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ACRF Instrumentation Status: New, Current, and Future

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Summary

The purpose of this report is to provide a concise but comprehensive overview of Atmospheric Radiation Measurement Program Climate Research Facility instrumentation status. The report is divided into 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.

Contents

1 New Instrumentation

1.1 Thin Cloud Rotating Shadowband Radiometer (TC-RSR) for LWP, r_{eff}, and τ_{cloud}

Andy Vogelmann and Mike Reynolds will modify an existing Brookhaven National Laboratory Fast Rotating Shadowband Radiometer (FRSR) to enable Qilong Min to apply his algorithms to retrieve liquid water path, visible optical depth, and effective radius for thin clouds. Although BNL had hoped to complete the work by summer for deployment during the AMF deployment to Germany or during CLASIC at SGP in June 2007, the delay due to the Continuing Resolution will likely prevent this. The TC-RSR will remain a BNL-owned instrument, with additional costs to ACRF for each IOP deployment for field operation and data reduction.

1.2 Optical Rain Gauge for SGP

An optical rain gauge will be acquired for the SGP for use with the Atmospheric Remotely Sensed Cloud Boundaries (ARSCL) value-added procedure (VAP). The AMF and TWP field sites already have optical rain gauges installed.

1.3 183 GHz Microwave Radiometer

Radiometrics Corporation has proposed to deploy at North Slope of Alaska (NSA)-Barrow a new 183 GHz microwave radiometer that they have developed under a U.S. Department of Energy (DOE) Small Business Innovation Research (SBIR) grant (ECO-00609).

STATUS – The radiometer has been deployed at Barrow to participate in the Radiative Heating in Under-explored Bands Campaign (RHUBC). The instrument appears to be working well.

1.4 High-Frequency (90/150 GHz) Microwave Radiometer

Mentor: Maria Cadeddu, Argonne National Laboratory

In response to the need for greater sensitivity (and therefore higher frequency) microwave channels to more accurately measure liquid water paths in thin clouds than the current 23.8/31.4 GHz instruments permit, a new High-Frequency Microwave Radiometer (MWRHF) has been acquired, and is currently deployed at Southern Great Plains (SGP) (ECO-00491).

Maria Cadeddu presented a poster on the MWR-HF at the ARM Science Team Meeting in Monterey.

STATUS – A hardware failure has occurred in the 150 GHz channel. The instrument has been returned to the manufacturer for repair. A second instrument has been deployed with the ARM Mobile Facility (AMF) at Heselbach, Germany.

1.5 Infrared Sky Imager

Mentor: Vic Morris, Pacific Northwest National Laboratory

An infrared (IR) sky imager from Blue Sky Imaging (http://www.aas.org/career/bluesky.html) was deployed at SGP in September 2005 to provide nighttime cloud cover measurements (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 SGP in late June 2006 and returned to service in August 2006.

Vic Morris presented a poster on the IRSI at the ARM Science Team Meeting in Monterey.

STATUS – In late January 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 Vic Morris conducted a comparison of cloud fractions from the IRSI and the TSI. The comparisons indicate the IRSI is still not producing correct values. In March Vic presented the results of the comparison at the ARM Science Team Meeting. Vic is working with Heitronics to arrange an extended demonstration of their Nubiscan instrument as a potential alternative to the device from BSI.

1.6 Add Multi-Filter Radiometers to Cessna 206 (In-situ Aerosol Profiling aircraft)

Currently, spectral albedo measurements are only possible at the SGP central facility using downward facing Multi-Filter Radiometers (MFR) on the 25-m level of the 60-m tower over a wheat field, and on a 10-m tower over the adjoining pasture. By adding a MFR to the Cessna 206 used for the In-situ Aerosol Profile (IAP), routine measurements of surface spectral albedo could be acquired over a broader area around the SGP central facility (ECO-00584).

STATUS – The Cessna 206 is currently in Wichita for the installation of the extended wingtips. Once this is complete the MFR can be installed.

1.7 DigiCORA-III for Manus, Nauru

Mentor: Barry Lesht, Argonne National Laboratory

The digiCORA is the ground station for the Vaisala balloon borne sounding system. In FY 2003-2004 new digiCORA-III systems were acquired and deployed at SGP-Central Facility (CF), NSA-Barrow, and AMF as the primary ground station for those sites. For reliability and compatibility reasons it is necessary to replace the digiCORA-II systems at Manus and Nauru with the new digiCORA-III systems (ECO-00598).

STATUS – Installation of the new digiCORA-III on Nauru has been delayed until the August RESET visit. A new digiCORA-III will be installed on Manus in June, after the necessary antenna upgrade kit is acquired. The old digiCORA-II systems will not be used as spares; they will be returned to the SGP.

2 Existing Instrumentation

This section describes the current status of the existing instrumentation, including any upgrades planned or in progress. The information is abstracted primarily from the Instrument Mentor Monthly Summary reports (available from the instrument web pages) and from ECO status updates.

2.1 Atmospherically Emitted Radiance Interferometer

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

Sarah Bedka and Dave Turner presented a poster on the characterization of dust properties at Niamey using AERI radiance data at the ARM Science Team Meeting in Monterey.

AMF (Heselbach) – The communications link between the interferometer hardware and the host computer in the upgraded electronics rack failed during transit to Germany. The interface employs a custom DSP module that appears to be malfunctioning. A spare DSP module failed to correct the problem. The original OS/2-based electronics rack that was operated at Niamey was successfully reintegrated with the interferometer subsystem. The AERI system calibration was confirmed and it was setup in operational mode. The upgraded WINDOWS-based electronics rack is being returned to the SSEC for problem diagnosis and repair.

NSA – This Windows XP-based AERI is operating nominally. RFI continues to be a problem at this site. Efforts to try to reduce the RFI noise in the NSA-C1 data via post-processing of the raw data are on going. Data from the second ER-AERI at Barrow are of marginal quality due to misalignment of the interferometer that occurred just prior to its deployment for RHUBC. In April the system was returned to SSEC so the interferometer can be sent to Bomem for proper alignment.

SGP – A power failure at the SGP site at Lamont had adverse effects on both AERI systems. One of the E14 system files was corrupted but the system recovered automatically at the start of the next day. Upon power restoration, a portion of the AERI-01 house keeping subsystem appears to have failed. Eight of 24 data channels are malfunctioning. Those channels are used to monitor subsystem component temperatures. The data collected from these channels do not affect collected data or the resultant radiance calibrations and the system otherwise appears to be operating normally.

TWP (Darwin) – Repaired, calibrated, and returned to service in mid-April.

TWP (Nauru) – This Windows XP-based AERI is operating nominally.
Spare – The OS/2-based spare AERI at SSEC would need to have the aging laser replaced in its interferometer before it could be sent to Darwin as a replacement.

2.1.1 Windows and Rapid-Sampling Upgrade

Migration of the AERI software from OS/2 Warp to Windows XP and related computer hardware modernization to enable rapid sampling of the IR spectrum at 10-s intervals was begun in FY2004 (ECO-00286). Upgraded AERI systems are currently operational at SGP, NSA-Burrow, and Tropical Western Pacific (TWP)-Nauru, and TWP-Darwin.

STATUS – An upgraded electronics rack and Windows XP computer were shipped to Germany to replace the old OS/2 electronics rack used with the AMF AERI system. Unfortunately the electronics subsystem failed in transit to Germany and has been returned to SSEC for diagnosis and repair. An upgraded AERI was successfully installed at Darwin in mid-April.

2.2 Aerosol Observing System

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

AMF (Heselbach) – In March Anne Jefferson traveled to Heselbach, Germany to install the AOS as part of the AMF deployment. Data collection started on 24 March. For the first two weeks of operation the data show the site to be fairly polluted for a rural setting. A replacement DVD/CD drive has been sent because the current drive occasionally malfunctions.

SGP – The repaired CPC (Condensation Particle Counter) was returned to SGP on 23 February. The NOAA loaner will be returned to the mentor.

2.2.1 Reconfigure Southern Great Plains Aerosol Observing System

The aerosol observing system (AOS) at SGP will be reconfigured to have similar components and data acquisition system as the aerosol systems for AMF, NSA, and the IAP aircraft measurements over the SGP (ECO-00569). This work is scheduled for 13 May – 1 June 2007.

2.3 Balloon-Borne Sound System

Mentor: Barry Lesht, Argonne National Laboratory

Vaisala has introduced an improved temperature sensor for the RS92 radiosondes. According to Vaisala, the new sensor offers the following benefits:

- Five times better mechanical strength for RS92 radiosondes without losing fast response, accuracy and very small solar radiation absorption
- The temperature sensor is strengthened with a strong quartz fiber, which is firmly integrated into the current sensor structure
- The new structure makes the sensor less prone to a damage during flight preparation or sounding
- The protective boom frame has been removed to improve the air flow to the sensor
- The removal of the protective boom frame changes slightly the visual appearance of the sensor boom.

During the short transition period the RS92 radiosondes with the fiber-reinforced temperature sensor can be traced by the radiosonde serial number. If the four last digits are between 3000 and 5999, the radiosonde is manufactured with the fiber-reinforced temperature sensor.

Overall radiosonde data recovery was excellent during March, with SGP 116/124 (94%), TWP/C1 (Manus) 62/62 (100%), and TWP/C2 (Nauru) 61/62 (98%). Normal operations at NSA were modified

during the month to accommodate the RHUBC IOP. Flights were made during 54 of 62 normal launch opportunities and an additional 45 flights were made at non-standard times for RHUBC. We also began testing AMF operations in Germany (FKB) during March. A total of fourteen training soundings were made at FKB. Note that the RHUBC soundings use non windfinding RS92 radiosondes.

Because the automated process used in the digiCORA-III to pre-fill the values of surface temperature, humidity, and pressure fails on occasion, Barry, Donna, and Mike worked with the DQ Office to develop a new daily report that should help assess the reliability of these values reported in the soundings.

2.3.1 Make Atmospheric Radiation Measurement Program-Barrow Soundings Available to the Global Telecommunication System

January 2007 – Soundings from SGP and NSA (Barrow) are now available to the global telecommunications system (GTS). Soundings from TWP (Manus and Nauru) will also be available to the GTS once the new DigiCORA-III systems are installed and operational there.

2.4 Broadband Radiometers (SIRS, SKYRAD, GNDRAD, BRS)

Mentor: Tom Stoffel, National Renewable Energy Laboratory

Tom Stoffel and colleagues presented a poster on effects of wild fire smoke over the SGP on shortwave irradiances at the ARM Science Team Meeting in Monterey.

SGP/BORCAL 2007-01 is in preparation by Site Operations and NREL team. Radiometers have been deployed and system checks are in process. Data collection should begin during clear sky conditions in early May. BORCAL reports and reference irradiance data for all 11 years of radiometer calibrations at the SGP Radiometer Calibration Facility are now available at http://www.nrel.gov/srrl/borcal.html.

SIRS (24@SGP) and BRS (1@SGP) – Data for March 2007 were generally excellent with 100% data collection except at C1 (90%), E7 (73%) and E12 (63%) due to communication problems between the data system computers and the SIRS data logger. Of the 1-minute irradiance data collected, more than 95% of the shortwave and 100% of the longwave data passed automated data quality tests. "Failed" shortwave (solar) data are generally limited to low irradiances (less than 300 W/sq m) at high solar zenith angles or can be attributed to the varying thermal offsets and time responses of the thermopile-based radiometers to rapidly changing sky conditions, e.g. cloud cover and water vapor concentrations.

SKYRAD/GNDRAD (3@TWP, 2@NSA, 1@AMF) – Downwelling broadband solar and atmospheric irradiances (SKYRAD) data for March 2007 were excellent with 100% data collection at all stations (NSA and TWP). Installation of the ARM Mobile Facility (AMF) at Heselbach, Germany in the Black Forrest was completed on 15 March. Of the 1-minute irradiance data collected, at least 99% of the shortwave and 100% of the longwave data passed automated data quality tests.

2.4.1 Pyrgeometer Calibration Improvements

Tom Stoffel and Ibrahim Reda have initiated an investigation into the source of the bias in the ACRF pyrgeometer blackbody calibration system. (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 NOAA/GMD.

STATUS – Reda has replaced the fluid in the Pyrgeometer Blackbody Calibration System at NREL with a new Dow 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.

Ibrahim Reda and colleagues presented a poster on pyrgeometer calibrations traceable to the World Infrared Standard Group (WISG) at the ARM Science Team Meeting in Monterey.

2.4.2 Radiometer Calibration Facility Data Acquisition System Replacement (deferred to FY2008)

The data acquisition system in the Radiometer Calibration Facility used for annual Broadband Outdoor Radiometer Calibration (BORCAL) activities is over ten 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 (CO_2FLX)

Mentor: Marc Fischer, Lawrence Berkeley National Laboratory

Marc Fischer and colleagues presented a poster on the CO_2 flux systems at the ARM Science Team Meeting in Monterey.

The CO_2FLX instruments at 4, 25, and 60 m on the SGP-CF tower are operating nominally with the exception of the net radiometers.

2.6 Carbon Monoxide System (CO)

Mentor: Sébastien Biraud, Lawrence Berkeley National Laboratory

A comparison of PGS CO_2 measurements against NOAA flasks and isotope flasks collected at all heights of the 60-m tower shows a difference on the order of 1 ppm. The amplitude of this difference cannot be explained by a single solution and needs to be further investigated.

2.7 CO_2 (Precision Gas) System (PGS)

Mentor: Margaret Torn and Sebastien Biraud, Lawrence Berkeley National Laboratory

Margaret Torn and colleagues presented a poster on the CO_2 systems at the ARM Science Team Meeting in Monterey.

The PGS is operating nominally.

2.8 Cimel Sun Photometer

Mentor: None (external data provided by NASA AERONET)

AMF (Heselbach) – Awaiting an upgraded, calibrated replacement (unit #98). Unit #168 will be returned to AERONET for upgrade and calibration.

NSA (Barrow) – Unit #252 has been reinstalled.

SGP (CF) – Unit #99 has been reinstalled. Cimel has corrected the firmware programming error.

TWP (Nauru) – An EPROM with the corrected programming for unit #402 has been sent to SGP. It will be installed during the next RESET visit to Nauru in August.

2.8.1 Internet Data Transfer

The transfer of CSPHOT data from the Cimel instrument to AERONET using geostationary operational environmental satellite or Meteosat will be replaced with an Internet data transfer to improve reliability of the transfer, to permit ACRF personnel to monitor the transfer, and to allow the raw data to be acquired, ingested, and archived for use by ARM Science Team members (ECO-00555). Internet transfer of CSPOT data to AEORNET has been initiated at TWP-Nauru and SGP, and NSA-Barrow sites.

2.9 Disdrometer

Mentor: Mary Jane Bartholomew, Brookhaven National Laboratory

Mary Jane Bartholomew presented a poster on the disdrometers at the ARM Science Team Meeting in Monterey.

TWP (Darwin) – Operating nominally. 100% uptime in March.

SGP – Returned to service at the end of April following calibration/repair.

2.10 Energy Balance Bowen Ratio Station

Mentor: David Cook, Argonne National Laboratory

Two recalibrated EBBR units were installed at E4 (Plevna) and E8 (Coldwater).

Vaisala no longer supports the combined temperature and relative humidity probes in the EBBR (2 per system) but does still offer recalibration services. Replacement probes are available from the EBBR manufacturer. The mentor has proposed that replacement of all 32 probes be phased in over 3 years. As the old probes are replaced they can be used as spares for the systems not yet upgraded to the new probes.

2.11 Eddy Correlation Station

Mentor: David Cook, Argonne National Laboratory

David Cook presented a poster on the ECOR systems at the ARM Science Team Meeting in Monterey.

AMF (Heselbach) – Operating nominally.

SGP – ECOR stations are operating nominally. Missing CO_2/H_2O data at E5 and E10 appear to be the result of damaged IRGA serial ports or the use of the wrong serial chip in the IRGA. Problems with the new optical isolators implemented to protect the ECOR computer serial ports during lightning have been traced to the serial driver chips in the infrared gas analyzers (IRGA). In preparation for CLASIC, several IRGAs were returned to the manufacturer for repair. Time keeping problems that occur following an unplanned shutdown of the ECOR computer have been addressed with a revised maintenance procedure and a script to update the BIOS clock every 24 hours.

2.11.1 Add Wetness Sensors

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 (ECO-00536).

January 2007 – Wetness sensor testing on an ECOR system similar to the ARM ECORs began at Argonne in mid-January.

2.12 G-Band (183.3 GHz) Water Vapor Radiometer

Mentor: Maria Cadeddu, Argonne National Laboratory

Maria Cadeddu presented a poster and gave an oral presentation on PWV and LWP retrievals using the GVR at the ARM Science Team Meeting in Monterey.

The GVR is operating nominally. GVR data are now available from the ARM Archive (nsagvrC1.b1). Varying levels of RFI are observed in all four channels. Comparisons between measured and model-calculated brightness temperatures are in good agreement.

2.13 Global Positioning System (SuomiNet)

Mentor: None (external data provided by SuomiNet/COSMIC)

Replacement receivers are in route to Manus and Darwin to preempt a failure due to the same problem experienced at Nauru.

SGP – Telecommunications problems at El Reno (E19) continue to affect data availability from the SuomiNet station. Wireless data communication equipment has been ordered for installation at El Reno (E19). All other SGP SuomiNet GPS stations and their associated meteorological sensors are operating nominally.

TWP (Manus) – Operating nominally.

TWP (Nauru) – In November the GPS receiver at Nauru failed. The repaired receiver is in route.

TWP (Darwin) – The replacement receiver has been installed and is operating properly.

NSA (Barrow) – (System belongs to the University of Alaska at Fairbanks (UAF) and is installed at the NOAA/CMDL site.) Operating nominally using a spare ARM met system.

NSA (Atqasuk) – In June 2006 University Navstar Consortium (UNAVCO) personnel installed a GPS receiver at Atqasuk for geodetic purposes. The spare ARM GPS meteorological system currently in use at Barrow will be connected to this receiver once the UAF met system is repaired and returned to Barrow, then the Atqasuk station will be incorporated into SuomiNet to provide precipitable water vapor data.

2.14 In-situ Aerosol Profiling

Mentor: John Ogren and Betsy Andrews, NOAA/ESRL/GMD

The Cessna 206 is currently in Wichita for the installation of extended wingtips.

2.15 InfraRed Thermometer

Mentor: Vic Morris, Pacific Northwest National Laboratory

InfraRed Thermometers (IRTs) have been deployed at 12 SGP extended facilities (ECO-345), operating at 5 Hz sampling rate. IRTs are also part of the SKYRAD and GNDRAD systems at TWP, NSA, and AMF. These are currently sampled at 0.5 Hz. Efforts to increase the sampling rate of the SKYRAD IRTs to 5 Hz are in progress (ECO-00368). An ECR has been submitted to install the IRTs at NSA and TWP in ventilated enclosures similar to those in use at the SGP.

AMF (Heselbach) – Data collection began on 15 March; data were generally good.

NSA – Data were generally good.

SGP – Data were generally good at most sites. In March the data were missing at E16. Higher sky temperatures were measured at E13 than both the AERI and the IRT at C1 because at low temperatures (below-60°C) the error due to the reflectance and temperature of the mirror becomes significant. Higher sky temperatures than at other facilities were measured at E19.

TWP – Data were generally good at all sites.

2.16 Multi-Filter Rotating Shadowband Radiometer and Related Systems (MFR, GNDMFR, NIMFR)

Mentor: Gary Hodges, NOAA/ESRL/GMDivision; John Schmelzer, Pacific Northwest National Laboratory

Gary Hodges presented a poster on the MFRSR upgrades at the ARM Science Team Meeting in Monterey. For his efforts Gary received one of the poster design awards presented by the ARM Chief Scientist Team.

John Schmelzer plans to retire at the end of May.

AMF – Operational at Heselbach.

NSA – MFRSRs, MFRs, and NIMFRs were re-installed in early April at Barrow and Atqasuk.

SGP – 8 of 22 Extended Facilities do not have operational MFRSRs.

TWP – Operating nominally.

2.16.1 Filter-Detectors

ACRF has ~50 multi-filter radiometers deployed in a variety of configurations including the MFRSR, the downward-facing MFR, and the NIMFR. The 6 narrow band (10 nm) filter-detectors in almost all of these sensors have degraded over time and are in urgent need of replacement. Perkin-Elmer has manufactured custom-designed and custom-built filter-detector assemblies to meet ACRF specifications (ECO-00580).

STATUS – John Schmelzer is refurbishing and calibrating MFRSR sensor heads using the new filter-detectors at the rate of 3-4 per week. Newly upgraded heads are being sent to SGP for installation with the new data loggers.

2.16.2 Multi-Filter Rotating Shadowband Radiometer Calibration and Data Processing Improvements

Problems with the calibration and data processing of the MFRSRs were revealed during the ALIVE campaign (ECO-00571). New calibration processing will be implemented. Old data will be reprocessed to apply corrections and the new processing algorithms.

STATUS – Data from the first MFRSR with the new data logger is now being ingested using the improved calibration and processing.

2.16.3 Establish MFRSR Calibration Facility at SGP

With the impending retirement of John Schmelzer, a facility for calibrating the MFRSRs is to be established at SGP. MFRSR calibration includes (1) cosine response characterization, (2) spectral bandpass characterization of the filter detectors, and (3) absolute (lamp) calibration. To establish the facility, the cosine bench and related items acquired by John Schmelzer at PNNL on behalf of ACRF will be relocated to the SGP Radiometer Calibration Facility (RCF) in May. Some modifications to the RCF may be necessary. Additional equipment will need to be acquired, including a monochromator and computer for performing the spectral characterizations. Joe Michalsky at NOAA GMD will be overseeing the task of establishing the facility as well as the routine calibrations to be performed using the facility. Joe will also direct other NOAA GMD staff to prepare documentation and train the SGP calibration technicians, and to review the resulting calibrations to ensure their validity prior to deployment in the field. (ECO-00617)

STATUS – Gary Hodges and Joe Michalsky traveled to PNNL in late April to meet with John Schmelzer before he retires.

2.16.4 Data Logger Replacement

The proprietary data loggers supplied with the MFRSRs and related instruments are to be replaced with Campbell Scientific CR1000 data loggers. This will permit them to be more easily maintained. It will also permit modifications to the operation of the instruments and data acquisition to be easily implemented (ECO-00350).

STATUS – Data from the first MFRSR with the new data logger is now being ingested. Once the first installation has been verified subsequent installations will follow.

2.17 Millimeter Cloud Radar

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

Kevin Widener presented a poster on the MMCR and WACR systems at the ARM Science Team Meeting in Monterey.

NSA/C1 – 100% up time in March.

SGP/C1 – In March the TWTA was reinstalled and run at 10% duty cycle for 2 days. There has been one helix current fault since then. 62% up time in March.

TWP/C1 (Manus) – Occasional data gaps in March. The power output of this system continues to decline. A new TWT has been sent to ASE to repair the old TWTA from Nauru. The repaired TWTA is expected to be returned to SGP by the end of April when it will be shipped to Manus.

TWP/C2 (Nauru) – 100% up time in March.

TWP/C3 (Darwin) – 98% up time in March.

2.17.1 MMCR Processor Upgrades

(ECO-00283) The spare PIRAQ-III processor will be installed in the MMCR at Darwin to replace the PIRAQ-III that failed. The NSA (Barrow) upgrade will be delayed until the failed processor is repaired or another spare is purchased.

STATUS – Vaisala reported that they were unable to find a problem with the failed boards from Darwin and is returning them to Kevin. Kevin will use these to upgrade the Barrow MMCR.

2.17.2 Add Polarization at Barrow

(ECO-00552) Because the PIRAQ processor does not support polarization, the installation of the orthomode transducer at Barrow is on hold until the next processor upgrade.

2.17.3 Spare Traveling Wave Tubes

New TWT will be ordered to replace the TWTs originally delivered with the MMCRs, which are well beyond their rated lifetime and are beginning to fail (ECO-00425).

Both of the two spare TWTs ordered in the fall of 2006 have been received. Because the TWTs only have a 2-year lifetime, at least one more TWT needs to be ordered this year to permit the TWT at Darwin to be replaced in November 2007.

2.17.4 Millimeter Wave Cloud Radar Spectra Processing

Spectra files produced by the upgraded MMCRs (C40 or PIRAQ-III processors) range from 8 to 15 Gigabytes per day. Algorithms for eliminating clear-sky periods and compressing the files need to be developed and implemented locally (ECO-00391).

January 2007 – The compression algorithms have been implemented at SGP.

2.17.5 Refurbish Millimeter Wave Cloud Radar Antennas

Beginning in 2007, over a three-year period the MMCR antennas will be refurbished and characterized on an antenna range (ECO-00551). 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 most likely be refurbished first to avoid impacting planned IOPs and SGP.

STATUS – The Barrow MMCR antenna will be swapped with the spare antenna in August.

2.17.6 Radome or Radome Dryer

The detrimental effect on the data of standing water on the current fabric radome has prompted the pursuit of a more satisfactory solution. Unfortunately discussions with potential suppliers have not been fruitful. This task is currently on hold (EC-00275).

2.18 Micro-Pulse Lidar

Mentor: Rich Coulter, Argonne National Laboratory

Rich Coulter and Tim Martin presented a poster on the new polarized MPL systems at the ARM Science Team Meeting in Monterey.

AMF – The new MPL at Heselbach is now operational.

NSA – The system is again producing good data following replacement of the detector by NSA technicians in January.

SGP – Good data to greater than 15 km is normal during nighttime and 10-15 km during daytime with no additional averaging beyond the 3 second averaging time presently in use by the instrument itself.

TWP – The new MPL at Nauru has been working well. Occasionally the system locks up in a way that requires the local operators to restart it manually. Replacing the detector at Darwin failed to resolve problems manifesting as thin, false cloud layers near 10 km and 20 km. A replacement laser diode has been shipped to Darwin to see if it will correct the problem. Declining output power of the Darwin system suggests the laser diode replacement would be beneficial anyway although it has not yet declined sufficiently to affect data quality.

A value-added processing (VAP) has been developed to produce a file with separated polarization states, averaged to 30 seconds. This will appear similar to the present MPL data in terms of averaging time. It will have two data streams, one for circular polarization and a second for cross polarization.

2.18.1 Modify MPL Polarization Switching and Data Acquisition

Based on suggestions by Jim Spinhirne at NASA GSFC, the new spare MPL will be modified as follows:

1. Switch polarizations between laser shots.

2. Use different data channels for each polarization. In combination with 1) this will permit essentially simultaneous 30-second averages to be acquired for each polarization.

3. Use a 1/2-wave plate rather than a 1/4 wave plate to acquire linear polarization directly.

These changes may make the new MPL more compatible with MPLNET.

2.19 MicroWave Radiometer

Mentor: Maria Cadeddu, Argonne National Laboratory

Six MWRs were compared during October-November 2006: serial numbers 04, 10 (both from SGP/CF), 11 (SGP/B1), 12 (SGP/B5), 18 (SGP/B6), and 21 (NSA/C2). Differences of as much as 0.7 K in brightness temperatures at 23.8 GHz (corresponding to ~0.5 mm PWV) were observed between radiometers. Shipment of several of these radiometers to Radiometrics for diagnosis and repair has been delayed due to funding limitations under the Continuing Resolution and the need to repair MWRs from TWP.

AMF (Heselbach) – Operational.

NSA/C1 (Barrow) – Operating nominally. Wet window voltage threshold adjusted.

NSA/C2 (Atqasuk) – Not in service. This radiometer (#21) has been sent to Radiometrics for inspection and repair.

SGP-CF – Operating nominally.

SGP-E14 – The power supply failed in mid-March. This radiometer (#04) has been sent to Radiometrics for inspection and repair.

SGP/B1 (Hillsboro) – Not in service. In October this radiometer was sent to the SGP central facility for inclusion in the MWR Inter-comparison IOP.

SGP/B4 (Vici) – No radiometer installed. In December 2005 the radiometer at Vici was sent to Darwin as a replacement for one damaged by lighting.

SGP/B5 (Morris) – Not in service. This radiometer (#12) has been sent to Radiometrics for inspection and repair.

SGP/B6 (Purcell) – In October this radiometer was sent to the SGP central facility for inclusion in the MWR Inter-comparison IOP. In December this radiometer was sent to Manus to replace the failed MWR there.

TWP/C1 (Manus) – This radiometer (#15) experienced a failure in October. A replacement circuit card failed to restore operation. A replacement radiometer from SGP (#18 formerly at SGP/B6) was shipped in December. Radiometer #15 required extensive (and expensive) repairs after ten years on Manus Island. It will be compared with MWRs at SGP prior to returning to service.

TWP/C2 (Nauru) – A replacement (#17) was installed in late November. The MWR (#16) has been repaired and returned to SGP for comparison with other MWRs there.

TWP/C3 (Darwin) – Operating nominally. Wet window voltage threshold adjusted.

2.20 MicroWave Radiometer Profiller

Mentor: Maria Cadeddu, Argonne National Laboratory

AMF (Heselbach) – Operational. A LN_2 calibration was performed on 23 March.

NSA (Barrow) – Following a LN_2 calibration in mid-March, agreement improved between the 2-channel and 6-channel PWV and LWP retrievals for the MWRP as well as the agreement with the 2-channel PWV and LWP retrievals for the MWR. More frequent, routine LN_2 calibrations have been scheduled. Surface temperature readings were largely incorrect, which affects the profile retrievals primarily. The problem first appeared in February. A new "superblower" has been ordered from Radiometrics that has replaceable temperature and humidity sensors.

2.21 Narrow Field of View Radiometer (NFOV)

Mentor: None

The 2-channel NFOV radiometer has been installed at Heselbach.

2.22 Raman Lidar

Mentor: Rob Newsom, Pacific Northwest National Laboratory

Dave Turner and colleagues presented a poster on the Raman lidar system at the ARM Science Team Meeting in Monterey.

The instrument's uptime for March 2007 was 90.2%. The majority of the lost time was due to routine instrument maintenance activities.

During the installation of the new automatic alignment sensor in April a spider web was discovered on the tertiary mirror of the receiving telescope. The web was nearly impossible to see looking from the top of the telescope, which is why SGP technicians hadn't noticed it. Once the web was removed the received signal increased by ~35%, which is about the amount of the previously observed loss of sensitivity.

Analysis of raw signal returns indicates the presence of a relative shift of 8 range bins between the low analog and photon count rate signals. Prior to the installation of the new detection channels for temperature and liquid water on 27 October 2005 the relative shift was 3 range bins. The current version of RLprof_Merge uses a relative shift of 3 range bins between the analog and photon count rate signals, regardless of the date. As a result, all WFOV results collected after 27 October 2005 would be adversely affected by this assumption. The current version of RLprof_merge is being modified to properly account for this change in the relative shift.

Temperature profile retrievals are adversely affected by high solar background noise during the daytime. This is believed to be due to out-of-band leakage into the rotational Raman channel. Adding a wider band filter to block the leakage is being considered.

2.22.1 Add Automatic Alignment System

Due to small thermal gradients in the laser and the lidar enclosure, the alignment of laser beam in the detectors' field-of-view (FOV) changes with time, which can affect the data quality, sometimes substantially. To address this operationally, the laser beam is swept through the detectors' FOV using a pico-motor controlled steering mirror to find the optimal location. This "alignment tweak" is scheduled to occur every 3 hours. Accounting for the potentially 3-hourly changes in alignments is the single largest uncertainty in the data processing codes. It affects all measurements, but the aerosol extinction measurements and the temperature profiles seem to be the most sensitive. Licel has recently developed a new product that permits the alignment of the lidar to be actively maintained (ECO-00586). The Licel alignment sensor was delivered in September.

STATUS – Rob Newsom, John Goldsmith, and Dave Turner successfully installed the new sensor in April.

2.23 Rotating Shadowband Spectrometer

Mentor: Peter Kiedron, NOAA/ESRL/GMD

Peter Kiedron and colleagues presented a poster comparing aerosol optical depths from a variety of instruments, including the RSS, during the ALIVE campaign at the ARM Science Team Meeting in Monterey.

The RSS is operating nominally. Field calibrations are nokminal. Automatic processing of calibration data is under development by Peter Kiedron and Jim Schlemmer.

Processed Langley data are available though January 24, 2007 at http://iop.archive.arm.gov/armiop/0special-data/asrc-rss/rss105/langley/. A comprehensive document on lamp calibration is available at: http://www.arm.gov/publications/tech_reports/handbooks/rss/manuals/

2.24 Radar Wind Profiler – 915, 1290 MHz

Mentor: Rich Coulter, Argonne National Laboratory

AMF – The new 1290 MHz system is now operational at Heselbach.

AMF (Niamey) – Somehow, after the windstorm on June 19, 2006, the rented 915 MHz system was apparently reinstalled in such a way that the wind direction is 90° off. The data will have to be reprocessed from July 2006 to January 2007.

NSA – System crashes frequently. The planned upgrade to new hardware, LAPXM software, and a new computer should help resolve this problem.

SGP – Currently, all systems at SGP are operating nominally. However, during the installation of the 1290 MHz RWP at Heselbach it was discovered that the output of moments data must be explicitly requested whereas formerly the moments were automatically output with the spectral data. As a result, no usable moments data were being produced from the central facility and Meeker systems between September 2006 and April 2007 when the configurations were corrected.

2.24.1 Upgrade to Digital Receivers

The four 915 MHz RWPs at the SGP are now 9-13 years old and are exhibiting increasingly frequent, strange, and expensive-to-repair failures. This may pose problems for CLASIC, scheduled in 2007. Due to the age of these systems, parts are increasingly difficult to obtain. Vaisala offers an upgrade for these systems that will replace the present interface, receiver and computer (including DSP board) with new components and will include the latest version of LAPXM, the operating system. The systems at SGP/CF and SGP/I3 have been upgraded. The systems at SGP/I2, SGP/I3, and NSA/C1 will be upgraded in 2007 (ECO-00567).

STATUS – The upgrade for the NSA system and the remaining two SGP systems have been ordered.

2.25 Radar Wind Profiler – 50 MHz

Mentor: Rich Coulter, Argonne National Laboratory

This system has been out of service for over a year.

In January 2006 the 50 MHz RWP at the SGP ceased transmitting. The transmitter was returned to ATRAD in Australia for diagnosis and repair. After reinstalling the transmitter the output power was still zero. The transmitter will be shipped to Vaisala for diagnosis.

2.26 Soil Water and Temperature System

Mentor: John Harris, University of Oklahoma

Data are OK for most sites. Sites E9 and E27 were problematic in February. Sites with one or more sensors needing replacement: E1, E5, E6, E8, E10, E13, E15, E16, E19, E20. New sensor arrays installed at E13, E19, and E20 last year will be activated in April or May.

2.26.1 Replace In-Ground Sensor Arrays

New redundant sensor arrays will be installed at all SGP EF sites. These will be installed in a phased manner: 5 sites per year over the 4 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 (ECO-00493).

STATUS – In May 2006, new sensor arrays were installed at E13, E19, and E20. Though initially planned, no new sensor array was installed at Cyril (EF-24) due to a gypsum outcropping. The original sensor array had been installed in a "hole" in the gypsum filled with soil. There was no other such area of soil and it is unlikely that soil moisture measurements at the site would be representative of the actual conditions of the surrounding area. The new sensor arrays will replace the original arrays (i.e., be connected to the data loggers) as soon as sufficient precipitation has "healed" the soil. The mentor believes this will happen within the next two rain events. The next round of sensor array installation is planned for April, but could be delayed until May depending on weather conditions.

2.27 Shortwave Spectrometer (SWS)

Mentor: Scott Kittelman, University of Colorado

Cloudy days in March at the ARM central facility resulted in high radiance values observed by the zenith looking narrow field of view Shortwave Spectrometer. Cloudy day radiance values occasionally reached five times radiance observed on the clear sky days. Due to the potential for hail-producing storms at SGP the protective cap was installed on the SWS light collector many times during March, which corresponds to a sudden and sustained drop to zero radiance. Typically the cap is installed late in the afternoon and removed early in the morning.

2.28 Surface Meteorological Instrumentation (SMET, SMOS, SURTHREF, THWAPS, MET, ORG, PWS)

Mentor: Mike Ritsche, Argonne National Laboratory

AMF (MET, ORG) – Lens heaters were connected to remove the ice that was accumulating and causing false readings. Electrical grounding issues are being investigated.

NSA (METTWR) – LoggerNet software upgrades have been completed. Accumulation of hoar frost and ice on the wind direction sensors continues to be a problem, particularly at the 40-m level of the Barrow tower. The measurements of the chilled mirror hygrometer (CMH) at Barrow are suspect due to a dubious calibration in December 2006. A corrected calibration was installed in mid-March. The CMH at Barrow and Atqasuk are having problems with snow/ice accumulating in their intakes and blocking the flow. The Present Weather Sensor (PWS) at Barrow is providing erroneous readings; a complete re-calibration will be done in May.

SGP (SMOS) – All systems are operating nominally with some data gaps at a few sites.

(THWAPS) – Re-calibration was initiated in 2006. Sites C1, B1 and B5 are overdue and remain to be finished.

TWP (SMET, ORG) – All systems are operating nominally. At Manus one of the redundant wind monitors failed in mid-March.

2.28.1 Develop Dynamic Rain Gauge Calibration Facility

The tipping bucket rain gauges at the 15 SGP/EF sites with SMOS are currently calibrated using only a "static" calibration: a measured volume of water is poured into the gauge and the number of bucket tips is checked to ensure they correspond. In reality, as the rain rate increases and the bucket tips more frequently some rain is not collected. The purpose of the dynamic calibration is to determine the correction factor as a function of rain rate to account for this behavior (ECO-00495).

STATUS – Calibrations are underway. A schedule for calibrating all SMOS rain gauges over the next six months has been developed.

2.28.2 Upgrade T/RH Probes and Wind Sensors for NSA Met Systems

Ice develops on the wind vanes, cup anemoneters, and aspirator inlets for the temperature and relative humidity 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 relative humidity probes with new, heated probes designed to operate in cold environments (ECO-00595).

STATUS – Deferred until higher priority instrument procurements are completed.

2.29 Tandem Differential Mobility Analyzer

Mentor: Don Collins, Texas A&M University

Chance Spencer and Don Collins presented a poster on the TDMA system at the ARM Science Team Meeting in Monterey.

Data from the TDMA are currently 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 Archive as "beta-data." An ingest is being developed to produce netcdf files for inclusion in the main Archive (ECO-587).

2.30 Hot Plate Total Precipitation Sensor (TPS)

Mentor: Mark Ivey, Sandia National Laboratory

Mark Ivey and colleagues presented a poster on the TPS system at the ARM Science Team Meeting in Monterey.

In late February and early March, the Hot Plate Total Precipitation Sensor indicated precipitation during periods when precipitation was not observed at the site or by other precipitation sensors nearby. Mark Ivey discussed this problem with the manufacturer. Yankee indicated that anomalous precipitation had been observed under cold conditions at other installations and an upgrade to the instrument's firmware was required. We are in the process of obtaining and installing that upgrade.

2.31 Total Sky Imager

Mentor: Vic Morris, Pacific Northwest National Laboratory

AMF – Operational at Heselbach.

NSA – The instrument has been reinstalled and is operational.

SGP – Operating nominally.

TWP – The TSIs at Darwin are operating nominally. Images at Manus and Nauru are occasionally hazy. Efforts to reduce moisture inside the camera housing continue.

New, improved mirror controllers are being developed by Ray Edwards at Brookhaven National Laboratory.

2.32 Meteorological Tower Systems

Mentor: David Cook, Argonne National Laboratory

60-m tower at SGP C1 (central facility) – nominal operation.
21-m tower at SGP E21 (Okmulgee) – nominal operation. Turkey vultures have been observed roosting on the wind speed/direction sensor.
40-m tower at NSA C1 (Barrow) – problems due to ice formation on temperature/humidity sensors and on the wind direction vanes continue. Replacement of these sensors with sonic anemometers and heated temperature/humidity probes has been proposed (ECO-00595).

SOWs have been prepared, quotes obtained, and Purchase Requisitions submitted for maintenance on the 60-m tower at SGP and the 40-m tower at NSA. SGP tower maintenance is tentatively scheduled for 23-27 July; NSA tower maintenance is scheduled for mid-August.

2.33 Vaisala Ceilmeter

Mentor: Vic Morris, Pacific Northwest National Laboratory

Data are generally good at NSA and SGP. Electronic ringing in the backscatter plot is visible at NSA-C2 (Atqasuk) and SGP-B5 (Morris, OK), but this does not affect the instrument's ability to detect clouds. Data were generally good at Manus, but the systems at Darwin and Nauru experienced reduced sensitivity to high clouds due to optical cross-talk problems.

2.34 W-band (95 GHz) Atmospheric Radiation Measurement Program Cloud Radar

Mentor: Kevin Widener, Pacific Northwest National Laboratory

AMF – 100% up time at Heselbach, Germany.

SGP – 71.5% up time in March due to a failed chiller fan.

In February 2008, following the deployment at Germany and prior to the deployment to China, the AMF WACR will be collocated with the SGP WACR for calibration.

2.34.1 Study Network Transfer of MMCR and WACR Spectra to Archive

ECO 00369 presents a mechanism to ship MMCR and WACR spectra data from measurement site to Archive by shipping hard drives. This requires significant costs in shipping of media, especially from the TWP Island sites, as well as significant staff effort to manage the relatively large number of disks and to implement the process at the sites and the Archive. This ECO proposes that we evaluate the feasibility of implementing data reduction algorithms (ECO-00391) at each MMCR and WACR installation and that of shipping the resulting files to the Archive via Internet.

STATUS – A version of this software has been tested. Implementation is underway (BCR-1349).

3 Future Instrumentation Planning

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

3.1 Future Microwave Radiometers

The 2-channel MWRs range between 8-15 years old. They are no longer being manufactured. Warren Wiscombe and Eugene Clothiaux are organizing a workshop to discuss/determine ACRF's plans for future microwave radiometers. The workshop will be held in November, just prior to the joint meeting of the Cloud Properties and Cloud Modeling Working Groups.

3.2 Atmospheric Radiation Measurement Program Volume-Imaging Array

The ARM Volume-Imaging Array (AVA) is a proposed radar system to be deployed at the ARM SGP site to address the ARM program's need of mapping 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 Kolias include:

- 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) and 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 VAP similar to the existing ARSCL but on a regular 3D grid.

- Development of an "AVA Simulator." Patterned after the well-known International Satellite Cloud Climatology Program Simulator, the AVA Simulator will perform forward simulations of radar observables, using as input large-eddy simulation model and cloud-resolving model 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, has been deferred until 2008 when simulations have been carried out to demonstrate its capabilities and further refine its requirements.

3.3 Absolute Scanning Radiometer

To provide an absolute IR flux reference, which could be used to calibrate the Eppley PIRs, Ells Dutton has suggested that ARM develop an Absolute Scanning Radiometer (ASR). This instrument would be functionally equivalent to an ASR developed by Rolf Philipona for the 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.

3.4 Portable Raman Lidar

Leosphere http://www.lidar.fr/ offers a portable MPL-type lidar that can be augmented with Raman capability. Raymetrics http://www.raymetrics.gr/(sold by Kipp & Zonen) also offers a Raman Lidar. Iwona Stachlewska of Leosphere deployed their non-Raman EZ Lidar at the SGP on 19 October for comparison with the ARM MPL system. Leosphere expects to have a commerical Raman system available in mid-to-late 2007. Raymetrics will not be able to furnish a demonstration Raman lidar system.

STATUS – Clarification of the scientific requirements for a portable Raman lidar is necessary before proceeding.

3.5 High-Resolution Oxygen A-Band and Water-Band Spectrometer

Qilong Min has submitted a proposal to build an A-band spectrometer for ARM. The 3-year proposal and budget were sent out for technical reviews. The technical reviews, along with the proposal and budget, were then provided to the Science Team Executive Committee. The Science Team Executive Committee directed Qilong to present his plan and budget to the Cloud Properties working group for prioritization. Qilong presented a revised work plan (water-band/cloud phase components removed) and has submitted a revised budget.

STATUS – At the 2007 ARM Science Team Meeting in Monterey Anthony Davis organized a discussion of the need for and possible approaches to providing A-band measurements at an ACRF field site.

3.6 Rotating Shadowband Spectrometer Overhaul

Peter Kiedron has demonstrated that the RSS built by YES 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 at SUNY-Albany for a complete overhaul.

3.7 Add 1.6 μm Channel to Multi-Filter Rotating Shadowband Radiometer and Narrow Field of View

Alexander Marshak has recommended that ARM support the development of a NFOV radiometer at 1.6 μm to permit the retrieval of droplet size distribution. Andy Lacis and colleagues have suggested a 1.6 μm channel be substituted for the unfiltered (broadband) channel in the MFRSR. Because the unfiltered channel is now being used in a broadband radiometer best estimate VAP for quality checking purposes, only a limited number of MFRSRs would be modified to accept a 1.6 μm channel.

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

John Ogren has suggested replacing the aging Optical Particle Counter included in the SGP AOS with a new Aerosol Particle Sizing Spectrometer to be integrated into the existing TDMA.

3.9 Infrared Thermometers for the Southern Great Plains Extended Facility Sites

Six IRTs were purchased in FY 2004, 9 additional IRTs were purchased in FY 2005. Some of these have been deployed with the AMF. Twelve SGP EF sites are currently equipped with IRTs; 10 additional IRTs would be needed to permit an IRT to be deployed at all 22 SGP extended facilities.

4 Small Business Innovation Research

The DOE SBIR web page is at http://www.er.doe.gov/sbir/

4.1 Eye-Safe Ultraviolet Backscatter Lidar for Detection of Sub-visual Cirrus (FY 2006)

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: "Eye-Safe ultraviolet Backscatter Lidar for Detection of SubVisual Cirrus"
http://www.science.doe.gov/sbir/awards_abstracts/sbirsttr/cycle24/phase1/039.htm

and to Physical Sciences, Inc.: "Field-Worthy ultraviolet Backscatter Lidar for Cirrus Studies."
http://www.science.doe.gov/sbir/awards_abstracts/sbirsttr/cycle24/phase1/044.htm

4.2 Instrumentation for Remotely Sensing Aerosol Optical Properties – Aerosol Phase Function (FY 2006)

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.: "CAPS-Based Particle Single Scattering Albedo Monitor."
http://www.science.doe.gov/sbir/awards_abstracts/sbirsttr/cycle24/phase1/040.htm

4.3 Unmanned Aerospace Vehicle-Suitable Cloud Radar (FY 2006)

Phase I funding was awarded to ProSensing, Inc: "High-Power, Pod-Mounted W-band Cloud Radar for Unmanned Aerospace Vehicles (UAV)."
http://www.science.doe.gov/sbir/awards_abstracts/sbirsttr/cycle24/phase1/045.htm

4.4 In-situ Measurement of Cloud Properties with Large Sample Volumes (FY 2007)

Warren Wiscombe contributed the following sub-topic and will be the technical contact.

The DOE ARM Program was formed to study the climatic effects of clouds. These effects, particularly how clouds respond to climate change (the so-called "cloud feedback" problem), are large yet poorly understood from both a measurement and modeling point of view (cf. Stephens 2005). Currently, there is a huge gap in spatial scale between in-situ measurements of cloud properties, typically from aircraft and balloons whose instruments have sample volumes on the order of cubic centimeters, and remote sensing retrievals of cloud properties, which have sample volumes ranging from tens of cubic meters (radar and lidar) to thousands of cubic meters (satellites). Most acute is the fact that in-situ measurements at a particular point give no information on the vertical distribution above and below that point, while active remote sensing retrievals typically give instantaneous vertically-resolved information. Since clouds are inhomogeneous down to centimeter scales, there is a complete lack of comparability between in-situ

measurements and remote retrievals; simple assumptions of homogeneity to scale up the in-situ measurements are certainly false. Clouds also evolve considerably in the course of a minute, and thus methods, which are slow in time (such as a balloon ascending, or an aircraft ascending or descending) fail to capture the instantaneous state which remote sensing sees. Thus, there is a great need for in-situ measurements which have fast vertical reach and much larger sample volumes, ranging from cubic meters to hundreds of cubic meters, in order to allow meaningful comparisons with surface and satellite retrievals of cloud properties. Without confidence in those surface and satellite retrievals, which are our only way to extend our reach to the whole planet, it is impossible to make progression key global change issues concerning cloud feedbacks on global warming.

Therefore, grant applications are sought to develop instruments to measure cloud properties in-situ, for scales ranging from cubic meters to hundreds of cubic meters, with particular emphasis on fast vertical profiling above and below the in-situ platform. (The platform need not be a traditional aircraft or balloon; instruments for small UAVs, kites, gliders, and tethered balloons will also be considered.) An example of such an instrument can be seen in Evans et al. (2003). Measurements of the following cloud properties are particularly wanted, in order of decreasing priority for cloud-climate applications: (a) extinction coefficient at one or more wavelengths in the solar spectrum away from strong water vapor absorption bands; (b) total water content (liquid plus ice); (c) liquid and ice water content separately; (d) effective radius, defined as the ratio of the 3rd to the 2nd moment of the drop size distribution; (e) absorption coefficient or single-scattering albedo at one or more wavelengths in the solar spectrum away from strong water vapor absorption bands; (f) the scattering phase function for ice clouds; (g) the drizzle and precipitation fraction of the total condensed water content; (h) the supersaturation; (i) the dispersion, a measure of the width of the drop size distribution.

Stephens, G. 2005. "Cloud feedbacks in the climate system: A critical review." *Journal of Climate* 18:237-273.

Evans, KF. 2003. "In situ cloud sensing with multiple scattering lidar: Simulations anddemonstration." *Journal of Atmospheric and Oceanic Technology* 20:1505-1522.