REPORT OF THE COMMITTEE OF VISITORS

Climate and Environmental Sciences Division
Office of Biological and Environmental Research
Office of Science
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Findings and Recommendations from a Review of Fiscal Years 2013-2015

Submission to the
Biological and Environmental Research Advisory Committee
(BERAC)

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Date Approved by the BERAC_____

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Executive Summary

On November 3, 2015, Dr. Patricia Dehmer, then Acting Deputy Director for Science Programs, charged the Biological and Environmental Research Advisory Committee (BERAC) to assemble a Committee of Visitors (COV) to evaluate the efficacy and quality of the processes used to solicit, review, recommend, monitor and document funding actions and to assess the quality of the resulting portfolio of CESD within BER. The Charge letter issued by Dr. Dehmer is in Appendix A. The CESD portfolio of scientific programs and facilities to be reviewed in the 2013 to 2015 period included:

(A) Earth System Modeling

(B) Regional and Global Climate Modeling

(C) Integrated Assessment

(D) Terrestrial Ecosystem Science/Carbon Dioxide Information Analysis Center

(E) Subsurface Biogeochemical Research

(F) Atmospheric System Research

(G) ARM Climate Research Facility

(H) Environmental Molecular Sciences Laboratory

(I) Data and Computing

In response to this charge, a Committee of Visitors (COV), comprised of 18 members, was formed in the spring of 2016. The COV met on July 19-21, 2016, in Germantown, Maryland.

The following is a brief summary of the COV's report, highlighting selected findings and recommendations.

Key findings are as follows:

1. The COV commends CESD for great job of incorporating the visions of DOE and USGCRP and coordinating with other federate agencies in developing its own vision and priorities. The inputs from broader scientific communities are mainly provided by

workshops that often sponsored by DOE. The workshop participants are invited by program managers or workshop co-chairs. The number of participants is limited by budget constraints.

2. The various program solicitations have been consistent with the priorities of CESD. Review panels have been of high quality with expertise relevant to the program in general and to the particular solicitations. CESD is supporting a useful mix of large and small projects, university and lab projects, proposal-driven funding and SFAs. For the most part, only top-ranked proposals have been funded, with a few exceptions to maintain program balance. The review process and funding decisions have been well documented. The management of Scientific Focus Areas (SFAs) has been rigorous, and the CESD program managers are commended for their diligence and devotion in running these world-class programs. The recent dramatic drop in proposal success rate is unfortunate but likely temporary. Overall, the COV finds that the funding decision process is appropriate and leads to outcomes that are consistent with the language given in the FOAs.

3. The principal investigators in the various programs are high-caliber scientists. The science produced by the programs is of high quality. The programs have made significant impacts on the respective fields and are well respected by the national and international community.

4. The program managers monitor projects through annual reports, research highlights, and presentations at workshops and conferences. The SFAs have been generally monitored more frequently through telecons. The current monitoring strategy is working well.

5. Program managers currently use the numbers of publications and users as the primary metrics of the impacts of their programs. These metrics alone may not fully reflect the value of CESD's investment, especially in terms of its benefits to the general public and policy makers.

6. One of CESD's major funding initiatives is the development of ACME, a global Earth system model. A lower-resolution version of ACME with ~100 km grid spacing is under development. This should not distract from ACME's stated objective of very high resolution Earth system modeling, nor from ACME's efforts to establish itself as uniquely targeting the niche of high-resolution earth system models run at exascale on DOE

Leadership Computing Facilities. While the high-resolution version of ACME can benefit from testing with a 100-km version of ACME, this relatively low-resolution version puts ACME into more direct competition with other modeling groups in the U.S. working at this resolution, thus risking duplication of effort.

7. CESD has played an unparalleled role in providing observations for advancing the understanding of climate processes, both nationally and internationally. The current budget of the Atmospheric Radiation Measurement (ARM) Climate Research Facility (ACRF) is about $68 M per year, and the total amount expended since effort's inception in 1989 is close to one billion dollars. It is the largest field program in the history of atmospheric science. The COV is pleased that the ACRF has broadened its collaborations with other programs within CESD through joint calls for proposals, such as GOAmazon, land-atmosphere interactions, and a recent joint proposal call with EMSL to study aerosol processes.

8. The Subsurface Biogeochemical Research Program has maintained a high quality research portfolio despite the 50% funding reduction and a gradual shift of focus area away from its historical emphasis on contaminants and towards watershed-scale carbon cycle studies over the past two funding cycles. Excellent use is being made of the unique facilities of participating laboratories (e.g., EMSL, JGI, synchrotrons), especially by new program directions. However, the merging of SBR with TES has caused some growing pains (such as transitioning of field sites) and may have resulted in some loss of momentum in the SFAs during reorientation. The COV applauds CESD's efforts to maintain scientific innovation and encourages continued engagement of the broader scientific community as SBR and TES jointly make their transitions to new focus areas.

9. The COV commends CESD for embarking on a forward-looking data management activity that will enable its research portfolio to remain world-class.

10. The travel budget continues to limit the ability of program managers to attend meetings and to interact with the larger scientific community. This makes project management much harder. The COV notes that a similar comment and associated recommendation were also made in the previous review. The issue has not yet been adequately addressed.

Key recommendations are as follows:

1) CESD could benefit greatly from the external perspectives of experts from the broader scientific community to strengthen its strategic planning. We recommend that CESD ask the National Academy of Sciences to create a study group for this purpose. The study group would be analogous to the Decadal Survey commissioned by NASA, NOAA and USGS that provides guidance to NASA's programmatic decisions in space and earth science. The work of the NAS study group would benefit not only CESD but the entire U.S. climate research program.

2) The 100-km atmosphere of ACME is for efficient testing in support of developing the very high resolution version, and its applications should be aimed at those related efforts within DOE.

3) Program managers should work to provide more detailed, constructive feedback to proposers. In particular, communication of the reasons for rejections of proposals should be more clearly stated to the applicant so that he or she can determine which aspects of the proposed project reviewed well or poorly. This is particularly important for proposals that reviewed well but were not funded. Program managers should consider internal peer-review of decision letters, which is used by NASA. Program managers should also consider asking review panel members to write or contribute to panel summaries.

4) In some cases, review panels appeared to lack demographic diversity with respect to gender, ethnic background, institution type, etc. The COV recommends that program managers carefully track diversity metrics for both review panels and the participants of strategic planning workshops and that that this data be made available provide to future COVs.

5) The ASR program should strive to maintain a balance between the scientific use of the ARM data and innovative remote sensing approaches for new data product development. ASR should support some high-quality climate research that fits with the program's foci but *does not* make use of ARM data. Increasing the number of joint solicitations with other

agencies would allow PIs and the program to more fully exploit long-term surface, satellite and other datasets for climate process research.

6) In view of many recent developments, the ARM Climate Research Facility should be reviewed externally within the next few years to supplement the internal review from 2014.

7) The COV recommends that CESD formulate a more formal and transparent process of initiating/terminating SFAs and other large projects. Consistency is needed in terms of review frequency, review process, and reporting format, for all SFAs and comparable large projects.

8) The nature of many CESD activities, e.g., model development, requires performance metrics beyond traditional measures such as publication numbers. We support the clear articulation of these alternate metrics and rigorous evaluation against them. For example, it would be useful to track the number of conference presentations (invited and contributed) by researchers funded through CESD, the numbers of citations of papers that result from CESD-funded research, etc.

9) The COV recommends that CESD continue or enhance coordination with other national and international agencies to leverage and complement CESD programs. For example, SBR should closely track advances being made in other agency programs (e.g., NSF Critical Zone Observatories) to maximize the complementarity of SBR research activities and maintain clear distinctions between DOE-funded work and that funded by NSF or other agencies. It is also important to identify opportunities for joint solicitations with other agencies. These can lead to increased scientific productivity without increased costs.

10) The COV finds that the balance of funding between DOE labs and universities in most CESD programs is largely appropriate, although the reduction of funding to universities in the SBR program is noted with some concern. The COV considers CESD's investments in university research to be critical for the missions of all its programs, and also for the training of graduate students who will enter the lab workforce. It is therefore recommended that CESD programs should increase funding in support of university research.

11) Research in subsurface radionuclide transport should not be abandoned entirely because it is still needed to better manage legacy nuclear waste and to maintain national expertise in this area, which largely resides in the national laboratories. Further integration with the elements of the TES program is encouraged where feasible.

12) The Data Management program should develop a clear list of high priority capabilities it needs to provide to the CESD community, including when and how those would be provided. Given the very limited funding of the program it is important to focus on strategies that actively encourage and facilitate collaboration with other programs both in DOE (CESD, BER, ASCR, HEP, BES) and other Federal Agency programs. CESD should develop a clear technical vision of the core capability that the Data Management program needs, enabling the program to leverage a wider spectrum of contributions from the community, both funded and unfunded. The data management program and the wider CESD program should consider whether or not CESD's data management infrastructure would functions better as a user facility. The longevity, operational funding and performance metrics of a facility would help to maintain the envisaged core capabilities.

13) The individual DOE program managers should have travel budgets and management support to attend and participate in person in key national and international meetings, and also to make site visits to their funded constituents and field observation sites. Program manager visits to constituents would result in a net cost saving to DOE because it would reduce the need for "reverse site visits" in which large groups of constituents travel to the Washington DC area. This issue has been raised in previous reviews. It is time to resolve it.

I. Introduction

A. COV Operation

The COV reviewed the following nine programs and facilities:

(A) Atmospheric System Research

(B) ARM Climate Research Facility

(C) Earth System Modeling

(D) Regional and Global Climate Modeling

(E) Integrated Assessment

(F) Terrestrial Ecosystem Science/Carbon Dioxide Information Analysis Center

(G) Subsurface Biogeochemical Research

(H) Data and Computing

(I) Environmental Molecular Sciences Laboratory

B. Charge to the COV

The COV was charged with providing an evaluation of the following:

1. *For both the DOE national laboratory projects and university grants, assess the efficacy and quality of the processes used by CESD programs during the past three years to:*
   a) solicit, review, recommend and document application and proposal actions, and
   b) monitor active awards, projects and programs.
2. *Within the boundaries defined by DOE mission and available funding, comment on how the award process has affected:*
   a) the breadth and depth of the portfolio elements and,
   b) the national and international standing of the portfolio elements.

The charge letter also asked the COV to assess the management and oversight of the CESD EMSL and ACRF user facilities.

C. CESD Program Administration

Gary Geernaert is the Director of CESD.

The responsibilities of the Program Managers are to 1) prepare solicitations for proposals, 2) review preproposals, 3) solicit external review of full proposals, 4) arrange for panel meetings (if employed), 5) make award recommendations to management based on reviewer evaluations and program priorities, 6) communicate decisions to PIs, 7) prepare budget requests, 8) monitor funded projects, 9) document all substantive communication with PIs, and 10) review annual and final reports. In the meantime, the PMs must arrange for the annual PI and Contractors' Meetings, hold workshops that help to define research paths, coordinate efforts with other Federal agencies, prepare for and respond to COV evaluations, attend research meetings, keep abreast of relevant cutting-edge science, and constantly engage the community to define research needs and future directions.

II. CESD Program Overviews and Recommendations

A. Earth System Modeling Program

1. Program Summary

The mission of the ESM program is to support the development of computationally advanced global climate modeling capabilities, as needed to understand and project the changes to the coupled climate systems, in support of Energy science and mission. ESM supports three types of projects: SciDAC (computationally intensive), paleoclimate, and other important model developments including support for related CESM (Community Earth System Model) development. The largest portion of the ESM budget is invested in the Accelerated Climate Modeling for Energy (ACME) project, a large multi-institutional DOE Laboratory-led climate model development project that is focused primarily on high-resolution coupled climate modeling for near-term climate change. ACME is a focus of collaboration with DOE computational expertise under the BER-ASCR (Office of Advanced Scientific Computing Research Scientific Discovery through Advanced Computing--SciDAC) program. DOE atmospheric and terrestrial data are also exploited in the context of sophisticated frameworks to test, analyze, calibrate, visualize and validate model results.

2. Quality and efficacy of funding process

The COV examined one FOA for the past 3 fiscal years: FOA 14-1036, one SFA: ACME, and three lab-funded projects. The FOA received 142 proposals, out of which 25 proposals were funded. The success rate was 18%. These success rates reflected the 22% reduction of pre-proposals that were discouraged for submission. Funding levels for ESM are $35.6M in FY2013, $35.2M in FY2014, $35.5M in FY2015. Below we first address the FOA process, and then review ACME.

(a) Solicit, review, recommend, and document application proposal actions

Findings:

- The committee found that the program solicitations were consistent with the priorities of the ESM program. The solicitations clearly stated the goals of the program, the expectations of the applicants, and the criteria for merit review.

- The committee found that the pre-application process was an effective means of providing feedback to applicant prior to generating a full proposal. This process reduced the total number of applications submitted to the program appropriate to ESM and saved time for program managers and review panels as well as PI teams who may otherwise have submitted a proposal unlikely to be funded.
- The committee found that the proposal reviews were conducted in compliance with DOE's published guidance. Review panels included at least 3 reviewers who have expertise in the fields relevant to the solicitation and the program. Panels consisted of both university and DOE National Lab reviewers. Reviewers were supplied with guiding questions to aid in the consistent review of each application.
- The award portfolio in its totality appeared to be well balanced and reflects a breadth of areas covered by the ESM program.
- The PMs felt the solicitation responses captured the right audience for their program. The COV noted that overall outcomes support that.

Comments:

- A random selection of both awarded and declined projects from the solicitation was evaluated. The committee determined that the documentation for making award recommendations was complete including the proposal, reviewer comments, and funding actions. The efficiency, or the time to decision, was within or close to the stated goal of 6 months. The committee noted that applicants that were considered for funding were required to respond to panelist comments prior to their notification of award.
- The project portfolio within ESM included three small lab-funded awards. The solicitation phase of these was not reviewed.

Recommendations:

- Momentum toward using PAMS for submission should be maintained.

(b) Process to monitor active awards, projects and programs

Findings:

- The program managers find the current annual reports adequate for their needs.

- The reports for the SFA activity were extensive and showed coherent leadership and active engagement of reviewers and program managers.
- The "highlights" that showcased specific project publications were useful as narrow snapshots of progress.
- The reporting to Office of Science of program outcomes and successes is appropriately aimed at peer-reviewed journal publications.
- The CESD website is being used to showcase successful program outcomes.
- Lack of travel funds is making project management much harder. The COV notes that this comment and associated recommendation were made in the previous review and that this issue has not yet been adequately addressed.
- IT does not adequately support the project management, making the job of the project managers more difficult.
- ESM was able to provide most of the project documentation in an electronic and searchable format. This was very useful for the COV review.

Comments:

- It is critically important that program managers have adequate travel support for site visits to ensure effective interactions between program managers and PIs. This is especially true for larger projects (SFA and others).
- Program managers need improved IT support.

Recommendations:

- The COV recommends that travel budgets be increased to facilitate the more efficient overall utilization of resources and to increase the overall program management efficiency.
- The COV recommends that IT support to the program managers be improved

3. ACME — A $22 M SFA in ESM

a) Scientific basis

The largest portion of the ESM budget is invested in the Accelerated Climate Modeling for Energy (ACME) project, a large multi-institutional DOE Laboratory-led climate model development project that is focused primarily on high-resolution coupled climate modeling for near-term climate change. The ACME model was initiated in 2014 from the Community Earth System Model (CESM), and its code continues to be designed to optimize performance on current and future DOE Leadership Class computers, in anticipation of the exascale era. ACME is addressing research questions that are most pressing to the DOE Office of Science, simulating the fully coupled climate system at high-resolution (15-25km and higher) and incorporating coupling with energy systems, water, and related technologies and infrastructures, with a focus on near-term hindcasts (1970-2015) for model validation and near-term projection (2015-2050) for societal planning. The model employs regional refinement using advanced adaptive mesh methodologies to provide ultra-high resolution to resolve critical physical and dynamical phenomena. The newest climate components as part of ACME are based on variable (atmosphere) as well as irregular (ocean, ice and land) grids. Sophisticated frameworks to test, analyze, calibrate, visualize and validate model results are under development, in order to assess the model against measurements. A critical scientific challenge is to maximize model performance by identifying the optimal combination of model resolution and process representation that provides information on climate trends, variabilities, extremes, and tipping points, of most interest to the DOE mission.

The ultimate goal of the ESM program, and the ACME system, is to understand the interdependencies of climate components, so that simulations of regional and global climate change exhibit a high degree of confidence and certainty, over decadal time scales. ACME science is addressing grand-challenge climate questions regarding the water cycle, biogeochemistry and cryosphere-ocean interactions, though these science problems are not unique to ACME and are being addressed by a number of other modeling efforts in the U.S. and around the world. Thus, ACME's unique niche will be to address these science problems with

very high resolution earth system models run at exascale on DOE Leadership Computing Facilities. For the water cycle, the project is estimating the dominant human and natural drivers of hydrologic changes. For biogeochemistry, the focus is on the effects of nutrient and hydrological changes on carbon exchange particularly with respect to terrestrial systems. For cryosphere-ocean interactions, the focus is on simulating and estimating likely changes to the Antarctic ice sheet, coupling with the ice sheet and the ocean, and the influence on ocean circulation and sea level. The first version of the ACME model (version 1, or v1) will be released at the end of 2017 and is intended to supply the research community with well-tested, well-documented codes.

b) History to date

The ACME concept was developed during early 2013 on the basis of joint DOE management and DOE Laboratory planning documents. The driving need was to achieve accurate, very high-resolution climate simulations, thereby requiring effective use of future exascale computers. A full proposal was solicited and was reviewed by a broad-based group of 18 reviewers and found to be Very Good initially. Refinement and resubmission of the proposal led to approval and commencement of funding in the middle of Calendar Year 2014. An extensive plan for project management, coordinated meetings, and extensive electronic collaboration across seven DOE Laboratories was established from the very beginning with well-defined tasks, timelines, and deliverables. High levels of participation by senior personnel were devoted to an enormous model-development effort. Extensive financial support for a 7-lab effort was achieved mainly by coalescing and/or redirecting existing ESM programs at various labs. A six-month review by a subpanel consisting mainly of the original reviewers was conducted in early 2015, followed by a similar progress review in June of 2016. Both these progress reviews were very positive. In addition, two computing requests to INCITE for resources from Leadership Computing Facilities were independently reviewed by outside experts and granted substantial allocations for both Calendar Years 2015 and 2016. ACME has also been invited to participate in early optimization programs for the next generation machines Aurora at ANL and Summit at ORNL, in order to facilitate and accelerate DOE exascale climate goals.

ACME has successfully assembled Version 1 and is in the process of testing it. Some obstacles in running the model in fully coupled mode are being addressed and an additional fourth year may be needed for the project to reach full fruition in the form of much improved high-resolution models and three completed capstone integrations. The release of a model with both superior scientific capability and superior performance capability is anticipated in 2017 or possibly 2018, at which time ACME can forge new bonds with the CESM program for broader scientific investigations. In the meantime, CESM continues to be supported at a level of about $3.2M by CESD's RGCM program.

Findings:

- ACME is progressing well toward its particular DOE goals, but may need an additional year to complete model development and carry out its capstone integrations.
- One of CESD's major funding initiatives is the development of ACME, a global Earth system model. A lower-resolution version of ACME with ~100 km grid spacing is under development. This should not distract from ACME's stated objective of very high resolution Earth system modeling, nor from ACME's efforts to establish itself as uniquely targeting the niche of high-resolution earth system models run at exascale on DOE Leadership Computing Facilities. While the high-resolution version of ACME can benefit from testing with a 100-km version of ACME, this relatively low-resolution version puts ACME into more direct competition with other modeling groups in the U.S. working at this resolution, thus risking duplication of effort.
- CESM will ultimately wish at some future time to run simulations on machines similar to those at Leadership Computing facilities. Thus, what CESD learns about running ACME at exascale can benefit CESM and other U.S. modeling efforts. Meanwhile, ACME can benefit from the CESM hierarchy of models including low resolution versions for multi-century simulations to study UQ and decadal climate variability. Those results would inform the ACME very high resolution simulations with regard to process context and internal variability.

Comments:

- The launch of ACME from CESM has led to concerns on the part of scientists in both CESM and ACME about their abilities to maximize scientific collaboration and progress in overall climate modeling.
- The special considerations of the DOE to have a high-resolution model that effectively uses future exascale machines justify the ACME effort. However, ACME and CESM should be complementary and collaborative to best advance the science. This is in the best interests of both DOE and NSF scientists.
- Increasing resolution is an integral part of an overall research strategy for ACME to address a variety of climate science problems that are relevant to the DOE mission, so leveraging DOE investments in CESM to use the CESM hierarchy of models of varying resolution and complexity to address relevant DOE science questions will complement the ACME high resolution effort.
- Thus, while the focus of ACME is on shorter time scales with very high resolution, a strengthened partnership with NSF and CESM can help to address a broad spectrum of climate change problems on longer time scales. Shared code infrastructures, interchangeable model modules, and common intra-component libraries allow enhanced collaboration to leverage efforts across DOE and NSF-funded modeling programs.

Recommendations:

- The 100-km atmosphere of ACME is for efficient testing in support of developing the very high resolution version, and its applications should be aimed at those related efforts within DOE.
- In view of the overall complexity of the ACME project, a fourth year of support should be provided before a quadrennial SFA review in 2018.
- The primary focus of the ACME effort should remain a 25km atmosphere (or higher) coupled to a high resolution version of MPAS-O, consistent with ACME securing a unique niche in the climate modeling community by targeting a very high resolution earth system model to run on exascale machines. The 100 km version of ACME that is now being tested

should be given second priority and used mainly for CESD-specific applications, such as those in biogeochemistry.

- The initial ACME 25-km version coupled to high resolution MPAS-O would benefit from comparison to the CESM2 25-km atmosphere coupled to the 1-degree version of POP (available in late 2017) to explore the added benefits of MPAS-O in a climate simulation with a similar resolution atmospheric model. This would be a good way to help establish credibility of ACME in the U.S. climate modeling community.
- ACME should provide expert guidance to CESM as ACME takes a leadership role in the use of more complex high performance computers, heading to exascale, to further leverage CESD investments in the CESM hierarchy of models.

4. Effect of the Award Process on Portfolios and their Alignment with IAR and CESD Priorities

(a) Breadth and Depth of portfolio elements

Findings:

- The projects enabled by the award process cover the ESM program's modeling portfolio very well.
- The projects involve modeling innovation that is in keeping with the stated goals of the ESM program. ASCR co-support appears balanced with model development in the FY13-FY15 portfolio.
- The ESM program has been effective at bringing new modeling approaches to CESD modeling efforts. In particular ESM support has been critical for the advancement of ACME and CESM, with the latter playing a prominent role in CMIP5 and the IPCC AR5.

Comments:

- There are strong synergies between ESM, RGCM and IAR programs.

Recommendations:

- The ESM program proactive engagement of NCAR and the university community in the future ESM program activities should be maintained.

(b) National and international standing of portfolio elements

Findings:

- The overall collection of activities is world-class and the program is doing an excellent job at maintaining US global standing in many important climate-modeling areas.
- The program made significant contributions to ACME and CESM, which are clearly among the most important national assets for studying climate and climate change.
- Program development and visibility have been greatly harmed by the inability of DOE program managers to travel to and participate in major national and international meetings. This impedes promoting the program, fully assessing program gaps, forging strategic alliances, recruiting new participants and identifying future directions.

Comments:

- Due to travel budget limitations, program manager's visibility is relatively low in comparison to the roles that the programs played. The DOE leadership impact on climate modeling may not be adequately appreciated and leadership opportunities may be missed. This is directly related to severe and inappropriate limitations of the travel budget for program managers.

Recommendations:

- The continued collaborations with NCAR and the community to the development of the CESM should be maintained to complement ACME efforts. CESM and ACME are highly leveraged assets for both CESD and for the community to advance earth system modeling in the United States.
- The individual DOE program managers should have sufficient funding and management support to attend and participate in person in key national and international meetings, and to make site visits to their funded constituents. The latter would be net cost saving to DOE so as to avoid making "reverse site visits" (i.e., having entire funded groups visit Germantown as opposed to a single program manager make a visit to the funded group).

5. *Other Review Criteria*

- *Are an adequate number of qualified reviewers (free from bias and/or conflicts of interest) selected for review of projects and grants?* Yes.
- *Are the Office of Science (SC) merit review criteria applied appropriately in the evaluations?* Yes.
- *Is documentation of the review process adequate and complete?* Yes.
- *What are the characteristics of the award portfolio?* The COV found the portfolio to be well balanced and consistent with what was called in the FOA.
- *Are progress reports on previously funded research useful in the evaluation of proposed research?* Yes.
- *What is the quality of overall technical management of the program?* Very good.
- *What are the relationships between award decisions, program goals and DOE mission?* Very well aligned.
- *Are there significant impacts and advances that have developed since the previous COV review that are demonstrably linked to DOE investment?* Yes, namely the the contributions of the program to the release of the CESM and component models, and to the development of ACME.
- *Were the responses of the program to the recommendations of the previous COV review appropriate?* Yes, except in regard to the need for increased travel budget.

B. Regional and Global Climate Modeling Program

1. *Program Summary*

The mission of RGCM program is to improve the predictive understanding of Earth's climate by studying the dominant sets of governing processes that describe climate change on regional scales; evaluating robust methods to obtain higher spatial resolution for projections of climate and earth system change; and diagnosing model systems that are cause for uncertainty in regional climate projections. The program goal is accomplished through sensitivity studies and

applications of regional and global earth system models that focus on various aspects of the climate system, including but not limited to, the understanding of feedbacks within the climate system, detection and attribution studies, developing capabilities for decadal predictability, and uncertainty characterization. RGCM investments are also dedicated to development of metrics for model validation.

2. Efficacy and Quality of Funding Processes

The COV examined FOAs for the past 3 fiscal years: DE-FOA-13-0919 and DE-FOA-0001036 (joint between ESM and RGCM). These calls received 23 (jointly between ASR and RGCM), and 90 (RGCM only) proposals, out of which 2 and 14 (during FY14 and FY15) proposals were funded by RGCM. The success rates were 9% and 15% respectively. The COV also reviewed the 5 SFA's that were active during the past 3 fiscal years: LLNL SFA, HiLAT SFA, WACCEM SFA, CASCADE SFA, and BGC SFA, as well as a large-value Cooperative Agreement. Funding levels for RGCM were $29M in FY13, $28M in FY14, $26M in FY15, which reflect reductions from the program's peak funding of $31M in FY11.

(a) Solicit, review, recommend, and document application and proposal actions

Findings:

- The FOA solicitations are consistent with program and CESD priorities.
- The success rate for applicants submitting proposals to the evaluated FOAs were lower by 5 to 29% compared to the previous FOAs evaluated in the 2013 COV.
- In general, only top ranked proposals were considered for funding, however exceptions were made which allowed for providing program balance. The review process and all funding decisions were well documented. The COV found these decisions to be appropriate and consistent with selection language stated in the FOA. Funded proposals were consistent with priorities and criteria stated in program announcements.
- FOA reviewer panels were well-balanced and comprised of leading experts in the fields associated with the FOA topics, with leading scientists from universities and national labs, both domestic and international. The COV noted that the 2014 FOA had a review panel of

54 scientists, which was appropriate to the number of proposal responding to the joint call of RGCM and ESM.

- Comments from reviewers were communicated to the PIs, with a few redactions. The COV is pleased with this practice.
- The lab SFAs and the large-cooperative agreement were not solicited as projects in the FOAs. They were either continuation of previous projects (4) or newly initiated (2) based on program needs and discussions with the DOE labs. The 5 FSAs target five well-defined research areas of strategic importance to CESD.

Comments:

- The review processes for the SFAs were as rigorous as for proposals responding to the FOAs. SFA's of this period went through a 3-year review. The large cooperative agreement with NCAR was not reviewed during this period.
- All funded proposals were of high quality.
- The COV notes that the communication of the proposal selection results for rejected proposals could be more clearly stated to the applicant so that the applicant can determine whether the proposed project reviewed well or reviewed poorly. Some applicants may not be aware that the phrase "and programmatic balance" is added to rejection letters of proposals that reviewed well but were not selected due to lack of available funding.

Recommendations:

- The COV recommends that the current standard of funding process be maintained, including the feedback of reviews to the PIs.
- The COV suggests consideration by CESD of whether a more formal and transparent process of initiating/terminating SFA and large projects should be implemented and communicated to the labs and the community.

(b) Processes to monitor active awards, projects and programs

Findings:

- Progress reports were actively monitored to ensure that funded research is progressing well.

- The program manager monitors the SFAs closely by several means: participating in monthly or quarterly telecons, reminding PIs to submit research highlights, annual reports, workshops and conferences.

Comments:

- The practice of asking for research highlights and organizing, posting them on the web is very valuable to assess research progress and communicate program results to the wide community. The committee commends this effort.
- It is critically important that program managers have adequate travel support for site visits to ensure effective interactions between program managers and PIs. This is especially true for larger projects (SFA and others).

Recommendations:

- The COV recommends consistent reviews, including the review frequency and review process as well as reporting format, across all SFAs and comparable large projects.
- The nature of many CESD activities, e.g., model development, requires performance metrics beyond traditional measures like publication and impact factors. We support the clear articulation of these alternate metrics and rigorous evaluation against them. This is relevant to other programs in CESD as well.

3. Effect of the Award Process on Portfolios and their Alignment with IAR and CESD Priorities

(a) Breadth and depth of portfolio elements

Findings:

- Program announcements were carefully formulated, partly in response to issues identified in workshops, to solicit proposals in important, cutting-edge areas.
- The overall quality of the science is excellent.
- The program's portfolio has clear alignment with national and international climate science research priorities such as those identified by US CLIVAR, USGCRP, and WCRP's Research Challenges.

- The portfolio is closely tied to the Office of Science goals related to climate and energy.

Comments:

- The committee commends the willingness of this program to engage with the broad climate science community and respond to the current needs for climate science.
- There are synergies between ESM and RGCM programs via a joint solicitation, and careful attention has been paid to make a better distinction between the programs.
- The committee sees the themes of the 5 SFAs to be well focused on the strategic objectives of CESD that are at the cutting edge of sciences.

Recommendations:

- As the ACME project progresses, the COV encourages continued joint calls with ESM to target specific outstanding issues in ACME and collaborative efforts between the SFAs, ACME, and the university community.

(b) National and international standing of the portfolio elements

Findings:

- The scientists represented in the portfolio are high caliber, both in the lab and non-lab components.

Comments:

- Rejection rates of the FOA proposals from many distinguished scientists indicate that the portfolio is highly competitive. The very positive reviews of all 5 SFAs by the review panels also speak for the quality of the sciences.

Recommendations:

- The individual DOE program managers should have sufficient funding and management support to enable them to attend key national and international meetings.
- It is strongly recommended that the synergies and links among DOE labs, NCAR, and university investigators be cultivated to ensure healthy collaborations.

4. *Other Review Criteria*

- *Are an adequate number of qualified reviewers (free from bias and/or conflicts of interest) selected for review of projects and grants?* Yes
- *Are the Office of Science (SC) merit review criteria applied appropriately in the evaluations?* Yes.
- *Is documentation of the review process adequate and complete?* Yes.
- *What are the characteristics of the award portfolio?* Well balanced, high quality, and consistent with what were called for the in FOAs.
- *Are progress reports on previously funded research useful in the evaluation of proposed research?* Yes.
- *What is the quality of overall technical management of the program?* Excellent.
- *What are the relationships between award decisions, program goals and DOE mission?* Very well aligned.
- *Are there significant impacts and advances that have developed since the previous COV review that are demonstrably linked to DOE investment?* The contribution of the program to the understanding and evaluations of the CESM and its component models, the initiation of SFAs in strategic areas of importance to CESD.
- *Were the responses of the program to the recommendations of the previous COV review appropriate?* Yes, except for the recommendation to increase the travel budget of program manager.

C. The Integrated Assessment Research Program

1. *Program Summary*

The mission of the IAR program is to advance a robust predictive understanding of Earth's climate and environmental systems and to inform the development of sustainable solutions to the Nation's energy and environmental challenges. The program works to achieve that mission with work produced toward these research goals:

- Process knowledge and innovative computational methods advancing next-generation, integrated models of the human-Earth system
- Process-level understanding of atmospheric systems and terrestrial ecosystems, extending from bedrock to the top of the vegetative canopy
- Coupled biogeochemical processes in complex subsurface environments to enable systems-level environmental prediction and decision support
- Enhance the unique capabilities and impacts of the ARM and EMSL scientific user facilities and other BER community resources to advance the frontiers of climate and environmental science
- Address science gaps that lead to solutions for DOE's most pressing energy and environmental challenges

The strategic goal of the IAR program is to reveal key insights into the long-term, complex interactions of human and natural systems in a changing climate and changing world. The program works to achieve this goal with these objectives:

- Improve understanding and model the complex interactions of human and natural systems, for example at the nexus of energy, water, and land systems.
- Explore developmental pathways, emissions, the role of energy innovations, and land as well as atmospheric cycles and forcings.
- Provide scientific basis for insights into climate change impacts, adaptations, and the effects of combined, multiple stressors.
- Develop global, national, and regional perspectives within economic, risk and other decision-relevant frameworks

2. Efficacy and Quality of CESD IAR Processes to Develop, Advertise, Award, and Track Funding Opportunities and Resulting Research

The COV examined funding agreements and their associated reviews begun or renewed during fiscal years 2013-2015. Program funding during these years was $8M in 2013, $10M in

2014, and $10M in 2015. Of this total, ~70% was directed to DOE labs with the largest share each year going to PNNL. Over these three fiscal years the lab allocation was ~$13.5M to PNNL, ~$4M to ORNL, and ~$1.2M to LBL with smaller amounts in some years to other labs.

Over the three years covered by this review, the ~30% of the IAR budget going to the wider research community included agreements with the Massachusetts Institute of Technology (MIT) for ~$3.4M and ~$4.1M with Stanford University.

We reviewed the PNNL SFA, the MIT Cooperative Agreement, and three smaller projects that included two workshops.

Findings:

- The committee found that all program solicitations were consistent with the objectives of the program and that procedures for solicitation, review, and reporting fully corresponded with the description of CESD, Office of Science, and DOE requirements.
- The review process was done primarily by panels with some mail review supplementation. All the proposals reviewed by the COV had three to five reviews. A rating of very good (7 or higher) was regarded as the minimum requirement for funding. Proposals receiving a score greater than or equal to 7 were regarded as marginal and selected according to program relevance, when funding was inadequate.
- In our examination of a sample of the awarded proposals from DOE labs and from the wider community of IAR researchers, the committee found a consistently high quality of reviewers and reviews, and that the proposal evaluation process was appropriate and equitably implemented.
- The proposals received were of very high quality and reviewers were generally able to provide constructive criticism useful to proposers. The committee attributed this to the experience of the proposers and the value of long-term relationships between BER and individual research groups.
- The active awards, projects, programs, and cooperative agreement were monitored and managed through a number of mechanisms: progress reports at varying time intervals, regular and ad hoc meetings, regular and special-purpose workshop and working group

meetings, and periodic updates to program strategy and implementation. The committee found that these processes are fully adequate for the level of IAR funding and for adherence to CESD, Office of Science, and DOE requirements.

- Workshops, particularly the Energy Modeling Forum meetings organized and run on multiple IAR-related topics each year under the agreement with Stanford for more than 20 years, have been very effective for obtaining specific input for the IAR program from the wider research community in the U.S. and internationally. This workshop input has been explicitly used by the IAR program manager both for short- and longer-term program strategic planning and to inform aspects of implementation for reaching program objectives and goals. . A significant aspect of this series of workshops for the purpose of broadening the field of external contributors has been its explicit design for one-third of its attendees each year not to have attended in the previous three years.

Comments:

- The IAR program manager summarized the review comments well and provided detailed justification for the determination of decisions and very useful explanations for program strategy, implementations, and internal and external assessments.

Recommendations:

- The COV recommends that the current funding processes be maintained.

3. Effect of the Award Process on Portfolios and their Alignment with IAR and CESD Priorities

Findings:

- As elsewhere in CESD, DOE information technology contracting does not adequately support IAR project management, making the job of the project managers, and the COV reviewers, more difficult.

- Related to the finding, above the IAR program manager was able to provide some though not all project documentation electronically. Sustained or faster conversion to all-electronic records would substantially help on-going internal processing and the reviews required of the IAR program manager, benefit the PIs working on IAR projects, and would make COV

review more effective and efficient in future. The COV recognizes that the process and timeline of converting paper to electronic documents are not under the control of the IAR program manager or CESD.

Comments:

- A random selection of proposals and reviews for both awarded and declined projects from the solicitation was evaluated. The committee determined that the documentation for making award recommendations was complete including the proposal, reviewer comments, and funding actions. The efficiency, or the time to decision, was within or close to the stated goal of six months.

Recommendations:

- Momentum toward using the DOE-wide Portfolio Analysis and Management System (PAMS) for all submissions and subsequent processing should be maintained and enhanced across CESD where possible. In addition, CESD could review the utility of deploying integrated project management software for all program managers to organize elements of the work which will not fit under PAMS.

- The IAR program manager, and all CESD program managers, should have more financial and administrative support for travel support for site visits to ensure effective interactions between program managers and PIs and the efficient execution of work under these agreements. This is especially true for larger projects designed to integrate across multiple fields of work and several PIs as is the case for IAR.

- The specific pages of the DOE CESD website for IAR could usefully be updated to provide information somewhat more like that included on the pages for the CESD RGCM section. The COV recognizes the many differences between IAR and RGCM which could restrict some information in possible future pages built for IAR, but think that more information where allowable through that source would be helpful to the program and its participants in DOE labs and the wider academic community.

4. *Other Review Criteria*

- *Are an adequate number of qualified reviewers (free from bias and/or conflicts of interest) selected for review of projects and grants?* Yes.
- *Are the Office of Science (SC) merit review criteria applied appropriately in the evaluations?* Yes.
- *Is documentation of the review process adequate and complete?* Yes. The reviews of the proposals are detailed and the scores justified.
- *What are the characteristics of the award portfolio?* Well balanced. It includes
  - Integrated assessment modeling
  - Model development including climate modeling (link to CAM3), water, sea-level rise and infrastructure vulnerability, wind power, and probabilistic techniques.
  - Participation in some IAM community model inter-comparisons
  - Summer workshops on climate change impacts and integrated assessment of climate change
- *Are progress reports on previously funded research useful in the evaluation of proposed research?* Yes.
- *What is the quality of overall technical management of the program?* The programs are very well managed.
- *What are the relationships between award decisions, program goals and DOE mission?* The alignment of award decisions and CESD's strategic plan is particularly well realized for this program. This program sits at a unique intersection between science, the continuing DOE missions, and expanding work around understanding and preparing for climate change threats and disruptions, particularly around conjoined questions in the energy-water-land context.
- *Are there significant impacts and advances that have developed since the previous COV review that are demonstrably linked to DOE investment?* Yes. Major advances since the previous COV review include the addition of water markets to both DOE IA models, the reformulation of the Global Change Assessment Model (GCAM, the internationally

prominent IA model sponsored by DOE) in terms of agro-ecological zones, and the advances toward an integrated Earth System Model. In addition, this DOE program has established itself in a dominant leadership position in the international IA community. This internationally recognized science leadership by CESD IAR in turn helps shape the international scientific agenda and represents another form of significant leveraging of DOE investments.

- *Were the responses of the program to the recommendations of the previous COV review appropriate?* Yes. The COV found that the responses to the recommendations in the previous review were fully appropriate for the issues that can be readily addressed or are within their control.

D. Terrestrial Ecosystem Science

1. Program Summary

The mission of the TES program is to improve the representation of terrestrial ecosystem processes in Earth system models thereby improving the quality of climate model projections and providing the scientific foundation of energy solutions for DOE. The program focuses on ecosystems and ecological processes that are globally or regionally significant, expected to be sensitive to climate change, and insufficiently understood or inadequately represented in models.

2. Efficacy and quality of funding processes

The COV examined the RFAs and FOAs for the past 3 fiscal years: FY2013 through FY2014 disseminated by the Office of Biological and Environmental Research and found three TES program solicitations designated as 12-0749 in FY2012 and 13-0919 in FY2013, and 14-1172 and LAB 14-0001 in FY2014.

Given that two large lab projects, Ameriflux (LBNL) and the Next Generation Ecosystem Experiment (NGEE) Arctic (ORNL) and NGEE Tropics (LBNL), represent significant investment, the general Lab vs. non-Lab funding is roughly proportionately balanced. Non-Lab solicitations resulted in 140 and 91 received proposals for 11-536 and 10-287 respectively, with a

funding rate of 9% and 29%. Funding levels for TES were $38M in FY2013, $45M in FY2014, $44M in FY2015. For the this peroid, 1/4 was non-Lab funding.

For the review, a random sampling of the both accepted and declined proposals was conducted which included all available documentation of the proposal, peer review process and management decisions and communication to the proposers and review panels. Tri-annual review of the SFAs was examined as were pertinent workshop reports, and individual annual investigator meetings.

(a) Solicit, review, recommend, and document application and proposal actions

Findings:

- The solicitation, peer review, and selection processes are rigorous, of very high quality, well documented, and consistent. This is a real strength of the program and its management team.
- The descriptive call of the solicitations in terms of area of research interests was multifaceted and somewhat nuanced in terms of key words.
- Consistency from solicitation to award selection is very good. The program provides a fair balance of continuity/closeout funding for activities/topics being phased out.
- The program does excellent jobs in the use of adequate number of reviewers for balanced review; use of reviewers having appropriate expertise/qualifications; use of a sufficiently broad pool of reviewers; avoidance of conflicts of interest.
- Processes are thorough and well documented – times to decision seem moderate/average, but given the quality of the final product, this is optimal.
- Documentation making recommendations is complete and usually much more than adequate -- documentation is thorough.

Comments:

- The CoV noted that diversity on some of the panels could be improved. Some panels had few women (others did seem to have a better balance).

- Also noted that the prior COV recommended striving for a greater percentage (~20%) of reviewers from international institutions and this has not been achieved to date. It is indeterminate how important a goal of 20% really is, but a few more would be beneficial.
- At least one selection decision was delayed by about 2 months, because one mail reviewer failed to deliver.

Recommendations:

- There may be a need to sharpen and prioritize the major elements of the research solicitation. It appears that priority topic areas may be somewhat buried in the narrative and these should be brought to the fore in the description of research interests. Avoid nuanced terms such as non-managed ecosystems or provided detailed descriptions.
- Keep up the good work.

(b) Processes to monitor active awards, projects and programs

Findings:

- The TES Program is managing large and expensive field experiments associated with SPRUCE, NGEE-Arctic, NGEE-Tropics and SFA projects. This management is primarily through phone calls. It is remarkable and regrettable that the PM has *never* visited the sites because of the restricted travel funds. It is essential that the PMs have a better hands-on understanding of these field experiments. We suggest some creative approach to provide access to the field sites as part of the program management functions rather than discretionary travel.
- The next generation field/modeling studies of critical environmental zones, the NGEE Arctic and Tropics projects are well conceived and implemented. One concern is that the primary goal is to include fine detail that is presently lacking in terrestrial ecosystem models. It is important to consider how scaling of these processes to larger scales and longer times and the potential role of emergent processes that may modify - perhaps even simplify - simulation of these ecosystems. Linking these small scale manipulation studies with flux measurements and mesoscale observations that could be based on the ARM and ANSL activities in these areas.

- Portfolio elements during the COV review period (FY13-15) reflect reorientation of some major lab SFA components of program from contaminant-transport biogeochemistry focus to more general watershed biogeochemistry focus. The new program focal areas include exploratory research into microbial community "-omics" research using state of the art methods available through the JGI and development of high-performance computational components of the virtual watershed model. Field-based studies provide ground truth observations for data-model integration and validation.

Comments:

- New program directions make excellent use of unique capabilities of participating laboratories. However, the merging of SBR with TES has caused some growing pains (such as transitioning of field sites) that may have resulted in some loss of momentum in the SFAs during reorientation. We laud CESD's efforts to maintain scientific innovation and we encourage continued engagement of the broader scientific community as SBR and TES together make this transition to new focus areas.
- The most effective management practice is the use of regular peer review of the National Laboratory SFAs and related research activities. This is a highly effective means of keeping research projects on track. The monitoring process is of high quality, and aligned with agency directions and priorities. DOE is to be commended for establishing this practice and implementing it very effectively during the past 3 years.
- The annual investigator meetings are very effective in promoting coordination and communication and the program managers use them very effectively to monitor and assess progress. Workshops and annual meetings are used well as a management tool.
- Interactions of program manager, particularly through workshops and investigator meetings, with the funded scientists seem very good, with excellent dialogue regarding scientific issues, opportunities and priorities
- Written progress reports are adequate and informative.
- The effectiveness of the site visits is not clear.

Comments:

- Grant results do not appear to be tracked very closely or reported in any way other than through lists of publications. The COV would have preferred to have seen a little more about scientific accomplishments in the overview presentations by the program managers – just a chart or two summarizing major progress toward established DOE program objectives.

Recommendations:

- Program managers should remain cognizant of advances being made in other agency programs (e.g., NSF Critical Zone Observatories) to maximize the complementarity of SBR research activities with those in other ongoing programs.

- Continue to maintain a strong and rigorous practice of frequent (at least every 3 years) external peer reviews of all large projects and National Laboratory research activities.

3. Effect of the award process on portfolios within the boundaries of DOE mission and available funding

(a) Breadth and depth of portfolio elements

Findings:

- The selection and award process results in portfolio content consistent with program goals and solicitation objectives.

- There is good balance of awards with respect to innovation, risk, and interdisciplinary research. It is noted that the program managers are eager to make sure there is room for new ideas and a reasonable number of high-risk research projects in the portfolio.

- The evolution of the portfolio with respect to new investigators and new science thrusts is evolving as DOE has prescribed and in an orderly way that allows for reasonable close out of projects or lines of research that must end. This is being very well done – although budget ups and downs have complicated the process and slowed some transitions into new areas of research.

- The relationship of the portfolio to other parts of the Division and the Office of Science was good, in particular the degree of substantive interaction among the program managers

within BER and the Office of Science. It is evident that they have all been working to foster positive, collaborative, collegial relationships and it seems to be paying off in program integration. The Board of Directors for NGEE is a wonderful example. The evolution of the SBR-TES relationship is not so clear or predictable.

- The relevance of the portfolio with respect to the missions of the program, division, Office of Science, and DOE was well established, and the programs were well coordinated. The award scope, size, and duration were appropriate.

Recommendations:

- To aid in future COV reviews, TES program managers should include a chart or two in their overview presentation to show the types of research activities conducted -- how each solicitation and SFA adds to the breadth or depth of research conducted toward the program's goals.

- There is a stated bias in the portfolio toward non-managed ecosystems. This is understandable, but managed ecosystems are a significant component of the Earth System, and it is difficult to see how one can test the predictive capacity of such models without accurate representation of these ecosystems. The COV recommends that CESD develop a strategy to deal with this gap, perhaps through cooperation with agencies that do support modeling of managed ecosystems.

(b) National and international standing of the portfolio elements

Findings:

- The new strategic focus on experimental work that advances predictive modeling is a unique aspect of the program. The approach in combining experimental ecosystems research with advanced land modeling has potential for significant payoffs in the future and represents a bold leap forward. DOE is to be commended for making the decision to move in this way and acting decisively to implement its plan.

- Ecosystem manipulation continues to be a strength and DOE continues to be a world-leader in the supporting technologies as well as in having the capacity to field such studies and commit to a significant duration (e.g., ~10 yrs).

- CDIAC is an essential and treasured community facility that is providing important services to the national and international carbon science communities.
- The portfolio's principal investigators are top scientists in their fields. Many leaders are of international stature. Also, it is worth noting that there are several bright and promising newer scientists included in the program.

Comments:

- Much of the research is at the state of the art and comparable to top research internationally. It is not clear that DOE is as much in the "class by itself" as it used to be in leading advanced field capabilities like FACE and AmeriFlux. However, new investments like NGEE may prove to re-establish that leadership position (it is too early to tell at this point).

Recommendations:

- If DOE is to maintain a scientific leadership role and spread the word regarding its new approach, DOE scientists and managers need to be able to attend key national and international scientific conferences and serve on international coordination groups. In order to do this, they need to be able to travel. DOE cannot influence and certainly cannot lead if DOE representatives are not at the table, in the hallways, and part of the side discussions. DOE senior management needs to work harder to justify the need for scientific coordination and communication-related travel – even a modest increase could make a big difference.
- Consider adding a researcher from the broad community on detail to the CESD management.

4. *Other Review Criteria and Questions*

- *Are an adequate number of qualified reviewers (free from bias and/or conflicts of interest) selected for review of projects and grants?* Yes. Excellent!
- *Are the Office of Science (SC) merit review criteria applied appropriately in the evaluations?* Yes. No deviations were found.

- *Is documentation of the review process adequate and complete?* Yes
- *What are the characteristics of the award portfolio?* Portfolios were consistent with what was solicited and/or with the analyses of the peer reviewers. In one case (NGEE) what was selected was modified significantly from what was solicited based on the findings of the peer reviewers.
- *Are progress reports on previously funded research useful in the evaluation of proposed research?* They are for the SFA's and other Lab activities – those reports appeared to be quite useful. Relatively few progress reports for grants were examined, but those did serve their purpose.
- *What is the quality of overall technical management of the program?* Excellent.
- *What are the relationships between award decisions, program goals and DOE mission?* Tightly coupled, with appropriate flexibility/adaptability. They are staying on course and making smart decisions.
- *Are there significant impacts and advances that have developed since the previous COV review that are demonstrably linked to DOE investment?* Yes. SFAs are being implemented well and appear to be very successful scientifically and the management strategy adopted to oversee and guide them is working well. The AmeriFlux network now has more secure future and a sound management structure for the core sites. These actions have addressed a long-standing concern of the community and DOE is to be commended for taking such strong and forward-looking actions.
- *Were the responses of the program to the recommendations of the previous COV review appropriate?* Yes, for the most part. A few things of note are itemized below:
    - DOE has begun development of an electronic grants information system, but it is not available yet. The paper files were in good order and easy to access and understand.
    - We did not see any quantitative metrics on output publications. That could have been quite helpful – although it may be more work than is reasonable to expect on the part of the program managers.

- There may still be room for improvement on communicating out to the public regarding accomplishments and activities (COV recommended Web pages for TES) – we did not hear or see much on that in our visit.
- Major kudos for stabilizing the support and future of AmeriFlux. Good follow through on the plans discussed back in 2013.
- Recommendation on annual solicitation for National Labs was not followed up on, but since this was not the intent for the SFAs, DOE inaction here seems appropriate.
- Recommendation to increase recruitment of reviewers from outside the US to ~20% has not been implemented. This is a challenging requirement and the failure to meet it is not a significant problem. There has been appropriate use of international reviewers on panels and a few more per panel might be helpful, but this does not necessarily impact the quality of the review if not achieved.

E. Subsurface Biogeochemical Research

1. Program Summary

The Subsurface Biogeochemical Research (SBR) program supports cutting-edge hydrobiogeochemical research that integrates physical, chemical, and biological observations over a range of scales from the pore- and microbial-scales in soils and aquifers through the reach- and watershed-scales into a unified model of watershed function. This view of watershed function aims to fulfill the promise of a predictive understanding through the construction of a virtual ecosystem based on state of the art applications of microbial community genomics and high-performance computing. The importance of these efforts in the SBR program lies in their promise to enable better knowledge of how subsurface biogeochemical systems are coupled to the atmosphere through surface water-groundwater exchange, nutrient fluxes, and greenhouse gas fluxes. In addition, better understanding of the impacts of these processes on climate change and conversely, the impacts of climate change and nutrient/contaminant loading on subsurface systems is being actively pursued.

2. *Efficacy and quality of funding processes*

(a) *Solicit, review, recommend, and document application and proposal actions*

Findings:

- The process of solicitation, proposal review, recommendation, and funding awards is found to be reasonably transparent and well managed. Available funds are being used efficiently to fund the best-quality research within the constraints of BER mission directions and programmatic balance.

(b) *Processes to Monitor Active Awards, Projects and Programs*

Findings:

- Annual progress reviews and periodic program reviews are effective mechanisms by which to monitor scientific productivity and help promote achievement of proposal objectives and milestones.

3. *Effect of the award process on portfolios within the boundaries of DOE mission and available funding*

(a) *Breadth and depth of portfolio elements*

Findings:

- Portfolio elements during the COV review period (FY13-15) reflect reorientation of some major lab SFA components of program from contaminant-transport biogeochemistry focus to more general watershed biogeochemistry focus. The new program focal areas include exploratory research into microbial community "-omics" research using state of the art methods available through the Joint Genome Institute and development of high-performance computational components of the virtual watershed model. Field-based studies provide ground truth observations for data-model integration and validation.

- The Subsurface Biogeochemical Research Program is well managed. Excellent use is being made of the unique facilities of participating laboratories (e.g., EMSL, Joint Genome Institute, synchrotrons). The program has maintained a high quality research portfolio despite the 50% funding reduction and gradual shift of focus area away from its historical emphasis on contaminants to watershed-scale carbon cycle studies during the past two funding cycles.

Comments:

- New program directions make excellent use of unique capabilities of participating laboratories. However, the merging of SBR with TES has caused some growing pains (such as transitioning of field sites) that may have resulted in some loss of momentum in the SFAs during reorientation. We laud CESD's efforts to maintain scientific innovation and we encourage continued engagement of the broader scientific community as SBR and TES together make this transition to new focus areas.
- The earlier SBR focus on radionuclide biogeochemistry was a distinctive feature of the program and especially appropriate for DOE laboratories in support of the DOE mission to manage legacy wastes from the legacy of nuclear programs. The gradual redirection of efforts away from radionuclide research into more generic carbon research has changed the identity of the SBR program made it less distinct from the NSF-funded research programs. In addition, the DOE labs have unique capabilities to accommodate laboratory studies of radionuclides and to train the next generations of radionuclide biogeochemists. This longstanding tradition should continue to be supported by DOE programs, especially SBR.
- Frequent communication between program scientist and the principle investigators during the program transition has resulted in the successful realignment of major lab SFA components with the desired new research direction.
- Program scientists have weathered the FY2013-2015 programmatic transition well and continue to be productive both in the completion of work done at the older field sites and initiation of work at the new field sites. We laud CESD's efforts to promote scientific innovation and we encourage continued engagement of the broader scientific community as SBR and TES together make this transition to new focus areas.

Recommendations:

- Research in subsurface radionuclide transport should not be abandoned entirely because it is still needed to better manage legacy nuclear waste and to maintain national expertise in this area, which largely resides in the national laboratories. Further integration with the elements of the TES program is encouraged where feasible. Greater involvement of

university collaborators is recommended to provide more opportunities for training the next generations of scientists.

- Program managers should remain cognizant of advances being made in other agency programs (e.g., NSF Critical Zone Observatories) to maximize the complementarity of SBR research activities with those in other ongoing programs and to maintain clear distinction of DOE-funded work from that funded by NSF or other agencies.

(b) National and international standing of the portfolio elements

Findings:

- Much of the work in the SBR program is at or near the leading edge of national and international efforts in the relevant science focus areas. The group of funded PIs includes highly productive scientists with strong track records of high-impact research activity as well as promising early-career scientists.

Comments:

- Reduction in SBR program funding by about 50% since FY 2010 has resulted in diminished scientific contributions from university scientists. This is suboptimal for the program's versatility and limits the opportunities for involvement of university students and postdocs who may become the future PIs for DOE

Recommendations:

- The COV recommends additional open solicitations of SBR proposals from university scientists.

- The COV recommends enhanced communication with research communities through town halls at major conferences.

4. Other Review Criteria and Questions

- *Are an adequate number of qualified reviewers (free from bias and/or conflicts of interest) selected for review of projects and grants?* Yes.

- *Are the Office of Science (SC) merit review criteria applied appropriately in the evaluations?* Yes.

- *Is documentation of the review process adequate and complete?* Yes.
- *What are the characteristics of the award portfolio?* The portfolio meets the requirements of scientific merit and programmatic balance.
- *Are progress reports on previously funded research useful in the evaluation of proposed research?* Yes, these provide an effective means for evaluation of the productivity and quality of the investigators.
- *What is the quality of overall technical management of the program?* Technical management is of high quality, and responsive to input from reviewers and the broader scientific community.
- *What are the relationships between award decisions, program goals and DOE mission?* The award decisions are closely aligned with program goals and the DOE mission.
- *Are there significant impacts and advances that have developed since the previous COV review that are demonstrably linked to DOE investment?* Noteworthy advances include omics work that links genomes to structure and function of microbial communities in a hydrobiogeochemical context; watershed scale computational models.
- *Were the responses of the program to the recommendations of the previous COV review appropriate?* The program has been highly responsive to the recommendations of the previous COV review. Actions of program managers have been well considered and are appropriate for continuing to support the productivity and quality of the SBR program.

F. Atmospheric System Research

1. *Program Summary*

The main goal of ASR is to advance process-level understanding of the key interactions among aerosols, clouds, precipitation, radiation, dynamics, and thermodynamics, with the ultimate goal of reducing the uncertainty in global and regional climate simulations and projections. The ASR program utilizes the long-term cloud, aerosol, precipitation, and meteorological datasets from the Atmospheric Radiation Measurement (ARM) Climate Research Facility, targeted field campaigns, laboratory studies, and process models to address key

uncertainties in processes associated with clouds and aerosols that affect the Earth's radiative balance and hydrological cycle and limit the predictive ability of climate models.

2. Quality and efficacy of funding process

The COV examined the 4 ASR FOAs during the past 3 fiscal years: 13-0885 ($8.3M/3 yr), 13-0919 ($2.2M total/3 yr), 14-1139 ($4M total/4 yr), and 14-1174 ($10M total/3 yr). There were 238 proposals submitted to these FOAs and 39 (16%) were funded. The percentage of ASR funding that went to national laboratories was 47%, 42% and 44% in FY13, FY14, and FY15, respectively. The total ASR funding level was approximately $26M each year between FY13-15.

For the COV review, a random sampling of both the accepted and declined proposals was conducted which included all available documentation of the proposal, peer review process, and management decisions and communication to the proposers and review panels.

(a) Solicit, review, recommend, and document application proposal actions

Findings:

- Funded proposals were consistent with priorities and criteria stated in program announcements.
- The solicitations, proposal reviews, and award decisions are rigorous. Communication with investigators and feedback to proposers was well documented.
- Funded projects were tracked closely through annual and final reports, workshops, site visits, regular reviews and direct communication. The award decision and management processes were appropriate and effective.
- The committee extensively reviewed the selected proposals including reviewer comments and program manager documentation. The committee also considered such materials for some declined proposals. The committee found the documentation sent to proposers of declined proposals that ranked high to be less than ideally informative.

Comments:

- The current balance of laboratory and university research is appropriate.

- The program managers successfully assembled large, diverse, and well-qualified sets of reviewers.

Recommendations:

- The balance between laboratory and university funding should be maintained in the future.
- The COV recommends increasing the number of joint solicitations with other agencies to more fully exploit long-term surface, satellite and other datasets for climate process research.
- The PMs should provide more detailed information to proposers of proposals that are highly ranked by the panel but not funded e.g., to maintain programmatic balance, etc.

(b) Process to monitor active awards, projects and programs

Findings:

- Funded proposals are monitored through annual reports, annual PI meetings, and research highlights.

Comments:

- Because of the limited travel funding available to PMs, the PMs are unable to adequately monitor how PI research presented at major workshops and conferences is received by the international research community.
- The travel cap also prevents the PMs from visiting DOE laboratories and interacting with the entire teams that receive funding by ASR. They see the PIs at annual meetings but rarely meet and interact with younger scientists who support the research.

Recommendations:

- ASR program managers should keep track of and present (e.g., during COV reviews) some of the more outstanding science highlights that have occurred during the past 3 years.
- Travel funding for program managers should be increased.

3. Effect of the Award Process on Portfolios and their Alignment with IAR and CESD Priorities

(a) Breadth and Depth of portfolio elements

Findings:

- The funded research is consistent with the goals in the FOAs.

Comments:

- The relationship between ASR and ARM is unique in the CESD portfolio, in that ASR-funded projects are required to make use of ARM data. This is reasonable up to a point, but ASR should not exist for the purpose of supporting ARM; instead, ARM should exist to enable the research of ASR and other elements of CESD as well as the climate research community at large.
- The ASR program's stated goal is to reduce the uncertainty in climate projections. Its approach to this goal is to emphasize cloud processes, which is appropriate given the level of uncertainty in such processes. The COV notes that the lion's share of the emphasis is related to cloud-aerosol interactions. This is natural given the program's history, but is nonetheless a narrow and limiting perspective.
- ASR is increasingly funding research on land-atmosphere interactions.

Recommendations:

- ASR should strive to maintain a balance between the scientific use of the ARM data and innovative remote sensing approaches for new data product development.
- The relationships between ASR, ARM, and the other atmospheric modeling components of CESD (RGCM and ESM) should be clarified both within CESD and to the external community. ASR, perhaps in conjunction with RGCM and/or ESM, should support some high-quality climate research that involves clouds and radiation and supports ASR goals but *does not* make use of ARM data.
- Efforts should be made to increase the number of joint solicitations with other agencies to more fully exploit long-term surface, satellite and other datasets for climate process research.

(b) National and international standing of portfolio elements

Findings:

- The funded ASR research is well regarded both nationally and internationally.

Comments:

- The ASR annual meetings and workshops are productive and useful.

Recommendations:

- The program can enhance its impact by establishing a broader set program-wide metrics in addition to number of publications. For example, it would be useful to track the number of conference presentations (invited and contributed) by researchers funded through ASR, track citations of papers from funded ASR research, etc.

4. Other Review Criteria

- *Are an adequate number of qualified reviewers (free from bias and/or conflicts of interest) selected for review of projects and grants?* Yes.
- *Are the Office of Science (SC) merit review criteria applied appropriately in the evaluations?* Yes.
- *Is documentation of the review process adequate and complete?* The internal documentation is adequate, but as noted above the PMs should provide more information to PIs with highly-ranked but un-funded proposals.
- *What are the characteristics of the award portfolio?* The award portfolio is well balanced.
- *Are progress reports on previously funded research useful in the evaluation of proposed research?* Yes.
- *What is the quality of overall technical management of the program?* Very good.
- *What are the relationships between award decisions, program goals and DOE mission?* They are consistent.

- *Are there significant impacts and advances that have developed since the previous COV review that are demonstrably linked to DOE investment?* The Large-Eddy Simulation initiative is an important advance.
- *Were the responses of the program to the recommendations of the previous COV review appropriate?* The responses were adequate.

G. Atmospheric Radiation Measurement Climate Research Facility

1. Program Summary

The Atmospheric Radiation Measurement (ARM) Climate Research Facility (ACRF) is a multi-platform scientific user facility with strategically-located *in situ* and remote sensing observatories collecting measurements to improve scientific understanding of the fundamental physics related to interactions between clouds, aerosols, and radiative feedback processes in the atmosphere — key atmospheric phenomena for the advancement of atmospheric process understanding and improved climate models. The program provides the national and international research community unparalleled infrastructure for obtaining these detailed and accurate measurements in diverse climate regimes. Within DOE, ARM's major partners are the Atmospheric System Research (ASR), Regional and Global Climate Modeling and Earth System Modeling programs.

ARM maintains three sites situated in climatically distinct locations to sample continental and marine conditions in mid-latitude and Arctic environments (U.S. Southern Great Plains, North Slope of Alaska, and the Azores). ARM also has an aerial measurement capability (AAF) and three mobile facilities (AMF) that can be used in experiments across the globe. Two of the mobile facilities deploy for 6- to 24-month durations, while the third is installed at Oliktok Point, Alaska, for an extended multi-year deployment. ARM continually develops and deploys new capabilities to enhance atmospheric research including new scanning cloud and precipitation radars, tethered balloon systems, and unmanned aerial systems. ARM is currently developing the capability to couple ARM observations with routine high-resolution model simulations to more tightly integrate observations and data processing with modeling.

ARM's current budget is about $68 M per year, and the total amount expended since effort's inception in 1989 is close to one billion dollars. It is the largest field program in the history of atmospheric science. It is by far the largest single element of CESD's budget. ARM and ASR together comprise almost a third of CESD's budget.

Comments:

- The COV commends the ARM facility for its creative initiative in synthesizing data with observations through routine use of large-eddy simulations. We encourage continuing exploration of the potential benefits of this approach including on-going engagement with the broader scientific community.
- The COV recognizes that ARM has produced several legacy datasets that are widely used by the community. These data were primarily from the program before ACRF was last reviewed. It is not clear to the COV what high-impact data the program has produced in recent years, especially data from the scanning radars.
- The ACRF has played an unparalleled role in providing observations for advancing our understanding of climate processes nationally and internationally. ACRF currently uses the numbers of publications and users as the main metrics to measure its impacts. These metrics alone may not fully reflect the value of the ~$68M annual budget, especially to general public and policy makers.

Recommendations:

- In view of many recent developments, the ARM Climate Research Facility should be externally reviewed again within the next few years. This will supplement the internal review carried out during 2014. The scope of the recommended external review should include the relationship between ARM and ASR.
- We encourage the ARM facility to continue to push towards making their data more readily to useful to a larger community, including via outreach (e.g. online tutorials) and thoughtful user-driven development of new observational products.

- The program should continue and possibly enhance joint field campaigns with other agencies and international organizations (e.g., TCAP, GoAmazon, ACAPEX/Calwater, PECAN, AWARE).
- The program should seek ways to more fully identify and communicate ARM's contributions to the climate community.

2. *Quality and efficacy of funding process*

ARM is operated by various DOE labs. Its budget is used primarily for operating the measurement sites (~95%) and purchasing equipment (~5%). Funding for facilities is directed from DOE Headquarters toward infrastructure maintenance and expansion, data archive and dissemination, and basic operations and management. Funding levels for the ACRF were $68M in FY2013, $68.6M in FY2014, $67.2M in FY2015. Priorties and planning for the ARM facilities are made following extensive discussions between DOE Program Managers and a DOE Infrastructure Management Board (IMB).

During 2013-15, ARM conducted the major field campaigns listed in the table below.

Table 1: Major ARM Field Campaigns during 2013-15.

Title	Location	Time	Principal Investigator	Major Facility
Two-Column Aerosol Project (TCAP)	Cape Cod, MA	Jul 2012 – June 2013	Larry Berg, PNNL	AMF1
Marine ARM GPCI Investigation of Clouds (MAGIC)	Ship between LA and Hawaii	Oct 2012 – Sep 2013	Ernie Lewis, BNL	AMF2
Biomass Burning Observation Project (BBOP)	Pasco, WA and Arkansas	July 2013 -Oct 2013	Larry Kleinman, BNL	AAF G-1
Green Ocean Amazon (GOAmazon 2014/15)	Manaus, Brazil	Jan 2014 – Nov 2015	Scot Martin	AMF1, AAF G-1
Biogenic Aerosols - Effects on Clouds and Climate (BAECC)	Hytiaala, Finland	Feb 2014 – Sep 2014	Tuukka Petaja	AMF2
ARM Cloud Aerosol Precipitation Experiment (ACAPEX)	NOAA Ron Brown; off the coast of CA	Jan 2014 – Feb 2014	Ruby Leung	AMF2, AAF G-1

Title	Location	Time	Principal Investigator	Major Facility
ARM Support for the Plains Elevated Convection at Night Experiment (AS-PECAN)	Oklahoma	Jun 2015 – July 2015	Dave Turner	SGP
ARM Airborne Carbon Measurements	Alaska	Jun 2015 – Sep 2015	Sebastien Biraud	AAF G-1
Evaluation of Routine Atmospheric Sounding Measurements using Unmanned Systems (ERASMUS)	Oliktok Point	Aug 2015 – Apr 2016	Gijs de Boer	AMF3

(a) Solicit, review, recommend, and document application proposal actions

Findings:

- ACRF solicitations for proposals are closely linked to the ACRF vision. The ACRF has broadened its collaborations with other programs within CESD through joint calls for proposals, such as GOAmazon, land-atmosphere interactions, and a recent joint proposal call with EMSL to study aerosol processes.
- The review of proposals and the PM decision-making procedures are appropriate and adequate. The laboratory (ARM infrastructure) proposals are mostly done by the laboratory lead PI typically describing the work to be done as part of the overall DOE laboratory funding, including maintenance and replacement of instrumentation and other support infrastructure such as hardware and software to operate and manage the ARM data Archive. The proposals for field campaigns using aerial measurements and mobile facilities are open to the research community in collaboration with the DOE laboratories. The proposals are reviewed by the ARM Science Board and the PM. The reviews of the proposals are informative and well documented in terms of main strengths, potential technical and logistic issues and programmatic concerns. The process is clearly sound and robust.
- Laboratory (ARM infrastructure) proposals are mostly done as annual "Field Work Proposals" by which the laboratory lead PI typically describes the work to be done as part of the overall DOE laboratory funding, including maintenance and replacement of

instrumentation and other support infrastructure such as hardware and software to operate and manage the ARM data Archive.

Comments:

- ACRF plays an increasingly important role in providing unprecedented observations to improve our understanding and modeling capability of the clouds, aerosol and radiation processes, as well the coupled earth system processes through its growing collaboration with other CESD programs.
- ACRF has well established mechanisms to seek and receive scientific inputs within the ARM/ASR and CESD communities. By comparison, inputs from researchers outside of ARM/ASR community for new research directions is limited.

Recommendations:

- The COV recommends an increase in the number of joint solicitations with other agencies because this would allow PIs and the program to more fully exploit long-term surface, satellite and other datasets for climate process research.
- Recognizing the growing costs of instruments and maintenance for the CESD facilities, the COV recommends that ACRF PMs continue to engage the science community to set priorities and maintain the proper balance of protecting legacy datasets and acquiring new instruments.

(b) Process to monitor active awards, projects and programs

Findings:

- Progress monitoring is robust overall. The PMs have weekly meetings/telecoms with the IMB and ARM technical Directors and Chief Operating officer, monthly reports from site managers, Data Center, ARM Aerial Facility on monthly milestone and financial dashboards since 2015. PMs also meet with IMB in person twice/year to discussion annual budget and yearly priorities and user needs. These activities cover all critical management and operation aspects of the ACRF.
- ARM has done great job of addressing the previous COV's recommendation to modernize the ARM data system. In particular, ARM has made significant improvements in its data

archive, such as a New Data Discovery browser with improved interface allows subsetting, filtering by data quality, quick look plots, an online metadata editor for easier documentation of PI data; on software tools for working with ARM data, such as ARM Data Integrator tool for combining multiple datastreams; on products for model/ observational comparisons such as initiation of ARM radar simulator and ARM model diagnostic packages and initial products for ARM scanning cloud radars.

- ACRF data users have increased by nearly 30% during the period of 2013-2015 relative to the previous three years.
- The ARM Facility has formal triennial reviews and an annual meeting of the ARM Science Board to review ARM user proposals. ACRF has responded swiftly to the major recommendations of its triennial review in 2014, and has developed draft Decadal Vision documents for ARM facility and Data, and established an ARM User Executive Committee.
- The process is robust overall. There is regular communication between the PMs and the IBM, covering the operation of the ARM sites and planning for the future.

Recommendations:

- None at this time.

3. Effect of the award process on portfolios

(a) Breadth and Depth of portfolio elements

Findings:

- ACRF has significantly strengthened its breadth and depth during the period of 2013-2015. In particular, ACRF has strengthened its capability as a world-class facility in measuring atmospheric processes of radiation, cloud, aerosols, precipitation and their interactions by providing new and more comprehensive observations including new scanning cloud radars, tethered balloon systems, and unmanned aerial systems. The program has expanded best estimate data products to address the couplings between carbon, aerosol and cloud processes, and between land and atmospheric processes, and is developing the capability to couple ACRF observations with routine large-eddy model simulations over an ARM site

domain as a way to synthesize observational capabilities. ACRF has also increased joint proposal calls and field campaigns with other CESD programs, federal and international agencies.

- The ARM data are freely available at the ARM website. There are approximately 150 individual requestors of ARM data per month.
- The number of scientific papers published using ARM data was 92 in FY13, 114 in FY14, and 118 in FY15.

Comments:

- As the spatial resolution of climate models is nearing the scale of the footprint of ACRF platforms, and as Earth System Model efforts ramp up, there is a need for closer interaction in designing integrated data infrastructure including both observations and model results. The COV commends the ACRF for its creative initiative in synthesizing data with observations through routine use of large-eddy simulations.
- The COV also commends the ACRF for growing collaborations with other CESD programs and other federal and international agencies such as NASA, NSF and NOAA, and Brazilian FAPESP. While the ARM Climate Modeling Best Estimate (CMBE) product has expanded to include soil moisture and temperature, a coordinated data infrastructure activity with other projects such as Obs4MIPS would further enhance the capability of the ACRF to anticipate future needs and maximize longevity and utility of ARM data.
- The ARM program has been upgrading the ARM data archive, including via a new data discovery browser with improved interface, improved software tools for using ARM data, improved products for model/observation comparisons, and updated radar products.

Recommendations:

- As the facility broadens its interactions with other programs with CESD a new assessment of the ACRF current and future capability to support the sciences of ASR, CESD and BERAC, and clear strategy on how to optimize ARM's future solicitations to support these sciences would be highly beneficial.

- The COV recognizes that ACRF's efforts will necessarily be influenced by CESD and BER priorities and by the close collaboration with the national labs. Nonetheless the program would benefit from increasing opportunities for the broader research community to provide input, especially with respect to research direction and initiatives.
- The program should expand exploration of the potential benefits of joint ACRF observations and routine use of large-eddy simulations, and aggressively pursue the development new high-impact data. The scanning radars seem an important but under-utilized opportunity
- As noted above, the program should continue joint field campaigns with other agencies and international organizations (e.g., TCAP, GoAmazon, ACAPEX/Calwater, PECAN, AWARE). Increase the number of joint solicitations with other agencies to more fully exploit long-term surface, satellite and other datasets for climate process research.
- ACRF management was proactive in the development of the "best estimate" data sets. The COV encourages the PMs to expand these efforts.

(b) National and international standing of portfolio elements

Findings:

- The ACRF continues to be a state-of-the-art observational program indispensable to national and international climate research. The fixed sites have proven to be unique and invaluable anchor points in, climate process studies, model testing and evaluation and climate data records worldwide. The enhanced AAF and AMF observational capabilities, especially the added third AMF allowing multi-year deployment and AAF unmanned aircrafts, complement the fixed sites by providing intensive observations over large variety of the climate regimes and the flexibility to adhere to changing priorities and circumstances, as well as promoting and establishing necessary international research links and activities.

Comments:

- The ACRF can further strengthen its leading role in providing high quality observations to support CESD mission by exploring and capitalizing ACRF's enhanced observational capability through, for example, producing new high-impact data.
- Collaborations with other federal and international agencies are very positive and demonstrate the standing of ACRF nationally and internationally.
- The ARM program is an active member of the international community. Members participate in and provide leadership in international workshops and field campaigns.

Recommendations:

- The COV encourages the program to continue exploring collaboration opportunities with national and international partners to leverage DOE resources and to enhance its impact on the climate system science research.
- The ACRF should invest in the development of new high impact datasets applicable to a broad base of user communities to capitalize ACRF's enhanced observational capability.
- Continued participation in international field campaigns is highly encouraged, particularly in locations where environmental conditions may provide vital data to advance ARM DOE research goals (aerosol-cloud-precipitation-radiation interactions).

4. Other Review Criteria

- *Are an adequate number of qualified reviewers (free from bias and/or conflicts of interest) selected for review of projects and grants?* Yes.
- *Are the Office of Science (SC) merit review criteria applied appropriately in the evaluations?* Yes.
- *Is documentation of the review process adequate and complete?* Yes, but this can be improved.
- *What are the characteristics of the award portfolio?* The portfolios are consistent with what was solicited.

- *Are progress reports on previously funded research useful in the evaluation of proposed research?* Not applicable.
- *What is the quality of overall technical management of the program?* Excellent.
- *What are the relationships between award decisions, program goals and DOE mission?* Closely linked.
- *Are there significant impacts and advances that have developed since the previous COV review that are demonstrably linked to DOE investment?* Yes. There are enhanced and broadened connections between ARM observations and models. These include the enhanced observations and routine LES simulations at the scale of a global model grid cell; enhanced boundary layer and soil moisture and temperature observations and best estimate products; field campaigns that address carbon, aerosol and cloud linkages; and an improved data archive and software tools.
- *Were the responses of the program to the recommendations of the previous COV review appropriate?* Yes.

H. Environmental Molecular Sciences Laboratory

1. Program Overview

The Environmental Molecular Science Laboratory (EMSL) is national scientific user facility that is funded and sponsored by BER. As a user facility, scientific capabilities of the lab (people, instruments and facilities) are available for use by the global research community. EMSL's mission is to lead molecular-level discoveries as related to BER's effort to translate to predictive understanding and accelerated solutions for national energy and environmental challenges. Capabilities at EMSL include advanced instrumentation for molecular spectroscopy, microscopy, among others, as well as supercomputing capabilities.

EMSL is reviewed by an external committee on a triennial basis, with the last review occurring in 2014. This review includes evaluation of EMSL scientific impact, operations, and management. Because the facility is already reviewed in detail, this COV evaluation focused on

the process of strategic planning for EMSL, outcomes of the 2014 review, and actions taken by EMSL and BER management.

2. Strategic Plan and Science Themes

Findings:

- The strategic planning for EMSL occurred throughout 2013-14 and was a science-driven process in which major science themes were developed in conjunction with program managers within BER. These science areas form a significant basis for decisions on facility investments as well as the proposal review process. We laud the careful efforts to maintain this science-focused strategy.
- The proportion of BER users supported by EMSL has significantly increased over the past three years and EMSL should be commended for its success in aligning better with the BER user community.

Recommendations:

- EMSL is encouraged to progress further along this path, in particular in strengthening further its support for atmospheric science.

3. Efficacy of Triennial Review

Findings:

- EMSL is reviewed by an external committee on a triennial basis. The 2014 review process involved a panel of reviewers with appropriate expertise areas and representing DOE laboratory and non-laboratory scientists. Records for this review process were thorough, and the COV greatly appreciate this.
- The strategic planning for EMSL was a science-driven process, in which major science themes were developed in conjunction with program managers within BER. These science areas form a significant basis for decisions on facility investments as well as the proposal review process. We laud the careful efforts to maintain this science-focused strategy.

- EMSL is reviewed by an external committee on a triennial basis. The 2014 review convened an impressive panel of reviewers for the task, and records for this review process were thorough.
- We are impressed by seriousness in which EMSL and BER management considered the review panel's recommendations. Response actions were developed and revised over a several month time frame between EMSL management and program managers within BER. We encourage the management team to maintain their outreach efforts and to find ways to monitor their progress and effectiveness of the outreach.
- The proportion of BER-funded users as increased substantially in the 3 year period, and this may reflect better alignment of the proposal awarding process with the Science Themes established in the EMSL strategic plan.
- The new Environmental System Science program was formed by combining the Terrestrial Ecosystem Science and Subsurface Biogeochemstry Research programs. Investments from ESS have a very strong focus on carbon biogeochemistry and watershed/subsurface hydrology, and the program has substantially divested from research on biogeochemistry of other elements (e.g. contaminants), an area of historical strength for CESD and not with other federal science agencies. We recognize that ESS is still in transition and that the merging of the two programs under decreases in budgets has yielded suboptimal utilization of resources (such as transitioning contaminant field sites for carbon cycling) that might not yet address the scientific needs. We laud CESD's efforts to maintain scientific innovation and encourage continued engagement of the broader scientific community as ESS makes this transition to new focus areas.
- Two major recommendations were provided by the 2014 review committee. They included: 1) Improvements to scientific outreach of EMSL capabilities as a way to broaden the user base; 2) Evaluation of computing support capabilities within the facility. We are impressed by the seriousness in which EMSL and BER management considered the review panel's recommendations. Response actions were developed and revised over a several month time frame after the review report was submitted and the plan was iterated between EMSL management and program managers within BER.

Recommendations:

- We encourage the management team to maintain their outreach efforts and to find ways to monitor their progress and effectiveness of the outreach. For example, a dedicated science outreach coordinator at EMSL could facilitate interactions with the broader community. This coordinator could also help increase EMSL's profile among the variety of environmental science communities.

- Another example of outreach would be to encourage collaborations across different programs within DOE. The joint EMSL-JGI user proposal call in 2013 produced impressive scientific achievements. Similar calls on a more regular basis would encourage continuing advanced at the frontiers of environmental science. We also encourage collaboration with other programs, perhaps by offering to add EMSL capabilities to the FOA descriptions of other programs and by offering "cost-share" type letters of support that can strengthen grant proposals to DOE programs and other federal science agencies.

- Another recommendation of the 2014 review was to improve the strategy for computing capabilities at EMSL. The unique feature of EMSL has been the integration of experiment and computing. While the EMSL computing strategy has merit, the COV has some concern that it may be deviating from the unique mission of EMSL. In particular, the plan does not have a clear vision on how computing and experiment can be used synergistically together to improve both the experimental process and the BER community's predictive capabilities.

- NWChem is a key community code supported by EMSL. We commend that the facility is starting to shift its focus of applying it to BES centric projects to a very much increased support for BER relevant topics to which it can contribute significantly. We encourage EMSL to progress further along this path.

- EMSL is a facility that supports a broad experimental and computational community. Unfortunately, the current computing strategy is too limited in its focus on computational models developed by EMSL, such as NWChem and Subsurface. It is necessary to reach out beyond EMSL and support a wider base of BER computational users and models to justify the investment in EMSL's computing capabilities. Furthermore, EMSL should offer significant support to its experimental facilities users, including support for their

experiment preparation, data analysis and management needs. We strongly suggest an in-depth review and adjustment of the EMSL computing strategy in line with other national and international experimental user facilities.

I. Data and Computing

1. Program Summary

The mission of the data management program is to develop and maintain a best-in-class data management and analytics capability for BER, based on observed and model generated data, plus supporting information, to serve existing and anticipated scientific questions and challenges. The program covers hereby both infrastructure and application development and integration work. This is a new BER program started in FY13.

Comments:

- The COV commends CESD for starting a forward-looking data management activity that will enable CESD research to remain world-class.
- The strategic vision developed for this program is exciting and suitably matched to the needs of the CESD research programs.
- The current budget is however inadequate to realize the strategic vision.

Recommendations:

- The program should clearly define a core set of capabilities that it can create within its budget.
- The program will need to develop a clear and compelling plan on how to effectively collaborate and leverage the developments of other related programs and research groups, and specifically how to entice them to seek collaborations with this program.
- The data management program might want to consider the formation of a data infrastructure facility. The longevity, operational funding and performance metrics of a facility would help to maintain the envisaged core capabilities.

2. Quality and efficacy of funding process

The program was set up with limited funding in FY13 (FY13 $2.9M, FY14 $5M and FY15 $5M) and has supported two existing archiving and analytics centers: Earth System Grid Federation (ESGF) and Carbon Dioxide Information Analysis Center (CDIAC). During that period funding for CDIAC has largely remained the same, whereas funding for ESGF has grown from $0.4M in FY13 to $2.5M in FY15.

(a) Solicit, review, recommend, and document application proposal actions

Findings:

- The Data Management Program did not release any University or Laboratory FOA's during the period FY13-FY15, the additional funding was allocated directly to existing projects.
- The overarching vision for the BER integrated data environment was developed by a small number of individuals based in DOE Laboratories. This vision provided the basis for a series of community workshops to identify key infrastructure needs in the community. The results of these workshops provided guidance for the renewal process of the existing projects.
- Both ESGF and CDIAC submitted renewal proposals, which were extensively reviewed.
- The reviews utilized numerical scores and qualitative comments to assess the program submissions. These were used to make subsequent funding decisions.
- Concerns raised during the reviews were passed on to the project teams and substantive responses required and delivered by both teams.
- Progress reports were submitted annually. The documents show that ESGF is progressing well against its plan. CDIAC had a review in the summer of 2015 for the first time in decades, which it failed. It was re-reviewed in FY2016 and again failed the review. The program manager provided information on how the CDIAC mission is planned to be supported moving forward.
- The two projects were reviewed as research projects, and not as long-term data infrastructure facilities.

Comments:

- The COV found the Data Management program manager to be very helpful to the review during the committee meeting, he was very responsive to any questions raised by COV members and provided substantive written and verbal information.
- The program as a whole is embedded in DOE/BER/CESD priorities and is synergistic with the CESD mission. It provides the important component of the overall BER capability.
- Further reaching coordination and alignment of data management activities across CESD programs are possible and were discussed, however there are at present no clear shared strategies, goals and milestones developed that would progress this agenda.
- Data Management and analytics are fast moving topic areas worldwide, COV members discussed with the program manager that by involving only a very limited community in its planning workshops and by continuing to fund existing projects rather than utilizing FOAs, BER is significantly limiting its pool of ideas and potential solutions.
- Some of the services provided by various activities in the Data Management program as well as similar activities in other programs such as EMSL computing, ARM data management etc. are more akin to user facilities than research projects. By operating them as research programs key functionalities such as operation, infrastructure renewal, building of new capabilities are difficult to fund, similarly key metrics and requirements for a facility incl. sustainability, reliability, fitness for purpose, user satisfaction, scientific output, etc. are not as rigorously reviewed as would be helpful.

Recommendations:

- CESD, facilitated through the data management program, should develop a shared vision, goals, timeline and success metrics for its aligned data management and analytics infrastructure, to inform future solicitations and project guidance.
- The Data Management program should issue broad FOAs for future solicitations or funding reviews incl. through SBIR to ensure it can assess a wide spectrum of possible solutions and evaluate its comparative merits.

- The data management program and the wider CESD program should review if the basic data management infrastructure for CESD would be better served by establishing it as a user facility (potentially with more partners akin to ARM).
- The Data Management program should develop a clear list of high priority capabilities it needs to provide to the CESD community, incl. when and how those would be provided. Given the very limited funding of the program it is important to focus on program strategies and measures that actively encourage and facilitate collaboration with other programs both in DOE (CESD, BER, ASCR, HEP, BES) and other Federal Agency programs.

(b) Process to monitor active awards, projects and programs

Findings:

- The process of monitoring active awards and projects within the Data Management program is based very comprehensively on annual reports, research highlights, external reviews (3 year cycle) and regular personal contacts between the program manager and PI's.
- This is a very small program at present, which has seen some growth over the past two years. As such its current scope is still quite limited in the context of its much broader vision.
- Despite its size the program has successfully reached out to a number of other relevant federal agencies in the US to integrate and leverage their capabilities as appropriate. The success of outreach within DOE has been comparatively limited.
- Additional funding committed by DOE ASCR in support of ESGF software stack redevelopment is the excellent example of the benefits of cross office collaboration.
- There is no evidence of technical interactions between the IDEAS project (software engineering standards and best practice etc.) and the projects in the Data Management Program.

Comments:

- Given the limited funding available to the Data Management program it is important to define in significant detail which capabilities need to be developed and operated by BER and which capabilities could be leveraged from the wider community and industry. At present the portfolio is focused on quite complex, one stop shop solutions, that do not allow for easy community contributions or integration of already existing alternative solutions.
- There is currently no clear strategy on how the wider community could contribute to the BER Data Management program, or what actions would be necessary to facilitate such the involvement from the architecture of the currently supported software development to active community outreach
- The reviews of both ESGF and CDIAC point towards problems in the area of software architecture and engineering, required to deliver reliable, fit for purpose data services. It is therefore surprising that there is currently no interaction between these projects and the jointly funded BER/ASCR IDEAS project, which specializes in this subject area.

Recommendations:

- Develop a clear technical vision of the core capability that the Data Management program needs to develop and support, enabling the program to easily leverage a wider spectrum of contributions from the community, both funded and unfunded.
- Develop a strategic plan on how to prepare the program to actively engage with a wider developer and user community.

3. Effect of the Award Process on Portfolios and their Alignment with IAR and CESD Priorities

(a) Breadth and Depth of portfolio elements

Findings:

- The program has currently only very limited funding, as well as having chosen to continue existing projects, rather than start anew. As such the breadth and depth of the program is rather limited.
- With ESGF and CDIAC the program focusses on two core service requirements in BER.

- The program has started to build links to other relevant programs in other agencies, to extend its capabilities through leveraging; these interactions are currently in their infancy.
- There are some interactions with other BER program managers with overlapping portfolio focus areas such as EMSL, ARM and TES.
- There was no evidence of a detailed plan and timeline on how the Data Management program will realize its broader vision, in particular given the very limited funding it currently has.

Comments:

- The program is currently limited in its breadth and depth; furthermore it is very limited in diversity of organizations and researchers funded.

Recommendations:

- The Data Management program should develop a clear list of high priority capabilities it needs to provide to the CESD community, incl. when and how those would be provided. Given the very limited funding of the program it is important to focus on program strategies and measures that actively encourage and facilitate collaboration with other programs both in DOE (CESD, BER, ASCR, HEP, BES) and other Federal Agency programs.

(b) National and international standing of portfolio elements

Findings:

- The Earth System Grid Federation (ESGF) is recognized as a world leading capability in its concept and in the service it provides to the modeling community.
- ESGF has had several years of insufficient funding to maintain its software infrastructure and a lack of investment to adapt to new user requirements and new software technologies.
- The Carbon Dioxide Information Analysis Center (CDIAC) is a world renowned repository of carbon data, which has an exceptionally broad user base, well beyond the scientific community.
- CDIAC failed two renewal reviews.

Comments:

- The program has started to reach out to a broader community in the US.
- ESGF subsequent reviews have pointed out that ESGF is currently based on older software technology and design principles, largely due to a lack of funding over the past years. It is hoped moving forward that these shortcomings and threats to its long term sustainability and adoption can be addressed through Data Management program funding and other investments such as the recent ASCR grant award. In this endeavor it might be useful to focus the investment on the crucial parts of the overall ESGF software environment, which are of high priority to CESD.

Recommendations:

- It is not clear that the revised Earth System Grid Federation will adequately serve either the high resolution components of CMIP6 or the ACME modeling program due to funding constraints and certain dated infrastructural aspects of the system. Investments need to be targeted at addressing these immediate DOE programmatic requirements, a close collaboration with DOE ASCR facilities (the Leadership Class Facilities and the Earth Sciences Network) and research (including the Scalable Data Management, Analysis, and Visualization Institute) will be essential to make this effort successful.

4. Other Review Criteria

- *Are an adequate number of qualified reviewers (free from bias and/or conflicts of interest) selected for review of projects and grants?* The review teams were adequate in number and included a selection of experts from different, relevant areas of expertise, ensuring that all necessary aspects of the review were covered both in terms of technical expertise and programmatic alignment. The program ensured these reviewers were free from bias and/or conflict of interest.
- *Are the Office of Science (SC) merit review criteria applied appropriately in the evaluations?* Yes they were, the guidance to the reviewers were clear in this respect and was followed.

- *Is documentation of the review process adequate and complete?* The COV reviewed the written material provided by the program manager, the documentation of the process was very detailed and complete.
- *What are the characteristics of the award portfolio?* At present, the portfolio includes only two DOE laboratory projects, which represent follow-on funding to pre-existing projects. Please see further comments above on the need to expand the pool of applicants to the program and the consideration to move from research projects to facilities.
- *Are progress reports on previously funded research useful in the evaluation of proposed research?* The progress reports were useful. The results of the reviews were even more insightful, however.
- *What is the quality of overall technical management of the program?* The program manager has done a good job within the budgetary constraints.
- *What are the relationships between award decisions, program goals and DOE mission?* The award decisions are clearly aligned to the program goals and DOE mission, moving forward a clear strategy is needed however to not only maintain the alignment, but ensure funding is spend on the most important capabilities required.
- *Are there significant impacts and advances that have developed since the previous COV review that are demonstrably linked to DOE investment?* Not applicable because this program became a separate entity very recently.
- *Were the responses of the program to the recommendations of the previous COV review appropriate?* Not applicable because this program became a separate entity very recently.

III. Crosscutting Themes

The COV engaged in topical breakouts with CESD staff on four cross-cutting topics, listed below:

Topic 1: User Facilities and Community Infrastructure (Paul Bayer, Jared Deforest, Jay Hnilo, Sally McFarlane, Rick Petty)

Topic 2: Interagency Coordination (Dorothy Koch and Bob Vallario)

Topic 3: Workshops and Initiatives (Shaima Nasiri and Dan Stover)

Topic 4: SFA Management and Alignment with CESD Strategic Plan *(Renu Joseph, David Lesmes, Ashley Williamson)*

Based in part of these breakouts, we have formulated the comments and recommendations below.

A. General

Findings:

- Program staff are spread rather thin with a variety of activities such as program management, strategic planning and coordinating interagency collaboration. The latter was described as the "night job." This gives the impression of fragility. Additional personnel would be helpful, perhaps in the form of IPAs.

Comments

- Currently, the review reports provided to PIs consist of the comments from the individual panel members and the PM. Points brought up during the panel discussion are not necessarily included and the most important feedbacks may not be clear to the proposers.

Recommendations:

- The SBR program is moving into water-energy nexus, which emphasizes the catchment-scale and watershed-scale hydrology. SBR and RGCM should develop a joint strategy to develop the capability to simulate high-resolution water routing.

- Add a concise panel review summary led by the primary panelist in the review report to highlight the most important feedbacks, especially those from the panel discussion, to the proposers.

- The synthesizing summary provided by program managers is uneven. Some, for example in recent declination letters for use of the ARM facility, are rich and detailed. Others are so generic as to be cryptic. The committee recommends that program managers be consistent in providing detailed, constructive feedback to proposers. Program managers should consider peer-review of decision letters, as is practiced at NASA. Program managers should also consider asking review panel members to write or contribute to the summaries.

- The committee also recommends that program managers routinely provide information as to whether the proposal was declined for lack of technical merit or for programmatic balance. This might be as simple as a sentence reminding those declined for programmatic reasons that program managers are happy to discuss results by phone. We note that a similar suggestion was made by the last COV: "PMs should continue to provide as much constructive feedback as possible to PIs of declined proposals."

- In some cases, review panels appeared to lack demographic diversity (gender, ethnic background, institution type, etc). The COV recommends that program managers track these metrics for review panels and attendees of strategic planning workshops and that that this data is provide at future COV evaluations.

B. User Facilities and Infrastructure

Findings:

- The CESD user facilities and infrastructure are the ACRF, EMSL, Data Management services including the Earth System Grid Federation (ESGF) and the Carbon Dioxide Information Analysis Center (CDIAC), and the AmeriFlux Network.

- User input occurs through user community meetings, user executive committees who communicate with the facility directors, ARM and EMSL workshops, and EMSL Science Theme Advisory Panel Workshops.

Comments:

- CESD user facilities and infrastructure have been significantly strengthened by, for example, new data archives and Data Discovery browsers of the ARM and ESGF systems, and new ARM SGP observation and operational LES product that aim to better connect

ARM measurements to support model evaluations and developments. However, it is not clear whether ESGF and ARM data systems will be able to deal with the high resolution model outputs from ACME and CMIP6, and the operational LES.

Recommendations

- Investments in ESGF and ARM data systems and tools are needed to effectively support the analysis of high resolution model outputs from ACME and CMIP6, with a close collaboration with DOE ASCR facilities and research (including Scalable Data Management, Analysis, and Visualization).

C. External Coordination and Collaborations

Findings:

- CESD's climate program represents a substantial fraction of the U.S. national effort, to the point that CESD's strategic decisions influence the direction of the national effort.
- Despite a lack of support staff and travel funds, CESD PMs have made extraordinary efforts to collaborate and coordinate with other federal and international agencies through various national and international committees, joint field campaigns, joint proposal calls to leveraged its contributions to the US and international climate researches.

Comments:

- CESD has done great job to incorporate the visions of DOE and USGCRP and to coordinate with other federate agencies in developing its own vision and priorities. The inputs from broader scientific communities are mainly provided by workshops that often sponsored by DOE and with limited participants invited by PM or co-chairs due to budget constraints. CESD could take commendations based on independent assessments by experts in boarder scientific community, such as NRC reports, to strengthen its strategic planning and it position as the uncontested federal leader in earth system predictability research.
- Increasing travel and staff support to the PMs is essential to support external collaborations, especially with international agencies.

Recommendations

- We recommend that CESD ask the National Academy of Sciences to create a study group analogous to the Decadal Survey, which was commissioned by NASA, NOAA and USGS, and which provides guidance to NASA's programmatic decisions in space and earth science. We envision that the NAS study group would collect and digest input from the scientific community in order to set goals, strategies and benchmarks for CESD's path forward, bearing in mind how CESD's program fits into the larger U.S. climate research picture. The work of the NAS study group would benefit not only CESD but the whole U.S. climate research program.

D. Workshops and Initiatives

Findings:

- CESD uses workshops to "engage the community" in order to identify emerging research topics, identify new research opportunities for CESD, and develop plans for field campaigns and other activities. The 22 workshops held during 2013-15 are listed in the table below.

Workshops during FY2013-15

Title	When	Program	Impact
Tropical ecosystems under CC	Jun 2012	TES, others	Led to NGEE Tropics
Water Cycle	Sep 2012	RGCM, SBR, 7 agencies	CESM strategy
US-EU climate change challenges	Nov 2012	CESD-wide	ESM; ACME; ARM collabs; etc.
UAV support to science needs	Jul 2013	ARM, ASR	SBIR, ARM
Atmospheric model testbeds	Aug 2013	ASR	ARM and ASR
High resolution models (e.g., LES)	May 2014	ARM, ASR	ARM; CMDV; FOAs
Molecular Sciences	May 2014	CESD, BSSD	EMSL-JGI collapse

Title	When	Program	Impact
Data&models belowground ecol	May 2014	TES, SBR	FOAs, SFAs
Land use land cover change	Jun 2014	IA, plus USGCRP	IAV FOA; CA; SFAs
Population dynamics	Jun 2014	IA, plus USGCRP	IAV FOA; CA; SFA
Mechanistic models of terr.environ.	Mar 2014	Data, SBR	FOAs in FY16; SFAs
ARM North Slope of Alaska	Sep 2014	ARM, ASR	Facility priorities
Climate-energy interdependence	Oct 2014	ESM, IA	SFAs, FOAs, ACME
ACME Exascale	Jan 2015	ESM, ASCR	CMDV
CMIP6 and Climate Model. Summ	Feb 2015	ESM/RGCM/IA, USGCRP	CAs; ACME
Model-data integration	Apr 2015	Data, SBR	Multiple FOAs
Aerial observation needs	May 2015	ARM, ASR, TES, SBR	Two FOAs in FY16
IAV federal group	July 2015	IA, EPSA, plus 7 agencies	EWN FOA in FY16
Secondary organic aerosols	July 2015	ASR	Steer SFAs
Virtual data integration	Aug 2015	Data	BAMS, FY17 FOA
High resolution modeling	Sep 2015	RGCM, NOAA	FOA in 2016
Facility-program coordination	Oct 2015	ARM, ASR, ESM	multiple

- CESD also attempts to enhance community engagement through "town hall" meetings at the AGU and AMS annual meetings and other national conferences.
- CESD distinguishes four types of workshops: 1) CESD-led workshops; 2) CESD-sponsored workshops; 3) CESD-partially supported workshops; and 4) Other/Fed sponsored workshops. Examples can be seen in the table above.

Comments:

- We commend CESD for seeking community input to inform the evolution of their program. The RGCM program in particular has excellent connections with the broader community, but we are concerned that this is not true across the board. In particular, we find that participation in CESD workshops is overly weighted towards the existing CESD science community.
- The perception of COV members is that town halls are dominated by laboratory interests, which limits broader community engagement.

Recommendations

- We recommend that CESD aggressively seek ways to broaden participation in CESD workshops.
- Act to increase community participation of the CESD town halls, for example, by allowing more time for questions and input from the audience during the townhalls. Advertise these events more broadly to the University community.

E. Management of Scientific Focus Areas (SFAs)

Findings:

- Overall impression: All the programs have very well preserved documentations that covers workshops, guidance letters, decision memos, award documents, and correspondents on significant events. The rigor in program management practice is evident in all those documents. We commend the CESD PMs for their diligence and devotion in running these world-class programs.
- The committee notes that program managers must frequently balance programmatic needs with the raw technical merit of each proposal as assessed by the panel reviews. Proposals that are highly ranked on technical grounds are not infrequently declined for programmatic reasons. In each case we examined, the reasoning for this decision is carefully thought out and well-documented, but the information provided when proposal is declined is limited and generic. It would be difficult for a proposer to determine on the basis of the decision letter whether any particular proposal was declined for lack of technical merit or for

reasons of programmatic balance. This is a missed opportunity. Knowing that a proposal was viable would encourage proposers to develop the idea further and might lead to fewer, better proposals being submitted to future FOAs.

IV. Responses to Previous COV Review

The table below summarizes the general recommendations made by the previous COV in October 2013, and the actions that have been taken in response. Most recommendations of the previous COV have been satisfactorily adopted or addressed.

Recommendations from the previous COV, and actions taken

Recommendation	Actions during FY13-15
Maintain flexibility with SFAs to allow exploratory research; reduce administrative burden, especially for teams with prior "excellent" reviews	Greater dialog with SFA teams prior to reviews, to assure alignment. Has led to more rapid BER approval process for most.
Maintain into the future the current balance of lab and university research	We have strived to maintain this balance through the period for the science programs.
Increase travel funds for PMs to attend scientific meetings	Travel budgets to BER staff has increased during the FY13-15 period
Improve DOE electronic grant information system	The PAMS system became operational and has reduced the amount of "hard copy" paperwork.
Develop program-wide metrics of performance and progress	ACME in particular prompted a process to assure that Labs reward staff using other metrics than just publications
PMs to engage the scientific community to assure protection of legacy data and acquiring new instruments	Numerous workshops on data management, cyberinfrastructure, and the future of facility capabilities were conducted during the period.
Maintain proactive collaborations with university community and investments in CESM	BER created a CESM branch model that links to the exascale strategy, and we expect ACME to be a major model once released. We continue to invest in CESM.
The MIT IA project should be based on a more sustained funding instrument.	The MIT project was converted to a Cooperative Agreement. So also were the NPS and Stanford projects.
Strengthen collaboration with other agencies on carbon cycle and modeling.	Joint FOAs were issued with NASA and NSF during the period, and aggressive efforts were placed on using the MODEX paradigm.
Maintain SBR expertise in radionuclide research at the Labs and Universities	BER is committed to sustained expertise, yet with more dual-use value to carbon and hydrobiogeochemistry that is of increasing importance to climate and environmental modeling.

Recommendation	Actions during FY13-15
ARM to continue development of “best estimate” data sets	Agreed. This has happened.
ARM needs better documentation of scientific input that support SISC and IMB decisions	ARM has done well to improve documentation.
Proposals to ARM should have summaries of previous activities to improve process	ARM has required summaries of its new proposals.
EMSL should strive to increase its user pool, especially to attract new users.	EMSL has dedicated considerable attention to increasing users, particularly on topics that are aligned with BER.

Listed below are issues that still need attention.

- The COV recognizes that progress has been made with PAMS, but it needs to be finished up.
- The COV was pleased to receive much of its input electronically. CESD should aim to provide *all* input to the next COV in electronic form, so that there will be no need for the next COV to dig through boxes of paper files.
- The COV appreciates that some sensitive information, such as the identities of reviewers, should only be accessible to the COV while at the DOE Headquarters. An effort should be made, however, to ensure that *all non-sensitive information* is provided to the next COV electronically in a form that can be accessed away from DOE Headquarters. This will make the work of the next COV more efficient and convenient.

Appendix A: Charge Letter

Department of Energy
Office of Science
Washington, DC 20585

Office of the Director

NOV 0 3 2015

Dr. Gary Stacey
Associate Director, National Soybean Biotechnology Center
Department of Microbiology and Molecular Immunology
271E Christopher S. Bond Life Sciences Center
University of Missouri
Columbia, MO 65211

Dear Dr. Stacey:

By this letter, I am charging the Biological and Environmental Research Advisory Committee (BERAC) to assemble a Committee of Visitors (COV) to assess the processes used by the Climate and Environmental Sciences Division (CESD) within the Office of Biological and Environmental Research (BER) to manage CESD research programs and its user facilities, the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL) and the Atmospheric Radiation Measurement (ARM) Climate Research Facility (ARM).

The COV should assess the operations of the CESD's programs for fiscal years 2013, 2014, and 2015. This includes funding at national laboratories and universities and other activities handled by the program during this time period. It should also assess the quality of the resulting scientific portfolio, including its breadth and depth and its national and international standing. Additionally, the COV should also assess the division's management and oversight of the ARM and EMSL user facilities for the same time period. Specifically, I would like the panel to consider and provide an evaluation of the following:

1. For both the DOE national laboratory projects and university grants, assess the efficacy and quality of the processes used by CESD programs during the past three years to:

   a) solicit, review, recommend and document application and proposal actions, and
   b) monitor active awards, projects and programs.

2. Within the boundaries defined by DOE mission and available funding, comment on how the award process has affected:

   a) the breadth and depth of the portfolio elements, and
   b) the national and international standing of the portfolio elements.

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COV members will be given access to all program documentation completed during the period under review including applications, proposals, review documents and other requests. COV members may also request, at their discretion, a representative sample of the program portfolio be provided. In response, CESD may suggest a sample of actions, including new, renewal and supplemental applications and proposals, awards, and declinations. In addition, COV members may also choose to review files through a random selection process. The guidance for all COV reviews within the Office of Science can be found at http://science.energy.gov/sc-2/committees-of-visitors/ and attachments therein.

The COV should take place in the third quarter of FY2016 (Summer 2016) at the BER/DOE Germantown location at 19901 Germantown Road, Germantown, Maryland 20874-1290. A discussion of the COV report by BERAC should be held no later than the Fall 2016 BERAC meeting. Following acceptance of the full BERAC membership, the COV report with findings and recommendations is to be presented to me, as the Acting Director, Office of Science.

If you have any questions regarding this charge, please contact Gary Geernaert, 301-903-3281 or by email Gerald.Geernaert@science.doe.gov.

Sincerely,

Patricia M. Dehmer

Patricia Dehmer
Acting Director, Office of Science

cc: Sharlene Weatherwax
Gary Geernaert

Appendix B: Committee of Visitors (2016)

Department of Energy
Office of Science
Washington, DC 20585

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Appendix C: COV Agenda

Department of Energy
Office of Biological and Environmental Research
Climate and Environmental Sciences Division
2016 Committee of Visitors' Meeting Agenda
July 19-21, 2016

Tuesday, July 19, 2016

6:00-6:15 pm	Working Dinner (Courtyard Marriott, Gaithersburg)
6:15-6:45 pm	Overview of BER and CESD (Gary Geernaert, CESD Division Director)
6:45-7:15 pm	Review of Charge Letter and Agenda (David Randall, COV Chair)
7:15-7:45 pm	Review of Meeting Logistics, Conflicts of Interest, Q&A (David Lesmes, Program Manager)

Wednesday, July 20, 2016

	Breakfast on your own (Offered at Hotel)
7:45 am	Shuttle Bus Transports Reviewers from Hotel Lobby to DOE-HQ
8:00-8:45 am	Badging and Security
8:45-9:15 am	Introductions and Logistics Room E-301
9:15-10:15 am	Briefings by Program Staff to Breakout Groups Group 1 (ESM, RGCM, IAR): Room G-426 Group 2 (ASR, ARM): Room E-164 Group 3 (TES, SBR, Data, EMSL): Room J-108
10:15-10:30 am	Break (Refreshments Provided in Room E-301)
10:30-12:00 pm	Breakout Sessions (CESD staff as needed) Group 1 (ESM, RGCM, IAR): Room G-426 Group 2 (ASR, ARM): Room E-164 Group 3 (TES, SBR, Data, EMSL): Room J-108
12:00-1:00 pm	Working Lunch

	Room E-301
1:00-3:00 pm	Breakout Sessions continue (CESD staff as needed) Group 1 (ESM, RGCM, IAR): Room G-426 Group 2 (ASR, ARM): Room E-164 Group 3 (TES, SBR, Data, EMSL): Room J-108
3:00-3:15 pm	Break (Refreshments Provided in Room E-301)
3:15-5:00 pm	Crosscutting Topical Breakouts with CESD Staff Topic 1: User Facilities and Community Infrastructure (Paul Bayer, Jared Deforest, Jay Hnilo, Sally McFarlane, Rick Petty) Room G-426 Topic 2: Interagency Coordination (Dorothy Koch and Bob Vallario) Room E-164 Topic 3: Workshops and Initiatives (Shaima Nasiri and Dan Stover) Room E-301 Topic 4: SFA Management and Alignment with CESD Strategic Plan (Renu Joseph, David Lesmes, Ashley Williamson) Room J-108
5:00-5:30 pm	Meeting with CESD Staff (Questions/Requests for Further Information) Room E-301
5:30 pm	Shuttle Bus Transports Reviewers from DOE-HQ to the Hotel
5:30-7:30 pm	Dinner on your own
7:30-9:00 pm	Executive Session: Reviewers at Hotel

<u>Thursday, July 21, 2016</u>

	Breakfast on your own (Offered at Hotel)
7:45 am	Shuttle Bus Transports Reviewers from Hotel Lobby to DOE-HQ
8:30-10:15 am	Breakout Sessions and Writing (CESD staff as needed) Group 1 (ESM, RGCM, IAR): Room G-426 Group 2 (ASR, ARM): Room E-164 Group 3 (TES, SBR, Data, EMSL): Room J-108
10:15-10:30 am	Break (Refreshments Provided in Room E-301)
10:30-12:00 pm	Breakout Sessions and Writing (CESD staff as needed)

	Group 1 (ESM, RGCM, IAR): Room G-426 Group 2 (ASR, ARM): Room E-164 Group 3 (TES, SBR, Data, EMSL): Room J-108
12:00-1:00 pm	Lunch (in DOE Cafeteria on your own)
1:00-2:00 pm	Executive Session Room E-301
2:00-3:00 pm	Committee Report Preliminary Findings to BER Staff Room E-301
3:00 pm	Meeting Adjourn
3:00 pm	Shuttle Bus Transports Reviewers from DOE-HQ to the Hotel

Appendix D: CESD Program Funding Opportunities and Outcomes

List of Funding Opportunity Announcements for FY2013-15

Solicitation Number	Title	Program Manager(s)
FY 2015		
14-1139	Atmospheric System Research – New Site Science Opportunities in the Eastern North Atlantic and North Slope of Alaska	McFarlane, Sally Williamson, Ashley
14-1172	Environmental System Science	Stover, Daniel
14-1174	Atmospheric System Research Program	Williamson, Ashley Nasiri, Shaima
FY 2014		
13-0919	Collaborative Research in Support of GOAmazon Campaign Science	Williamson, Ashley Stover, Daniel Joseph, Renu
14-1036	Climate and Earth System Modeling: SciDAC and Climate Variability and Change	Koch, Dorothy Joseph, Renu
LAB 14-0001	Extreme-Scale Application Software Development Productivity (Extreme-Scale Software Infrastructure)	Lesmes, David
FY 2013		
12-0749	Terrestrial Ecosystem Science	Stover, Daniel
13-0885	Atmospheric System Research Program	Williamson, Ashley McFarlane, Sally

CESD Solicitation Funding Statistics for FY2013-15

			Success Rate %			
Solicitation/ Year	Pre-Proposals	Proposals Received	Renewal Awards	New Awards	Awards by Other Agency	%
FY 2013						
12-0749	207	121	0	14	0	12%
13-0885	143	107	0	12	0	11%
FY 2014						
13-0919	N/A	49	0	6	0	12%
14-1036	181	142	0	25	0	18%
LAB 14-0001	2	2	0	1	0	50%
FY 2015						
14-1139	5	5	0	2	0	40%
14-1172	185	117	0	11	0	9%
14-1174	148	96	0	19	0	20%

Appendix E: Acronyms and Abbreviations

Acronym	Meaning
ACRF	ARM Climate Research Facility
AMS	American Meteorological Society
AGU	American Geophysical Union
ARM	Atmospheric Radiation Measurement
ARRA	American Recovery and Reinvestment Act
ASCR	Office of Advanced Scientific Computing Research
ASR	Atmospheric System Research
BER	Office of Biological and Environmental Research
BERAC	Biological and Environmental Research Advisory Committee
BID	Biological Interactions and Dynamics
CCSM	Community Climate System Model
CDIAC	Carbon Dioxide Information Analysis Center
CENRS	Committee on Environment, Natural Resources, and Sustainability
CESD	Climate and Environmental Science Division
CESM	Community Earth System Model
CLM	Community Land Model
CMBE	Climate Modeling Best Estimate
CMIP	Coupled Model Intercomparison Project
COV	Committee of Visitors
DOE	U.S. Department of Energy
EMSL	Environmental Molecular Sciences Laboratory
ERSD	Environmental Remediation Sciences Division
ESGF	Earth System Grid Federation
ESM	Earth System Modeling
FOA	Funding Opportunity Announcement

Acronym	Meaning
ESM	Earth System Modeling
FWP	Field Work Proposal
FY	Fiscal Year
GCAM	Global Change Assessment Model
IFRC	Integrated Field Research Center
HPC	High Performance Computing
IA	Integrated Assessment
IAM	Integrated Assessment Model
IAR	Integrated Assessment Research
IARPC	Interagency Arctic Research Policy Committee
IMB	Infrastructure Management Board
IOP	Intensive Operational Period
IPCC	Intergovernmental Panel on Climate Change
JGI	Joint Genome Institute
MIT	Massachusetts Institute of Technology
MOU	Memorandum of Understanding
NCAR	National Center for Atmospheric Research
NGEE	Next Generation Ecosystem Experiment
PAMS	Portfolio Analysis and Management System
PCMDI	Program for Climate Model Diagnosis and Intercomparison
PI	Principal Investigator
PM	Program Manager
PNNL	Pacific Northwest National Laboratory
RGCM	Regional and Global Climate Modeling
SBR	Subsurface Biogeochemical Research
SC	Office of Science
SciDAC	Science Discovery through Advanced Computing

Acronym	Meaning
SFA	Scientific Focus Area
SIP	Science of Interfacial Phenomena
SISC	Science Infrastructure Steering Committee
TES	Terrestrial Ecosystem Science
USGCRP	U.S. Global Change Research Program