM radiosonde data being available to the meteorological community at large via the Global Telecommunications System.

The integration of ARM UAV operations into the SGP CART site scientific mission was initiated successfully during the April 1994 IOP, which used a small UAV (GNAT) that could ascend only to 6.7 km (about 22,000 ft). However, delays in developing, testing, and gaining operational approval for the larger UAVs needed for radiation measurements at higher elevations have precluded their subsequent use over the SGP CART site. Manned aircraft have been used, as during the ARESE IOP. The hope is that this situation will be rectified in the near future, with the deployment of the "Altus" UAV and other aircraft during the September 1996 Water Vapor IOP, and permit the valuable operation of UAV-mounted radiation and other instruments over the SGP CART site during the second half of 1996 and 1997. Such operational activities would likely occur during 1997. All UAV operations will be supported by climatological analyses by the SST of historical cloud and wind data for the SGP vicinity.

By December 1996, the scientific operation of the SGP CART site will have begun to benefit significantly from guidance provided by the SAC. This dividend is likely to grow during the following two years. The fundamental role of the SAC is to ensure that the operation of the site addresses the goals and objectives of the ARM Program (recently published in the formal *Science Plan*) to the fullest possible extent, including through successful adaptation to changing circumstances and opportunities. Such performance will ensure that the flows of data to the Science Team members are appropriate to their needs, of consistently high quality, and as continuous as possible. For example, the recent redoubling of efforts by the SST to help ensure the quality of SGP data is consistent with the strong encouragement offered by the November 1995 SAC review. Because the membership of the SAC is divided approximately equally between Science Team members and nonmembers, its guidance reflects both the inherently more parochial concerns of the Science Team members and the broader global-change perspective of the others. The recommendations from the November 1995 SAC meeting are now being acted upon by the SST and will be reflected in the scientific capability of the site during 1997 and 1998. Those recommendations included the aforementioned need for increased attention to quality assurance and quality control of the SGP instruments and data streams, the necessity of making midcourse corrections to ensure that the configuration and operation of the SGP CART site are in full consonance with the ARM *Science Plan* priorities, the desirability of converting the present document into an article for publication in the *Bulletin of the American Meteorological Society* that would publicize the scientific potential of the site, and the inauguration of an SST "Visitor Program" that would particularly involve cloud and radiation data analyses and simulations with the goal of enhancing the site's observational capabilities in those crucial areas. The recommendations from a follow-up June 1996 SAC review of the SST's research program and its interactions with the site program managers and site operations manager will be received during the next six months. Thus, from mid-1996 onward, the SAC guidance will have continuing effects on the scientific mission of the SGP CART site. This fact, coupled with the anticipated completion of the site by late 1996, should result in optimal operation of this ARM locale with respect to the goals and objectives of the overall ARM Program during 1997 and 1998.

8 REFERENCES

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APPENDIX A:

ACQUISITION AND DEPLOYMENT OF INSTRUMENTS

TABLE A.1 Status of Instrument Acquisition and Deployment on June 30, 1996[a]

Instrument	Mentor	Ordered	Delivered	Central Facility Installation/ Acceptance	Extended Facility Installation/ Acceptance	Boundary Facility Installation/ Acceptance	Comment
WSI	Thorne	Done	Done	Done	None planned	None planned	An additional WSI will be installed at an auxiliary facility in 1996.
MWR	Liljegren	Done	Done	Done	None planned	Done	—
IR thermometer	Liljegren	Done	1 unit; 2 more in 1996	2/96	None planned	None planned	For use with the MWR.
BBSS	Lesht	Done	Done	Done	None planned	Done	—
EBBR	Cook	Done	Partial	Done	10 units installed; 3 more in 1996	None planned	Instrument changeouts for calibration implemented summer 1995.
915-MHz RASS	Coulter	Done	1 unit; 3 more in 1996	Done	None planned	None planned	Additional units to be placed midway between central and boundary facilities.
50-MHz RASS	Coulter	Done	Done	Done	None planned	None planned	—
SMOS	Hart	Done	Done	Done	12 units installed; 3 more in 1996	None planned	—
BLC	Campbell	Done	Done	Done	None planned	None planned	—
MPL	Griffin	Done	Done	4/96	None planned	None planned	—
Raman lidar	Goldsmith	Done	Done	Summer 1996	None planned	None planned	—

TABLE A.1 (Cont.)

Instrument	Mentor	Ordered	Delivered	Central Facility Installation/ Acceptance	Extended Facility Installation/ Acceptance	Boundary Facility Installation/ Acceptance	Comment
Calibration facility	Stoffel	Done	4/96	5/96	None planned	None planned	—
60-m tower	Cook	Done	Done	Done	None planned	None planned	—
25-m-level temperature and relative humidity on 60-m tower	Cook	Done	1 unit; 1 more in 1996	2/96	None planned	None planned	—
ECOR	Hart, Cook	Done	Done	Done	4 installed; 8 more in summer 1996	None planned	—
SWATS	Schneider	Done	Partial	1 installed in fall 1995	7 installed in fall 1995; 15 more by spring 1997	None planned	—
Aerosols							
Manifold sample system	Leifer	Done	Done	Done	None planned	None planned	—
Ozone monitor	Leifer	Done	Done	Done	None planned	None planned	—
Optical absorption system	Leifer	Done	Done	Done	None planned	None planned	—
3-λ integrating nephelometer	Leifer	Done	Done	Done	None planned	None planned	—
1-λ integrating nephelometer	Leifer	Done	Done	Done	None planned	None planned	—

TABLE A.1 (Cont.)

Instrument	Mentor	Ordered	Delivered	Central Facility Installation/ Acceptance	Extended Facility Installation/ Acceptance	Boundary Facility Installation/ Acceptance	Comment
Optical particle counter	Leifer	Done	Done	Done	None planned	None planned	—
Condensation particle counter	Leifer	Done	Done	Done	None planned	None planned	—
Broadband Radiometers: SIROS							
MFRSR	Schmelzer, Larson	Done	Partial	Done	18 installed; 5 more in 1996	None planned	—
Broadband radiometer loaners (ARM BSRN)	DeLuisi	Done	Done	Done	None planned	None planned	QME planned to compare ARM BSRN with SIROS.
Pyranometer (ventilated)	DeLuisi	Done	Partial	Done	17 installed; 5 more in 1996	None planned	—
Pyranometer (upwelling 10 m)	DeLuisi	Done	Partial	Done	17 installed; 5 more in 1996	None planned	—
Shaded pyranometer (ventilated)	DeLuisi	Done	Partial	Done	17 installed; 5 more in 1996	None planned	SciTec trackers and shading assemblies in use.
Pyrgeometer (shaded and ventilated)	DeLuisi	Done	Partial	Done	17 installed; 5 more in 1996	None planned	SciTec trackers and shading assemblies in use.
Pyrgeometer (upwelling 10 m)	DeLuisi	Done	Partial	Done	17 installed; 5 more in 1996	None planned	—

TABLE A.1 (Cont.)

Instrument	Mentor	Ordered	Delivered	Central Facility Installation/ Acceptance	Extended Facility Installation/ Acceptance	Boundary Facility Installation/ Acceptance	Comment
Pyrheliometers (NIP)	DeLuisi	Done	Partial	Done	17 installed; 5 more in 1996	None planned	SciTec trackers and shading assemblies in use.
Other Radiometric Instruments							
UV-B sensor	DeLuisi	Done	Done	6/96	None planned	None planned	—
PAR	DeLuisi	Done	Done	6/96	None planned	None planned	—
Pyranometer for 60-m tower	DeLuisi	Done	Done	Done	None planned	None planned	—
Pyrgeometer for 60-m tower	DeLuisi	Done	Done	Done	None planned	None planned	—
UV spectrometer	IDP/SUNY Albany	IDP in progress	In progress	In progress	None planned	None planned	—
Rotating shadowband spectrometer	IDP/SUNY Albany	IDP in progress	In progress	In progress	None planned	None planned	—
AERI	Griffin, Best	In progress	Partial	Done	None planned	4 in fall 1996	First boundary facility installation to occur at Vici.
AERI X	Griffin, Murcray	No	No	Summer 1996	None planned	None planned	—
SORTI	Griffin, Murcray	In progress	Winter 1996	Winter 1996	None planned	None planned	—

TABLE A.1 (Cont.)

Instrument	Mentor	Ordered	Delivered	Central Facility Installation/ Acceptance	Extended Facility Installation/ Acceptance	Boundary Facility Installation/ Acceptance	Comment
Special IR broadband radiometer	None assigned	None	Unknown — unmet measurement	Unknown	None planned	None planned	—
MFR for upwelling at 10 m and 25 m	Schmelzer, Larson	Done	Done	Done	None planned	None planned	—

[a] AERI, atmospherically emitted radiance interferometer; ARM, Atmospheric Radiation Measurement (Program); BBSS, balloon-borne sounding system; BLC, Belfort laser ceilometer; BSRN, Broadband Solar Radiation Network; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; IDP, Instrument Development Program; IR, infrared; MFR, multifilter radiometer; MFRSR, multifilter rotating shadowband radiometer; MPL, micropulse lidar; MWR, microwave radiometer; NIP, normal-incidence pyrheliometer; PAR, photosynthetically active radiometer; QME, quality measurement experiment; RASS, radio acoustic sounding system; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station; SORTI, solar radiance transmission interferometer; SUNY, State University of New York; SWATS, soil water and temperature system; UV, ultraviolet; WSI, whole-sky imager.

TABLE A.2 Status of Radiometric Calibration Facility on June 30, 1996

Component	Mentor	Procurement Status	Delivery	Site Installation/ Acceptance	Comments
Calibration trailer (shell)	Stoffel	Done	Done	Installed	Not equipped
Reference spectroradiometer	Cannon	Done	To NREL[a]	Winter 1996	Response: 300-1,100 nm
Extended-wavelength spectroradiometer	Cannon	On hold	TBD[b]	TBD	Response: 300-3,000 nm
Site reference cavity radiometer	Stoffel	Done	To NREL	Winter 1996	NREL calibration checks, fall 1993 and fall 1994
Program reference cavity radiometer	Stoffel	Done	To NREL	Accepted	NREL calibration checks, fall 1993 and fall 1994; primary location, NREL
Site working-standard cavity radiometer	Stoffel	Done	To NREL	Winter 1996	NREL calibration checks, fall 1993 and fall 1994; window installed
Control computer for cavity radiometers	Stoffel	Done	To NREL	Winter 1996	—
Atmospheric optical calibration system/reference sunphotometer	Cannon	On hold	TBD	TBD	Part of spectral capability
Automatic solar trackers for direct and diffuse solar radiation	Stoffel	Done	To NREL	Winter 1996	—
Large solar tracker	Stoffel	On hold	TBD	TBD	For spectral measurements
Reference diffuse pyranometers	Stoffel	Done	To NREL	Winter 1996	—

TABLE A.2 (Cont.)

Component	Mentor	Procurement Status	Delivery	Site Installation/ Acceptance	Comments
Working standard pyranometers, pyrheliometers, and pyrgeometers	Stoffel	Done	Winter 1996	Winter 1996	Control and measurement radiometers; assurance units
Automatic solar trackers for pyrgeometers	Stoffel	Done	Winter 1996	Winter 1996	—
Tracker controller computer	Stoffel	Done	Winter 1996	Winter 1996	—
Power supply for trackers	Stoffel	Done	Winter 1996	Winter 1996	—
Silicon pyranometers and pyrheliometers	Stoffel	Done	To NREL	Winter 1996	—
NIST standard lamps[c]	Stoffel	Done	Done	TBD	At NREL
Controlled current source for lamps	Stoffel	On hold	TBD	TBD	Control NIST lamps
Reference blackbody cavities	Stoffel	Specifications to be written; might be fabricated at NREL	Winter 1996	TBD	—
Optical breadboard system	Stoffel	On hold	TBD	TBD	Specifications complete
Data acquisition system for solar radiometry	Stoffel	Done	Winter 1996	Winter 1996	Functional tests completed at NREL 5/95
Additional items for data acquisition for solar radiometers	Stoffel	Done	To NREL	Winter 1996	—
Blackbody circulators	Stoffel	Done	To NREL	Winter 1996	—

TABLE A.2 (Cont.)

Component	Mentor	Procurement Status	Delivery	Site Installation/ Acceptance	Comments
Master computer system	Stoffel	Specifications to be written	Winter 1996	Spring 1996	—
Inclinometer with power supply	Stoffel	Specifications to be written	Winter 1996	Spring 1996	—
Electronics test and calibration gear	Stoffel	Specifications to be written	Winter 1996	Spring 1996	—

[a] NREL, National Renewable Energy Laboratory.

[b] TBD, to be determined.

[c] NIST, National Institute of Standards and Technology.

TABLE A.3 Future and Potential Instruments[a,b]

Instrument	IDP Investigator/Mentor	Procurement	IDP Testing
Ultraviolet spectroradiometer[c]	Harrison	No	Fall 1996
Rotating shadowband spectrometer[c]	Michalsky, Harrison	No	Fall 1996
SORTI	Murcray, Griffin	Summer 1995	Winter 1996
Millimeter cloud radar	Moran/Widener	SOW, fall 1994	Fall 1996
Passive microwave water vapor profiler[c]	Unknown	Unknown	Unknown
Temperature and relative humidity at 25-m level on central facility 60-m tower	Cook	Fall 1995	Winter 1996
Ceilometers at SGP boundary facilities[c]	Unknown	Unknown	Unknown
Nondimensional vegetative index and leaf area index sensors at extended facilities[c]	Unknown	Unknown	Unknown
BBSS upgrade	Lesht	1996	1996
Zenith sky radiance (near-IR) instrument	Schmelzer	Unknown	Unknown
Optical transmissometer	Hart	Summer 1996	Late 1996
Sunphotometer at SGP central facility	Halthore	Unknown	Unknown
Valero radiometers[c]	Valero	1995	Fall 1995-1996

[a] Includes IDP instruments.

[b] Abbreviations: BBSS, balloon-borne sounding system; IDP, Instrument Development Program; IR, infrared; SGP, Southern Great Plains; SORTI, solar radiance transmission interferometer; SOW, statement of work.

[c] Potential candidate.

APPENDIX B:

OBSERVATIONS, MEASUREMENTS,

AND EXTERNAL DATA

TABLE B.1 CART Observation Status on June 30, 1996[a,b]

Observation	Platform
From the AERI	
Wave number (520-1800 cm^{-1})	sgpaeri01ch1C1.al
Mean IR radiance spectra ensemble	sgpaeri01ch1C1.al
Standard deviation of spectra ensemble	sgpaeri01ch1C1.a1
Wave number (1800-3020 cm^{-1})	sgpaeri01ch2C1.a1
Mean IR radiance spectra ensemble	sgpaeri01ch2C1.al
Standard deviation of spectra ensemble	sgpaeri01ch2C1.al
Mean IR radiance at 675-680, 700-705, 985-990, 2295-2300, 2282-2287, and 2510-2515 cm^{-1}	sgpaeri01summaryC1.al
Standard deviation of the radiance at 675-680, 700-705, 985-990, 2295-2300, 2282-2287, and 2510-2515 cm^{-1}	sgpaeri01summaryC1.al
Brightness temperature at 675-680, 700-705, 985-990, 2295-2300, 2282-2287, and 2510-2515 cm^{-1}	sgpaeri01summaryC1.al
From the BBSS	
Sonde temperature profile	sgpsondewrpn*.al
Sonde relative humidity profile	sgpsondewrpn*.al
Sonde pressure profile	sgpsondewrpn*.al
Sonde wind speed profile	sgpsondewrpn*.al
Sonde wind direction profile	sgpsondewrpn*.al
From the BLC	
Cloud base height at three levels	sgpblcC1.c1
Fron the BSRN	
Direct beam-normal solar radiance	sgpbsrnC1.a1
Downwelling hemispheric diffuse solar radiance	sgpbsrnC1.a1
Downwelling hemispheric solar irradiance	sgpbsrnC1.a1
Downwelling hemispheric IR radiance	sgpbsrnC1.a1
From the EBBR (at 10 Sites)	
Sensible heat flux to surface	sgp30ebbrE*.al
Latent heat flux to surface	sgp30ebbrE*.al
Net radiation flux to surface	sgp30ebbrE*.al
Soil heat flux to surface	sgp30ebbrE*.al
Top and bottom temperatures	sgp30ebbrE*.al
Top and bottom relative humidities	sgp30ebbrE*.al
Top and bottom vapor pressures	sgp30ebbrE*.al
Atmospheric pressure	sgp30ebbrE*.al
Soil moistures at five points	sgp30ebbrE*.al
Soil temperatures at five points	sgp30ebbrE*.al
Soil heat flow at five points	sgp30ebbrE*.al
Soil heat capacity at five points	sgp30ebbrE*.al
Scalar and resultant wind speeds	sgp30ebbrE*.al
Mean and standard deviation of wind direction	sgp30ebbrE*.al

TABLE B.1 (Cont.)

Observation	Platform
From the MFR	
10-m upwelling hemispheric irradiance (414, 500, 609, 665, 860, and 938 nm)	sgpmfr10mC1.a1
10-m upwelling broadband hemispheric irradiance	sgpmfr10mC1.a1
25-m upwelling hemispheric irradiance (414, 500, 609, 861, and 938 nm)	sgpmfr25mC1.a1
25-m upwelling broadband hemispheric irradiance	sgpmfr25mC1.a1
25-m upwelling longwave hemispheric irradiance	sgpmfr25mC1.a1
25-m upwelling shortwave hemispheric irradiance	sgpmfr25mC1.a1
From the MPL	
Cloud base height	sgpmplC1.a0
From the MWR (5 at CF and BFs)	
Column-integrated precipitable water vapor	sgpmwrlos*.al
Column-integrated liquid water path	sgpmwrlos*.al
23.8-GHz brightness temperature	sgpmwrlos*.al
31.4-GHz brightness temperature	sgpmwrlos*.al
IR (9.7-11.6 μm) sky temperature	sgpmwrlos*.al
From the Profiling Radars	
915-MHz wind speed profile	sgp915rwpwindC1.b1
915-MHz wind direction profile	sgp915rwpwindC1.b1
915-MHz virtual temperature profile	sgp915rwptempC1.b1
50-MHz wind speed profile	sgp50rwpwindC1.b1
50-MHz wind direction profile	sgp50rwpwindC1.b1
50-MHz virtual temperature profile	sgp50rwptempC1.b1
From the SMOS (at 12 EFs)	
Mean and standard deviation of wind speed	sgp30smosE*.al
Mean and standard deviation of wind direction	sgp30smosE*al
Vector-averaged wind speed	sgp30smosE*.al
Mean and standard deviation of temperature	sgp30smosE*.al
Mean and standard deviation of relative humidity	sgp30smosE*.al
Vapor pressure	sgp30smosE*.al
Mean and standard deviation of barometric pressure	sgp30smosE*.al
Snow depth	sgp30smosE4.al
Precipitation total	sgp30smosE4.al

TABLE B.1 (Cont.)

Observation	Platform
From the SIROS (at 17 EFs)	
Upwelling longwave hemispheric irradiance	sgpsirosE*.al
Downwelling longwave diffuse hemispheric irradiance	sgpsirosE*.al
Upwelling shortwave hemispheric solar irradiance	sgpsirosE*.al
Downwelling shortwave diffuse hemispheric irradiance	sgpsirosE*.al
Shortwave direct normal irradiance	sgpsirosE*.al
Hemispheric downward solar irradiance (415, 499, 608, 664, 860, and 938 nm)	sgpsirosE*.al
Hemispheric downward total solar irradiance (415, 499, 608, 664, 860, and 938 nm)	sgpsirosE*.al
Diffuse hemispheric downward solar irradiance (415, 499, 608, 664, 860, and 938 nm)	sgpsirosE*.al
Diffuse hemispheric downward total solar irradiance	sgpsirosE*.al
Direct beam-normal solar irradiance (415, 499, 608, 664, 860, and 938 nm)	sgpsirosE*.al
Direct beam-normal total solar irradiance	sgpsirosE*.al
From the Tower	
Mean and standard deviation of temperature, 25 m	sgp30twr25mC1.a1
Mean and standard deviation of relative humidity, 25 m	sgp30twr25mC1.a1
Mean and standard deviation of vapor pressure, 25 m	sgp30twr25mC1.a1
Mean and standard deviation of temperature, 60 m	sgp30twr25mC1.a1
Mean and standard deviation of relative humidity, 60 m	sgp30twr25mC1.a1
Mean and standard deviation of vapor pressure, 60 m	sgp30twr25mC1.a1

[a] AERI, atmospherically emitted radiance interferometer; BBSS, balloon-borne sounding system; BF, boundary facility; BLC, Belfort laser ceilometer; BSRN, Broadband Solar Radiation Network; CF, central facility; EBBR, energy balance Bowen ratio; EF, extended facility; IR, infrared; MFR, multifilter radiometer; MPL, micropulse lidar; MWR, microwave radiometer; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station.

[b] All the data are available.

TABLE B.2 CART-Derived Measurement Status on June 30, 1996[a,b]

Measurement	Platform
Retrieved absolute temperature profile	sgpaeriprofC1.c1
Retrieved dew point temperature profile	sgpaeriprofC1.c1
Retrieved water vapor mixing ratio profile	sgpaeriprofC1.c1
Comparisons of AERI retrieved profiles with radiosonde observation (retrieval - sonde)	sgpqmeeariprofC1.c1
Comparisons of AERI retrieved profiles with tower *in situ* measurements (retrieval - sonde)	sgpqmeeariprofC1.c1
Differences of observations and calculations of profiles (AERI retrieval - sonde)	sgpqmeaeriprofC1.c1
Integrated precipitable water vapor (from sonde)	sgpaerilblcloudsC1.c1
Cloud base height estimates (2)	sgpaerilblcloudsC1.c1
Nonclear sky flag at AERI sample times	sgpaerilblcloudsC1.c1
Differences of observations and calculation of IR radiances (AERI - LBLRTM) and supporting statistical summaries	sgpaerilbldiffC1.c1 sgpaerilblC1.c1 sgpaerimeansC1.c1
Input for LBLRTM (rundecks 550-1799 cm^{-1})	sgplblch1C1.c0
Input for LBLRTM (rundecks 1800-3020 cm^{-1})	sgplblch2C1.c0
Output of LBLRTM (IR spectral radiance 550-1799 cm^{-1})	sgplblch1C1.C1
Output of LBLRTM (IR spectral radiance 1800-3020 cm^{-1})	sgplblch2C1.C1
Average (1-min) 23.8-GHz brightness temperature (CF only)	sgp1mwravgC1.c1
Average (1-min) 31.4-GHz brightness temperature (CF only)	sgp1mwravgC1.c1
Average (1-min) column-integrated water vapor (CF only)	sgp1mwravgC1.c1
Average (1-min) column-integrated liquid water (CF only)	sgp1mwravgC1.c1
Average (1-min) IR brightness temperature (CF only)	sgp1mwravgC1.c1
Average (5-min) 23.8-GHz brightness temperature (CF and BFs)	sgp5mwravg*.c1
Average (5-min) 31.4-GHz brightness temperature (CF and BFs)	sgp5mwravg*.c1
Average (5-min) column-integrated water vapor (CF and BFs)	sgp5mwravg*.c1
Average (5-min) column-integrated liquid water (CF and BFs)	sgp5mwravg*.c1
Average (5-min) IR brightness temperature (CF and BFs)	sgp5mwravg*.c1
Retrieved absolute temperature profile	sgpmwrprofC1.c1
Retrieved water vapor density profile	sgpmwrprofC1.c1
Retrieved cloud liquid water content profile	sgpmwrprofC1.c1
Retrieved columnar water vapor	sgpmwrprofC1.c1
Retrieved columnar liquid water	sgpmwrprofC1.c1

TABLE B.2 (Cont.)

Measurement	Platform
Comparisons of MWR retrieved profiles with radiosonde observations (retrieval - sonde)	sgpqmemwrprofC1.c1
Differences of observations and calculations of profiles (MWR retrieval - sonde)	sgpqmemwrprofC1.c1
Input for LBLRTM (rundecks 23.8 and 31.4 GHz)	sgplblmwrC1.c0
Calculated 23.8-GHz brightness temperature	sgpqmemwrlblC1.c1
Calculated 31.4-GHz brightness temperature	sgpqmemwrlblC1.c1
Averaged total water vapor along path	sgpqmemwrlblC1.c1
Integrated vapor column from sonde (using MWR IPM)	sgpqmemwrcol*.c1
Integrated vapor column from sonde (direct calculation)	sgpqmemwrcol*.c1
23.8-GHz brightness temperature using sonde (MWR IPM)	sgpqmemwrcol*.c1
31.4-GHz brightness temperature using sonde (MWR IPM)	sgpqmemwrcol*.c1
Atmospheric mean radiating temperature using sonde (MWR IPM)	sgpqmemwrcol*.c1
Merged virtual temperature profile from 915- and 50-MHz RASS	sgprwptempC1.c1
Data quality profile for the virtual temperature	sgprwptempC1.c1
Calculated W to E component of wind	sgpsondewndcalc*.c1
Calculated S to N component of wind	sgpsondewndcalc*.c1
Scaled water vapor profile from the sondes to match 23-GHz line strength measured by MWR	sgplblsondeC1.c1

[a] AERI, atmospherically emitted radiance interferometer; BF, boundary facility; CF, central facility; IPM, instrument performance model; IR, infrared; LBLRTM, line-by-line radiative transfer model; MWR, microwave radiometer; RASS, radio acoustic sounding system.

[b] All the data are available.

TABLE B.3 CART External Data Status on June 30, 1996[a,b]

Measurement	Platform
From Satellites	
AVHRR channel 1 "albedo," channel 2 "albedo," channel 3 brightness temperature, channel 4 brightness temperature, channel 5 brightness temperature, satellite-solar azimuth angle, satellite zenith angle, and solar zenith angle	sgpavhrrnnX1.a1[c]
AVHRR radiances: channel 3 calibrated radiances, channel 4 calibrated radiances, and channel 5 calibrated radiances	sgpavhrrnnradX1.a1
AVHRR coastlines and rivers	avhrr_sgp.rivers
AVHRR state lines	avhrr_sgp.state_lines
AVHRR annotated latitude and longitude	avhrr_sgp.lat_lon
GOES-8[d,e] visible: visible channel "albedo," satellite-solar azimuth angle, satellite zenith angle, and solar zenith angle	sgpgoes8visX1.a1
GOES-8[f] channel 1 "albedo," channel 2 brightness temperature, channel 4 brightness temperature, channel 5 brightness temperature, satellite-solar azimuth angle, satellite zenith angle, and solar zenith angle	sgpgoes8X1.a1
GOES (4-km) coastlines and rivers	goes_ir_sgp.rivers
GOES (4-km) state lines	goes_ir_sgp.state_lines
GOES (4-km) annotated latitude and longitude	goes_ir_sgp.lat_lon
GOES (1-km) coastlines and rivers	goes_vis_sgp.rivers
GOES (1-km) state lines	goes_vis_sgp.state_lines
GOES (1-km) annotated latitude and longitude	goes_vis_sgp.lat_lon
From GOES Data	
GOES-derived products: cloud amount (low, medium, and high), visible optical depth (low, medium, and high), IR optical depth (low, medium, and high), emissivity (low, medium, and high), cloud center height (low, medium, and high), cloud top height (low, medium, and high), cloud temperature (low, medium, and high), cloud thickness (low, medium, and high), reflectance (low, medium, and high), albedo (low, medium, and high), cloud center temperature (low, medium, and high), cloud top temperature (low, medium, and high), visible optical depth standard deviation (low, medium, and high), cloud center temperature standard deviation (low, medium, and high), broadband longwave flux (clear sky and total), narrowband IR flux (clear sky and total), broadband shortwave albedo (clear sky and total), narrowband visible albedo (clear sky and total), clear temperature, clear temperature standard deviation, narrowband visible albedo standard deviation, clear visible reflectance, and solar zenith angle	sgpgoes8minnisX1.c1 (covers area at 32-42° N, with 0.5° resolution) sgpgoes8minnis_acfX1.c1 (a 3 × 3 array of 0.3 resolution pixels centered on central facility)

TABLE B.3 (Cont.)

Measurement	Platform
From the National Centers for Environmental Prediction (NCEP) RUC Model	
Gridded meteorological fields (eight daily) of height, temperature, relative humidity, and horizontal wind components, every 25 kPa from the surface to 100 kPa, covering most of North America (subsets also available)	sgpf00allruc60X1.c1
Gridded meteorological fields (eight daily) of height, temperature, relative humidity, and horizontal wind components, every 25 kPa from the surface to 100 kPa, covering most of the SGP CART site	sgpallruc60X1.c1
Derived variables from RUC data, similar to those in ngm250derived	sgpruc60derivX1.c1
From the Arkansas Basin Red River Forecast Center	
Hourly precipitation estimates for an area much larger than the SGP CART site, at 4-km resolution	sgpabrfcpcpX1.c1
From the NCEP ETA Model	
Gridded meteorological fields (four daily) of height, temperature, relative humidity, and horizontal wind components, every 50 kPa from the surface to 100 kPa, covering most of North America (subsets also available)	sgpalleta90X1.c1
Gridded meteorological fields (four daily) of height, temperature, relative humidity, and horizontal wind components, every 50 kPa from the surface to 100 kPa, covering most of the SGP CART site	sgpeta90X1.c1
Horizontally averaged values, derived from eta90 data, of surface pressure (reduced to sea level), tropopause pressure, and surface temperature	eta90derived
Slab-averaged vertical profiles, derived from eta90 data, of temperature (T), -(u*dT/dx + v*dT/dy), water vapor mixing ratio (q), -(u*dq/dx + v*dq/dy), horizontal wind components (u and v), (du/dx + dv/dy), -(u*du/dx + v*du/dy), - (u*dv/dx + v*dv/dy), and geopotential height (Z), dZ/dx, dZ/dy, d2T/dx2, d2T/dy2, d2q/dx2, d2q/dy2, d2u/dx2, d2u/dy2, d2v/dx2, d2v/dy2	eta90derived
From the NOAA Wind Profiler Demonstration Network	
Profile of hourly consensus wind components	sgp60wpdnwndsX1.b1
Profile of 6-min moments of wind components	sgp06wpdnmmtsX1.a1
Hourly surface observations	sgp60wpdnsurfX1.b1
Profile of 6-min moments of temperature components	sgp06wpdnrassX1.00
Profile of hourly consensus of temperature with RASS capability	sgp60wpdnrassX1.00
Precipitable water vapor from stations which have GPS systems	sgp30wpngps.c1

TABLE B.3 (Cont.)

Measurement	Platform
From the NWS	
Surface hourly observations	sgp60nwssurfX1.a1
Upper air observations	sgpnwsupaX1.00
Six-second resolution soundings	sgp06snwsupaX1
From the Kansas Surface Mesonetwork	
Daily observations of maximum air temperature, minimum air temperature, total precipitation, total solar radiation, maximum 5-cm soil temperature, minimum 5-cm soil temperature, maximum 10-cm soil temperature, minimum 10-cm soil temperature, average relative humidity, maximum relative humidity, minimum relative humidity, mean wind speed, resultant wind speed, resultant direction, standard deviation of direction, and maximum (fastest minute) wind speed	sgp1440ksumesoX1.a1
Hourly observations of average temperature, average relative humidity, average wind speed, average wind direction, average solar radiation, total precipitation, average 10-m temperature	sgp60ksumesoX1.a1
From the Oklahoma Mesonetwork	
Observations of air temperature, relative humidity, wind direction, wind speed, total solar radiance, total rainfall, and 5- and 10-cm soil temperatures (15-min average)	sgp15okmX0.a0
Observations of air temperature, relative humidity, wind direction, wind speed, total solar radiance, total rainfall, and 5- and 10-cm soil temperatures (5-min average)	sgp05okmX0.a0

[a] AVHRR, advanced very-high-resolution radiometer; CART, Cloud and Radiation Testbed; ETA, National Centers for Environmental Prediction model; GOES, geostationary orbiting Earth satellite; GPS, global positioning system; IR, infrared; NCEP, National Centers for Environmental Prediction; NOAA, National Oceanic and Atmospheric Administration; NWS, National Weather Service; RASS, radio acoustic sounding system; RUC, rapid update cycle; SGP, Southern Great Plains.

[b] All the data are available.

[c] The "nn" in the "avhrnn" file name is the sequence number for the NOAA satellite (e.g., NOAA-12 or NOAA-14).

[d] The GOES IR channels may vary with the schedule for use at a particular time.

[e] The resolution of these data is 1 km, and the area covered is 33.68 to 39.42°N, 95.43 to 99.43°W.

[f] The resolution of these data is 4 km, and the area covered is 24.33 to 47.26°N, 89.65 to 105.31°W.