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ACRF Instrumentation Status: New, Current, and Future

December 2007 – January 2008

Atmospheric Radiation Measurement
Climate Research Facility
U.S. Department of Energy

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Abstract

The purpose of this report is to provide a concise but comprehensive overview of Atmospheric Radiation Measurement Climate Research Facility instrumentation status. The report is divided into the following four sections: (1) new instrumentation in the process of being acquired and deployed, (2) existing instrumentation and progress on improvements or upgrades, (3) proposed future instrumentation, and (4) Small Business Innovation Research instrument development. New information is highlighted in blue text.

Acknowledgments

This report is developed largely from the information submitted to and managed within our Instrument Mentor Monthly Summary (IMMS) reporting system (http://www.db.arm.gov/IMMS/). Special thanks to our Instrument Team for providing timely and complete updates to the IMMS, to Kathy Doty, our developer and administrator of IMMS, and Rolanda Jundt, who ensures this information is posted accurately on the ARM website.

Contents

1. New Instrumentation

This section describes approved new instrument deployment and upgrade activities for the current fiscal year.

1.1 Thin-Cloud Rotating Shadowband Radiometer for Liquid Water Path, Visible Optical Depth, and Effective Radius for Thin Clouds

Andy Vogelmann and Mike Reynolds modified an existing Brookhaven National Laboratory (BNL) fast rotating shadowband radiometer (FRSR) to enable Qilong Min to apply his algorithms to retrieve liquid water path (LWP), visible optical depth (τ_{cloud}), and effective radius (r_{eff}) for thin clouds. The thin-cloud rotating shadowband radiometer (TC-RSR) will remain a BNL-owned instrument; however, the ARM Climate Research Facility (ACRF) will incur costs that cover field operation and data reduction for each field campaign deployment.

This development work is documented in EC0-00635, *Develop and Test Thin-Cloud Rotating Shadowband Radiometer (TC-RSR)*. The system is calibrated and currently undergoing final testing at RMR Co. before field-testing at the Southern Great Plains (SGP) site. Andy will submit a field campaign request when the system is ready for deployment, most likely in January 2008.

The development team is hopeful that measurement accuracies of optical depths within 2%, r_{eff} within 10%, and LWP within 2 gm^{-2} are attainable. Other field campaigns and experiments that might use this system include the ARM Mobile Facility (AMF) deployment to the Azores and with the VAMOS Ocean-Cloud-Atmosphere-Land Study (VOCALS) experiment off the coast of Chile. This instrument is well suited to study thin, oceanic clouds and marine stratus for shipboard and marine deployments.

STATUS – Development is in progress. See http://www.rmrco.com/dev/tcrsr/. An Intensive Operations Period Request (IOPR), IOPR-2007-05707, was submitted by Mary Jane Bartholomew. Upon approval, the TC-RSR will be deployed at our SGP site to evaluate performance and perform preliminary inter-comparisons with ACRF instruments. The resulting data set will be documented and archived for scientific record at our ARM Data Archive.

1.2 Infrared Sky Imager

Mentor: Vic Morris, Pacific Northwest National Laboratory

An infrared sky imager (IRSI) from Blue Sky Imaging (http://www.aas.org/career/bluesky.html) was deployed at the SGP site in September 2005 to provide nighttime cloud-cover measurements, which was documented in ECO-00429.

Problems with moisture infiltration of the imager necessitated its return to the manufacturer for repair/revision in October 2005. The unit was returned to the SGP site in late June 2006 and returned to service in August 2006. In late January 2007, SGP technicians resolved hardware problems and restored the IRSI to operation. Software modifications by the manufacturer have corrected the image mask problem, which has permitted cloud fraction to be derived from the images. In February 2007, Vic

Morris conducted a comparison of cloud fractions from the IRSI and the total sky imager (TSI). The comparisons indicate the IRSI is still not producing correct cloud fractions.

STATUS – Vic Morris has completed an inter-comparison of IRSI systems. This field campaign was approved under IOP number 2007-05673, IRSI Inter-Comparison Study, associated EWO-12214, and conducted from August 27 to September 23, 2007. Four instruments were installed during the inter-comparison; Vic is collecting the data for archival and analysis.

Instrument	Data Available
Blue Sky Imaging Ltd. (BSI) All Sky Thermal IR Camera 320C	09/02 – 10/10/2007
Solmirus All Sky IR Visible Analyzer	08/28 – 09/11/2007
Heitronics Nubiscope	08/27 – 10/05/2007
Atmos Cloud IR Radiometer 4	08/30 – 09/28/2007
Atmos Cloud IR Radiometer M	08/30 – 09/17/2007

1.3 Rotating Shadowband Spectrometer (RSS) Overhaul

Peter Kiedron demonstrated that the rotating shadowband spectrometer (RSS), built by Yankee Environmental Systems, Inc., is capable of providing valuable measurements of direct, diffuse, and global spectral irradiance. Peter also has identified problems with the RSS that affect the stability of its calibration and the linearity of its response. Peter has recommended that the RSS be removed from service and sent to him for a complete overhaul.

Engineering Change Order, ECR-00661 *RSS Refurbishment*, is approved to perform the upgrade and overhaul of the RSS. Peter Kiedron is the lead. The Working Groups and the Science Team Executive Committee (STEC) recommended the re-engineering of the RSS for implementation in FY2008.

1.4 Aerosol Particle-Sizing Spectrometer to Replace Optical Particle Counter at Southern Great Plains

John Ogren suggested replacing the aging optical particle counter (OPC) included in the SGP Aerosol Observing System with a new aerosol particle-sizing spectrometer (APS) to be integrated into the existing Tandem Differential Mobility Analyzer (TDMA).

Engineering Change Order, ECO-00640 *Replace AOS Optical Particle Counter with Aerodynamic Particle Sizing Spectrometer,* is approved and in process. The Working Groups and STEC approved the

addition of an APS in FY2008 to replace the OPC component of the TDMA. Don Collins, TDMA Instrument Mentor, has responsibility for integrating the APS with the SGP AOS.

1.5 Infrared Thermometers for the Southern Great Plains Extended Facility Sites

In FY2004, 6 infrared thermometers (IRTs) were purchased, 9 additional IRTs were purchased in FY2005. Some of these have been deployed with the AMF. There are 12 SGP extended facility sites currently equipped with IRTs; 10 additional IRTs would be needed to permit an IRT to be deployed at all 22 SGP extended facilities.

The Working Groups and STEC recommended the addition of the remaining SGP IRTs during FY2008. Please reference ECO-00345, *Install Zenith-Pointing IRT Network at SGP*. Vic Morris is the leader.

1.6 Add Scanning Capability to the W-Band ARM Cloud Radar

During the December 2007 ARM STEC meeting a scientific and programmatic consensus was reached to add a scanning capability to our SGP W-band ARM cloud radar (WACR). This enhancement to the WACR will provide an ACRF product for evaluating the 3D cloud properties first at the SGP site and then, depending on portability (or transportability) and robustness, other ACRF research sites.

Engineering Change Order, ECO-00658 *WACR–Add Scanning Capability*, is in process to plan the initial science, operational, and technical objectives of the development, leading to a procurement specification. Kevin Widener is the leader.

1.7 Oxygen A-Band Spectrometer

The A-band spectrometer is approved by the ARM STEC (December 2007) to advance our understanding of 3D radiative transfer effects and in validating broadband heating rate profiles. The objective is to simultaneously retrieve τ_{cloud} and r_{eff} for low LWP clouds. Simulations demonstrate that accuracies for,τ_{cloud}, r_{eff} , and LWP are 2%, 10%, and 2g/$m_{2,}$ respectively.

Engineering Change Request, ECR-00660, was submitted to document this proposed instrument development task. Qilong Min is the principal investigator. Unfortunately, due to funding uncertainties related to high priority instrument development and near- and far-term budget constraints, this activity was cancelled for FY2008. The ECR is tabled.

1.8 Next-Generation Microwave Radiometers

The Working Groups and the STEC have approved the competitive procurement of next-generation microwave radiometers (MWRs). The systems are specified to provide three channels operating at 23, 31, and 90 GHz. The strategy is to replace our current aging MWRs with systems that broaden our measurement performance parameters and provide an economic product life cycle for the future. A procurement specification is in development based on the November 2007 “ACRF MWR Futures” workshop outcomes.

The procurement specification is completed and has been provided to the PNNL contracting team for an open solicitation. ECR-00664, *Next Generation MWR Procurement/Deployment*, is in review for this activity. Maria Cadeddu is the leader.

1.9 Photoacoustic Spectrometer (PA)

The December STEC approved the Working Group's recommendations to deploy an instrument that provides photoacoustic (PA) extinction of aerosols. The PA instrument and associated measurements will be added to the existing ACRF AOS and the SGP. A science objective is to produce a high-quality data set to investigate the reported bias in the absorption measurements made by the particle/soot absorption photometer instruments.

Engineering Change Order, ECO-00663, is approved and in process to document this specification, procurement, and deployment. Dubey Manvendra is the leader.

2. Existing Instrumentation

This section describes activities that are ongoing to improve the performance or maintain existing instrumentation, including any planned or in-progress upgrades. The information is abstracted primarily from the Instrument Mentor Monthly Summary (IMMS) reports database (http://www.db.arm.gov/IMMS/), which can be used for a collective and historical view of instrument status. Individual IMMS reports may be reviewed by following links to specific instruments from our Instrument Webpage (http://www.arm.gov/instruments). ACRF Mentors provide updates to our IMMS under these categories;

1. Data Review
2. Instrument Performance Issues and Trends
3. Current Task Status
4. Near-Term Plans
5. Accomplishments

Information related to the progress and status of instrument engineering also is available from our Engineering Change Order (ECO) database (http://eco.arm.gov).

Helpful links to instrument related ACRF webpages are listed below:

- Instrument Systems and *Mentors* - *http://www.arm.gov/instruments/mentors.php*
- Instrument Locations - *http://www.arm.gov/instruments/location.php*
- Instrument Mentor Monthly Summaries - *http://www.db.arm.gov/IMMS/*
- Data Quality Reports - *http://www.db.arm.gov/cgi-bin/PIFCARDQR2/SignIn.pl?form=dqr*
- Data Quality Program - *http://dq.arm.gov/*.

2.1 Aerosol Observing System (AOS)

Mentor: John Ogren and Anne Jefferson, NOAA/ESRL/GMD

There are no open Engineering Tasks related to the AOS instrument suite.

2.2 Atmospherically Emitted Radiance Interferometer (AERI)

Mentor: Dave Turner, Space Science and Engineering Center, University of Wisconsin

Engineering Change Order, ECO-00286 *AERI OS Upgrade & Rapid Scanning Capability*, is complete. This ECO upgrades the AERI operating system to a current Windows version, revise hardware, drivers, and data acquisition electronics. Of primary scientific importance, the AERIs are modified to accommodate a rapid scanning capability as a part of this ECO.

2.3 Balloon-Borne Sound System (BBSS)

Mentor: Rich Coulter (with Mike Ritsche and Donna Holdridge), Argonne National Laboratory

There are no open Engineering Tasks related to the AOS instrument suite.

2.4 Broadband Radiometer Station (BRS, SIRS, SKYRAD, GNDRAD, BRSN)

Mentor: Tom Stoffel, National Renewable Energy Laboratory

Calibration, SGP/BORCAL 2007-01, has been completed. The newly calibrated radiometers will be exchanged with instruments in the field, which then will be included in SGP/BORCAL 2007-02. Broadband outdoor radiometer calibration (BORCAL) reports and reference irradiance data for all 11 years of radiometer calibrations at the SGP Radiometer Calibration Facility (RCF) are now available at http://www.nrel.gov/srrl/borcal.html.

Engineering Change Order, ECO-00559 *Pyrgeometer Calibration Improvement*, is in process. Tom Stoffel and Ibrahim Reda have initiated an investigation into the source of the bias in the ACRF pyrgeometer blackbody calibration system in accordance with ECO-00559. At blackbody temperatures less than -20°C, the Dow Corning 200 fluid viscosity increases, which inhibits mixing and results in a temperature gradient of 3°C from the base to the top of the hemispherical blackbody. A new set of fluid dispersion manifolds (perforated annuli) has been developed to reduce the temperature gradients in the blackbody. Additionally, a replacement fluid with better low temperature (viscosity) characteristics has been identified. Pyrgeometers calibrated using the new manifold and fluid will be compared with pyrgeometers having calibrations traceable to the World Infrared Standard Group (WISG) and with pyrgeometers calibrated by the NOAA Earth System Research Laboratory's Global Monitoring Division.

Reda has replaced the fluid in the pyrgeometer blackbody calibration system at the National Renewable Energy Laboratory (NREL) with a new Dow Corning fluid that offers better low-temperature performance and provides more uniform blackbody temperature control. Preliminary data suggest the

3°C temperature difference between the top of the blackbody hemisphere and the 45° elevation at -30°C is now less than 1°C. Reda continues to explore methods for confirming/correcting this lower ΔT.

Engineering Change Order, ECO-00642 R*eplace SGP/RCF BORCAL Data Acquisition and Control System,* is approved for FY2008 implementation and is in process. The data acquisition system in the RCF used for annual BORCAL activities is more than 10 years old and needs to be updated. NREL has recently replaced their BORCAL data acquisition system using internal funds. The SGP system should be a duplicate of the NREL system for software compatibility and performance assurance.

2.5 Carbon Dioxide Flux System (CO2FLX)

Mentor: Marc Fischer, Lawrence Berkeley National Laboratory

There are no open Engineering Tasks related to the CO2FLX instrument suite.

2.6 Carbon Monoxide System (CO)

Mentor: Sébastien Biraud, Lawrence Berkeley National Laboratory

There are no open Engineering Tasks related to the CO instrument suite.

2.7 Cimel Sun Photometer (CSPOT)

Mentor: None (external data provided by NASA AERONET) – Infrastructure Contact is Laurie Gregory at Brookhaven National Laboratory

There are no open Engineering Tasks related to the CSPOT instrument suite.

2.8 Disdrometer (DISDROMETER)

Mentor: Mary Jane Bartholomew, Brookhaven National Laboratory

There are no open Engineering Tasks related to the DISDROMETER instrument suite.

2.9 Eddy Correlation Station (ECOR)

Mentor: David Cook, Argonne National Laboratory

Engineering Change Order, ECO-00657 *Replace Single Board Computer in ECOR*, is in process to upgrade the computers in the ECOR instruments. Dave Cook is the leader. The computers are being upgraded due to maintenance and performance issues.

Engineering Change Request, ECO-00536 *Add Wetness Sensors to ECOR System,* is in process. Periods of dew, frost, and precipitation often cause data from the CO_2/H_2O sensor and sonic anemometer to be incorrect. Adding a wetness indication would provide the data user with a more reliable source of information concerning this condition, as indicated in ECO-00536.

Wetness sensor testing began at Argonne in mid-January on an ECOR system similar to the ACRF ECORs. Testing so far indicates that different phases of water and types of dew/frost/precipitation produce different voltage levels from the wetness sensor. Changes to the ECOR programming are underway.

Engineering Change Order, ECO-00633 *Improve Eddy Correlation Station Software,* is in process. Tim Martin, in association with David Cook, has proposed to systematically evaluate, document, and reorganize the instrument software to allow for code maintenance and more flexible incorporation of additional logic and sensors, such as the proposed wetness sensor. In addition, the user interface needs to be improved to give access to more debugging and diagnostic messages from the ECOR program.

2.10 Energy Balance Bowen Ratio Station (EBBR)

Mentor: David Cook, Argonne National Laboratory

Engineering Change Order, ECO- 00645 *Replace T/RH and PRTD Probes in EBBR with Combined T/RH/PRTD Probes*, is in process to upgrade the temperature and relative humidity sensors of our EBBR systems. These upgrades to our 14 operational systems will take place over the next 4 years, spares are included. Dave Cook is the leader.

2.11 G-Band (183.3 GHz) Water Vapor Radiometer (GVR)

Mentor: Maria Cadeddu, Argonne National Laboratory

Engineering Change Order, ECO- 00637 *Upgrade Computer for GVR* is in process to provide an updated control and user interface computer for the GVR. Maria Cadeddu is the leader.

Engineering Change Order, ECO-00653 *Deploy MP183 Radiometer at the SGP for Testing,* is in process to document the performance characteristics of this system before shipment to the North Slope of Alaska research site. Maria Cadeddu is the leader.

2.12 Infrared Thermometer (IRT)

Mentor: Vic Morris, Pacific Northwest National Laboratory

Engineering Change Order, ECO-00345 *Install Zenith-Pointing IRT Network at SGP*, is in process to establish an IRT network at the SGP research site. The remaining 10 IRT instruments are in queue for deployment the fiscal year.

Engineering Change Order, ECO-00616 *Install IRTs in Ventilated Enclosures,* is in process to update our IRT enclosures. In implementing ECO-00345 (Install Zenith-Pointing IRT Network at SGP) a HEPA filtered ventilated enclosure for the IRTs was designed that keeps debris, and incidentally most rain, off the gold mirror and IRT lens. This enhancement is being implemented on TWP and NSA IRT instruments.

2.13 Micropulse Lidar (MPL)

Mentor: Rich Coulter, Argonne National Laboratory

Engineering Work Order, EWO 12257 *Upgrade MPL Operating System*, is created to document the upgrade to the MPL operating system in collaboration with the MPL vendor, Sigma Space, to improve operational stability.

2.14 Microwave Radiometer (MWR)

Mentor: Maria Cadeddu, Argonne National Laboratory

The Working Groups and the STEC have approved the competitive procurement of next-generation microwave radiometers (MWRs). The systems are specified to provide three channels operating at 23, 31, and 90 GHz. The strategy is to replace our current aging MWRs with systems that broaden our measurement performance parameters and provide an economic product life cycle for the future. A procurement specification is in development based on the November 2007 "ACRF MWR Futures" workshop outcomes.

The procurement specification is completed and has been provided to the PNNL contracting team for an open solicitation. ECR-00664 *Next Generation MWR Procurement/Deployment*, is in review for this activity. Maria Cadeddu is the leader.

2.15 High-Frequency Microwave Radiometer (MWRHF)

Mentor: Maria Cadeddu, Argonne National Laboratory

Engineering Change Order, ECO-00641 *Order and Install MWRHF Heater Modules,* is in process to update the heater modules on the radiometer blowers. Maria Cadeddu is the leader.

NOTE: The two high-frequency microwave radiometers (MWRHFs) are new instruments that are still under testing.

2.16 Microwave Radiometer Profiler (MWRP)

Mentor: Maria Cadeddu, Argonne National Laboratory

There are no open Engineering Tasks related to the MWRP Instrument suite.

2.17 Millimeter Wave Cloud Radar (35 GHz) (MMCR)

Mentor: Kevin Widener, Pacific Northwest National Laboratory; Karen Johnson, Brookhaven National Laboratory

Engineering Change Order, ECO-00610 *MMCR Digital Transceiver Upgrade*, is on hold (Waiting). Costs for the upgrade are substantially more than originally budgeted. MMCR upgrades are on hold pending recommendation to resume by the STEC. The main focus of the millimeter wave cloud radar (MMCR)

digital receiver upgrade is to develop a completely digital transceiver. This will provide new capabilities such as increased sensitivity using advanced modulation techniques and an up-to-date computing platform that will be supportable for a minimum of five years. Another significant improvement will be to provide for more robust calibration, health monitoring, and automatic notification of anomalies. The plan is to accomplish this upgrade in the following phases: (1) evaluation and design, (2) development and integration, and (3) testing, documentation, and training. Costs for the upgrade are substantially more than originally budgeted.

Engineering Change Order, ECO-00552 *Barrow MMCR-Polarization Upgrade,* is on hold (Waiting). Because the PIRAQ-III processor does not support polarization, the installation of the orthomode transducer at Barrow is on hold until the next processor upgrade. This ECO will be on a hold status until the next processor upgrade to the Barrow MMCR, as tasked under ECO-00610 *MMCR Digital Transceiver Upgrade.*

Engineering Change Order, ECO-00629 *MWR Field Support Kit*, was recommended by the Cloud Properties Working Group and approved to assure radar parts are available to prevent operational downtime. Also, new traveling wave tubes (TWTs) will be ordered to replace the TWTs originally delivered with the MMCRs, which are well beyond their rated lifetime and are beginning to fail. This is documented in ECO-00425.

One Coherent Up-Down Counter is in the procurement queue for FY2008, along with two TWTs, two Antennas, and a spare PIRAC board. Our FY2009 procurement plan includes three additional TWTs and two antennas. Radar data availability and quality are high priorities of the Working Groups.

Engineering Change Order, ECO-00655 *MMCR - End-to-End Calibration Analysis* is in process to provide a calibration study of the ACRF MMCR systems was recommended and approved by the STEC for FY2008. A contract will be awarded to perform an end-to-end characterization of the MMCR transmitter/receiver calibration.

Engineering Change Order, ECO-00391 *Millimeter Wave Cloud Radar Spectra Processing*, is in process to filter the spectra files produced by the upgraded MMCRs (C40 or PIRAQ-III processors) which range from 8 to 15 GB per day. Algorithms for eliminating clear-sky periods and compressing the files need to be developed and implemented locally.

The data are collected, processed, and shipped hourly. The MMCR spectra compression software has been running at the SGP site since October 1, 2007. BCR-01301 tracks this effort. The compression results are monitored via plots posted at:

http://c1.dmf.arm.gov/data/process/sgp/sgpmmcrspecmaskC1.a0/2007/.

Overall, the results look very good. There is concern that spectra for some very thin potential clouds are being removed. Approaches to identify these features and retain the spectra at such time-height points without saving very large hydrometeor-free regions of data are under evaluation. All raw (uncompressed) spectra data are being retained for 90 days to allow time to review the compression results. Discussion is ongoing to determine when the shipping of spectra on hard drives will be halted.

Engineering Change Order, ECO-00551 *Refurbish Millimeter Wave Cloud Radar Antennas,* was begun in 2007, and over a three-year period, the MMCR antennas will be refurbished and characterized on an antenna range. The spare antenna is complete and the contract for the new feed and sub-reflector has been placed. Once these are complete, they will be installed on the antenna reflector and calibrated. The Barrow MMCR antenna will be refurbished first to avoid impacting planned field campaigns at SGP.

2.18 Multi-Filter Rotating Shadowband Radiometer and Related Systems (MFRSR, MFR)

Mentor: Gary Hodges, NOAA/ESRL/GM Division

Engineering Change Request, ECO-00350 *MFRSR Integrating of Campbell Data Logger,* is in process to modernize the data acquisition systems for our MFRSR instrument.

2.19 Narrow Field-of-View Radiometer (NFOV)

Mentor: Gary Hodges, NOAA/ESRL/GMD

Engineering Change Order, ECO-00621 *Deploy an Optical Range Gauge at the SGP Central Facility*, is in process

2.20 Optical Rain Gauge (ORG)

Mentor: Mary Jane Bartholomew, Brookhaven National Laboratory

Engineering Change Order, ECO-00621 *Deploy an Optical Range Gauge at the SGP Central Facility*, is in process. Mike Ritsche is the leader, working with Mary Jane Bartholomew, to wrap up the final documentation and installation details.

2.21 Precision Carbon Dioxide Mixing Ration System (PGS)

Mentor: Sebastien Biraud, Berkley National Laboratory

There are no open Engineering Tasks related to the PGS instrument suite.

2.22 Radar Wind Profiler – 915, 1290 MHz (RWP)

Mentor: Rich Coulter, Argonne National Laboratory

Engineering Change Order, ECO-00567 *Upgrade CF and 13 RWPs with Digital Receivers*, is in process to upgrade the ACRF RWP receivers.

2.23 Radar Wind Profiler – 50 MHz (RWP)

Mentor: Rich Coulter, Argonne National Laboratory

Engineering Change Order, ECR-00662 *50-MHz Wind Profiler Decommissioning*, is submitted to begin the process of removing this radar wind profiler. This recommendation was generated by the ARM Sunset

Committee, which is chaired by the ARM Chief Scientist. This aging system has experienced maintenance and performance conditions that are too expensive given the science utility of the corresponding data set.

2.24 Raman Lidar (RL)

Mentor: Rob Newsom, Pacific Northwest National Laboratory

There are no open Engineering Tasks related to the RL instrument suite.

2.25 Rotating Shadowband Spectrometer (RSS)

Mentor: Peter Kiedron, NOAA/ESRL/GMD

Peter Kiedron demonstrated that the rotating shadowband spectrometer (RSS), built by Yankee Environmental Systems, Inc., is capable of providing valuable measurements of direct, diffuse, and global spectral irradiance. Peter has also identified problems with the RSS that affect the stability of its calibration and the linearity of its response. Peter has recommended that the RSS be removed from service and sent to him for a complete overhaul.

An Engineering Change Request (ECR), ECR-00661, was submitted and approved to perform the upgrade and overhaul of the RSS. Peter Kiedron is the lead. The Working Groups and the Science Team Executive Committee (STEC) recommended the re-engineering of the RSS for implementation in FY2008.

2.26 Shortwave Spectrometer (SWS)

Mentor: Scott Kittelman, University of Colorado

There are no open Engineering Tasks related to the SWS instrument suite.

2.27 Soil Water and Temperature System (SWATS)

Mentor: John Harris, University of Oklahoma

The soil water and temperature system (SWATS), deployed at the SGP site, is designed to provide information about the temperature of the soil and the status of water in the soil profile. Because the SWATS array is aging, the sensor arrays are undergoing a replacement program.

Engineering Change Order, ECO-00493 *Replace Failing SWATS Sensors*, is in process to add new redundant sensor arrays that will be installed at all SGP extended facility sites. These will be installed in a phased manner: five sites per year over four years, beginning in 2005 with the sites having multiple failed sensors given highest priority. After the soil recovers from the installation process in 6-12 months, the new sensor array will be connected to the existing SWATS data acquisition system in place of the old sensor array.

2.28 Surface Meteorological Instrumentation

Mentor: Mike Ritsche, Argonne National Laboratory (SMET, SMOS, SURTHREF, THWAPS, MET, METTWR [NSA Site])

Engineering Change Order, ECO-00595 *Upgrade T/RH Probes and Wind Sensors for NSA Met System.*

Ice develops on the wind vanes, cup anemometers, and aspirator inlets for the temperature and RH sensors, which clog and affect the data quality. To alleviate these problems, the mentor has proposed to replace the wind speed and direction sensors at NSA (both Barrow and Atqasuk) with sonic anemometers and to replace the temperature and RH probes with new, heated probes designed to operate in cold environments. This is documented in Replacement sensors on order. Mike Ritsche is the leader.

2.29 SuomiNet Global Positioning System (SuomiNet)

Mentor: None (external data provided by SuomiNet/COSMIC) – Rick Wagener, Brookhaven National Laboratory is our infrastructure contact.

Please see http://www.unidata.ucar.edu/data/suominet/ and http://www.arm.gov/xds/static/suomigps.stm for the details on the SUOMIGPS data.

2.30 Tandem Differential Mobility Analyzer (TDMA)

Mentor: Don Collins, Texas A&M University

Data from the TDMA currently are acquired and processed by Don Collins. Processed data are then delivered to ACRF on a monthly basis and stored in the IOP area of the ARM Data Archive as "beta data." An ingest is being developed to produce netCDF files for inclusion in the main Data Archive, as documented in ECO-00587.

The communications group is contacting Don Collins to develop a web area, enter instrument metadata, and edit the instrument handbook. The TDMA needs to have an entry added to the IMMS reporting system.

The Working Groups and STEC approved the addition of an APS in FY2008 to replace the OPC component of the TDMA. Don Collins, TDMA Instrument Mentor, has responsibility for integrating the APS with the SGP AOS. See ECO-00640, *Replace AOS Optical Particle Counter with Aerodynamic Particle Sizing Spectrometer.*

2.31 Total Precipitation Sensor (TPS)

Mentor: Mark Ivey, Sandia National Laboratory

The total precipitation sensor (TPS), TPS-3100, was returned by Yankee Environmental Systems, Inc. in October. We shipped the instrument to Jessica Cherry at the University of Alaska Fairbanks (UAF), who will set up the instrument at UAF for evaluation.

Engineering Change Order, ECO-00344 *Snow Measurement Instrumentation Needs for the NSA*, is in process to add and evaluate this capability. Bernie Zak is the leader.

2.32 Total Sky Imager (TSI)

Mentor: Vic Morris, Pacific Northwest National Laboratory

Engineering Change Order, ECO-00625, was approved and is in process to update the control boards of our TSI-880 systems. This update will reconcile issues with the real time clock and power supplies.

Engineering Change Order, ECO-00644, was approved to upgrade the TSI software to allow use of new versions of the Axis camera. Concepts to incorporate the packaging and mechanical design of the new version of the Axis camera will be covered in a new ECR.

2.33 Tower - Meteorological Tower Systems (TWR)

Mentor: David Cook, Argonne National Laboratory

Engineering Change Order, ECO-00645, was approved to provide a replacement meteorology system for the tower. The new system is using sonic anemometers in place of the cups and vanes, and a new Vaisala T/RH system in place of the present ones. Testing of the new system will begin in November at Argonne National Laboratory.

2.34 Vaisala Ceilometer (VCEIL)

Mentor: Vic Morris, Pacific Northwest National Laboratory

There are no open Engineering Tasks related to the VCEIL instrument suite.

2.35 W-Band (95-GHz) ARM Cloud Radar (WACR)

Mentor: Kevin Widener, Pacific Northwest National Laboratory

Engineering Change Order, ECO-00369 *Study Network Transfer of Millimeter Wave Cloud Radar and W-Band ARM Cloud Radar Spectra to Archive*, presents a mechanism to transport MMCR and WACR spectra data from the measurement site to the ARM Data Archive by shipping hard drives. However, the cost of shipping media is high, especially from the TWP island sites, and significant staff effort is required to manage the number of disks and to implement the process at the sites and the ARM Data Archive. A companion ECR was entered, ECO-00575, to study the network transfer of MMCR and WACR spectra to the ARM Data Archive.

ECO-00391 proposes that we evaluate the feasibility of implementing data reduction algorithms at each MMCR and WACR installation and shipping the resulting files to the ARM Data Archive via the Internet. A version of this software is in the release process to test ECO-00391 and /ECO-00575. Implementation is underway and documented in BCR-1349.

3. Future Instrumentation Planning

In this section, instrumentation that has been proposed for future acquisition and discussed by the Working Groups–but not yet approved for purchase–are presented with any status information.

3.1 Atmospheric Radiation Measurement Program Volume-Imaging Array

The ARM Volume-Imaging Array (AVA) is a proposed radar system to be deployed at the SGP site to address the ARM Program's need to map 3D cloud and precipitation structures at short to medium ranges (i.e., 20-75 km). The AVA system will provide time-resolved 3D precipitation fields, domain-averaged rainfall rate, cloud coverage throughout a volume, cloud-top heights, hydrometeor phase information (using polarization), horizontal and vertical variability of clouds and precipitation, and low-level convergence and divergence using dual-Doppler techniques. Principal elements of the AVA proposal prepared by Pavlos Kollias include the following:

- Three networked scanning radars arranged in a triangle with 20-30 km legs: one operating at 35 GHz (same 8.6-mm wavelength as the MMCR), capable of scanning the vertical region probed by the current MMCR, and two radars operating at 9.4 GHz (3.2-cm wavelength, so-called "X-band"). All three radars will be transportable, scanning, polarimetric, and Doppler.

- Development of a useful 3D cloud value-added product (VAP) similar to the existing ARSCL but on a regular 3D grid.

- Development of an "AVA Simulator." Patterned after the well-known ISCCP Simulator, the AVA Simulator will perform forward simulations of radar observables, using as input LES model and CRM outputs of cloud properties together with the characteristics of the AVA radars. The results will be used to develop and optimize volumetric radar scanning strategies, develop and evaluate inverse retrieval techniques, and develop prototype 3D ARSCL-like VAPs for the ARM community.

- A collaborative effort with the Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS) to deploy the CIRPAS 9.4-GHz phased-array radar at the ARM SGP site every year for 1-2 months of continuous observations.

STATUS – Consideration of the AVA, as such, is on hold, until simulations have been carried out to demonstrate its capabilities and further refine the requirements.

3.2 Collaborative Adaptive Sensing of the Atmosphere

ACRF is a member the Collaborative Adaptive Sensing of the Atmosphere (CASA) consortium; this concept is being assessed to determine its utility to ARM and ACRF science objectives. There is a good analysis data set available to the community that spans the CLASIC experiment. The precipitation fields and related data products from the CASA array are being incorporated into ARM cloud modeling and properties research. In parallel, a life-cycle cost and logistical feasibility assessment is underway within the ACRF infrastructure, including site preparation and leasing, infrastructure, operations, towers, installation costs, radar modifications, data infrastructure, and processing impacts. See www.casa.umass.edu.

STATUS: Ongoing review of needs and impact

3.3 Absolute Scanning Infrared Radiometer

To provide an absolute infrared (IR) flux reference, which could be used to calibrate the Eppley PIRs, Ellsworth Dutton suggested that ARM develop an absolute scanning infrared radiometer (ASIR). This instrument would be functionally equivalent to an ASIR developed by Rolf Philipona for the World Meteorological Organization (WMO). This instrument would not be used for routine data acquisition, but instead would provide a calibration reference. As such, it would participate in WMO inter-comparisons at Davos, Switzerland, every five years.

STATUS – In December 2006, a description of the desired instrument capabilities was published in Fed Biz Ops (solicitation number 111506). Based on the published description, rough order-of-magnitude cost estimates have been received from several interested organizations. At this time, an estimated beginning of the instrument deployment would be FY2010—depending on the review of overall instrument priorities by the STEC and the ACRF Infrastructure Management Board.

3.4 Raman Lidar for Optical Extinction and Water Vapor Profiles

There is the need to deploy a Raman or high spectral resolution lidar extinction lidar at our North Slope of Alaska Barrow research site to provide measurements of optical extinction and water vapor profiles.

STATUS – Scientists within ARM Working Groups are refining science needs and discussing instrument and measurement approaches. A target milestone for deployment, pending favorable scientific and infrastructure review, will take place in FY2010.

STATUS – This task is in the queue for discussion and recommendation by science working groups and the STEC.

3.5 Upwelling Spectral Measurements Using Multi-Filter Radiometers at ARM Mobile Facility Sites

Approved for FY2009 Implementation – Downlooking MFRs for the AMF are needed to estimate the surface spectral albedo. The Working Groups and STEC recommend acquiring two, one for the main AMF facility and one for its ”supplemental” facility. The radiometers will be placed on 10-m towers for better representative measurement.

Engineering Change Order, ECR-00659, was entered to guide and document the addition of upwelling MFRs to the ACRF AMF. Gary Hodges is the leader. Some ramp up to provide this measurement is expected this year. The first radiometer will be installed and verified during our AMF Azores experiment in FY2009 even though surface albedo at the AMF central site will not be representative of the local scale—due to the dominate effects of the surrounding sea surface. A second upwelling MFR is proposed for addition to the AMF Supplemental Site during FY2010, a spare MFR head will be purchased then.

3.6 1.6-Micron Multi-Filter Rotating Shadowband Radiometer Channel

This device was built by replacing an unfiltered channel on a multi-filter rotating shadowband radiometer (MFRSR) with an InGaAs detector and a 1.6-µm filter for scientific evaluation. The Radiative Processes Working Group would like to have these data available for analysis, and run the head at the SGP in the field campaign mode. Before a field campaign is begun, we need to run this system through the SGP Cosine Bench Calibration. Pending review of the data, the Radiative Processes Working Group would like to consider the costs to add a 1.6-µm channel to select ACRF MFR/MFRSR heads.

This task is approved by the STEC to continue for evaluation. Engineering Change Orders, ECO-00580, and Engineering Work Order, EWO-10875, were established to provide this capability. Gary Hodges is the owner of the ECO/EWO.

3.7 Automatic Radiosonde Launcher for the North Slope of Alaska Barrow Research Site

The sonde launcher is proposed to optimize downstream operational costs and thereby enable additional daily sonde launches. However, additional information is requested to determine its ability to work reliably in such an extreme climate. This information may be obtained either from demonstration or, perhaps, verification from operations at a similar site.

Doug Sisterson talked with Vaisala about this system. Their specification does state performance in climates from tropical to polar; there is a need to verify NSA suitability. There is an Autosonde operating in Whitehorse, Yukon, but that is only at about 60.66 N (Barrow is at 71 N). There is also a system at Bodo, Norway, at 69 N. Barry is checking with Vaisala to see if it has any installed at higher latitudes and to ascertain performance.

Based on the December STEC meeting discussions, this system is on hold until possibly FY2010.

4. Small Business Innovation Research

The U.S. Department of Energy (DOE) Small Business Innovative Research (SBIR) web page is available at http://www.er.doe.gov/sbir/.

4.1 Eye-Safe Ultraviolet Backscatter Lidar for Detection of Sub-Visual Cirrus (FY2006/FY2007)

Based on recommendations from the 2004 Cloud Properties Working Group meeting, this subtopic was substituted for the A-band spectrometer subtopic. Connor Flynn is the technical contact. Phase I funding was awarded to Aculight Corporation for "Eye-Safe UV Backscatter Lidar for Detection of SubVisual Cirrus."

See http://www.science.doe.gov/sbir/awards_abstracts/sbirsttr/cycle24/phase1/039.htm.

Phase I funding was also awarded to Physical Sciences, Inc., for "Field-Worthy UV Backscatter Lidar for Cirrus Studies."

See http://www.science.doe.gov/sbir/awards_abstracts/sbirsttr/cycle24/phase1/044.htm.

STATUS – Awarded funding to proceed to Phase II development.

See http://www.science.doe.gov/sbir/awards_abstracts/sbirsttr/cycle24/phase2/p2_award.htm.

4.2 Instrumentation for Remotely Sensing Aerosol Optical Properties – Aerosol Phase Function (FY2006/FY2007)

Based on recommendations from the Aerosol Working Group, this subtopic was added to the aerosol measurements subtopic. Phase I funding was awarded to Aerodyne Research, Inc., for "CAPS-Based Particle Single Scattering Albedo Monitor."

See http://www.science.doe.gov/sbir/awards_abstracts/sbirsttr/cycle24/phase1/040.htm.

STATUS – Awarded funding to proceed to Phase II development.

See http://www.science.doe.gov/sbir/awards_abstracts/sbirsttr/cycle24/phase2/p2_award.htm.

4.3 Unmanned Aerospace Vehicle-Suitable Cloud Radar (FY2006)

Phase I funding was awarded to ProSensing, Inc., for "High-Power, Pod-Mounted W-Band Cloud Radar for UAVs."

See http://www.science.doe.gov/sbir/awards_abstracts/sbirsttr/cycle24/phase1/045.htm.

STATUS – This instrument system proposal did not receive SBIR Phase II funding.

4.4 In Situ Measurement of Cloud Properties with Large Sample Volumes (FY2007)

The following two proposals were selected for 2007 Phase I funding:

- "Dual Wavelength In Situ Cloud Lidar" by Physical Optics Corporation

  NOTE: This is the same company that received 2005 Phase I funding for the Oxygen A-Band instrument.

- "A Dual-Wavelength In Situ Cloud Lidar with Very Large Sample Volume" by SPEC Incorporated.

STATUS – This instrument system proposal did not receive SBIR Phase II funding.