Report of the BERAC Review Panel on the Atmospheric Radiation Measurement (ARM) Climate Research Facility (ACRF)

March 11, 2011

Prepared by the Subcommittee of the Biological and Environmental Research Advisory Committee (BERAC) on ACRF Review

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1. INTRODUCTION

In August 2010, Dr. William Brinkman, Director of the Office of Science of the U. S. Department of energy, charged the BERAC to provide a review of the mission, operation, and future plans of its ACRF user facility. This report is in response to the charge letter, prepared by a review panel on behalf of the BERAC (Appendix B).

ACRF is a national user facility that provides critically needed observations of atmospheric radiation, clouds, aerosols, precipitation, and related atmospheric thermodynamic and dynamic variables for the study of global climate change for the broader national and international research community.

Objectives of the ACRF facility are to

- Collect and develop comprehensive and continuous long-term data sets of radiation, aerosols, clouds, precipitation, dynamics, and thermodynamics over a range of environmental conditions at several fixed and mobile sites situated in climatically diverse locations.
- Supplement the long-term data sets with laboratory studies and shorter-duration field campaigns, both ground-based and airborne, to target specific atmospheric processes under a diversity of locations and atmospheric conditions.
- Enable research by providing data support to understand and parameterize the processes that govern clouds and radiation.
- Enable research by providing data support to improve climate models.

ACRF consists of the following components:

- Three fixed sites
- Two mobile facilities (AMF)
- An aerial facility
- Data processing, data quality control, and data archive facilities
- Personnel and technological infrastructure to maintain and operate these components.

The locations of the ACRF fixed sites and deployment of the mobile and aerosol facilities to date or under planning are shown in Figure 1.

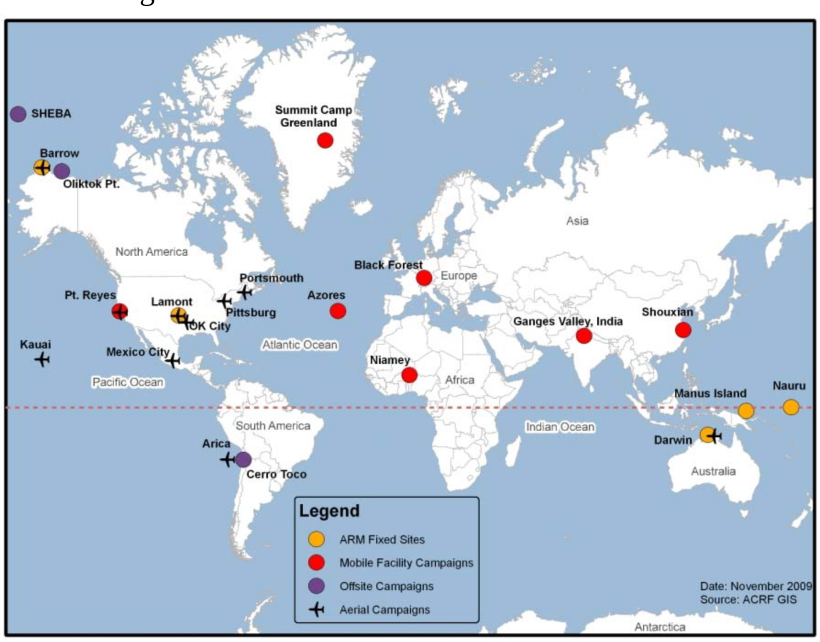

Figure 1. Locations of the ACRF fixed sites, mobile facility deployments, and other field campaigns

The charge letter specifically asked for evaluation of eight questions (Appendix A). The panel divided these questions into four groups:

(1) Science impact and support
(2) Management
(3) Resources
(4) Recommendations

The review panel consisted of six people, three from the university community, and one each from NASA, NOAA, and NCAR which is sponsored by the NSF. Two of the panel members are members of the BERAC. Composition of the panel membership is in Appendix B.

In conducting the review, the panel had a two-and-a-half day meeting in Ponca City, Oklahoma to examine relevant ACRF reports and publications, visit the ACRF SGP Central Facility, and to interview operation managers of the various ACRF sites. The panel heard eleven presentations by the ACRF Infrastructure Management Board on the ACRF management structure and process, ACRF operations, the Aerial Facility, the Field Campaign Process, the Engineering Process, Instruments and Data Products, Communications and Outreach, the Recovery Act, and ACRF Accomplishments. ACRF Program managers Wanda Ferrell and Rickey Petty were present at the review meeting to answer questions; Dr. Gary Geernaret, Director of the Climate and Environmental Sciences Division of BER, and ASR (Atmospheric System Research) Program manager Dr. Ashley Williamson were also present to answer ACRF related questions.

2. FINDINGS

2.1 Science Impact and Support

Charge letter question:

Is the use of ARM Climate Research Facility resources making a significant impact in climate change science?

The review panel evaluated the science impact of ACRF with two criteria. The first is based on science progress in which ACRF has made critical contributions; the second is based on usage statistics of ACRF data and peer-reviewed publications enabled by ACRF.

The panel found that ACRF has made a significant contribution to climate change science by providing the following unique datasets and measurement capabilities, which did not exist before:

(1) A vertical cloud profiling dataset, including macro- and microphysical properties, at high temporal resolutions in a range of climate conditions. These data are critical to improving the treatment of cloud overlap in models, quantifying the radiative heating profile of the atmosphere, developing cloud climatologies, and improving the understanding of cloud processes.
(2) A spectrally-resolved infrared radiance dataset, which has helped to greatly improve infrared radiative transfer models, reducing uncertainty from about 10 W/m^2 before ACRF to 1-2 W/m^2 currently.
(3) Improvement in the ability to measure atmospheric water vapor, reducing the uncertainty in the column amount of precipitable water vapor from 10-15% to 3-4%.
(4) An atmospheric state dataset (i.e., profiles of temperature, humidity, and wind) together with the vertical cloud property dataset, and large-scale atmospheric dynamics forcing dataset, which can be used to drive single-column models and cloud resolving models over the ACRF sites, thereby allowing the physics of these models to be evaluated against observations.

(5) Unique observations of the microphysical properties, chemical composition, and radiative properties of aerosols, both from the ground and with the many airborne field campaigns, thereby allowing the impact on the radiative budget to be quantified in diverse locations, as well as how aerosols affect cloud properties and evolution and vice versa.
(6) Long-term, statistically relevant, airborne observations of liquid, ice, and mixed-phase cloud properties, aerosol properties, and trace gases, thereby allowing detailed process-level understanding of cloud-radiation-aerosol-precipitation interactions.

ACRF has played a critical role to enable the following progresses of climate change science:
(1) Improved radiative transfer codes in several major Atmospheric General Circulation Models, including the Community Atmospheric Model (CAM) in the Community Earth System Model of the United States.
(2) Improved parameterizations of cloud and convection parameterization in the CAM.
(3) Incorporation of the improved aerosol indirect effects on climate in the CAM.
(4) The development of a multi-scale modeling framework, wherein cloud resolving models are embedded inside each grid of a general circulation model (GCM), allowing for a more complete treatment of complex cloud processes in climate models.
(5) Improved physical parameterizations and performance of climate and weather prediction models in other countries, such as at the European Center Medium Range Weather Forecasting (ECMWF).

From the perspective of user statistics, ACRF has been credited by over one thousand peer-reviewed publications since 2004.

Active users of the ACRF data and facility have exceeded six thousand (Figure 2)

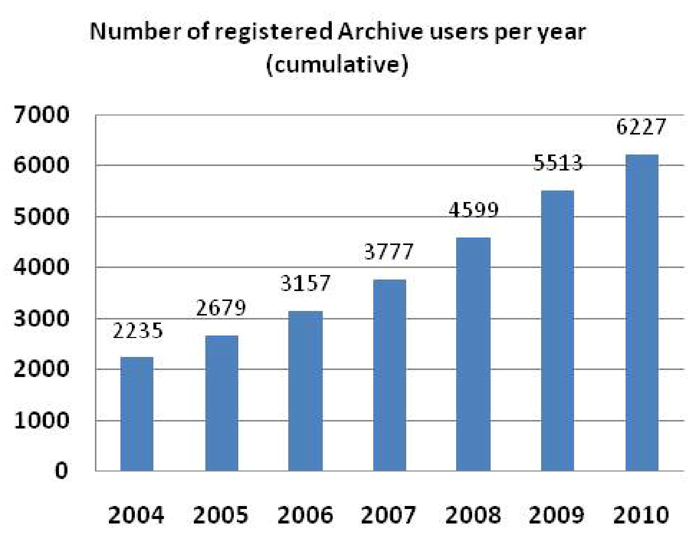

Figure 2. Number of registered users of the ACRF data archive

The panel made some recommendations on how ACRF may further enhance its impact on climate science research. These are described in Section 2.4.

The panel concluded that observational dataset collected by ACRF has had a significant impact on climate change science, and will continue to be a critical resource to the climate science community.

Charge letter question:
Does ACRF adequately support the science objectives of DOE Atmospheric System Research program and the general scientific user community? If so, is it appropriate for a BER-supported user facility?

The science objectives of the Atmospheric System Research (ASR) Program are (1) to understand the life cycles of aerosols, clouds, and precipitation processes and their interactions on different time scales, and (2) to develop parameterizations that incorporate this process-level understanding in climate models. The overall science objectives are pursued by three ASR working groups which are the Aerosol Life Cycle, the Cloud Life Cycle, and the Cloud-Aerosol-Precipitation Interactions working groups. The more specific science objectives of the working groups have evolved and continue to evolve in time and are presently articulated in the ASR science plan by the working groups via their science steering committees. These working groups are co-chaired by members from the ASR science team, where one chair has expertise in modeling and the other with expertise in observations. The six working group co-chairs constitute the majority of the Science and Infrastructure Steering Committee (SISC), which discusses scientific priorities within the ASR program and makes recommendations to the ACRF managers to help address these priorities. This close relationship allows ACRF to remain cognizant of the science needs of the ASR science team.

The support from ACRF to ASR and the general scientific user community has taken several forms, including the following:

- ACRF provides the ASR science team and the larger science community with a suite of observations that allow for study of science questions related to radiation, cloud, aerosol, and precipitation. The data have been accessible, reasonably validated, and contain the metadata information needed for the science team to understand and utilize the observations.
- ACRF provides the ASR science team and the larger science community with the capability to propose new instruments, new measurements, and field campaigns for the pursuit of their science objectives.
- ACRF provides the ASR team and the larger science community important high-level processed products, from raw measurements to integrated geophysical physical variables, so that they can be directly used for process understanding and model parameterization development.

The panel discussed the degree of processing required to produce a certain geophysical quantity needed by the science community. Voltages from instruments form the most basic level of measurement; i.e., this is the raw measurement. Level 1 data refer to basic geophysical quantity that is native to a particular instrument or measurement system and requires minimal assumptions to produce from the voltages. An example of Level 1 data would be calibrated profiles of radar reflectivity that are derived directly from power scattered back to the radar antenna by hydrometeors in the atmosphere. Level 2 data includes geophysical quantities produced from Level 1 data by the application of algorithms that convert the measurement to a physical quantity. An example of level 2 data would be liquid water concentration in a cloud that is calculated from the radar reflectivity by applying an algorithm that has been developed from theoretical and empirical considerations. Finally, Level 3 data would be composed of statistics derived from the Level 1 and 2 quantities. Frequency distributions of the liquid water concentration for certain averaging periods or under specified conditions would be an example of level 3 data.

ACRF has been highly effective in collecting and delivering the basic level and Level 1 data streams. It has also delivered some highly-demanded Level 2 products. The panel considers the development of Level 2 and Level 3 products as a critical joint effort between ACRF and ASR; this will be described as a recommendation in Section 2.4.3.

The panel agrees that ACRF has adequately supported the science objectives of the DOE ASR program and the general science user community. Given the critical needs of the climate science community, the complexities of the facilities, the scale of the measurement operations, and the technical and science expertise required, the panel thinks that it is not only appropriate but also important for DOE BER to operate ACRF.

2.2 Management

Charge letter question:
Is ACRF management effectively setting priorities, tracking progress, and resolving problems that impact facility operations?

Setting Priorities
To set its priorities, ACRF management sought input from the ASR Science Team via the Science and Infrastructure Steering Committee (SISC) and during its annual meetings, from the ACRF Science Board, and from ACRF-initiated workshops. In 2008, ACRF Program Manager Wanda Ferrell organized a workshop of 30 prominent climate scientists to identify strategies for the use and structure of the ACRF, and to answer these questions: what are the outstanding science questions for the next ten years, and what measurements, instruments, and data products are needed to address the science questions? Feedbacks from the science community, such as this workshop, have been the main driver of the program.

The panel found the ACRF management to be highly effective in carrying out prioritized tasks. ACRF implemented a management model that includes a Science Board and an Infrastructure Management Board (IMB). The Science Board consists of the ASR Science Working Group Chairs and appointees from the general climate science community who aren't supported by ASR; the IMB consists of ACRF Technical Director, Operations Manager, Archive Manager, Instrument Coordinator, and Aerial Facility Manager. The first group provides feedbacks and guidance on the science priorities; the second group carries out the operations and delivers the data products.

The panel is also impressed by the foresight of the ACRF program managers in seeking new opportunities, knowing the limitations and strengths of the facilities, and planning for new activities. When resources from the American Recovery Act became known in late 2008, ACRF had already identified a list of highly desired instruments and capabilities to address some of the most challenging science questions. Therefore, when funding from the Recovery Act became available and fully released to ACRF in September 2009, it could quickly start the design, review, and acquisition of new instruments. By the end of 2010, most the newly acquired instruments had been deployed. This is a good reflection of ACRF management in constantly evaluating and planning for its priorities.

The panel is impressed by the effort of the ACRF management to actively solicit inputs from the science community to set its priorities, and to decisively act on these inputs to run the facilities.

Tracking Progress
ACRF tracks its progress through the following process:

- Monitoring of operational status of all ACRF instruments at all sites at the Pacific Northwest National Laboratory (PNNL)

- Usage of its datasets, segregated into various forms such as different instrument and data types and demographics of the users
- Peer reviewed publications that use ACRF datasets
- Research highlights that use ACRF datasets
- Status report at the annual ASR Science Team Meeting
- Regular meetings of the ACRF Science Board, Science and Infrastructure Steering Committee, and Infrastructure Management Board – each meets multiple times per year.

The panel found that there is a mechanism to track progress in ACRF at various levels, and it is working well.

Resolving Problems
The panel found that the ACRF management structure and approach are effective in resolving problems in its operations. Responsibilities for each operation component and procedure are clear and visible to the ACRF operations community and the user community. Problems are resolved through the following forums:

- Real-time monitoring of instrument functions and quality control of data streams at PNNL
- Weekly teleconferences of ACRF Problem Review Board and Engineering Review Board
- Weekly teleconferences of the Infrastructure Management Board, consisting of technical director, managers of operations, instruments, engineering, data archive, and aerial facility
- Bi-weekly teleconferences of ACRF operation site managers
- Bi-weekly teleconference of the data systems and data quality control personnel
- Monthly Instrument Status Reports
- Monthly Value-Added Product Reports
- Annual meeting of the ASR science team
- Flexibility of ACRF program managers to encourage and act on feedback at all levels.

The panel considers ACRF management to be highly effective in operating the user facility.

Charge letter question:
Are the ACRF and participating laboratory management roles and responsibilities effectively carried out and coordinated?

The ACRF infrastructure management team is dispersed among several of the DOE national laboratories, which makes it a challenge to coordinate the many activities that are a part of the facility. PNNL houses the offices of ACRF Technical Director, Engineering Manager, Instrument Coordinator, and Aerial Facility; Argonne National Laboratory (ANL) houses the offices of the ACRF operations manager, Southern Great Plains site manager, and the site manager for the second mobile facility; Oak Ridge National Laboratory (ORNL) houses the ACRF data archive; Sandia National Laboratory (SNL) houses the office of the site manager for the North Slope of Alaska facility; Los Alamos National Laboratory (LANL) manages the first mobile facility and the Tropical Western Pacific sites; and Brookhaven National Laboratory (BNL) and Lawrence Livermore National Laboratory (LLNL) house ACRF high-level data processing units. ACRF functions at the levels of instrument, measurement, data quality control, processing and delivering, are dispersed throughout the national laboratories.

The panel found that interactions and coordination among the laboratories are very good: the ACRF runs seamlessly across the laboratories as a single user facility. The team’s activities are coordinated via the Infrastructure Management Board, to which the various managers belong, and Facility

Science Board, which ensures the objectives of the program; the two boards work together jointly reporting to the ACRF program managers. The team uses an engineering-based approach to management. It regularly and frequently communicates using a series of conference calls, email exchanges, and web-based tools that are specific to the different aspects of the program. These mechanisms allow issues to be quickly identified and progress to resolve them to be tracked. Further, we note that the team seems to be continuously looking for ways to improve the processes and efficiency associated with coordinating this large and complicated program, for which we compliment them. We also found a mission emphasis among this group that is exemplary. Even though they are dispersed among the national laboratories, they are focused much more on accomplishing the ACRF mission than on parochial laboratory issues that may interfere with accomplishment of the larger ACRF goals. The collegial nature and mission focus explains the success of the ACRF generally.

Under the ACRF management structure, roles and responsibilities are transparent within ACRF and to the community. An outside user is able to quickly find the right contact person to address problems.

We believe that the ACRF management team is effectively carrying out its responsibilities; the coordination among the national laboratories is almost seamless.

Charge letter question:
Is there an ongoing program of self-assessment or external benchmarking aimed at continuously improving ACRF management and operations?

ACRF carries out the following self assessment activities:

- Infrastructure Management Board teleconference to conduct weekly review of status
- Data coordination call for bi-weekly assessment of data issues
- Monthly Science and Infrastructure Steering Committee call.
- ASR working group meetings in the autumn and science team meeting in the spring to engage users and solicit input on current course for data products and other activities
- Conducting user satisfaction survey by communications team after each aerial facility campaign
- Compiling lessons learned for major deployments
- 2007 Archive user workshop to solicit feedback on archive usability
- 2009 Facility User Survey
- Annual Accomplishments Reports
- Tracking progress of data and facility usage, and the science impact, as described in the answers to the first charged question in this section.
- Seeking comments through the web page from the wide community, using comment boxes dedicated for various aspects of the program, each with a submit button.

The ACRF team has been continuously assessing progress to improve their management and operations. However, there is no formal self-assessment program that is documented.

2.3 Resources

Charge letter question:
Is the user model for allocating resources for all ACRF capabilities appropriate? Does ACRF attract the best mix of users?

ACRF resources go to the following activities: instrument and engineering, fixed site operations, mobile facility operations, aerial facility operations, technical coordination, data management operations, data archive and delivery. ACRF allocates about half of its resources to measurements at the three types of sites – three fixed sites, two mobile facilities, and the aerial facility; the first type is for continuous measurements and fixed-site field campaigns, the other two types are for field campaigns. ACRF allocates about a quarter of its resources on data processing, management, archive, and delivery.

The user model of ACRF is to either access the ACRF data archive to download data directly, or to propose field campaigns through a peer-review process of proposals. All data from the field campaign are made available to the general user community. ACRF also has the mechanism for users to add instruments or measurements to supported field campaigns.

Because ACRF data are openly available, it has a good base of users in the climate science community, including the national laboratories, universities, research institutions, and educational organizations. The solicitation of field campaigns has also attracted teams of scientists across institutions and different countries that have included instruments supported by other institutions. The panel has made recommendations for ACRF to further expand its user bases in Section 2.4.2.

The panel finds the ACRF user model to be suitable for its missions; the model is compatible with the allocations of resources. It has a very good mix of users.

Charge letter question:
Are there adequate resources to accomplish the BER mission at ACRF in the current budget scenario? Are ACRF processes for allocating and managing BER resources (personnel and funds) appropriate?

ACRF has, through the American Recovery and Reinvestment Act, upgraded and added new observing facilities in 2010-11 that have challenged the leadership team to seek efficiencies in operations. They were well positioned to make the investment because of prior planning for the future by the leadership team, and have made excellent use of the Recovery Act investment, acquiring and deploying instrumentation that will move ACRF toward solving the next generation of climate science questions.

The addition of new assets required a reallocation of resources and efforts to insure that both existing and new facilities provide high quality data to ASR and broader community users. Acquiring and operating additional facilities, particularly the suite of new radars with their large data generation capacity, has also placed additional demand on the ACRF data archive to process and store data and provide it to users. ACRF is achieving its goal of end-to-end deployment and processing of these assets and data.

The United States, through the American Recovery and Reinvestment Act, has made a significant investment in ACRF infrastructure and the scientific payoff will rely on the successful and effective operations of the new instruments. It is therefore of the greatest importance that the resources required to keep the facilities at their full operating capacity be maintained in the future.

ACRF processes and procedures for allocating and managing BER resources are balanced and well carried out. The leadership has had the challenging job of managing a facility that has staff in several National Laboratories. Prioritization of the resources for these facilities has been targeted at carrying out the key scientific questions of ASR and the broader user community. Part of the success has come from the good working relationship between the staff of the various labs, and the years of professional experience of the key leaders associated with each of the facilities in ACRF.

At the end of the review meeting, Wanda Ferrell presented a plan of reorganizing the ACRF Infrastructure Management Board by reducing the complexity of the management hierarchy to more effectively manage the newly acquired facilities. This is a positive step by the ACRF management to adjust resource allocations appropriately based on new program needs.

The panel believes that ACRF has been functioning well under the present budget challenges even with the increased demand from the ARRA instrument purchase and deployment. It is critical that current level of funding be maintained, and budget implemented in future years that includes operation, maintenance and production of data products from the full ACRF instrument suite. The allocations of personnel and funds in ACRF are appropriate.

2.4 Recommendations

Charge letter question:
Could changes be made to increase the impact of ACRF on DOE Science Goals?

The panel recommends the following changes or additions to increase the scientific impact of the ACRF:

2.4.1 Data quality

The legacy of the ACRF, as measured by its long-term value to the science community, will be defined by the quality of its data products. Data quality and the documentation of data quality are two of the most important attributes of an observational program like ACRF.

ACRF implements its data quality control procedures through three mechanisms: (1) the Data Quality Office (DQO) in which all data streams are visually inspected by student interns and infrastructure personnel, (2) instrument mentors that provide additional expertise for each instrument system, and (3) individual PI investigations. The latter mechanism is a form of decentralized quality control of value-added products. The DQO generates a quality control text file associated with each data file; when a user orders a data file, the quality control text file is automatically retrieved.

Because of the importance of data quality, the panel finds that changes can be made to improve the process. These include the following:

(1) The instrument mentors, the site scientists (in coordination with the ASR), and the DQO, should all participate formally and interactively in a well-defined data quality control protocol. Each of these entities should have a clear, and coordinated, responsibility in this task. The approach should include evaluating the data streams individually and as part of the cohesive whole (i.e., via intercomparisons, physical consistency, etc.). The methodology should be streamlined such that problematic data can be quickly identified, documented, investigated, and corrected.

(2) While the quality control text files that are presently produced are valuable, given the amount of data files most users download, it is practically very difficult for users to inspect all the text files. ACRF should consider flagging the data within the data files by adding a QC variable in the data files to facilitate automated use of data quality information.

(3) Re-processing of some data streams should be considered for highly valued products if new calibrations, algorithms or improvements become available. Given the maturity of ACRF

program, the re-processing should be considered as a routine component in the ACRF operations plan.

2.4.2 User workshop

ACRF currently conducts some outreach and K-12 education activities, to a limited extent, from its technical director's office, to promote the program. The committee sees opportunities for ACRF to make a larger impact on the atmospheric community by organizing an annual or biannual user workshop, targeting undergraduate and graduate students as well as young scientists.

ACRF is uniquely positioned to educate this group of potential users about how the instruments function, what geophysical parameters can be measured, what are the uncertainties and limitations of the measurements, and how the ACRF data can be accessed. The workshop should include tutorial sessions on the basic instrument theories and possible demonstrations of the measurements, with instrument mentors participating in these sessions. Such tutorials can be videotaped and posted on the ACRF website for broader audience to view.

Given the constraint of resources, ACRF may explore partnerships with other user workshops of community resources, such as those for the Weather Research and Forecasting Models (WRF), and the Community Earth System Model (CESM).

The payoff from the user workshop to the program will be in several significant ways: training of students who may be entrained in instrument and measurement sciences; a much wider user base of ACRF products; more careful use of ACRF data; and development of more value-added ACRF products by the community.

2.4.3 Production of Level 2 Value Added Products

The creation of Level 2 value added products (VAPs) from ACRF measurements is often necessary for the observations to have a significant impact in the modeling community. ACRF has recognized this requirement and devoted considerable effort with some success on delivering geophysical descriptions to the community that adds value beyond the basic calibrated measurements from ACRF instruments. However, many necessary geophysical variables remain undeveloped with only marginal prospect for operational implementation in a reasonable time frame. Because of their importance as input into ACRF Showcase Data sets (Section 2.4.5 below), the committee recommends the following steps be taken:

(1) A VAP mentor program should be established following the successful form of the instrument mentor program. These mentors would be chosen competitively from the broader scientific community and contracted to produce for the ACRF data archive specific Level 2 quantities from ACRF data.
(2) VAP products should be reprocessed on some reasonable timeframe so that recent innovations in technology are incorporated into the products.
(3) A component of the VAP mentor program should include development of instrument simulator software packages that take model output and produce simulations of ACRF measurements.

2.4.4 Coordination and resource sharing with other federal agencies and institutions

ACRF has had a good track record of collaborating with NASA and agencies in foreign countries (e.g., Germany, Republic of Azores, China), but the committee sees more opportunities for ACRF to work with other US federal agencies and institutions including other science areas supported by BER. These include considerations of the following:

(1) The ACRF field campaigns at its fixed sites and AMF sites may be more closely coordinated with those of other funding agencies. ACRF may seek managers of NSF, NASA and other agencies to sit on its review board of proposals, and vice versa, so that various funding agencies are mutually informed of proposed activities.
(2) ACRF should make formal arrangement with the Science Steering Committee (SSC) of the Community Earth System Model (CESM) to present ACRF products at the annual NCAR CESM workshop and the Atmospheric Model Working Group Workshop (AMWG).
(3) NSF and NOAA currently jointly fund Climate Process Team (CPT) proposals, in which people specializing in measurements, process studies, and climate modelers work together to improve climate models in the US. ACRF may seek to participate formally or informally in these CPTs to offer expertise and data support.
(4) ACRF may consider scheduling the ACRF/ASR working group meeting jointly with regular climate science workshops in the community such as workshops of the NSF Center for Multiscale Modeling of Atmospheric Processes (CMMAP) to enhance its visibility in the climate modeling community.
(5) ACRF could actively engage climate modelers participating in the international program of Cloud-Feedback Model Intercomparison Project (CFMIP) by supporting it with ACRF data.

2.4.5 ACRF Showcase Dataset

The current ACRF Climate Modeling Best Estimate (CMBE) product, which synthesizes multiple datasets into a single dataset of quality controlled geophysically important variables at standard temporal and vertical resolutions, facilitates wide use of ACRF data by the modeling community. The committee suggests this product be adopted formally by ACRF, expanded, and continuously improved as the showcase product for the modeling community. Specifically,

(1) Value-added products (VAPs), in general, need to have uncertainty estimates added. Furthermore, all good quality, and highly desirable value-added products (VAPs) should be incorporated into the CMBE (See recommendation 2.4.3) so that the CMBE represents as full a description (with uncertainty) of the physical state of the atmosphere above the ACRF fixed and mobile sites as is technologically feasible.
(2) A committee or board should be formed to decide what products and what formats should be included in this ACRF branded product. This committee should include climate modelers who know the needs of end users, measurement scientists who know the limit of algorithms, and operational people who know the feasibility of obtaining the measurements.
(3) Funding of the elements in the brand product can take two forms: ACRF programmatic funding for highly desirable data product or VAP development (See recommendation 2.4.3); ASR funding for specific tasks such as research that develops innovative approaches to utilizing new data streams.
(4) The name of this brand product should reflect the ACRF program to increase its visibility.

2.4.6 Other recommendations

(1) Cross fertilization of climate research programs within BER is recommended. ACRF is known to most people in the Global and Regional Model programs, but many people in the measurement community and ASR are not familiar of the BER modeling programs. ACRF may consider asking BER modeling programs to make regular presentations at the ASR annual meetings, and vice versa.
(2) ACRF should include in its steering community people beyond ASR that reflect its objective of serving the broader user community.

(3) It will be a good improvement to the ACRF outreach if ACRF were to add self-explanatory signs near its instruments, describing their basic features and measurements, both at the ACRF fixed site and mobile facilities.

3. CONCLUSION

Summary answers to the eight questions, in the order listed in the charge letter to the review panel, are as follows:

(1) The panel concludes that observational datasets from ACRF have made significant impacts on climate change science. Chief among these are the improvements of infrared radiative transfer models; measurement capability of atmospheric water vapor; understanding of atmospheric processes controlling the vertical distribution of clouds; improved parameterizations of convection, clouds, radiation, and aerosol-indirect effects in climate models, in particular the Community Atmospheric Model of the CESM.

(2) The panel agrees that ACRF is supporting the science objectives of the DOE ASR program and the general science user community. It is appropriate and important for DOE BER to operate ACRF because of the critical needs of its measurements by the climate science community, the complexities of the instruments, the scale of the operations, and the technical and science expertise required to run such a facility.

(3) The panel finds the ACRF user model highly suitable for its missions; it has a very good mix of users using its fixed site data, its field campaigns at the mobile facilities, and its aerial facility. The user model is compatible with the allocations of ACRF resources.

(4) The panel thinks that changes can be made in the areas of data quality, user base, and coordination with other agencies for ACRF to improve its impact.

(5) The panel finds that coordination among the national laboratories is almost seamless, and the ACRF management team is effectively carrying out its responsibilities in an exemplary fashion.

(6) The panel is impressed by the effort of the ACRF management to actively solicit and then act decisively upon inputs from the science community in setting its priorities. The panel finds that there is a mechanism to track progress in ACRF at various levels, and it is working well. The panel considers ACRF to be one of the most effectively managed programs in atmospheric measurements.

(7) The ACRF team has been continuously assessing progress to improve their management and operations. However, there is no self-assessment program that is formally documented.

(8) The panel believes ACRF is functioning well under the current budget scenario even with the increased demand of newly acquired instruments. However, the current level of resources must be maintained to operate the newly acquired instruments and associated data processing infrastructure. The allocations of personnel and funds in ACRF are appropriate.

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Office of the Director

August 30, 2010

Dr. Gary Stacey
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Dear Dr. Stacey:

The Biological and Environmental Research (BER) program within the U.S. Department of Energy (DOE) supports the operation of the Atmospheric Radiation Measurement (ARM) Climate Research Facility (ACRF), a national scientific user facility. The ACRF operates field research sites around the world that support global and climate change research. Five primary locations—the Southern Great Plains centered in Oklahoma; Darwin, Australia; Manus, Papua New Guinea; Nauru; and the North Slope of Alaska, plus aircraft and two portable ARM Mobile Facilities, are instrumented to collect high quality atmospheric and surface measurements to address climate change science questions. The facility has approximately 900 scientific users annually.

Scientists use the ACRF data to study the effects of solar and terrestrial radiant energy, aerosols, clouds, and the Earth's climate. The facility also supports interdisciplinary research involving hydrology, ecology, and weather forecasting. As part of this effort, ACRF staff process and enhance base measurements to create new data streams called value-added products. Software tools are then provided to help users work with and analyze these products.

The facility management is coordinated by the Infrastructure Management Board, a team of managers for the following activities: Technical Coordination Office, Operations, Archive, and the Aerial Facility. These managers oversee facility activities and utilize the expertise of six other DOE national laboratories for specific aspects of the ACRF. This unique partnership contributes to the DOE mission to provide for the energy security of the nation. This mission includes understanding climate impacts of current and future energy production and developing solutions as part of a sound energy strategy.

To ensure that the ACRF is meeting its mission and is being operated and managed in an efficient manner, BER periodically conducts a peer review of ACRF's operations and plans. By this letter, I am charging the BERAC to provide advice to the Office of Science on the mission, operation, and future plans of the ACRF. I would like the review panel to consider and evaluate the following issues:

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- Is the use of the ARM Climate Research Facility resources making a significant impact in climate change science?
- Does ACRF adequately support the science objectives of the DOE Atmospheric Systems Research program and the general scientific user community? If so, is it appropriate for a BER-supported user facility?
- Is the user model for allocating resources for all ACRF capabilities appropriate? Does ACRF attract the best mix of users?
- Could changes be made to increase the impact of ACRF on DOE science goals?
- Are the ACRF and participating laboratory management roles and responsibilities effectively carried out and coordinated?
- Is ACRF management effectively setting priorities, tracking progress, and resolving problems that impact facility operations?
- Are there adequate resources to accomplish the BER mission at ACRF in the current budget scenario? Are ACRF processes for allocating and managing BER resources (personnel and funds) appropriate?
- Is there an ongoing program of self-assessment or external benchmarking aimed at continuously improving ACRF management and operations?

I request the BERAC report on its findings and recommendations at its spring 2011 meeting.

Sincerely,

W. F. Brinkman
Director, Office of Science

cc: Anna Palmisano
David Thomassen
Gary Geernaert
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Appendix B: Members of Review Panel

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Appendix C: Acronyms

ACRF	Atmospheric Radiation Measurement Climate Research Facility
AMF	ARM Mobile Facility
AMWG	Atmospheric Model Working Group
ANL	Argonne National Laboratory
ARM	Atmospheric Radiation Measurement
ASR	Atmospheric System Research
BER	Biological and Environmental Research
BERAC	Biological and Environmental Research Advisory Committee
BNL	Brookhaven National Laboratory
CAM	Community Atmospheric Model
CESM	Community Earth System Model
CFMIP	Cloud-Feedback Model Intercomparison Project
CMBE	Climate Modeling Best Estimate
CMMAP	Center for Multiscale Modeling of Atmospheric Processes
CPT	Climate Process Team
DQO	Data Quality Office
ECMWF	European Center Medium Range Weather Forecasting
GCM	General Circulation Model
IMB	Infrastructure Management Board
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
NCAR	National Center for Atmospheric Research
ORNL	Oak Ridge National Laboratory
PNNL	Pacific Northwest National Laboratory
SISC	Science and Infrastructure Steering Committee
SSC	Science Steering Committee
SNL	Sandia National Laboratory
VAP	Value Added Product
WRF	Weather Research and Forecasting Model