Minutes of the
Biological and Environmental Research Advisory Committee Meeting
November 29-30, 2007
American Geophysical Union
Washington, DC

BERAC members present:

Michelle S. Broido, Chair
S. James Adelstein
Eugene W. Bierly
Joyce E. Penner
David A. Randall
Margaret A. Riley
Warren M. Washington (Thursday only)
Raymond E. Wildung
Mavrik Zavarin
Steven M. Larson
Margaret Leinen
Steven Padgette
Robert E. Dickinson
Barbara J. Wold (Friday only)
Joanna S. Fowler
Raymond F. Gesteland (Thursday only)
Keith O. Hodgson
David T. Kingsbury

BERAC members absent:

James R. Ehleringer
John Pierce
James M. Tiedje
Patricia A. Maurice
Chris Somerville
John Wooley

Presentations given by:

Allison Campbell, Director, Environmental Molecular Sciences Laboratory
Kenneth Davis, Pennsylvania State University
Tim Donahue, Great Lakes Bioenergy Research Center, University of Wisconsin, Madisons
Jerry Elwood, Acting Associate Director, Office of Biological and Environmental Research, DOE Office of Science
Kerry Emanuel, Massachusetts Institute of Technology
Jim Hack, National Center for Atmospheric Research
Mike Holland, Office of Management and Budget
Naoke Ishibe, National Research Council
Ray Johnson, BERAC Recording Secretary, Oak Ridge Institute for Science and Education
Jay Keasling, Joint BioEnergy Institute, Lawrence Berkeley National Laboratory
Martin Keller, BioEnergy Science Center, Oak Ridge National Laboratory
Cheryl Kuske, Joint Genome Institute Center Director, Los Alamos National Laboratory
Rick Stevens, Director, Mathematics and Computer Science Division, Argonne National Laboratory
David Thomassen, Chief Scientist, Office of Biological and Environmental Research, DOE Office of Science

Thursday, November 29, 2007

At 8:57 a.m., **Chair Michelle Broido** called the meeting to order. She said there had been an extraordinary number of changes over the past year. There was also one new member, **Steve Padgette,** who will be sworn in later in the meeting. Next, she asked each Committee member to introduce themselves. She said the Committee will be presenting updates from BER in response to several of the changes.

At 9:02 a.m., she introduced **Jeffrey S. Amthor,** who provided an update on actions taken in response to the "Report of the BERAC Subcommittee Reviewing the FACE and OTC Elevated CO_2 Projects in DOE."

BERAC Reviewed 6 BER-funded Elevated CO_2 Ecosystem Experiments:

- FACE -- Deciduous Forest (constructed mixed hardwood stands), Wisconsin
- FACE -- Deciduous Forest (pre-existing sweetgum plantation), Tennessee (ORNL)
- FACE -- Coniferous Forest (pre-existing loblolly pine plantation), North Carolina
- FACE -- Desert Shrub (natural system), Nevada (NTS)
- OTC -- Oak Scrub (natural system), Florida

- OTC -- Salt Marsh (natural system)

BERAC's report included eight recommendations:

First, during fiscal year (FY) 2007 enter into the harvesting phase for several projects. Second, enter into harvesting phase by FY 2010 for the remaining projects. Third, future funding decisions for research at experimental sites should be considered within context of harvesting schedules. Fourth, hold workshops to plan harvesting phase of the projects. Fifth, funding should continue after elevated CO_2 treatments end for harvesting, data analysis, cross-site synthesis and publication of program results. Sixth, plan and initiate a workshop to plan the next generation of climate change and elevated CO_2 experiments, incorporating multiple interacting climate-change factors and potentially different elevated CO_2 designs and/or technologies. Seventh, develop stronger linkages in studies of microbial processes between DOE's Terrestrial Carbon Processes and Genomics: GTL programs in future elevated CO_2 projects. Lastly, no new elevated CO_2 projects should be initiated until after workshop recommendations on the future design of elevated CO_2 experiments to address multiple interacting factors.

The first recommendations in BER Responses are to start harvesting some sites in FY 2007. Two of the six projects entered the harvesting phase in FY 2007: 1) The desert shrub system in Nevada (FACE 2) the oak scrub system in Florida (OTC). In both experiments, CO_2 fumigation ended and plants and soils are being harvested, analyzed and archived. With the Nevada FACE plot in May 2007, perennial plants were harvested in 2/3 of each plot. Fumigation then ended July 1, with extensive soil excavation, sample archiving, and sample and data analysis underway. The Florida OTC plot in 2007 elevated CO_2 treatments ended, plants were harvested and soil coring (2.5m) occurred. Sample archiving, sample analysis, data analysis, synthesis and publication of results are underway.

The second recommendation from BER Responses is to start harvesting other sites by FY 2010. Plans are being developed and/or reviewed for entering the harvesting phase for the three remaining FACE projects before FY 2010: 1) the deciduous forest system in Wisconsin (in review and still writing) 2) the deciduous forest system in Tennessee (planning) 3) the coniferous forest system in North Carolina (planning). All three of these experiments began in the 1990s. The remaining OTC experiment, the salt marsh experiment in Maryland, which began in the 1980s, will be continued with non-DOE funding.

A proposal for the Wisconsin FACE site to complete the FACE experiment is in the peer review process (a decision is expected next month). The plan is to continue treatments through the end of the 2009 "growing season." Final harvest and site decommissioning (land is owned by USFS) would commence immediately after that. The harvesting procedure and sample archiving process will be designed in part from user input. This is the world's largest experimental study of ecological effects of changes in atmospheric composition, which has been going on since the 1990s. The Tennessee FACE site is in its 11th year of elevated CO_2 exposure. A focus in 2008 will be on explaining the increased fine-root proliferation. During and after the final year of elevated CO_2 exposure (2009), trees and soil will be harvested (into 2010). The facility will be dismantled. Requirements for sample archiving are being considered.

The third recommendation from BER Responses is that future funding decisions for research at the sites should be considered within the context of the harvesting schedules. All proposals for research will be funded by BER at the FACE and OTC sites are, and will be, evaluated within the context of both the timetables and the objectives of the harvesting phase for each experiment.

The fourth recommendation is to hold workshops to plan harvesting of the experiments. A workshop, hosted by ORNL, was held (in FY 2007) to consider issues central to the harvesting of the FACE experiments. There has been good participation and each of the participants talk to each other frequently on the progress. Cross-site synthesis activities were discussed. Sample archiving plans, needs and storage facility requirements were also considered. Individual-site and cross-site harvesting (and archiving) issues are still being discussed among the site scientists. Future workshops will be convened as deemed necessary by the site scientists.

The fifth recommendation is that funding should continue after CO_2 treatments end for harvesting, analysis, among others. Funding is planned through at least September 2009 for the Nevada FACE site to continue with harvesting, analysis and synthesis, and publication of results. Planning for post-elevated-CO_2 activities at the other FACE sites includes consideration of the scientific and financial needs for harvesting, sample archiving, data analysis, synthesis and publication activities.

The sixth recommendation is to plan and initiate a workshop on next generation experiments. ORNL has been asked to coordinate a workshop on the scientific and infrastructure needs for the next generation of climatic change and elevated CO_2 ecosystem experiments. A seven-member steering committee met the day before (this meeting) and a two-day workshop is being scheduled for Jan-Feb 2008. The workshop will consider what experiments are needed to answer important scientific questions and what infrastructural requirements those experiments would have (such as what are the next generation of experiments, what are the future needs and what progress needs to take place.)

The seventh recommendation is to have stronger linkages in studies of microbial processes between the Terrestrial Carbon Processes (TCP) and Genomics: GTL programs. The TCP program is considering a long-term strategy for improved linkages to the Genomics: GTL program. In the meantime, both the TCP program and the Program for Ecosystem Research are collaborating with Joint Genome Institute (JGI) to characterize soil microbial genomic responses to long-term elevated CO_2 treatments in the elevated-CO_2 projects. **Cheryl Kuske** will present an overview of the effort later in the meeting.

The last recommendation is to have no new elevated-CO_2 projects initiated until workshop results have been considered, with more time needed to think about it. No new elevated-CO_2 experiments have been initiated since the BERAC report was approved. No new elevated-CO_2 experiments are presently being considered for funding by BER.

Warren Washington questioned if **Amthor** needs to coordinate with other agencies. **Amthor** responded by stating the experiments in the field are in coordination with steering committees and that these experiments will continue. **JoAnne Fowler** asked how the experiments have changed things scientifically. **Amthor** stated that although detailed results differ in each ecosystem, elevated CO_2 stimulates production. "We are taking JGI sampling at all sites (in the past and future), look at different ecosystem sites and it will depend on sources. **Cheryl** will discuss later in the day."

At 9:23 a.m. **Bob Vallario** was asked to provide an overview of progress and highlights of the Integrated Assessment Research Program (IARP). The focus of his presentation was to provide a progress report in response to the May 2007 "BERAC Report on the Integrated Assessment Research Program Review" recommendations, including an IARP overview, shifts, progress and plans. The IARP mission is to advance the basic research and the scientific capacity to understand decades-to-century climate change from the perspective of the scale and effects of human influences and natural systems and to understand the possible long-term impacts from such changes, including the role of adaptations and feedback mechanisms.

He provided a snapshot of the major elements and interactions. The example used was for internal planning. Major elements are represented and demonstrated strong interactions in climate research. A simplified version is that human systems and emissions and other climate drivers relates to climate focus, climate response and human and natural systems impacts.

In looking at Inherent Complexity in Modeling the Human Dimensions, some of the contributing elements from diverse fields include the following sciences: energy, environmental, economic, health, land management, water management, social/behavioral, industrial, transportation, building, marine and coastal, agricultural, animal, materials, plant, forestry, geo-engineering, bioengineering, population sciences, among others. The goal is to understand the human dimensions and consequences of climate change. All of these are creating change in driving climate, mitigating climate, impacts from climate and adapting to climate.

The BERAC Summary Recommendations are to improve integration of Integrated Assessment Models (IAMs) with state-of-the art Earth System Models (ESMs); improve representation of climate change impacts; use near-term objectives and metrics for greater transparency and to document progress; increase attention to validation, evaluation, and uncertainty surrounding [model] results; and increase attention to science-based tools for modeling practical policy options versus optimized; cost-effective policies.

The response-to-date has come through five main mechanisms: Draft Climate Change Research Division (CCRD) Strategic Plan, Snowmass '07 Annual Integrated Assessment Meeting, Joint Global Change Research Institute (JGCRI)/Oak Ridge National Laboratory (ORNL) Summer Workshop Series, Lead PI Meeting for integrated assessment and funding directions.

Michelle Broido asked how many people were at the PI meeting and commented that there is usually a small turnout. **Vallario** said he had four teams represented. **Broido** asked how that small group help generate information that is not self-serving. **Vallario** said the plans are not constructed by the group, they are constructed by DOE.

Goals/Plans

1. Improve integration of IAMs with state-of-the-art ESMs

- JGCRI/ORNL summer workshop (Third in Series) – Workshop bringing IARP communities together with ESM, IAV and computational communities to advance ideas and pathways for improved integration
- Round 5 Intergovernmental Panel on Climate Change (IPCC) scenarios – IARP support for the international Integrated Assessment Modeling Consortium, building on a new and innovative closely coupled approach by the IA and ESM communities to provide the drivers for ESMs, AOGCMs, and others for the next round of IPCC assessments
- Co-planning, co-funding of research within CCRD–co-funding of emissions (aerosols) research with Atmospheric Sciences PM and IARP participation in recent ARM Workshop. Joint activities/planning with Climate Modeling community including UCAR/NCAR interactions with Pacific Northwest National Laboratory (PNNL) and Massachusetts Institute of Technology (MIT) IARP teams.
- Draft CCRD Strategic Plan – a particular emphasis in behind-the-scenes planning for the draft CCRD Strategic Plan
- Lead PI meeting – emphasis discussed and vetted in first "corporate" IARP planning meeting held at Snowmass
- Laboratory Strategic Focus Areas (SFAs). Emphasis incorporated in SFAs for labs supporting IARP

2. Improve representation of impacts in IAMs

- JGCRI/ORNL Summer Workshops (First and Second in Series) – workshops on impact and adaptation. CCSP has acknowledged these as pivotal contributions to revisiting the CCSP strategic plan given both increased emphasis to impacts and adaptation and human dimensions in general
- Snowmass '07 Annual Integrated Assessment Meeting – Strong Week 1 Focus; T. Janetos on behalf of IARP in Week 2 session on paths forward
- MIT Grant Renewal. Significant emphasis in grant renewal for MIT Research Team
- ORNL support. Primary emphasis in new, "startup" SFA for ORNL in support of IARP
- Draft CCRD Strategic Plan – reflects ideas for a significant shift in emphasis toward impacts and adaptation.
- Emphasis in upcoming, routine grant solicitation – (ongoing)

3. Use near-term objectives and metrics

- Draft CCRD Strategic Plan – major progress in developing objectives as a work in progress and within an integrated planning framework
- JGCRI/ORNL Summer Workshop Series – additional venues that are helping to inform evolving program objectives

4. Increase attention to validation, evaluation, and uncertainty surrounding results

- Snowmass '07 Annual Integrated Assessment Meeting – two key themes through most of the sessions:
  - Validation – CCSM analog and possible paths forward through Stanford's Energy Modeling Forum (EMF).
  - Uncertainty – S&T session contributed innovative perspectives on uncertainty characterization and use of probabilistic methods
- Preliminary plans for a "validation" workshop – intended to be a path forward workshop for IARP with Lead PIs and several other invited participants. Originally planned for November but put on hold until beginning of next year.

- JGCRI/ORNL Summer Workshop Series – extensive discussions on uncertainty and probabilistic methods. Recognition of key importance given data/characterization issues for impacts and adaptation and the understanding of tipping points and distribution "tails". Workshop reports forthcoming.

5. Science-based tools to model practical policy options versus optimized, cost-effective policies.

- Snowmass '07 Annual Integrated Assessment Meeting – Half-day set aside to address alternative methods and modeling approaches (included as part of two-day S&T session).
- Upcoming EMF and MIT workshops - Early FY '08 workshops will partially address this challenge
- CCSP Interagency Working Group on Human Contributions and Responses/Decision Support – issue raised in group discussions on possible future interagency research priorities

In summary,

- Past emphasis on jumpstarting the process - significant progress in response to main BERAC recommendations
- Additional shifts, progress and participation should be expected
- Searching for high-leverage opportunities and strategic shifts within a constrained (flat) budget profile (now more than ever as we face developmental issues)

Robert Dickinson said that new areas are emerging and what epitomizes the expanded list is the great detail with capabilities.

At 9:45 a.m., **David Thomassen** updated the Committee on the BER Response to Climate Change Research Division COV Report. **Thomassen** said that BER values input from the Committee and presented a list of key recommendations. The good news is we are making great progress, but still have a long way to go. He began his presentation by looking at the key questions raised and recommendation made by the COV report:

Is the proposal review process rigorous and fair?

- Documentation is needed on how merit reviews are conducted including information provided to the reviewers
- Over time, the diversity of reviewers used is often low. Reviewers should be chosen from a larger pool. No documentation is provided on the criteria used to select reviewers.
- While there is no evidence that program chief scientists play an inappropriate role in the proposal review process the possibility for bias or conflict of interest does exist
- A pre-proposal system is recommended that is used as a way to both reduce the burden of reviewing proposals that clearly do not address the program announcement and to discourage prospective applicants from submitting proposals that would not be relevant to the terms of reference in the announcement
- Allocation of large computing resources is made separate from allocation of funding for research. This places an unnecessary burden on investigators.
- The review process for lab proposals is difficult to evaluate

Are funding decisions adequately documented and justified? Yes, but we need to do a better job with documentation.

- Program Managers (PMs) should include their suggestions for Principal Investigators (PIs) to address reviewer comments in either the funding letter or as a memo for the record (if guidance to PIs is given verbally) and that similar information should be documented for declined proposals
- Self-study with outside members should be conducted to establish a checklist for standard project documentation in official files of record for both funded and declined proposals
- Written justifications in declination letters to PIs could be improved. These are often perfunctory.
- Decisions on national laboratory projects are not always as well justified or documented as are university project funding decisions. Project files for laboratory projects usually contain a summary of required deliverables but often do not contain the required reports themselves.
- There is little documented detail concerning the rationale for continued funding of large-scale multi-lab projects
- PM requests for budget changes need to be documented
- Interim project reports do not seem to have an impact on projects
- Reporting and documentation should be consistent for lab and non-lab projects and that actions be taken based on these reviews to optimize project success

Does the solicitation process for proposals provide sufficient and useful guidance to prospective applicants? Does the process link the research to mission needs of DOE and its programmatic goals and objectives? Does the process ensure a reasonable and appropriate turnover of funded investigators to enable and foster the support of new projects and scientists by programs?

Are the progress and outcomes of multiyear projects adequately monitored and evaluated to justify decisions about continued funding?

- Two types of projects require additional oversight:
    - uncompeted projects – need periodic scheduled review, proactive program management and documentation against project goals
    - very large (multi-cycle) projects – need to ensure periodic reporting and external review at frequencies consistent with level of investment. Reporting and review must be adequate to determine whether timelines and milestones toward project goals are being met.
- No documentation on sunset dates for infrastructure projects that are presumably expected to continue indefinitely
- There is little evidence of documentation of progress on milestones, technical issues, and related items on a regular basis in between 3-5 year major reviews. Substantive annual reviews are needed.

Does the process consider the depth and balance in a research portfolio?
It is not clear how and at what frequency DOE-lab research efforts are reviewed. As a result, there is some question as to how balance is evaluated and adjusted in a research environment where high priority questions change over relatively short time scales.

Does the process solicit and encourage a reasonable amount of exploratory, high-risk research?
Programs need to increase their investment in high-risk (10%) and innovative (25%) research. Perhaps more focused research challenges in solicitations? Is consultation with reviewers to develop a measure of success? It was noted that NIH has done a better job in recent years of identifying and funding high risk research so that their model should be looked at more carefully. Defining high risk research is difficult and some have suggested that if more than 20% of s collection of high risk projects "succeed" scientifically then they really weren't high risk.

Does the process enable the support of coherent suites of projects that are integrated and collectively of added scientific value to the program?

- Final reports should be required of all projects and should be included in project jackets
- PMs should prepare overall program reports of accomplishments and proposed future directions every three years as part of COV preparation process
- Close interaction of the program manager with the scientific community is essential to identification of innovative rather than routine projects, of demand driven rather than safe projects, of relevant to societal needs rather than of personal interest themes, and to the management of such efforts once approved and funded. PMs need to get out into the community.

Does the process result in a portfolio of research elements and programs that have national and international scientific standing?

- Program should conduct periodic citation index reviews and analyze them through time to understand their significance. Publication impacts over time can be used as a metric for evaluating high profile funding decisions.
- It would be of value to support "program" documents/Web sites that identify the spectrum of DOE investments, lab locations, principal points of contact and potential research opportunities.

Additional Issue:
Investments and core capabilities at DOE labs are not obviously or readily available for use by other federal agencies.

At 10:10 a.m., **Jim Hack** presented a recap on the Computational and Informational Technology Rate Limiters to the Advancement of Climate Change Science. **Hack** identified **Eugene Bierly** as his co-chair. The Climate Science Subcommittee received their charge on August 15, 2007 and constituted on September 10. The subcommittee was made

up of several laboratory representatives and a representative from the University of Washington. In early October, the Subcommittee had a teleconference and a meeting at AGU on October 16-17.
ASCAC-BERAC Subcommittee Panel Meeting

- Ground rules
  - Need to interpret charge broadly
  - Cannot solve the world's climate problems
  - Need to converge on a few key points
    - focused on DOE's strengths, opportunities for leverage
    - stay away from institutional issues as much as possible
  - Goal is relatively short balanced response
    - point to upcoming NRC (and other) reports

Some of the bottlenecks to progress in climate modeling investments by ASCR and BER:

ASCR facilities/infrastructure investments	**BER** basic science/observational/modeling investments
Computational solutions	Computational requirements
Software solutions	Software needs
Algorithm/applied math solutions	Algorithm needs (e.g. efficiency)
Data management solutions	Data management needs
Networking solutions	Networking needs
Collaboration technology	Collaboration technology needs

To ensure progress, adequate investments are needed in basic knowledge, in observations, and in modeling techniques.

Hack examined some extreme events, such as storms, floods, droughts and cyclones. There are more frequent droughts and periods of intense precipitation, direct loss of life and injury, indirect effects, such as loss of shelter, population displacement, contamination of water supplies, loss of food production, increased risk of infectious disease epidemics (diarrhoeal and respiratory) and damage to infrastructure for provision of health services.

Improving Climate Models (Effect of Systematic Errors) Efforts to reduce systematic errors crucial – biases affect both a model's climate sensitivity and also utility as a predictive tool. Two approaches are needed: (1) improve existing physical parameterizations (2) more accurate incorporation of phenomena. A working hypothesis is that the internal dynamics of the system are more accurately represented at higher resolution.

Improving Climate Models (*Upscaling Research)*
Basic requirement: the research community needs to gain considerable experience running models in climate mode with mesoscale processes resolved, together with theoretical and diagnostic efforts, to:

- improve understanding of multi-scale interactions in the coupled system
- identify those of greatest importance and those that require more data to understand
- document their up-scaling effects on climate
- identify those processes that can be parameterized, and those that cannot

Science Opportunities
- Decadal prediction on regional scales
  - Accuracy in global models
- Climate extremes (heat waves, drought, floods, synoptic events, etc.)
- Climate variability (low frequency variability)
- Water cycle, particularly in the tropics
  - Potential impacts on biofuels
  - Interactions of the water cycle on mitigation and adaptation strategy
  - Amplifier on carbon cycle response to global warming
- Human induced impacts on carbon cycle

    - Half of impacts are taken up by the system (will that change?)
    - How will climate change affect the carbon cycle?
- Sea level rise
    - Melting of the Greenland and Antarctic ice sheets
- Abrupt climate change

Rate limiters

- Decadal prediction
    - Ocean assimilation
        - Ingesting observations
        - Applied mathematics
        - Rapid exploration of design space
        - Computationally intensive
            - Ensembles, Resolution Assimilation methodology (4-D VAR, ensemble Kalman filters)
    - Atmospheric resolution
        - Explicit representation of important phenomenology (≤100km feature size)
        - Need to revisit parameterization techniques and assumptions
            - e.g., statistical equilibrium assumptions questionable
        - Challenge to simultaneously & accurately represent climate and weather
        - Can't necessarily rely on NWP experience for vision of path forward
- Climate Extremes
    - Ability to capture higher-order moments of climate (e.g. Heat waves, growing season, drought, floods, synoptic events, etc.)
    - Baseline resolutions need to be higher
    - Demands on data storage, management, scaling of analysis tools, human resources
    - Questions about relationships of extreme events to large scale climate variability
    - Climate variability (low frequency variability)
    - Separating signal from noise (signals emerging from unforced variability)
    - Stationarity of climate statistics
    - Observationally limited
    - length of instrumented record
    - Limited by basic scientific knowledge
    - process understanding
    - Carbon cycle
    - Dynamic vegetation cycles (succession)
    - Scale interaction questions (wide dynamic range in time/space scales)

Models

- Carbon cycle
- Forcing terms that represent multi-scale nature of problem (e.g. water cycle)
- Need for evaluation infrastructure (accelerate prototyping process)
    - Test cases
    - Data for evaluation
    - Staged increases in complexity
    - Modularized functionality
- Time to start with a clean piece of paper? Well-managed, end-to-end, multi-faceted enterprise
- Questions about reward structure for development activities
- Validation and Verification tests

Observations

- Carbon cycle measurements activities
    - Unique opportunity to integrate measurements into models
    - Enhanced process modeling for incorporation in component models
- Assimilation systems for chemical and biogeochemical observations

    - Use of in situ and satellite observations
- Continued investments in targeted process studies like ARM
    - Decade of experience in fielding complex observational systems
    - Resolve continuing uncertainties about clouds, aerosols and radiation

Computational Algorithms

- Scalable isotropic dynamical cores (dynamic load balancing capabilities)
- Alternative vertical discretizations
- Implicit or large time step discretizations
- Robust grid remapping algorithms
- Assimilation methodologies
    - Ocean, carbon cycle, …
    - adjoints, ensemble Kalman filters, …
- Need to address multi-scale science
    - Variable resolution refinements
    - Uniform high-resolution
- Error estimation techniques

Production Quality Software

- High-performance parallel I/O standard
- Future programming models
    - MPI/OpenMP replacements
    - Methodologies and tools required to exploit highly parallel architectures
        - performance analysis tools
        - libraries
    - Tools for refactoring application codes
    - Language improvements
- Componentization
- verification; unit testing, …
- Scalable and distributed analysis software
- Math and application frameworks
- Benefits to partnerships in development of software environment
- DOE needs to exercise more control of the broader activity
- Substantial investment in software for current and future machines a priority

Facilities

- Capacity at the order 1000 processor level is inadequate
- Availability of machines and allocation strategies
- Data management, migration and analysis
- Suitable storage hierarchy, bandwidth, support for workflow and analysis
- Provision for dealing with both model and observationally generated data
- Allocation process (INCITE) may be suboptimal
- Programmatic deliverables subject to second proposal process
- Improved partnership between OASCR and other offices in SC
- Future requirements will increase both capacity and capability requirements
- Some of these scientific initiatives are ready to exploit enhanced resources
- Resource allocation
- Optimally managing facility for production, high-throughput debug and analysis work
- Priority to evolve toward stable operating environment
- Facilitate environment for scientific productivity

Hack provided a summary of draft recommendations: strategically invest in collaborations on the development of algorithms and scalable software supporting climate change science to reduce or eliminate rate limiters; continue to invest in leadership class computational facilities, data storage facilities, analysis environments collaborative tools and technologies and carefully coordinate these resources to support climate research productivity across the DOE and the broader national and international efforts; focus the scientific effort to pursue robust predictive capability of lower-probability/higher-risk impacts, including climate extremes and abrupt climate change; develop computational and theoretical foundations for new modes of climate simulation, including ensemble short-range forecasts and Earth system assimilation and develop a strong scientific understanding of leading-order uncertainties in the carbon cycle, in particular how the efficiency of natural carbon sinks will change with our changing climate.

Warren Washington said it was a good report, but as he looked through it, he did not see any new recommendations on how to manage the issues and expansion, collaboration between the two offices that he believed we needed to require improvements in the science and computing capabilities. **Hack** said there needs to be better management between the two offices in working together and that there are many opportunities. He also said that allocation of processes and resources is another issue. **Joyce Penner** said there is a lack of fundamental knowledge about aerosols. **Broido** suggested that BERAC approve the report with specifis comments addressing concerns and **Raymond Orbach's** request. The report will be approved before final report to include clarifications.

At 10:52 a.m., **Broido** declared a 10-minute break.

At 11:04 a.m., **Broido** introduced **Naoko Ishibe** to provide "a highly anticipated presentation on nuclear medicine and where we are headed." **Ishibe's** update included a look at the National Academies' report, "Advancing Medicine Through Innovation." She discussed the background of the DOE program, the various committee members involved and acknowledged DOE-OBER (**Mike Viola**), DOE-NE (**John Pantaleo**) and NIH (**Belinda Seto**).

The background of the project is that basic nuclear medicine research has been funded through DOE-OBER's Medical Applications and Measurement Sciences Program. DOE funding for the program was reduced by 82% ($50.6M) in FY 2006, with nuclear medicine, radiopharmaceuticals and instrumentation only receiving a combined $10.8 million in 2007 versus more than $63.8 million in 2002. The impact of the cuts to DOE Program includes:

- In FY 2005, 32 principal investigators, 18 technicians and 19 post-doctoral and graduate students were supported by the DOE-OBER program
- Subsequently, 13 staff and 9 students left due to the cut in funding (33% loss)
- Research that was terminated include:
    - Development of the helium-3 based accelerator as a table-top generator of 15 MeV protons
    - Clinical testing of new prostate PET camera
    - Development of new technetium chemistry in its application in biological systems

The statement of task was that the National Academies will perform a "state of the science" review of nuclear medicine and will provide findings and recommendations on the following future needs/issues. 1. Radiopharmaceutical development for the diagnosis and treatment of human disease. 2. Computational and instrument development for more precise localization of radiotracers in normal and aberrant cell physiologies 3) National impediments to the efficient entry of promising new radiopharmaceutical compounds into clinical feasibility studies and strategies to overcome them 4. Impacts of shortages of isotopes and highly-trained radiopharmaceutical chemists and other nuclear medicine scientists on nuclear medicine basic and translational research, drug discovery and patient care, and short- and long-term strategies to alleviate these shortages if they exist.

In light of these future needs, the National Academies should examine the medical applications and measurement sciences program and make recommendations to improve its research and isotope impacts on nuclear medicine. These recommendations should address both research thrusts and facility capabilities but should not address program management issues.

Some of the emerging opportunities include assessing the efficacy of new drugs, developing targeted radionuclide therapeutics and developing hybrid imaging instruments. The findings and recommendations include the 1) loss of Federal Commitment for Nuclear Medicine Research - a national nuclear medicine research program should be coordinated between DOE and NIH, with the former emphasizing the general development of technology and the latter the disease-specific applications; 2) Cumbersome Regulatory Requirement - clarifying and simplify regulatory requirements, including those for toxicology and current good manufacturing practices and imaging protocols need to be standardized; 3) Inadequate Domestic Supply of Medical Radionuclides for Research - consideration of building a dedicated accelerator and upgrading existing research nuclear reactor 4) Shortage of Trained Nuclear Medicine Scientists

- NIH and DOE, in conjunction with professional societies, should consider convening expert panels to identify the most critical national needs and determine how to develop appropriate curricula to train the next generation of nuclear medicine scientists 5) Need for technology development and transfer - DOE-OBER should continue to encourage interdisciplinary collaborations between chemists, physicists, engineers, and computer scientists that can be effectively translated into the clinic.

Developments since report was released: Senate Energy and Water Development Appropriations language for FY 2008 included $34M for the Medical Applications and Measurement Sciences Program, with $20 million dedicated to nuclear medicine research. The House version did not include funding for nuclear medicine research. In addition, an Op-Ed was published in the *Des Moines Register*; interested researchers have contacted their Senators and Representatives; and a request has been made by the Chemical Sciences Roundtable for a Presentation at their next meeting in February 2008.

James Adelstein stated he found the report complicated. He said he would like for BERAC to point out how the Academies' report could or should impact BER. He said he sees this as an inter-agency report and that there are political issues involving funding. **Steven Larson** said there is intense interest for BERAC to make recommendation to DOE. There is a need for agencies to collaborate with training and when budgets become an issue. **Joanna Fowler** said training is essential for future success. **Raymond Wildung** asked if there was an agency that could provide earlier information related to drug approval. Larson said NCI and FDA have partnered to improve the process for getting things new drug discoveries rapidly introduced in a safe way. FDA has serious responsibilities to make sure things are approved, but DOE can serve an important role in the basic and biological sectors.

At 11:30 a.m., **Rick Stevens** presented an update on the joint Advanced Scientific Computing Advisory Committee (ASCAC)-BERAC subcommittee on modeling for GTL. He discussed the participants, which included panel members and invited guests (10 external participants, engineers, system biologists and researchers).

The Subcommittee Charge was to convene a joint panel to examine the issue of computational models for GTL; how progress could be accelerated through targeted investments in applied mathematics and computer science and how these can be incorporated to meet the needs of computational biology; the joint panel should consider whether the current ASCR long-term goal is too ambitious, given the status and level of buy-in from the community; it needs to consider what is happening in the computational-science and life-sciences communities. It should discuss possible intermediate goals that might be more relevant to the two programs and it should identify the key computational obstacles to developing computer models of the major biological understandings necessary to characterize and engineer microbes for DOE missions, such as biofuels and bioremediation.

The status of the "Modeling in GTL" report included the preliminary findings and recommendations. There were plans to be revised before the Christmas break. The background material for the report from the panel presentations was a 10-15 page summary to provide context for the findings and recommendations. In addition, linkages will be made to two important NRC reports that have impacted the modeling charge: the role of theory in advancing 21st Century Biology and catalyzing Inquiry at the Interface of Computing and Biology.

In examining computational modeling and simulation as enablers for biological discovery, there are numerous ways models are useful in biology:

- Provide a coherent framework for interpreting data
- Highlight basic concepts of wide applicability
- Uncover new phenomena or concepts to explore
- Identify key factors or components of a system
- Link levels of detail (individual to population)
- Enable the formalization of intuitive understandings
- Used as a tool for helping to screen unpromising hypotheses
- Inform experimental design
- Predict variables inaccessible to measurement
- Link what is known to what is yet unknown
- Generate accurate quantitative predictions
- Expand the range of questions that can meaningfully be asked

What is the relationship between the structure of a pathway and its function? The Hypothesis: The topology of a pathway alters organismal phenotypic functions and is evolutionarily conserved across phenotypically similar genomes.

<u>Example Findings:</u>

- Unlike EMP pathway in anaerobic bacteria, *Z. mobilis* utilizes ED pathway like aerobes
- Two genes (incl. *mdh*) are missing in *Z. mobilis* TCA cycle → low biomass.
- All genes except for 6-P-fructokinase are present in EMP pathway → inactive EMP.

“Natural Selection” approach:

- initialize many potentially viable types
- allow system to self-organize …
- fittest physiologies (parameter combinations) succeed
- less fit physiologies “excluded”

Finding. Modeling and simulation are beginning to play a critical role in integrating our understanding of biological mechanisms at multiple levels, including specific cellular subsystems such as metabolism, motility, signaling, regulation, differentiation and development.

These are critical areas of understanding that are relevant to advancing DOE mission areas. The community is ready to take big steps in the direction of more complete models, models that incorporate more detailed biological mechanisms and to apply these models to more areas of biological science. It was noted that integrative modeling of biological systems complement the relatively well-developed field of atomistic modeling (e.g. molecular dynamics, etc.) that can contribute to DOE mission areas in biology, but which is not sufficient to meet the long-term bioengineering goals alone.

Finding. While there has been considerable progress in advancing integrative modeling during the last decade (as witnessed in the high quality of presentations heard by the subcommittee), this progress has been largely driven by a relatively small number of research groups that have been successful at piecing together research support from a number of disparate sources (e.g. NIH, NSF, DOE, DAPRA). There is not currently a long-term research program of appropriate scale aimed explicitly at developing biological modeling and simulation capabilities relevant to DOE missions.

Finding. The ASCR supported components of the GTL program are not currently supporting projects in applied mathematics or computer science primarily targeted at developing integrated modeling and simulation capabilities for microbes or plants.

Recommendation #1 The 10-year OMB PART goal for ASCR the joint modeling and simulation activity of ASCR and BER be modified to read.*“(ASCR) By 2018, demonstrate significant advances in the capability to predict an organisms’ phenotype from its genome sequence, through advances in genome sequence annotation, whole genome scale modeling and simulation and integrated model driven experimentation”*

This PART goal should be accompanied by a specific set of metrics of progress. Example metrics could include for a given organism: *the fraction of an organism’s genes and gene products included in a model, number of correct metabolic phenotype measurements predicted, number of transcription regulatory elements in a model, number of correct gene expression experiments predicted, fraction of correct predictions of essential genes, number of organisms for which predictive models can be generated, etc.*

Recommendation #2 DOE should develop an explicit research program aimed at achieving significant progress on the overarching goal of predictive modeling and simulation in DOE relevant biological systems. This program should be a joint effort between ASCR and BER and should include a diversity of modeling approaches. The program should leverage existing experimental activities, as well as support the development of new experimental activities that are directly tied to the needs of developing predictive models. This new research program should be aimed at advancing the state-of-the-art of cell modeling directly, should include equal participation from biologists and mathematicians, computer scientists and engineers and should be indirectly coupled to the more applied goals of bioenergy, carbon cycle research or bioremediation. This program will need to be supported at a large-enough scale that a multiple target approach can be pursued that will enable progress on many intermediate goals simultaneously by different research groups.

Recommendation #3 DOE should establish an annual conference that focuses on highlighting the progress in predictive modeling in biological systems. This meeting should be an open meeting and separate from any programmatic PI meeting. One goal of the meeting would be to establish a series of scientific “indicators” of progress in predictive modeling, similar to successful indicators associated with the competitive assessment of structure prediction (CASP). These types of measures will enable the community to benchmark progress on methods and will be critical to assessing the impact of the research program on fundamentally advancing the state-of-the-art. Example metrics could include predicting essentiality in microbial genomes, predicting gene expression patterns in novel environments, predicting yields in metabolic engineering scenarios.

Finding. Integrative modeling and simulation efforts are highly dependent on the curation of genomics data and associated integrated pathway and protein databases that support metabolic reconstruction, interpretation of microarrays and other experimental data. These databases are the foundation for the development of models and provide the critical biological context for a given organism or problem. Through resources like NIH’s NCBI and NIAID and the dozens of community lead database projects there is reasonable coverage of model organisms (e.g. *Escherichia coli, Saccharomyces cerevisiae* and *Caenorhabditis elegans*, etc.) and pathogens, however there is not the same level of support for curating the data associated with organisms related to energy and the environment.

Finding. Modeling and simulation in microbial systems has advanced in many areas simultaneously. Today for some systems we have useful and interesting predictive models for core metabolism, for global transcription regulation, for signaling and motility control and for life-cycle development and differentiation. However, we do not yet have many integrated models that include two or more of these capabilities. Also, the successful examples in each case are typically limited to a few model systems and have not be generally extended to the hundreds of organisms relevant to DOE whose genomes are now available.

Recommendation #4 The modeling and simulation research program should be supported by an explicit series of investments in the modeling technology, database and algorithms and infrastructure needed to address the computational challenges. The appropriate early targets for a comprehensive attack on predictive biological modeling are specific functions of microbial organisms (e.g. cellular metabolism, motility, global transcription regulation and differentiation and life-cycle development). The focus should include advancing the predictive skill on well-studied models (e.g. *E. coli, B. subtilis*, etc.) but begin to push on to those organisms that stretch the capability beyond the existing well studied model systems (e.g. *Clostridium, Shewanella, Synechocystis*) and small consortia (communities) of microorganisms relevant to DOE missions such as those associated with bioremdiation, carbon sequestration and nitrogen fixation and fermentation and degradation. We also recommend that the lower eukaryotes (e.g. Diatoms, Coccolithopores, single cell fungi) and plants should be included as targets in longer-term modeling and simulation goals.

Finding. There are a number of obstacles to reaching the visionary goal of a predictive model useful for engineering of an organism derived largely from its genome and related data. Here are four obstacles. First, we lack integrated genomics databases and the associated computational methods for supporting curation, extension and visualization of comparative data explicitly focused on supporting the development of modeling and simulations for DOE relevant organisms. Second, we lack robust mathematical frameworks and software implementing those frameworks for integrating models of metabolism with those of gene regulation which are two of most highly developed areas of modeling and simulation at the whole cell level, but whose mathematical representations are quite different. Third, we lack the multi-scale mathematics and associated software libraries and tools for integrating processes in cellular models of disparate scales (e.g. molecular scale to that of the whole cell and microbial community) that would enable the modeling community to begin the process of integrated whole cell scale models with atomistic simulations of specific mechanisms. Fourth, all of computational biology should be framed in a computational and analytical theory that incorporates evolution as the basis for understanding and interpreting the results from comparative analysis. For example, we have not yet developed the algorithms needed to make rapid progress on questions such as understanding the major forces governing the evolution of metabolism and regulatory networks. Understanding these forces will be critical to creating the stable engineered strains needed for large scale bioproduction of materials.

Recommendation #5 DOE should establish a mechanism to support the long-term curation and integration of genomics and related datasets (annotations, metabolic reconstructions, expression data, whole genome screens, phenotype data, etc.) to support biological research in general and the needs of modeling and simulation in particular in areas of energy and the environment that are not well supported by NSF and NIH. This mechanism should target the creation of a state-of-the-art community resource for data of all forms that are relevant to organisms of interest to DOE. This should be a joint activity of ASCR and BER with ASCR responsible for the database and computational infrastructure to enable community annotation and data sharing. It should also leverage the work of established groups.

Recommendation #6 DOE should work with the community to identify novel scientific opportunities for connecting modeling and simulation at the pathway and organism level to modeling and simulation at other space and temporal scales. Examples that could be investigated include integration of microbial models into ocean and terrestrial ecology models which in turn are coupled to global climate models and models of bioremediation environments that can couple organism metabolic capabilities to external biogeochemistry. This multi-scale coupling is beginning to be explored, but much more can be done and it is likely to yield significant scientific insight.

At 12:05 a.m. **Broido** introduced **Kerry Emanuel** to discuss hurricanes and climate change. The program looks at the effect of climate change on hurricane activity and hurricanes in the climate system. The effect of climate change on hurricanes has seen no obvious trend in Global Tropical Cyclone (TC) Frequency from 1970 to 2006. There are an average of 90 storms per year and there is no "rhyme or reason" or theory why this number is consistent.

Better Intensity Metric:
The Power Dissipation Index is a measure of the total frictional dissipation of kinetic energy in the hurricane boundary layer over the lifetime of the storm (designed to measure a hurricane's energy). The power dissipation is based on three data sets for the Western North Pacific (smoothed with a 1-3-4-3-1 filter). The Atlantic Storm Maximum Power Dissipation has gone up significantly since 2000.(Smoothed with a 1-3-4-3-1 filter). The Atlantic Sea Surface Temperatures and Storm Max Power Dissiaption (Smoothed with a 1-3-4-3-1 filter).

The energy production is because hurricanes act as heat agents. The distribution of entropy in Hurricane Inez, 1966, was measured by aircraft. The heat was being pulled out of the ocean. The theoretical upper bound on hurricane maximum wind speed is a ratio of exchange coefficients of enthalpy and momentum, outflow temperature and air-seas enthalpy disequilibrium. The heat engine theory predicts maximum hurricane winds.

The combination of the sea surface temperatures, incoming solar radiation, net outgoing radiation, ocean-mixed layer entrainment, temperatures at the top of the storm and surface trade wind speed are derived by combining potential intensity expression with ocean surface energy balance. What is Causing Changes in Tropical Atlantic Sea Surface Temperature? The temperatures are changing.

Pushing back the record of tropical cyclone activity is Paleotempestology. This is a new technique and is beginning to flourish. At Pope Beach Marsh, Massachusetts, the amount of sand was caused by a large number of storms.

Projecting into the Future: Downscaling from Global Climate Models. Today's global climate models are far too coarse to simulate tropical cyclones. Our approach is:

- Step 1: Randomly seed ocean basins with weak (25kt) warm-core vortices
- Step 2: Determine tracks of candidate storms using a beta-and-advection model
- Step 3: Run a deterministic coupled tropical cyclone intensity model along each synthetic track, discarding all storms that fail to achieve winds of at least 35 kts
- Step 4: Assess risk using statistics of surviving events

Synthetic Track Generation, Using Synthetic Wind Time Series

- Postulate that TCs move with vertically averaged environmental flow plus a "beta drift" correction (Beta and Advection Model, or "BAMS")
- Approximate "vertically averaged" by weighted mean of 850 and 250 hPa flow

Synthetic wind time series

- Monthly mean, variances and co-variances from NCEP re-analysis data
- Synthetic time series constrained to have the correct mean, variance, co-variances and an power series

Tropical Cyclone Intensity

- Run coupled deterministic model (CHIPS, Emanuel et al., 2004) along each track

- Use monthly mean potential intensity, ocean mixed layer depth, and sub-mixed layer thermal stratification
- Use shear from synthetic wind time series
- Initial intensity specified as 12 ms^{-1}
- Tracks terminated when $v < 17$ ms^{-1}

Calibration
- Absolute genesis frequency calibrated to North Atlantic during the period 1980-2005

Why does frequency decrease? Entropy difference between boundary layer and middle troposphere increases with temperature at constant relative humidity.

Feedback of Global Tropical Cyclone Activity on the Climate System

Results from EPIC 2001
Raymond et al. (2004) report that background mixing is essentially zero in the tropical eastern Pacific.

"Motions below the thermocline were very weak, but they intensified…as energy from a strong storm worked its way downward. The accompanying mixing accounted for most of what little mixing there was between depths of 100-200 m. Mixing in the thermocline…appears to respond mostly to wind stress.:
"…the strongest atmospheric disturbances are likely to cause an inordinately large fraction of the total mixing. Profound errors could occur in climate models, which fail to take this into account."

Summary:
- Tropical cyclones are sensitive to the climate state
- Observations together with detailed modeling suggest that TC power dissipation increases by ~65% for a 10% increase in potential intensity
- Storm-induced mixing of the upper tropical ocean may be the principal driver of the ocean's thermohaline circulation
- Increased TC power dissipation in a warming climate will drive a larger poleward heat flux by the oceans, tempering tropical warming but amplifying the warming of middle and high latitudes
- This feedback between TCs and ocean heat flux is not included in any current climate model; its inclusion may change our understanding of climate dynamics and our predictions of the earth's response to increased greenhouse gases

Broido announced a break for lunch at 12:45 p.m.

At 2:15 p.m., **Ken Davis** was asked to provide a progress report and emerging challenges on AmeriFlux. **Davis** said he would provide an overview of Ameriflux, a status report, recent research progress and the emerging challenge: improving climate system modeling and what is needed to meet the challenge.

AmeriFlux has 93 active sites in 3 countries, 32 research teams, companion Canadian network and most major ecoregions in N. America covered. Calibration lab runs comparisons across sites, open-access, central data base enables global use of observations and has been operational since 1996.

The science objectives are to quantify exchange of carbon, water and energy between terrestrial ecosystems and the atmosphere across a range of vegetation types, disturbance histories, and climatic conditions, understand processes governing the terrestrial carbon cycle and linkages with the water, energy and nitrogen cycles and produce a high-quality data base and synthesize observations across the network.

Core measurements are fluxes of CO_2, water vapor, and sensible heat flux via eddy covariance, radiative fluxes and micrometeorological conditions and biophysical characterization of sites (e.g. vegetation age and type, nutrient status, carbon pool sizes, soil type).

The current AmeriFlux Structure: A Cooperative
- Membership requirements:

    - Address common science questions in strategic plan
    - Collect certain measurements year-round
    - Share data in standard format via common database
    - Participate at annual meetings, in calibration and inter calibration activities and in network-wide syntheses of results
- No support or funding comes with membership, such as data management and submission requirements, synthesis contributions
- Responsibilities of membership are not binding

Characteristics of the Cooperative Structure
- Structure is very inclusive, participation is broad and growth has been rapid (20 sites 10 years ago, now ~100, 350 worldwide)
- Funding structure encourages experimentation and innovation (with each funding cycle, each site must propose something "new" or risk a poor review)
- Structure is ideal for learning how to build a network
- Structure is not ideal for maintaining a coherent, long-term network

The status of AmeriFlux - AmeriFlux has data holdings of 548 sites, years of half-hourly data from 100 sites and Flux measurements spanning 1991-2007. Investigators have produced approximately 100 peer-reviewed publications per year for the past five years and multi-site syntheses are increasingly common.

The Fluxnet dataset accounts for 305 site-years of data. More than 50 proposals for global synthesis papers received from site investigators. Global data not yet open-access (although the AmeriFlux portion is open). Approximately 30% of submitted AmeriFlux site-years were rejected due to incomplete or insufficient quality data - network is somewhat heterogeneous.

Length of data record and sponsors for active AmeriFlux sites shows 11 new sites began in 2007, the mean operating age is 5.7 years and 10 sites have been operating for more than a decade but some of these have uncertain future funding. The major sponsors for active sites – DOE (39), None (17), USDA (15), NOAA (7), NSF(7), Universities (5), and NASA (3). The non-centralized nature of AmeriFlux leads to instability in the network - potentially high turnover rate among sites

The AmeriFlux network of decadal-scale flux measurements is emerging within a global coop of networks of "standardized" flux and biological measurements; coherent network observations are central elements of many new synthesis studies. Research and publication are moving from site studies to network studies; there is increasing use of network data products by the carbon cycle and climate modeling communities; a recent decrease in the number of funded sites and the potential for a high turnover rate among sites; some sites are providing insufficient data for synthesis activities and network goals are compromised by funding sites individually

Recent research highlights include 1) process studies to quantify and understand processes that influence ecosystem-atmosphere interactions 2) diagnoses of regional carbon budgets (construct large scale flux estimates) and applications of flux network data to improve climate system modeling

Quantification of climate-ecosystem interactions: clouds, aerosols and ecosystems
- AmeriFlux data quantifies the impact of clouds and aerosols on carbon sequestration and evapotranspiration at the land surface
- Flux observations showed aerosol and cloud effects on light quality and photosynthesis
- Importance of diffuse light effects now being incorporated in regional/global land surface models
- Similar process-oriented studies, using single or multiple sites, are ongoing and common across AmeriFlux sites.

Diagnoses of regional carbon budgets: regional clusters of flux towers shows several studies have now combined flux tower observations, satellite remote sensing, environmental conditions and terrestrial carbon cycle models to estimate regional fluxes.

Assimilation of flux measurements into terrestrial carbon cycle models

- Diurnal, synoptic and seasonal cycles, and mean annual fluxes can be reproduced well
- Interannual variability in mean annual fluxes is not simulated well
- Results broadly consistent with previous efforts (e.g. Braswell et al., 2005)

Emerging challenge is to evaluate and improve climate prediction/projection using climate system models. A problem is the uncertainty in the interaction of the terrestrial carbon cycle and climate. In addition, improving predictive skill in coupled climate-carbon cycle modeling. An AmeriFlux role will be to provide a CO_2 flux network data product that can be used as the instrumental temperature record has been used. Coupled models would be jointly constrained by atmospheric CO_2 and instrumental T records.

The NCAR Community Climate Systems Model (CCSM) Carbon and Land Model intercomparison Project (C-LAMP) has several objectives, including to:

- Provide feedback to the science community on the performance of terrestrial biogeochemistry models coupled to CLM within CCSM3
- Provide a new observation-based diagnostics package for terrestrial carbon cycling in coupled carbon-climate models
- Define, conceptually, how biogeochemistry should be evaluated in climate models

What is needed to meet this challenge? Sustain and enhance a core set of long-term, high-quality flux measurement sites, continue mechanistic research to improve model structure and identify important climate-ecosystem interactions, Conduct network design studies (how many sites are needed? what mix of shorter vs. longer term sites is optimal? how long are the required time series? what complementary data are needed at each site?) and sustain and enhance an easily-accessed, homogeneous and data base.

The summary of status:

- An AmeriFlux network of decadal-scale flux measurements is emerging within a global coop of networks of "standardized" flux and biological measurements
- Coherent network observations are central elements of many new synthesis studies. Research and publication is moving from site studies to network studies.
- There is increasing use of network data products by the carbon cycle and climate modeling communities
- There is a recent decrease in the number of funded sites and the potential for a high turnover rate among sites
- Some sites are providing insufficient data for synthesis activities
- Network goals are compromised by funding sites individually

Recommendations: 1) The AmeriFlux science steering group recommends sustaining and enhancing a core network of long-term, high-quality flux measurement sites to address the increasing need for syntheses of multi-site, long-term data records. 2) A coherent network of sites has added value that exceeds a collection of individual, short-term studies. A mechanism should be developed to recognize this added value when questions of funding arise. 3) A stable core network will provide a critical contribution to our ability to predict future climate by enabling the development and evaluation of coupled carbon-climate models and earth systems analysis models.

Topics that can be addressed with integration of AmeriFlux data and models

- Where and when will forests be vulnerable to fires, and how do changes in forest processes affect climate?
- How would biofuel harvesting impact forest functioning and C sequestration?
- How will changes in water availability and population impact water availability to crops and forested watersheds that serve urban areas?
- What are potential interactions between future climate scenarios, and carbon, water, and nitrogen cycling?

Contributions of AmeriFlux Research to DOE Climate Change Science Program Elements

- Climate forcing – carbon cycle, atmospheric water vapor
- Climate change prediction
- Responses of ecosystems to climate change
- Climate mitigation

Warren Washington asked if the observation of the nitrogen-cycle is substantially different? **Davis** answered that they are not. **Eugene Bierly** said there was no quality control and PIs needed to maintain continuity and data. **Davis** said to take advantage of the data and funding for the sites, are based on site investigations and there needs to be more emphasis on the network. **Broido** asked if this should be a calling for a workshop or if any were planned**.** **Roger Dahlman** said no, not any at the present time. The program is at a point to where it is needed for the data management system and that it will be addressed at a future conference. **Broido** said the coordination occurs at the science meetings where there are investigators and agencies are present. They look at how things are progressing and coordinate an inter-agency look so a common message can be improved. There is another real-time issue implemented by all the agencies, which includes observation, inventories, profiling data, gather data for analysis using different methodology. The result comes together, which is good, but does not state if it can be sustained.

Next, **Martin Keller** was asked to provide an update on the BioEnergy Science Center (BESC). The fundamental science of biomass recalcitrance is poorly understood. Three linked scientific focus areas will enable BESC to understand and overcome biomass recalcitrance – biomass formation and modification, characterization and modeling and biomass deconstruction and conversion.

BESC is organized to provide clear operations and science accountability. In addition, BESC has well-defined objectives, such as

Revolutionize the processing of biomass within five years

- Improve overall yields
- Simplify operations through consolidated bioprocessing (CBP)
- Decrease (or eliminate) the need for costly chemical pretreatment

Apply a systems biology approach and new higher-throughput pipelines

- Reduce recalcitrance by targeted modification of plant cell wall composition and structures
- Develop and understand single microbes or microbial consortia and their enzymes to enable CBP for low-cost cellulose hydrolysis and fermentation
- Provide a synergistic combination of modified plants and CBP for even more cost-effective biofuel production

BESC will revolutionize how biomass is processed within five years.

Modifying cell wall composition and structure can reduce recalcitrance

- More sugar is solubilized by cellulose when the lignin content of alfalfa cell walls is reduced
- Strategy is feasible for *Populus* and switchgrass

The challenge (part one) is that lignocellulosic biomass is complex and heterogeneous. “Omic” capabilities for systems biology includes genomics, transcriptomics, proteomics, interactonmics and metabolomics. Together, these can provide a deeper picture of how a microbe or plant is functioning. This can assist in identifying where improvements need to be made.

The second part of the challenge is lignocellulosic biomass is difficult to breakdown and ferment. Microbial hydrolysis and enzymatic hydrolysis: A fundamentally different relationship between microbes and cellulose. In searching for new biocatalysts and examining hypothesis – will higher temperature microbes be more effective?

The goal is understanding leading to an improved cellulosome – a deep proteme analysis of the cellulosome of C. thermocellum identified more than 20 “new” cellulosomal components.

At 3:11 p.m., **Tim Donahue** began discussing Great Lakes Bioenergy Research Center (GLBRC). The vision is plugging the scientific, agricultural, economic and technological excellence in the Great Lakes Basin into the energy grid. The mission is to perform fundamental research aimed at removing bottlenecks in the biomass to bioenergy pipeline.

Integrated research goals are to improve plant biomass, improve biomass processing, improve conversion of plant biomass to liquid and other fuels, evaluate sustainability of biomass to biofuels pipeline and develop and use enabling genome-based technologies. “Our structure and research centers are different,” said **Donahue**. “We bring new opportunities to the table, with our programs reflecting we are making models to solve problems.”

GLBRC Thrust 1: Improved Plant Biomass - The Objectives: obtain mechanistic understanding g of biochemical & regulatory pathways needed to divert plant carbon into: More digestible cell wall polymers, starch, fructans and other digestible carbohydrates and plant-derived oils. Less than 50% of Thrust One budget devoted to creation of energy crops with novel forms of biomass storage

GLBRC Thrust 2: Improved Biomass Processing - The objective: improve conversion of plant cell walls into fermentable or chemically-convertible materials by analyzing a range of plant material and pretreatment conditions and discovery and application of improved enzymes. The goals are enhanced biomass conversion potential. Combinatorial, high throughput, screen of candidate materials with various pretreatments for improved cell wall digestion (with Thrust 1). Understand pretreatment chemistries. Identify and quantify relevant small molecules produced by pretreatment chemistries (with Thrust 5). Screen products for fermentation (microbes) or conversion (chemistry). Assess fermentatability (with Thrust 3) and assess use in catalytic conversion (with Thrust 3).

The goals are to discover/improve deconstruction enzymes.

- Bioprospecting in cellulose-degrading ecosystems (with JGI)
- High-throughout screening of genetic material from promising niches.
- The engineer improved enzymes (with Thrust 5).

Another goal is to integrate pretreatments with suitable enzymes for high sugar yield

- Optimize combinations of existing and new enzymes to hydrolyze biomass
- Develop suites of enzymes tailored for specific pretreated biomass samples (with Thrust 5)

Decrease enzyme cost

- Test expression of new cellulolytic enzymes in plants (with Thrust 1)
- Improve expression of cellulolytic enzymes in maize, alfalfa and other plants (with Thrust 1)

GLBRC Thrust 3: Improved Biomass Conversion – The conversion of biomass into energy products: improve methods for converting plant biomass into materials that can replace fossil fuels ethanol, hydrogen and chemical feedstocks. During aerobic growth, optimize production of desired extracellular cellulases and hemicellulases (with Thrusts 2 and 5). During anaerobic phase, optimize production of enzymes, transporters and pathways to optimize ethanologenesis (with Thrust 5).

The GLBRC targets for removal of bottlenecks in ethanologenesis. 1) Minimize genome 2) optimize gene expression 3) optimize exporters and importers 4) optimize metabolic network 5) anchor enzymes to microbe 6) industrially robust microbes.

The GLBRC Trust 4 - Sustainable bioenergy practices are the development of a sustainable bioenergy economy: support the biomass-to-bioenergy pipeline by developing ecological, agricultural and life cycle practices that are economically viable and environmentally responsive. Overcoming bottlenecks in agricultural, industrial and behavorial systems to improve carbon neutrality and net greenhouse gas mitigation across the entire biofuel life cycle at multiple scales and the ecosystem services in biofuel landscapes (e.g. water quality, biodiversity and pest suppression). The objective of Thrust 4 is to determine elements of integrated biofuel production systems that can be optimized to improve environmental and economic sustainability. The goal is to predict behavior of novel production systems.

The GLBRC Trust 5: Enabling Bioenergy Technologies – The objective is to provide cutting-edge genome-based technologies that enable the innovation, discoveries and creative solutions needed to remove biofuels bottlenecks (high-throughput screens, global analyses, metabolic flux analysis, protein and metabolic engineering and computational modeling).

The mapping of biofuels regulatory networks includes cluster sets of co-regulated genes to identify network structure, high resolution analysis of biofuels transcription factor binding sites (with JGI) and predictive models for bioenergy regulators and regulates (with DOE Jacquard cluster). The bioenergy protein blueprints are isotope-assisted protein abundance measurements, localization of proteins in sub- or extra-cellular fractions and monitor and map sites of covalent modifications that impact biomass or fuel production.

Bioenergy metabolites use MS and NMR pipelines to quantify critical biofuel or biomass intermediates, discovery platform for new biofuel metabolites, isotope assisted flux balance analysis and predictive computational models for diverting carbon skeletons into biomass or biofuels pathways (with DOE Jacquard cluster).

The protein expression and engineering is high throughout the pipeline for protein expression and functional analysis, multiplex screening for new and improved biofuel enzymes and computational predictions of active sites, protein-protein interfaces or protein stability to engineer new biomass pathways or improve biofuel enzymes (with BACTER and DOE Jacquard cluster.)

The GLBRC Trust 6: Education and Outreach – The objectives are to develop a coordinated bioenergy education and outreach program and to solve today's bioenergy bottlenecks while training the bioenergy leaders of tomorrow. "We have programs in place, with discussions, workshops and developing exhibits on biomass and bioenergy," said **Donahue**. "We also plan to conduct seminar programs, summer research programs to attract graduate students. We are proud to have this center and hope to come back and tell you how successful we have become."

At 4:02 p.m., **Jay Keasling** was introduced to discuss the Joint Bioenergy Institute (JBEI). At a glance, they have taken a start-up company approach, with a highly-focused research agenda and single operation and facility. There are six partners (three DOE national labs, two universities and one foundation). The four science and technology divisions are feedstocks, deconstruction, fuels synthesis and cross-cutting technologies. The industry partnership program unpins the growth of the biofuels industry and ensures technology transfer to the biofuels industry.

Some of the key challenges in converting lignocellulosic biomass to fuels are that cellulose and hemicellulose are occluded by lignin, lignin is recalcitrant to depolymerization and inhibitors are released from biomass. Lignin is recalcitrant to deploymerization. With enzymes, the challenges are lignocellulose is difficult to depolymerize and pretreatment methods from inhibitory by-products. With manomers, challenges include existing biofuels are not primal, organisms can only utilize a fraction of the monomers and inhibitors released from biomass limit fuels production.

The JBEI has an interlocking approach with three scientific divisions – feedstocks, deconstruction and fuels synthesis. With feedstocks, some of the challenges in developing bioenergy crops include the following: cellulose and hemicellulose are occluded by lignin, making deconstruction difficult; functional groups on hemicellolose can inhibit fermentation and are not efficiently converted to fuels and lignin is recalcitrant to depolymerization. The approach that is being used is to understand and modify polysaccharide biosynthesis (with a focus on hemicellulose); reduce feruloylation by engineering alternative pathway; modify lignin to aid deconstruction (introduction of cleveable linkages); and switchgrass, rice and Arabidopsis as model plants (switchgrass sequencing).

Plants

Example: reduce the complexity of cell wall building blocks or change their composition

- Xylans contain acetate esters and grass xylans contain additional ferulic acid esters
- Acetate esters are problematic for deconstruction and subsequent fuels fermentations
- Ferulate & diferulate esters are crosslinked with lignin. This results in grass cell walls being difficult to enzymatically digest

The objective is to change composition and cross-linking.

Example: change the monomers in lignin

- Systematic analysis of (lignin) cell wall oxidases
- Develop replacement strategies for lignin
- Apply advanced imaging technology to determine structure of plant cell walls

The objective is to change the monomer composition of lignin.

In Feedstocks, developing bioenergy crops has deliverables of improving understanding of all cell wall synthesizing and modifying enzymes using rice and Arabidopsis; transgenic plants with optimized cell wall composition for deconstruction; translate genetic developments from model plant systems to proposed bioenergy crops.

With deconstruction, providing a source of fermentable sugars, the challenges include lignocellulose is difficult to process due to low accessibility of crystalline cellulose fibers, presence of lignin "seal" and hemicellulose cross-links and small pore sizes in lignocellulose. In addition, acid pretreatment methods result in the formation of by-products that are inhibitory to subsequent biofuels fermentation and results in a loss of sugars. The approach is to understand the chemical and structural changes from current biomass pre-treatment approaches, understanding the fundamental interactions that govern lignocellulolytic enzymes and exploring new microbial environments and employ directed evolution to produce more active and stable lignocellulolytic enzymes.

The objective of improving enzyme performance is to optimize enzyme structure and function. The deliverables include optimal pretreatment methods for target biomass feedstocks, improved lignocellulolytic enzymes with enhanced activity and stability, understanding of how microbial communities degrade lignocellulose and cost-effective pretreatment and enzymatic depolymerization methods with minimal by-products and inhibitor formation.

The recent result in ionic pretreatment studies of switchgrass shows that raw switchgrass samples were processed to isolate different parts of the plant, intact bulk samples were then exposed to 1-ethyl-3-methylimidazolium (acetate salts) at 120°C, biomass deconstruction tracked as a function of temperature and time and confocal images taken with dual wavelength excitation (405 and 543 nm).

In biofuels synthesis, ethanol and next generation biofuels, some challenges include existing biofuels do not have the full fuel value of gasoline, require energy-intensive purification processes, are toxic at high concentrations and cannot be transported using traditional means. In addition, microorganisms convert only a limited number of precursors to fuels and inhibitors resulting from the pre-treatment process prevent growth and biofuel productions are additional challenges.

The approach taken was to develop pathways for production of future biofuels, to understand mechanisms of fuel toxicity and stress response, to engineer organisms to produce and withstand high concentration of biofuels and to engineer organisms for consolidated biopressing (cellulose production with simultaneous fermentation of sugars to biofuels.). The production of next-generation biofuels includes a large number of potential fuel molecules being produced from central metabolic intermediates (such as alkanes, alcohols and esters), the need to construct precursor biosynthesis pathways and to understand their impact on cell physiology.

The deliverables for ethanol and the next generation biofuels include organisms engineered to produce and withstand high concentrations of biofuels, organisms resistant to by-products formed during deconstruction, sequence and regulatory information for metabolic pathways producing biofuels and models of metabolic pathways for fuel synthesis and their mode of regulation.

With technology and the new tools for biofuels research, some of the challenges include few tools available for bioenergy/biomass research, new high throughout biochemical and `omics approaches needed for all aspects of bioenergy research and advanced imaging techniques can be leveraged to characterize biomass and biomass deconstruction processes.

The approach is to provide technologies for scientific discovery, implement high-throughput off-the-shelf systems, automate, parallelize and miniaturize throughput-limiting procedures and develop new technologies for enzyme characterization.

Example: Automation of Limiting Processes

- Cloning, protein expression and enzyme assays will be rate limiting without high-throughput (HT) technologies
- JBEI will implement HT cloning and expression technologies and develop new microfluidic tools for HT enzyme assays

The deliverables for technology in new tools for biofuels research includes high-throughput microfluidics platforms for large scale analysis of plant and microbial enzyme activities, ligno- and glycol-arrays for rapid screening of enzymatic function,`omics pipelines for systems biology, integrated data capture, analysis and dissemination and parts, devices, chassis for synthetic biology.

In interdependent research, cross-cutting technologies will aid the research in multiple divisions and research will be interdependent with discoveries in one area influencing the research in the other areas. A single JBEI facility will foster research interactions. Integrated operation ensures effectiveness, cost-efficiency and unity.

The JBEI facility, Emery Station East, has 61,000 rentable square feet, is environmentally friendly, access to adjacent 80-seat conference center, shuttle services and 90 parking slots.

In accelerated start-up, research at partner facilities in FY07, research begins at partner institutions, such as LBNL and UCB, Sandia National Labs, Lawrence Livermore National Lab, Carnegie Institute of Science and UC Davis.

The JBEI organization is a research organization designed to be decisive and nimble, modeled on technology "start-up." It is dedicated management for science, technical integration and scalability. JBEI leverages the Bay Area biotech and high-tech industry. Vibrant industries grow around intellectual centers, such as Silicon Valley and biotech industry around UCB, UCSF and Stanford and the Bay Area and California becoming centers for renewable energy. The benefits of JBEI location in the Bay Area and California are it is an intellectual environment, recruiting and commercialization.

In commercializing JBEI's products, JBEI's technology transfer program will
- Efficiently commercialize innovative biofuels technologies
- Promote dialogue among researchers, industry, and VCs
- Provide opportunities for industry to collaborate with JBEI
- Complement and further JBEI's biofuels research

The mechanisms
- Industry Advisory Committee
  - Companies from key sectors: feedstocks, enzymes, fuels production, biotechnology, genetics and chemistry
  - Provide feedback on JBEI research from an industry perspective
- Central management of IP and industry interface
- Industry Partnership Program
- Central data repository of all JBEI IP and IP agreements
- Industrial scientist sabbaticals at JBEI

The impacts will elucidate & modify plant cell wall structure and synthesis, provide efficient, cost-effective routes for deconstruction of lignocellulose, engineered organisms for scalable production of ethanol and next generation biofuels, enabling and integrating technologies for bioenergy research, integrated science and technology to transform the U.S. biofuels industry

Broido said all of these research areas included in all three Bioenergy Research Centers should be applauded.

At 4:35 p.m., **Cheryl Kuske** was introduced to provide on the report on Free Air Carbon Dioxide Enrichment Experience (FACE) research workshop. The goal for soil community metagenomics of DOE's FACE and OTC sites is a comprehensive, field-scale understanding of the responses of soil microbial communities and their processes to long-term (10 year) elevated CO_2, and comparison of responses across terrestrial ecosystems.

The goal is to develop a science & implementation plan based on metagenomic technology, to assess responses of the below ground communities to CO_2 in DOE terrestrial ecosystem FACE and OTC sites. The objective is to establish a roadmap for implementing metagenomic analysis of soil communities across several FACE sites. The facilities are FACE sites, JGI sequencing resources and other DOE facilities. The people and experience include FACE scientists, JGI personnel, national labs and university scientists and DOE program management.

The August workshop accomplishments included identifying major ecological questions that should be addressed across the FACE and OTC sites, determining optimal DNA sequencing technologies to answer those questions, determining the best strategies for implementing sequencing technology in these field-scale experiments and discussing how best to coordinate sample, sequencing, and data management. The ecological research questions **1)** Within each site, has 10 year elevated CO_2 affected the soil microbial community (abundance, composition) and ecosystem processes conducted by this community? **2)** Have the soil communities in different ecosystems responded similarly or in different patterns to elevated CO_2?

Why soil metagenomics? Benefits and potential impacts include:

- Greatest source of biodiversity on Earth
- Soil communities are central to multiple DOE mission areas and potential for multiple impacts is high
- Abundant biomass - large amounts of DNA for multiple genomic studies

The technical challenges are that diversity is high, biofilms and physical attachment affect DNA. Extraction efficiency is a problem therefore standard protocols are critical, non-uniformity of substrates and patchiness so field sample replication is essential and fungal biomass is present and important, but fungal genomes are complex.

Metagenomics ~ Community Genomics are any gene-based comparison that spans across the collective microbial genome in an environment. The targeted metagenomics focus on specific genes. Some of the pros include immediate link to function and high depth of coverage in complex community can provide strong abundance/composition information. The cons are single/few genes studied, clone/sequence approaches are thorough, but time consuming and only see what you know to look for. The new potential with 454 pyro-sequencing has larger panels of genes, multiple pathways, resolution of sequencing without cloning, larger number of sequences for each gene and single pass sequencing w/ lower quality.

In community genomics, shot-gun metagenomics is a clone and sequencing random fragments. The characteristics are broad brush, unbiased survey; community complexity dictates level of resolution & ability to link to function; functional interpretation is limited due to our inability to ID genes in the sequences obtained; eukaryotic genomes have lower probability of gene detection by random sequencing.

The challenges and novelty of application of metagenomics to FACE/OTC sites are Comparative metagenomics, not just descriptive, strong need to tie to ecosystem function, similar parent material within a site, experimental framework with replication, link soil microbial results to field-scale ecology and will enhance and stretch our current sequencing technology.

The hierarchical research and sequencing strategy – the tiered datasets cross-inform to improve our ability to interpret ecological relevance.

Tier I: Ability to relate metagenome data back to field-scale soil response at FACE sites
Tier 2: Phylogenetic species surveys
Tier 3: Targeted metagenomics using 454 pyro-sequencing
Tier 4: Transcriptome analysis of soil fungi
Tier 5: Seasonal, year-to-year patterns & ozone effects
Tier 6: Shot-gun metagenomics

Hierarchical Research and Sequencing Strategy

Tier 1 Measurements: Ability to relate metagenome data back to field-scale soil response at FACE sites.

In response to elevated CO_2:

- has the microbial biomass changed?
- have functional properties or process measures changed?
- what is the variability across field replicates?

Tier 2 Sequencing: phylogenetic species surveys
In response to elevated CO_2:

- has the relative abundance or composition of bacteria/fungi/archaea changed?
- has the relative abundance of the major phyla/species within a domain changed?

Tier 3 Sequencing: Targeted metagenomics using 454 pyro-sequencing
In response to elevated CO_2:

- has the functional diversity or composition been altered?
- how have key microbial species/processes been changed?

Tier 4 Sequencing: Transcriptome analysis of soil fungi
In response to elevated CO_2:

- has activity of abundant soil fungi changed?
- especially with regard to carbon utilization

Tier 5 Sequencing: Seasonal, year-to-year patterns & ozone effects (Rhinelander site)
In response to elevated CO_2 and/or ozone:

- how do changes relate to seasonal responses and year-to-year variability?
- how did soil communities respond to elevated ozone?
- were there any combined effects of elevated CO_2 and ozone?

Tier 6 Sequencing: Shot-gun metagenomics
In response to elevated CO_2:

- has the overall community been altered?
- what new properties are present?
- how do communities compare across sites?

The roadmap document was circulated to workshop participants and DOE management. Two of the six FACE/OTC sites have been deconstructed. Soil samples are archived with the primary site scientist and at LANL. Pilot studies are in progress for Tier 2 (rRNA surveys), Tier 3 (454 targeted metagenomics) and Tier 4 (fungal transcriptome) sequencing.

Margaret Riley questioned the new technology involving phylogenetic species. She believes that there are two approaches that can be taken, including the community approach based on diversity. **Raymond Wildung** questioned the attention to sampling methodology because we want to have a thorough plan. **Wildung** also said that he hopes they will take advantage of all the things we are doing. **Riley** asked how sampling is going to be handled and will soil samples be available? **Kuske** said “anything is possible, but sampling is done using methods to get a statistical basis.”

Before ending the day’s meeting, **Broido** said the Committee should consider “How to encourage the consideration of high-risk research.” High risk research discussion will continue the following morning.

Broido adjourned the meeting at 5:12 p.m.

Friday, November 30, 2007

At 8:43 a.m., **Chair Broido** called the meeting to order. She told the Committee there were still many topics to discuss and speakers to be heard. She introduced **Jim Adelstein** to talk about the status of the BERAC subcommittee review of the Low Dose Radiation Research Program. **Adelstein** began his presentation by providing an overview of the program, which supports competitive peer-reviewed research aimed at informing the development of future national radiation risk policy for the public and the workplace. Since its beginning in 1999, the focus of research has been to study cellular and molecular responses to doses of x- or gamma- radiation that are at or near current workplace exposure limits; in general, for total radiation doses that are less than 0.1 Sievert (10 rem). "This is the dose of people who are exposed to radiation," said Adelstein. "It is also commonly received by those who work in nuclear industries. There are now concerns of from what people will get during a terrorist attack. These are important elements 10 years into the program."

Adelstein also provided a look at the Low-Dose Radiation Research Program budgets for FY 2006 and 2007 (dollars in thousands).

	2006	2007
National Laboratories		
BNL	300	1184
LBNL	4093	3389
LLNL	1245	950
LANL	1000	70
ORNL	100	429
ORISE	200	200
PNNL	1555	1483
	8493	7705
Universities	8422	9412
Conference Grants	91	82
Total	17,006	17,199

From under Secretary for Science to **Michelle Broido**, the charges were as follows:

Charge 1: Assess the scientific accomplishments, the quality, and the technical innovation of the program's research portfolio.
Charge 2: Assess whether the current portfolio is taking best advantage of advances in biological research and integrative models.
Charge 3: Evaluate whether this growing body of scientific knowledge and new biological paradigms provide sufficient justification for reconsideration of the risk estimate models that currently set regulatory dose limits for DOE workers and the public.
Charge 4: Identify any additional biological issues or technical hurdles that the Program needs to address in order to wholly inform regulatory policy.

The goal of the DOE Low Dose Radiation Research Program is to support research that will help determine health risks from exposures to low levels of radiation. This information is critical to adequately and appropriately protect people while making the most effective use of our national resources.

Uncertainty has led to speculation as to the actual shape of the curve describing the dose-risk relationship at low doses.

Enter the potential of biology to settle this issue – with particular emphasis on, so-called, "non-targeted phenomena" including: genomic instability, bystander effects and adaptive responses. **Adelstein** provided an overview of the differences between the bystander effect versus the adaptive response and what has developed as a battle of the national academies:

From BEIR (Biological Effects of Ionizing Radiation) VII – National Academies of the USA
…current scientific evidence is consistent with the hypothesis that there is a linear, no-threshold dose response relationship between exposure to ionizing radiation and the development of cancer in humans

From Académie des Science – Institut de France
While LNT eat no-threshold) may be useful for the administrative organization of radioprotection, its use for assessing carcinogenic risks, induced by low doses, such as those delivered by diagnostic radiology or the nuclear industry, is not based on valid scientific data.

An alternative to Charge Three, which is practically beyond a reasonable possibility for this review, would be to evaluate whether this growing body of scientific knowledge may lead to new biological paradigms for understanding low dose radiation effects on human health.

The BERAC Low Radiation Dose review panel includes: **Adelstein** – BERAC, Chair; **C. Norman Coleman** – National Cancer Institute; **Shirley Fry** – Formerly ORAU; **Dudley Goodhead** – UK Medical Research Council; **John B. Little** – Harvard School of Public Health; **Jack A. Nickoloff** – University of New Mexico; **Julian Preston** – Environmental Protection Agency; **Thomas M. Roberts** – Dana-Farber Cancer Institute

He discussed the proposed agenda of the upcoming Low-Dose meeting, which included:

- Introduction to the program, program management, program budget, proposal and post-award review
- Program goals, accomplishments and prospects
- Select program investigators' view on whether/how research has led to new models for understanding low-dose effects and what technical hurdles, if any, need to be obviated to inform risk estimates
- Individual project review
- Development on statements on
    - Quality, productivity, technical innovation
    - Taking advantage of current biologic research including integrative models
    - Emergence of new biological paradigms and implications for risk estimates
    - Critical biologic issues or technical hurdles needing address

At 9:08 a.m., **Jerry Elwood** was introduced to provide an overview of the new charge to BERAC to implement a workshop on the grand scientific challenges in climate change research.

"We have received another charge to BERAC to implement a workshop on the grand scientific challenges in climate change research," said **Elwood**. "I have had several conversations with **Raymond Orbach** to have workshops to see about our investments, who should be involved and the overall challenges in change climate. We need to provide these answers and decide what type of workshop is needed."

The workshop should define the grand scientific challenges in climate change research related to core scientific goals of the U.S. Climate Change Science Program (CCSP) strategic plan and identify research priorities and a path forward to address the grand challenges and needs, including research capabilities that are required. Research capabilities would include key experimental, observational and computational capabilities that are essential to adequately address the grand challenges and needs.

In addition, the workshop should identify grand scientific challenges regarding understanding past and present climate variability and forcing; reducing uncertainty and improving confidence in projecting how climate will likely respond at regional to global scales in the future in response to natural and human-induced forcing; understanding and predicting the sensitivity and adaptability of managed and natural ecosystems to climate change; integrating data and knowledge from research and observations on climate and Earth system processes into climate and Earth system models and modeling.

The workshop will involve leading experts, irrespective of affiliation, be done under BERAC; be by invitation only (except for agency observers); implemented by the Executive Committee with co-chairs; and produce a FACA report authored by invited attendees and Executive Committee members. Furthermore, the Executive Committee decides on experts to invite, other CCSP agencies can recommend experts for Executive Committee to consider for invitations as participants, agency representatives may attend (only as observers), attendance limited, but must include an appropriate range of expertise and perspective needed for breakout groups on each area, the workshop report to be public and available to all agencies and DOE to cover workshop costs and travel costs of some or all experts invited to attend. All CCSP agencies are invited to co-sponsor the workshop with DOE – a joint CCSP-CCTP (Climate Change Technology Program) workshop, which will be held early in 2008 in Washington, DC or a nearby suburb.

Broido said these are two workshops that have a very interesting scope. **Elwood** said the workshops will focus on carbon cycles, discuss and prioritize, with the goal of being an information-gathering workshop. "We have been charged with the future direction," said **Elwood.** The two workshops may have some redundancy, but will compliment each other. Our committees will work together to decide priorities." (NOTE: Separate workshops to identify scientific grand challenges and to develop a strategic plan for the Climate Change Research Division had originally been discussed; however, at this time on the grand challenges workshop is being planed.) **David Randall** asked "How do all of these future plans fit together?" **Elwood** said "the goal will be to discuss our future plans, the joint report and the scope, which is much narrower than it was in the beginning." **Broido** said the workshops should take advantage of reports and recommendations and layout the framework for the future of climate change and the work already done. **Robert Dickinson** said the existing work should be a great starting point. "We need to stay with **Orbach's** questions, but broaden it to what DOE might do in the future," said **Dickinson**.

Margaret Leinen said we should produce new strategic plans every three years to the President and Congress. The program should have a new strategic plan by May 30, 2008. You will make this the highest priority. The report should be written as a assessment report to meet the requirements of climate changes. **Eugene Bierly** believes this report will be unique and wonderful. He said this will put more pressure on other groups to move forward. **Broido** asked for a consensus that there will not be a discussion until after the workshop is held.

At 10:00 a.m., **Mike Holland** was introduced to give his perspectives from the Office of Management and Budget. **Holland** began his presentation by stating that while he was at OSTP and on Capitol Hill, BER did not command much, if any, of his attention. But coming back a second time, he sees several opportunities. BER does face an unusual problem for a program in the Office of Science. There is almost no part of the BER portfolio where it is either the dominant source of Federal funds or even a major source of Federal funds. At the current time he is at a "starting point" with the BER program with a lot of discussion needed. This also provides an opportunity to have a "flexible potential and amazing opportunities."

By contrast, Nuclear Physics and High Energy Physics are 80% -90% of the funds in those fields. Fusion sponsors 100% of magnetic confinement fusion research. BES is nearly four times larger than the NSF division of materials Research.

Holland said he felt he was "too easy" on BER the first time around. He hopes the Committee will forgive him as he overcorrects and presents his opinions a great deal more bluntly this time.

The thumbnail sketch of what he said is that the more he looks at the details of BER, the less he understands. He hopes the Committee can resist the tendency in DC to interpret anything but high praise as opposition. In this case, "nothing could be further than the truth." He said BER is a portfolio with incredible scientific potential and he wants to see that potential realized.

He said he wanted to provide a clear starting point for the conversation we're going to have in the upcoming year or more on how we can start realizing the potential of BER. His impression at the moment is to "start digging to ensure that they have merit."

BER has a unique role within DOE with respect to climate change science, but it seems that basic climate science in BER has been losing ground to application-oriented research in the Biological division. Programs now in the Climate Change Research division were approximately 42% of the BER total in 2001, but have fallen to only 35% in the FY 2008 request. BER appears to have a unique set of field facilities that can provide the experimental data necessary for increasing our confidence in the predictability of climate models. For example, ARM is well run and has had significant scientific impact. A second generation of FACE experiments could provide extraordinary relevant results about ecological response in a simulated future climate regime.

In addition, BER and ASCR have the right mix of skills to make a significant contribution on the climate modeling front, if the effort is carefully designed and openly vetted.

Holland also questioned the clarity of whether BER's modeling efforts are tightly coupled to the field assignments. Do the models have the locations or experimental agendas of the program's field facilities? Are modelers required to show that they can simulate the data out of these facilities?

The tough question is exactly what the right next step is. With major climate modeling capabilities at NSF and NOAA, would DOE be the right agency to give the resources to? What is the relative value of additional modeling at any agency compared to additional observational or experimental data?

Unfortunately, BER is only the fourth largest pot in the Climate Change Science Program, so it is difficult for him to get the full CCSP picture. Holland said he "doesn't have the CCSP-wide plans, evaluations and priorities and would need to successfully argue for significant new resources for the Climate Division." The question he said he can't answer is how much of what DOE does well the CCSP program eally needs and he is surprised and unhappy to find himself in that position.

Regarding biological research, BER should be supporting science that changes the way DOE and the energy sector – not NIH – do business. He said he was not sure he can say whether that is happening. The GTL Bioenergy Centers may ultimately do that, but he can't really tell. Given his understanding of them, they seem like they belong to EERE. He added that he can't tell where are three or what scientific question each is targeting.

Holland said he was not questioning whether DOE or the Office of Science should be engaged in biology. "That seems non-debatably obvious to me. I do not understand GTL any more now than I did in 2001 before I left for OSTP and I see that as a problem."

I medical/radioisotope applications, he thinks this is an area where BER has a unique competence and he wants to see it flourish. He does want to see the line redrawn between BER and NIH on biomedical applications. He believes the recent Academy study, *Advancing Nuclear Medicine Through Innovation*, urges us to fix and not just restore funding to this area.

In facilities and field experiments, mid-sized science facilities are, in nearly every way, very different than the big facilities. There is no "standing army" dedicated to the operation and maintenance of a central accelerator complex or computer. Collaboration with staff scientists is especially important.

Field experiments are different yet again. "We do not yet have a really good generically applicable conceptual model of how to think about the management and evaluation of these things and BER or DOE are not only entities to struggle with this. We could usefully spend some time debating out some SC-wide guidelines for thinking about these mid-sized things, since we do seem to have an increasing number of them. It is not just BER with EMSL, JGI, ARM, FACE and Ameriflux. BES also has it's nanoscience centers. "NSF is facing this is spades with NEON."

Holland ended his presentation by stating BER has a good role not filled by anyone else. "We need to figure out how to ask good questions to push facilities in the right direction. "I want centers to be productive and we need to show they are wise investments. I do not have a confidence concerning big facilities, but I believe it is important to get there with mid-sized facilities.

Broido said at the bioenegy meeting the day before would have assisted Holland with a better understanding. She asked how does BERAC as a group help to inform you? **Holland** said that the Committee should set a very easily articulate science goals or science drivers. He said the Committee should look at the problems that need to be solved, which can make a world of difference in determining the most important science drivers. He also advised to look at the "pockets of opportunities" to take a look at what has come out of the series of workshops, the challenges and opportunities. It has generally resulted that does not seem to the technology office to off load the basic energy needs.

At 10:48 a.m., **Allison Campbell** provided a progress report on the environmental molecular sciences laboratory. There were two reviews (in 2005 and 2006) and over the past 10 years of operation, there have been a lot of accomplishments.

In May 2005, there were two concurrent reviews by BERAC (to look at the relationship, science, structure, user model and prioritization) and the SC Office of Project Assessment (to look at the management, oversight, resources, non-BER funding and self-assessment). The purpose of the reviews was to assess quality of user research, assess effective management and operation of EMSL and justify continued and potentially increased investment in EMSL. In June 2006, there was a joint BERAC Lehman review, with **Michelle Broido** to assess EMSL response to 2005 review recommendations.

The positive findings were science performed is very high and cutting-edge quality; EMSL capabilities are unique; additional funding is needed to maintain state of the art; and endorsed focus around scientific themes. The areas for improvement included shared mission and scientific leadership; strategic planning/science themes/calls for proposals/research needs to cut across facilities; advisory committees; external peer review; capital revitalization; radiological capabilities; user counts/ user survey and benchmarking.

The mission (from William Wiley, PNNL's director at the time EMSL was conceived) was to have an innovative multipurpose user facility providing "synergism between the physical, mathematical, and life sciences." EMSL, a national scientific user facility at the Pacific Northwest National Laboratory, provides integrated experimental and computational resources for discovery and technological innovation in the environmental molecular sciences to support the needs of DOE and the nation.

EMSL science themes provide the basis for staff hiring, proposals calls, capital and operational investments.

- Understand how physical properties and chemical composition of aerosols affect their interaction with radiation, water, and other gaseous species in the atmosphere and how these characteristics change during the aerosol life cycle
- A systems-level understanding of the functional dynamics of microbial, extremophile, and cellular communities (and their components) in the environment
- Unraveling the mechanisms behind the fate and transport of contaminants and other constituents in subsurface systems
- Understanding and gaining control of atomic- and molecular-level structure-function relationships at interfaces that enable the optimization of interfacial properties, such as the control of catalytic activity and selectivity

The hiring senior staff to increase EMSL's scientific and management leadership helped us realize our mission and recognize we still need to hire more people. "We have had a lot of accomplishments over the past couple of years.

Building a vision of a "single" EMSL with coordinated, scheduled proposal calls that encourage integration of capabilities was also instrumental. EMSL wide calls for proposals were science-theme calls, capability-based calls and eliminated facility-based calls. The measures were proposals that use multiple systems (baseline 45% utilize >2 capabilities and >60& ST proposals >2 capabilities), proposals from external users and proposals from new users.

Two committees with redefined charters and revitalized membership have new charters and new membership. People are encouraged to come to EMSL and spend time to get insight one-on-one outside of the normal review cycles.

In addition, we established consistent policies and practices for external peer review across all EMSL facilities. All user proposals are externally peer reviewed consistent review criteria, science merit, alignment with EMSL mission, science themes, and resources; consists of approximately 250 scientists serve as reviewers and the Web portal developed to facilitate timely reviews.

In recapitalizing EMSL, plan for new experimental capabilities to allow EMSL to address key environmental molecular science challenges for the next decade; radiological NMR and recapitalization workshops were used to identify key science challenges and important capabilities; strategic plan outlines rationale for science themes, investment strategy for computing and capital equipment, and involvement of users/advisory committees in workshops; overview of science drivers and investment areas captured in the EMSL "Gold Book" – Due in final form in December 2007 and developed with users, advisory committees and DOE.

In looking at atmospheric aerosol chemistry, the science vision is to understand how physical and chemical properties of aerosols affect aerosol's interaction with radiation, water and other gaseous species in the atmosphere and how these characteristics change during the aerosol life cycle. The science drivers are to unravel the mechanisms of aerosol particle formation and growth; understand the changes that occur inside and on the surfaces of aerosols during their atmospheric lifetime and evaluate how the changing chemical and physical properties of aerosols affect the formation and evolution of cloud droplets and ice crystals and subsequent aerosol deposition. To achieve this vision, we need the ability to operate at ambient conditions, chemical characterization using field- and laboratory-deployable systems and chambers that ensure collection and analysis of representative samples, *in-situ* multidimensional, high-throughput probes and ultra-fast spectroscopic probes of non-equilibrium systems. The science questions are the mechanisms of aerosol particle formation and growth and what changes occur inside and on the surfaces of aerosols during their atmospheric lifetime.

In biological interactions and dynamics, the science vision is towards a systems level understanding of the functional dynamics of microbial, extremophile and cellular communities (and their components) in the environment. The science drivers are mechanisms by which microbes sense changes environmental change, responses to changes in terms of production of specific proteins, multiprotein complexes, metalloproteins, cell surface molecules or metabolites, location of molecular complexes and how do they catalyze the their intended reactions. To achieve this vision, we need controlled growth and cultivation of cells and communities, molecular-level probes to detect, localize, and track individual molecules in whole cells, methods to characterize posttranslational modifications of proteins, multiprotein complexes and metalloproteins and where applicable their catalytic mechanisms amd measurements in living systems over extended time scales and at the highest resolution. The science questions are what are the molecular level mechanisms by which microbes sense changes in environmental conditions and what are the molecular level responses to these changes in conditions in terms of production of specific proteins, multiprotein complexes, metalloproteins, cell surface molecules or metabolites, where within (or possibly outside) of the organism are these specifically produced molecular complexes located and how do they catalyze the specific reactions for which they were intended. The capabilities are the growth, identification and selection individual organisms or subsets of organisms from a microbial consortium

In geochemistry/biogeochemistry and subsurface science, the science vision is unraveling the mechanisms behind the fate and transport of contaminants and other constituents in subsurface systems. The science drivers are unraveling the genesis, properties, and effects of nanominerals and nanostructured materials in the environment, understanding the dynamics of reactions at complex interfaces with high temporal and spatial resolution and bridging the gap between molecular and continuum. To achieve this vision, we need imaging of complex heterogeneous systems, *in-situ* characterization of biomineralization and mineral surface reaction dynamics, development of techniques for microscale reactive transport studies and enhanced capabilities to handle radionuclides.

In science of interfacial phenomena, the science vision is to understand and gain control of atomic- and molecular-level structure-function relationships at interfaces that enable the optimization of interfacial properties, such as the control of catalytic activity and selectivity. The science drivers are understanding and ability to rationally design, synthesize and characterize complex surfaces, films, and interfaces and controlling structure function relationships of surfaces and interfaces. To achieve this vision, we need chemical and structural characterization of surfaces, interfaces, and nanostructured materials as a function of environment and time, ability to synthesize complex oxide interfaces, films, and surfaces with nanoscale control as well as methods to observe and control growth processes in real time and ability to prepare and handle samples to retain desired properties.

Overarching technical thrusts are key areas for EMSL leadership. Overarching science and technical challenges in all four science themes: Bridging scales in space and time; Moving from static to dynamic; Multi-scale structure synthesis and high resolution characterization; and real time integration of computation and experimental methods
Technology Thrusts have impact across science themes

The development of the world's highest-field Fourier-transform ion cyclotron resonance (FTICR) mass spectrometer and is a partnership with Florida State University's magnet laboratory.

Unparalleled sensitivity and dynamic range for analyzing proteome complexity - The concept is zero-cryogen-demand fully shielded magnet corresponding to National High Magnetic Field Laboratory conceptual design, automated sample preparation, high-resolution separations inlet and data management based on EMSL design, single cell proteome measurements when coupled with online cell selection and cell preparation system. The outcome is whole protein proteomics – for post-translation modification identification and greatly expanded dynamic range and sensitivity for identification of low abundance proteins.

A goal is to move EMSL toward capabilities for *in situ* imaging with high spatial and energy resolution coupled with in situ reactivity. The concept is an aberration-corrected transmission electron microscope (TEM) platform with custom environmental cells and probing chemical, structural and site-specific chemical information in conditions relevant to many catalytic and geochemical studies. The outcome is to understand the interfacial and defect control of catalytic reactions and the chemical nature of nanoparticles and understanding about the role of interface and particle structure on reactivity.

Development of unique one of a kind *in situ* NMR probes. The concept is to build upon EMSL's leadership in NMR probe design and development to design a suite of in situ NMR probes for biological and interfacial. *The outcomes* are *in* *situ* catalysis probe to study reaction products and dynamics, high-temperature MAS probe at temperatures of more than 400ºC, first-of-a-kind 900-MHz system for solid-state structural determination of proteins in membranes (unparalleled resolution and sensitivity).

EMSL awards contract to HP for next generation supercomputer.

- Balanced system based upon requirements defined in the Greenbook.
  - 116.3 TFlop theoretical peak
  - 93.6 TFlops sustained
  - 37 Tbytes memory
  - 1.55 Gbytes/sec node to node
- Testing and porting codes will start later this year
- Migrating users and projects in spring 2008
- Fully functional summer 2008

In FY06 and FY07, there were numerous awards and recognitions. In celebrating 10 years as a national scientific user facility, there have been more than 10,000 users of the facilities, more than 2,300 publications with 26 journal covers, 38 patents issued and significant scientific impact.

EMSL Grand Challenges are a new model for user facility to address significant science problems.

- Multi-institution, multidisciplinary teams
- Utilize integrated sets of capabilities of the EMSL
- Address highly significant scientific problems
- Develop new capabilities for EMSL users
- Bring new users to the facility

EMSL's world-leading integrated oxide surface science research capability has transformed our understanding of metal oxide thin films and the dynamics of geochemical interfaces.

- More than 20 instruments developed for synthesis, characterization and testing many using a common sample platen enables controlled environment transfers
- Transformed our understanding of metal oxide thin films and the dynamics of geochemical interfaces (theory and experiment)
- Enabled discovery of new spintronic materials based on metal doped oxides
- Enabled the development of the first diesel exhaust emission catalysts meeting 2010 emission standards

EMSL's NWChem has enabled revolutionary expansion of computational chemistry and geochemistry.

- Enables scientific discovery in a wide range of scientific areas including studies of condensed phase and interfacial systems
  - Molecular processes in aqueous systems
  - Interactions at geochemical interfaces and in biomolecular systems.
- Parallel and highly scalable chemistry software developed by a tightly integrated team of computational chemists, applied mathematicians, and computer scientists

PNNL/EMSL's world leading mass spectrometry proteomic capability is transforming the breadth, detail, and impact of proteome characterization and measurement

- Consists of customized mass spectrometry systems with automated front-end separations technology and integrated with advanced data-intensive computing and data visualization software, for dependable high-throughput operations
- Developed in partnership with OBER, PNNL, and NIH funding, using systems integration approach, and employing multi-disciplinary technology and applications teams
- Combined peptide-level and whole protein characterization approaches

- Providing sophisticated and detailed biological understanding of environmentally relevant microbes (Deinococcus, Shewanella, Rhodobacter, Cyanothece) and microbial communities
- Application to DOE programs in environmental cleanup, carbon sequestration, and bio-energy production

Broido said you have a long way to go but I applaud the progress you have made.

At 11:15 a.m., **Jerry Elwood** provided an update on the state of BER. "We have been very busy and appreciate everything you have done for BER and value your input."

In FY 2008, the operating status is "the same thing all over again." We will be operating under a continuing resolution (CR) until at least December 14, 2007, with a year-long CR possible. CR allows continuation of on-going activities under terms and conditions of FY 2007 appropriations; spending rate is constrained. This does not allow new program starts or cancellations of existing programs. This does not allow new starts of projects in existing programs.

Hopefully, we will get appropriations soon. The BER FY 2007 appropriation, FY 2008 request, and the FY 2008 House and Senate Marks are as follows (in thousands):

- FY 2007 Appropriation $479,184
- President's FY 2008 Request: $531,897
- House mark $581,897
- Senate subcommittee mark $605,320

CR constrains funding at FY 2007 appropriation.

The staffing issues have been a problem and it is critical that we have people in these positions. There are two vacant division director positions. Filling the division director positions is contingent on first filling the AD position. In staffing changes in BER, the departures are **Mike Viola** and **Shirley Derflinger**. The new hires include **Elizabeth White** (Human Subjects Protection program); **Susan Gregurick** (Computational Biology); **Patrick Glynn** (Manager of Bioenergy Research Centers) and **Terry Jones** (Administrative Assistant for Environmental Remediation Sciences Division).

In Operational Changes in BER Program Funding at DOE Labs there is support of scientific focus areas (SFAs):

- Portfolio of BER-funded program research at a lab that takes advantage of unique scientific capabilities, strategic focus, flexibility, and administrative resources of national labs
- Retains use of and reliance on rigorous merit review
- Focus on team-based research efforts

The intent is to strengthen and broaden BER-funded scientific and technical contributions made by DOE labs, provide greater flexibility to BER and Labs to rapidly address new scientific and technical challenges as they arise, and enable BER to help Labs develop and sustain core competencies that contribute to BER Scientific Focus Areas (SFAs).

Life and Medical Sciences:
Updates:

- 3 GTL Bioenergy Centers funded
- GTL solicitations completed in FY2007
    - New Analytical and Imaging Technologies for Lignocellulosic Material Degradation
    - Quantitative Microbial Biochemistry and Metabolic Engineering for Biological Hydrogen Production
    - New Genomic Strategies and Technologies for Studying Complex Microbial Communities and Validating Genomic Annotations
    - Ethical, Legal, and Societal Implications (ELSI) of Research on Alternative Bioenergy Technologies, Synthetic Genomics, or Nanotechnologies
- NAS Study of State of the Science in Nuclear Medicine – recommendations relevant to DOE undergoing internal discussion
- FY 2008 Solicitations:
    - Plant feedstock genomics for bioenergy – joint solicitation between DOE and USDA-CSREES

- Nanotechnology Research Investigating Fate, Transport, Transformation, and Exposure of Engineered Nanomaterials - joint research solicitation between EPA, NSF & DOE
- GTL Microbial Hydrogen Production (planned)

GTL Strategic Plan — first draft release planned for February 2008:

Updating of the GTL Roadmap released July 2005, to include:

- Science & Technology Objectives, Science Hallmarks
- Program Integration of Research Centers, Scientific User Facilities, National Laboratory SFAs, university grants and awards
- Coordination with other BER divisional programs (CCRD & ERSD), Inter/Intra-Agency programs
- Alignment of GTL Program Goals Against DOE Missions and Long Term Measures
- Opportunities for New Elements and Topics with Increasing Emphasis
- Grand Challenges

From DOE Joint Genome Institute, some bioenergy-related genomes completed in 2007.

In climate change research, updates include strategic planning (draft plan to be revisited and modified as needed, depending on outcomes of BERAC workshop on Scientific Grand Challenges in Climate Change Research) and the key commitments are completed two of the three CCSP Synthesis and Assessment Reports (SAP 2.1 and 4.5) for which DOE is responsible. SAP 3.1 is nearly complete.

FY 2007 Solicitations Completed:
- ARM Science
- Atmospheric Science

Pending Solicitations:
- Abrupt climate change modeling
- Integrated assessment research

The climate change science program status:
- Center for Biological Diversity, et al case against CCSP for failure to comply with Global Change Research Act (GCRA) provisions
- Executive Branch decided to comply with court's decision rather than appeal
- Court retains jurisdiction over CCSP until provisions are satisfied
- Case involves CCSP failure to submit a revised Strategic Plan to Congress every three years, and to satisfy global change assessment provisions of Section 106 of the GCRA

With the court case against CCSP, the court ordered CCSP to publish a revised summary of proposed CCSP Strategic Research Plan in Federal register for public comment by March 1, 2008 and submit revised summary to Congress no later than 90 days thereafter and produce a scientific assessment that satisfies Section 106 of the GCRA by May 31, 2008. CCSP agencies have responsibility to satisfying the court order.

With regard to the SFAs, **Jim Adelstein** asked how do we make sure that we get the best sciences available. **Elwood** said we will need to buy into the idea that we need to get the best science from labs or simply go elsewhere. **Barbara Wold** asked how resources will be allocated and what are the parameters? Elwood said we will get a team of experts, get a report on the strengths, go to labs with a review and asked what do you plan to do to respond to the weaknesses and make adjustments? **Mavrik Zavarin** said that BER needs to be committed to funding. And balance it with rigorous reviews. He is concerned that you are hearing that labs want a long-term commitment of funding. Elwood said the process now does send a message to labs that we are in this in the long-run and we need to send message that we want to sustain interest. **Broido** said that as **Elwood** comes up with a clearer vision, to keep us informed on how this process goes. Elwood agreed and said they are still in the process of implementing.

At 12:02 p.m., **Broido** asked for new business and public comment. **Eugene Bierly** asked if the BER would handle universities differently. He said it is very important to get a program officer and attract really good people. **Barbara**

Wold said we should let scientists know there is a fraction of the money that is in mind that is high-risk. It should be justified by reviewers, possibly send out for additional input. **Raymond Gesteland** said it is a “mixed bag” experience. We gave instruction to PI that had some constraints (the ones that were high risk) after reviewing, stopped and reviewed exploratory proposals. We still need to work on how to communicate not to always be so conservative and these will be reviewed differently. **Wold** said she ran an internal high-risk program. The criteria was high-risks, but received high gains. Margaret Riley said it will take training reviewers and administrators. Over the past five years, she has seen it work and said she hopes to see new centers. **Broido** said the grand challenges that we have reviewed and are still concerns are still valid, understanding the grand challenges program will not continue in its current form. We agree that EMSIL is dedicated in finish the grand challenges and any future grand challenges should not be challenged.

At 12:17 p.m., **Broido** adjourned the meeting.