



Regency Room, Hilton Washington DC/Rockville Executive Meeting Center
1750 Rockville Pike
Rockville, MD 20852
Thursday, October 6, 2011 at 9:00 am.

Agenda Thursday, October 6, 2011 (Day One)

Time	Topic	Page	Speaker
8:30	Closed session for BERAC members only for Annual Ethics Briefing		
9:00	Welcome & Introductions		
10:00	State of BER Report		Sharlene Weatherwax, BER Associate Director
11:00	BREAK		
11:15	Climate and Environmental Sciences Division Update Biological Systems Science Division Update		Gary Geernaert Todd Anderson
12:45	Lunch		
2:15	Science Talk – “Geophysical Signatures of Subsurface Microbially-Mediated Processes: Toward Quantification of In-Situ Ecosystem Functioning”		Susan Hubbard
3:15	Office of Science Update		William Brinkman, Director
3:45	New Charge (BERAC): Technology Implementation for Long Term Vision		
4:45	New Business. Public Comment.		

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Agenda Friday, October 7, 2011 (Day Two)

Time	Topic	Page	Speaker
8:30	Biological Systems Science Division Committee of Visitors Report		Dan Bush, Colorado State University
9:30	Continued discussion of new Charge (BERAC)		
10:15	Advanced Scientific Computing Research		Dan Hitchcock
11:15	BREAK		
11:30	BER Workshop Reports: <ul style="list-style-type: none"> • Structural Biology • Biosystems Design • GoAmazon 		<ul style="list-style-type: none"> • Roland Hirsch • Pablo Rabinowicz • Dorothy Koch (for Wanda Ferrell)
12:15	New Business. Public Comment.		

Dr. Gary Stacey, Chairman, was presiding.

WELCOME

Dr. Stacey welcomed committee members and opened the first of two days of the Biological and Environmental Research Advisory Committee (BERAC). He noted that they were trying to create a more cohesive committee where members know each other and can share ideas easily. He said to accelerate that change the seating arrangements had been adjusted and an hour had been allotted in the agenda for introductions, for members to introduce themselves and briefly discuss their work and research.

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ANNOUNCEMENTS

Dr. Stacey made several announcements. He referred to the teleconference that members took part in during the summer and advised that through the Office of Science (SC) the advisory committee meetings were being simulcast on the web. He noted that no cameras were being used for the current meeting and the public would instead see what was presented on the screen. They would hear audio but would not see the speakers.

ROLL CALL

Committee/Voting Members Present:

Dr. Gary Stacey, Chair
Dr. Janet Braam
Dr. Robert E. Dickinson
Dr. James R. Ehleringer
Dr. Joanna S. Fowler
Dr. Paul Gilna
Dr. Susan Hubbard
Dr. Andrzej Joachimiak
Dr. L. Ruby Leung
Dr. Gerald (Jay) Mace
Dr. Joyce E. Penner
Dr. David A. Randall
Dr. Karin Remington
Dr. G. Phillip Robertson
Dr. Herman (Hank) Shugart
Dr. Judy D. Wall
Dr. Warren M. Washington
Dr. Raymond E. Wildung
Dr. Mavrik Zavarin
Dr. Minghua Zhang

Committee/Voting Members Absent:

Dr. Gregory Petsko
Dr. Margaret Riley
Dr. Gary Sayler
Dr. Herman Shugart
Dr. James M. Tiedje

INTRODUCTIONS AND CURRENT WORK/RESEARCH

Dr. Stacey asked that they go around the table and introduce themselves and discuss their current activities:

- Dr. Joanna Fowler introduced herself and said she was from Brookhaven National Laboratory. Noted she was an organic chemist and stated that their group works on the development of radio tracers and imaging instrumentation for applications in biological systems. Commented that at the current time they were working to phenotype plants producing radioactive carbon dioxide and radioactive nitrogen to explore questions about what moves in plants. Stated that they were using short-lived positron emitters to look at dynamic processes in real time and in whole plants.

Explained that as chemists they were involved in creating complex molecules and signaling molecules and molecules involved in systemic acquired resistance, an inducible defense mechanism in plants. Explained that they made things like oxine and salicylic acid and salicylates and azelaic acid and track them in plants. Advised that part of the process involved being able to compare different plants, different genotype plants and different varieties. Discussed the article in Nature entitled "Increased Soil Emissions of Potent Greenhouse Gases under Increased Atmospheric CO₂". Discussed in detail the effects of the study which was a meta-analysis of 49 studies where atmospheric CO₂ was increased, other conditions were looked at and they then studied the assumption that if atmospheric CO₂ was increased you could slow climate change because the plants would pick up the CO₂.

- Dr. Robert Dickinson introduced himself and said he was from the University of Texas at Austin. Stated that he is a climate modeler that reviews all aspects of climate modeling. Stated that he has been concentrating for several years on wind atmosphere interface and in particular working on the details of canopy radiation and trying to make it three dimensional. Mentioned several committees he is involved with, two NRC (National Research Council) committees, one that is chaired by Dr. W. Washington, looking at the overview committee for the U.S. global change research program. Noted another committee that is developing strategy for climate modeling in the U.S.
- Dr. Judy Wall introduced herself. Stated she was from the University of Missouri in Columbia, in the biochemistry department. Noted she has been there for 34 years and is working on anaerobic microbes and the genetics of sulphate-reducing bacteria. Stated that one of the things that currently has her excited as a classical geneticist, where a great deal of work is being done to get one or two mutants, is that they now have a library of 14,000 mutant-sequenced sites.
- Dr. Ruby Leung introduced herself. Stated she was from Pacific Northwest National Laboratory and is a climate modeler. Explained that she has been working on the regional scale modeling, regional scale climate conditions. Commented on some of her current work, a project in which they were using different approaches that allowed them to get regional resolutions and to see the advantages

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of one over the other. Stated that she is working with a multi-lab team on that project. Noted they are also looking at land atmosphere interactions particularly related to land surface hydrology and sub-surface processes. Commented that she is serving on one NRC (National Research Council) committee and they just had a meeting which concerned a national strategy for advancing climate modeling in which approaches for the U.S. were discussed.

- Dr. Phillip Robertson introduced himself. Stated that he is a carbon nitrogen bio-geo chemist and commented that he works primarily on nitrogen availability with respect to trace gas reduction in the area of nitrous oxide and other trace gases produced in particular managed eco-systems. Noted that he works primarily in intensively-managed agricultural systems in the Midwest and his work involves an attempt to understand what the drivers are in the carbon and nitrogen cycles of those systems. Commented on some of the broader impacts of their work and one which is the development of carbon credits for nitrous oxide abatement. They have been working in collaboration with the electric utilities to quantify ways in which they might allow farmers to be credited for using practices that would be more nitrous oxide friendly and thereby get credit for them on the emerging carbon registries.

Stated they have developed a new appreciation for regulatory agencies and colleagues who go through regulatory procedures. Stated that after two years of trying they were on the cusp of getting through the validators to get the new protocol based on nitrogen rate reduction through two of the major carbon registries in the U.S. Explained that it would have implications for reactive nitrogen in the bio-sphere in general and explained in further detail. Stated it was based on some of their findings concerning the relationship between nitrous oxide and rates of fertilization.

- Dr. Minghua Zhang introduced himself. Stated that he was from the State University of New York at Stony Brook and is a climate modeler interested in moist physical processes within climate models and in particular cloud feedbacks. Stated that they try to understand why models differ in cloud feedbacks and how to use the observational data to constrain them. Commented on some of his current research and noted it is to design a simple framework to test the physical processes and stated that what they found was that it was a mixing between the boundary layer air and the free tropospheric air which was important to the cloud feedback, especially low cloud feedback. Stated that different models parameterize the process differently so the problem is the classic problem of turbulence with moisture involved. Stated a second area that he is working on is an understanding the atmospheric processes by integrating different types of data from field experiments and he explained in further detail.
- Dr. Karin Remington introduced herself. Stated she is a director for an extramural program in bioinformatics and computational biology at the National Institute of General Medical Sciences at NIH (National Institutes of Health). Added that her training is in mathematics and computer science and that she worked for a number of years in genomic science at Celera Genomics and at the Venter Institute. Stated that about four years ago she joined NIH to direct the Center for Bioinformatics and

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Computational Biology. Commented about several areas of her work of interest to BERAC and stated that they might be aware of the intended establishment of a new center for the advancement of translational sciences at NIH. Stated that it required the dismantlement of the National Center for Research Resources due to a limit on the number of research institutes NIH is allowed to have. Noted that it had caused concern and their center was working to incorporate some of the programs from that dismantled center. Noted they were waiting for Congressional approval so they were in limbo at the moment. Discussed an inter-agency effort that she is co-chairing, the senior steering group for big data. Noted that they are being encouraged regularly by OSTP (Office of Science and Technology Policy) as they are excited about the idea of big data and the challenges surrounding it.

- Dr. Jay Mace introduced himself. Stated he has been with the University of Utah for about 15 years. Stated that they study the atmosphere with radars and LIDARs and various remote sensors to try to understand the processes that many climate modelers want to put into their models. Added that they try to render those from measurements and data. Commented about his research using a quote from a Buddhist monk who said if you looked deeply you could see the clouds and rain and he added that quote precisely described his goal. Stated that the DOE (Department of Energy) had installed a number of new radars at the ARM (Atmospheric Radiation Measurement) sites that could see the clouds and rain. Stated that he is in the process of developing algorithms that will separate that information and that will describe the dynamics of the atmosphere and the coupling between the dynamics, the clouds and the precipitation.
- Dr. David Randall introduced himself. Stated he is an atmospheric scientist at Colorado State University (CSU) and has been there for 23 years. Noted that he is a director of a science and technology center, an NSF (National Science Foundation) center at CSU that is focused on a new way of representing clouds and climate models and which is very computer-intensive. Stated that the early states of the research were funded by the ARM program. Explained that one of his activities is coordinating the lead author the IPCC (Intergovernmental Panel on Climate Change) chapter, a working group on the Fifth Assessment which is in progress. Noted that the first order draft will be finalized in the coming weeks. Added that in August he completed a book due for release in the spring of 2012 about atmospheric physics and climate and it is aimed at sophomore physics majors with limited exposure to atmospheric science.
- Dr. Susan Hubbard introduced herself. Stated that she is from Lawrence Berkeley National Laboratory (LBNL) and noted that she is a subsurface scientist and her expertise is in using geophysical methods to understand flow and transport properties and processes in the subsurface related to environmental remediation. Noted that she would not go into detail on her current research as she was presenting her work for the committee. Mentioned an area that she only recently has been exposed to which she found exciting and this concerned some of the terrestrial eco-systems and feedbacks with the climate. Added she was recently part of a small group that took a charter flight along the permafrost gradient in the Arctic to scope out field study sites for the next

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generation eco-system experiment and related details of the flight and processes. Discussed recent articles in publications on the same subject.

- Dr. Paul Gilna introduced himself. Stated that his background is in classical pharmacology but noted that he refers to himself as a recovering pharmacologist. Stated his current role is the director of the BioEnergy Science Center at Oak Ridge National Laboratory (ORNL). Stated that two recent events inspired him regarding what he wanted to say at the committee meeting. The first was the passing of Steve Jobs and the second one, not related, was that all of the bioenergy centers had just submitted their renewal proposals. Explained the reason he conjoined the two was that either of the events would cause one to step back and reflect, in particular, asking to what extent have we made a difference? Stated that the body of work represented by the three bioenergy centers has changed the field of bioenergy research and he considered that uncontested. Stated that the DOE and BERAC had collectively made a difference.
- Dr. Raymond Wildung introduced himself. Stated he has worked with BER (Biological Environmental Research) continuously for 44 years, the first 38 years as a Principal Investigator (PI). Stated it has been a pleasure to watch the evolution of the programs with massive changes in the socio-political landscape. Noted that the SC has been versatile with staff and capable of responding to challenging national needs and priorities. Added that the response included the opportunities of the bioenergy centers and the stimulus funds, always with the goal of doing good science. Commented that despite the funding issues the SC was better positioned scientifically than ever before to serve the nation.
- Dr. Joyce Penner introduced herself. Stated that what she liked to do is put the most mechanistic and physically-realistic representations of climate science into models. Noted that the mechanisms that she put into the models would be taking up too much computer time to actually be used in long-term climate simulations. Added that they now have climate models with chemistry. Discussed several different advances her students are working on. Noted that one is to change the way that nitrate is incorporated into aerosol particles and she elaborated. Stated a second area they have been involved in is aerosol cloud interactions and she elaborated.
- Dr. Mavrik Zavarin introduced himself. Stated he is from Lawrence Livermore National Laboratory and that he is a geochemist and his focus is on mineral water interface, geochemistry and in particular the interaction of actinides and fission products at the mineral water interface and their reactive transport on the subsurface. Commented that recently they have focused on looking at the reversibility and kinetics of plutonium on mineral surfaces that would be relevant for subsurface transport. Added that it turns out in many cases that the kinetics are what drives the long-term transport of actinides in the subsurface and that there is not a lot of data out there to constrain what the rates are and how those affect the long-term migration of the actinides. Talked about a conference he has recently attended in Beijing focused on radio-nuclide migration. Noted that at the conference he was happy to see a lot of SBR (Subsurface Biogeochemistry Research) and BER

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research represented there. Commented on several topics that came up, one in which they received an overview of the energy issues in China. Discussed energy production in China including details on the construction of nuclear power plants. Noted that he sees a lot of interesting work coming from the Europeans on developing open-access databases for subsurface reactive transport modeling.

- Dr. Janet Braam introduced herself. Stated that she was from the Department of Biochemistry and Cell Biology at Rice University. Stated that she is a plant biologist studying fundamental cell biology and using plants as a model system. Added that she has a focus on studying plant responses to stress, both abiotic and biotic stress. Stated that they are interested in plant responses to herbivore and fungal infections and they study the role of the circadian rhythm in plant responses to stresses. Commented that her work has recently brought her into a new area and noted that how chlorophyll biogenesis is regulated is not understood. Considered this an important problem and noted that they are working on the regulation of chlorophyll biosynthesis in plants. Noted that it is important because it is the most abundant pigment on earth and is critical for photosynthesis and the way of life.
- Dr. James Ehleringer introduced himself. Stated he was from the University of Utah and has been there for 34 years. Stated he is an ecosystem scientist interested in carbon and water cycles in the western U.S. with an interest in urban ecosystems. Added that one of the things that they are doing is maintaining a five-station CO₂ network within the Salt Lake Valley, the longest-running continuously available public dataset on CO₂ in urban ecosystems in the world. Noted that the dataset has been going for 11 years and he noted the limitations but also confirmed that they have been able to come up with basic observations and applications which he elaborated on. Noted that one of them is CO₂ treaty verification. Discussed one of the problems and an opportunity in that many of them collect data and there is a time between when it is published and when it is made available and a mechanism was needed to recognize high-quality data and enable it to be made available for modelers and others to use. Discussed the concept of an untapped social network of information with spatially relevant data that could be obtained with smart phones and the use of that information for environmental purposes that would provide opportunities for them. This was elaborated on further.
- Dr. Warren M. Washington introduced himself. Stated he is from (NCAR) the National Center for Atmospheric Research and has been there for 48 years. Added that he has been a PI with BER since 1978. Stated that in the early part of climate modeling and working with DOE he was involved in building models that could be used for looking at things like increasing carbon dioxide. Stated that his group is the group that carries out the large number of climate change experiments for the IPCC assessment. Stated that the last assessment was the largest of any in the world and noted that they are heading towards several petabytes of data coming out of their simulations. Stated that he is the chair on the committee for the Academy which is reviewing for the U.S. global change program, the

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strategic draft. Encouraged members to go to the website for public comments (<http://www.globalchange.gov/whats-new/631-federal-register-notice-announcing-public-comment-period-for-the-usgcrp-strategic-plan>). Stated it came out on Friday and is a new program of the 16 agencies involved in climate change research and is changing from a climate change orientation to global change. Noted that BER was well poised to see more interaction among disciplines. Gave details about the program. Noted that they lost a crucial instrument for climate change and global change when the Aqua Satellite went down October 5th. Added it was the instrument that measured sea ice and ocean temperature. Said no replacement was planned so there would be a gap in their data.

- Dr. Andrzej Joachimiak introduced himself. Stated he is from Argonne National Laboratory (ANL) and the University of Chicago and stated he has been at Argonne for 18 years. Added that he is a structural biologist that uses cyclotron radiation for research. Stated he is the head of the Structural Biology Center and the Midwest Center for Structural Genomics which is NIH funded. Stated that 15 years ago they had a vision that they could accelerate protein structure determination and they had to create structure genomics programs in the U.S. and around the world. Noted that today in many cases they can determine structures in real time using cyclotron facilities and he elaborated on why it is important.
- Dr. Gary Stacey introduced himself and noted that he had mentioned he wanted them all to make good use of their BERAC colleagues. Mentioned the articles in Nature and Science that he was involved in putting it together and hosting a plant research summit that was held in late September 2011 in D.C. assisted by Dr. Robertson. Stated that the summit was sponsored by the Howard Hughes Medical Institute and the major hosting organization was the American Society of Plant Biologists. Indicated that he had wanted to do it for many years as agricultural and plant sciences are a fragmented group and can go from things that are very translational to things that are fundamental.

For that reason the groups are speaking from many disparate voices to the public, Congress and other groups. Confirmed that it is important to have the groups come together and that it needed to be done now in view of the funding situation. Seventy-five plant scientists were invited from a variety of areas of expertise. The summit was held to identify what the grand challenges are. Stated that another recent development was that he has re-initiated the practice of communication among the Chairs of the various advisory committees to share information. Noted that all the other Chairs welcomed the interaction. Discussed the collaborative project he began with Dr. Joachimiak and elaborated on it.

THE STATE OF BER REPORT

Dr. Sharlene Weatherwax, Associate Director of Science, Biological and Environmental Research

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- Welcomed them all to the advisory committee meeting. Noted that BERAC had a rich diversity in areas of expertise and she wanted to incorporate time for discussion for that reason.
- Indicated that she would be giving them an update on BER with respect to funding. Noted that the good news was that they were on a continuing resolution and it would be signed shortly and it would be continuing through mid November.
 - The first area was in biological systems science.
 - She reviewed funding for FY2011 which ended on September 30th showing all the major line items.
 - She noted that the figures for FY2012 had been voted on by the House and that was the House mark but the Senate Committee had not yet voted on the amount. So fiscal year 2010 would begin starting at the (House) mark shown on the slide.
 - She pointed out the difference in the figures between what the House and Senate Committee had.
 - Areas listed included: genomic science; radiological sciences; ethical, legal and societal issues; medical applications; biological systems facilities & infrastructure; and SBIR/STTR.
 - The second area was in climate and environmental sciences.
 - She stated that they ended fiscal year 2011 in good shape.
 - She pointed out again the low House figure which was voted on compared to the Senate Committee figure. She added that because the Senate Committee had not voted on it yet they were held to the lower (House) mark.
 - She confirmed that they were already working on their FY2013 budget.
 - She stated that some of the ramifications of being held at the lower mark were that it was restricting certain things pending resolution on the final budget. She added that this would include issues dealing with program direction which in turn impacted personnel hiring and travel.
 - Areas listed included: atmospheric system research; environmental system science; climate and earth system modeling; climate and environmental facilities and infrastructure; and SBIR/STTR.
- Reviewed some of the personnel changes since the last meeting:

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- Mr. Patrick Horan had arrived and was now the Science Assistant in CESD (Climate and Environmental Sciences Division).
- She stated that she was no longer acting but was the permanent associate director for BER.
- She noted that she had formally stepped down from her position as the division director of BSSD Science and a posting was done for the position and it closed September 9.
- Discussed the Early Career Research Programs. Advised that it was to support the development of individual research programs of outstanding scientists early in their careers and in the SC areas.
- Outlined the conditions/information of the programs. Stated that the applicants should be no more than 10 years past receiving their PhD. Noted that in 2011 there were seven awards in BER and they were five-year awards in the sum of \$750,000 over five years for universities and \$2,500,000 over five years for national laboratories.
- Commented on the awardees from national laboratories:
 - Matt Marshall of Pacific Northwest National Laboratory with an interest in multi-system analysis of microbial biofilms.
 - Yongqin Jiao of Lawrence Livermore National Laboratory with an interest in systems level investigation of uranium resistance and regulation by *Caulobacter crescentus*.
 - Susannah Tringe from Lawrence Berkeley National Laboratory with an interest in microbial communities in biological carbon sequestration.
- Commented on the awardees from universities:
 - Tim Bertram from University of California at San Diego with an interest in, in situ measurements of heterogeneous reactions on ambient aerosol particles: impacts on atmospheric chemistry and climate.
 - Heileen Hsu-Kim from Duke University with an interest in nanoscale mercury sulfide-organic matter interactions and implications for solubility and biomethylation.
 - Samuel Hazen from the University of Massachusetts, Amherst with an interest in plant-microbe genomic systems optimization for energy.
 - Mary Dunlop from the University of Vermont with an interest in engineering robust hosts for microbial biofuel production.
- Noted that all of the winners initiated their awards in FY2011 and the announcement had closed for this year's competition.

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- Advised that they had just had the announcement of the 2010 PECASE (Presidential Early Career Award for Scientists and Engineers) winners. Explained that they take the Early Career winners from the previous year and enter them into the pool for PECASE. Advised the winners were just announced and the president named 13 DOE researchers. Noted it was the highest honor that the government could confer on an early career scientist.
- Advised that out of the 13 PECASE winners BER had two and they were Victoria Orphan from the California Institute of Technology and Wei-Jun Qian from Pacific Northwest National Laboratory. The winners would receive their awards during a ceremony at the White House.
- Noted that BER research took place with: trans-disciplinary science; systems-based, data intensive and diverse research; world class, high impact user facilities; and scientific partnering to meet DOE mission needs.

COMMITTEE DISCUSSION

A member wanted to know about the real impacts starting the year under the CR. He asked what RFPs (Request for Proposals) if any, were cancelled or delayed. Dr. Weatherwax responded that starting out the year at the low mark meant they had to cancel several solicitations that they had planned and that was done after reviewing the budget and deciding that by the time they had a resolution on those it was unlikely that they would then be able to issue the solicitation and get proposals reviewed in time to make recommendations for the fiscal year. She noted the solicitations would be deferred until the next fiscal year or reconfigured. The member stated he was concerned with continuity. Dr. Weatherwax responded that they tried not to impact too many people but she stated there was usually some lead time so people going up for competitive renewal would have sufficient time to plan.

A member stated that she wanted to make a correction in that there were three PECASE winners from BER. She noted the third one was Christiane Jablonowski. Dr. Weatherwax responded she had had to look into that and she stated that they funded her under the SciDAC (Scientific Discovery through Advanced Computing) program. She stated that several programs wanted to include her and her award went through the ASCR (Advanced Scientific Computing Research) office.

A member stated that deferring applications and waiting a year was not practical. Dr. Weatherwax responded that she understood but until there was a resolution to the budget they would have to wait. Once there was some resolution they could move ahead.

A member noted that they would be talking about the COV (Committee of Visitors) report soon but he brought up the point about the deferral because every time they had a COV he noted one of the recommendations was that there was insufficient staff and funding and a lack of administrative support. He asked if there was a strategy or a way of looking forward. Dr. Weatherwax responded that she appreciated the work of the BER staff with their extra work. She added that it complicated their grant

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process when they did not receive funding until late in the year and staff had to work extra hours to try to process awards. She noted that they recently had a BER retreat and one of the things they did was to try to encourage everyone to talk about how they did business across the office because they had found that people were doing things inconsistently and because of that they wanted to standardize and harmonize the business processes. She stated that David Thomassen was developing a program manager handbook to facilitate staff in doing their work.

A member asked her to tell him about the budgets in the other offices related to BER such as ASCR. Dr. Weatherwax responded that she knew that overall the SC did not come out so badly in the House mark. She stated there was some specific language directed at BER and some of the other offices were not targeted in that way. She noted though that every office was starting the year lower than hoped for. She noted that Dr. Brinkman might discuss the budget profile overall. She noted that during these times it was of paramount importance to be able to utilize available resources across the government and make good use of available funds to continue things considered critical.

A member asked what the impact would be if the Senate and House could not agree and there would be an automatic 2 percent reduction. Dr. Weatherwax responded that she did not know at this point.

A member asked about her comment of putting programs on hold and deferring hiring of personnel. She asked about the impact on hiring. Dr. Weatherwax responded that program direction controls things like personnel salaries, benefits and travel. She added because the SC was held at a lower level they had to ensure that they did not spend their total budget for the year. She added that they had a certain number of personnel and even though some had left they were not able to backfill those positions. She stated that once they had a firm number for FY2012 they would be able to proceed.

Dr. Phillip Robertson noted that it was great to hear about the Early Career Awards and the BER successes. He said that the awards to the universities were \$750,000 and asked for clarification asking if it was an annual amount or the total five years. Dr. Weatherwax responded that that was the total. He asked about the difference between the national labs and the university awards. Dr. Weatherwax said the award levels were set across the whole Office of Science and it reflected the difference in the overhead burden between the labs and the universities.

A member asked given the flat budget if there were some areas that she thought BER could or should be going in. Dr. Weatherwax responded that BER in each division had a systems approach and she thought that increasingly they would think of things where they could leverage expertise across the divisions. She thought they had started this already with some program managers working across different divisions.

A member asked Dr. Remington about the cost of sending large datasets across the internet, was that something that her committee was considering and would it be something that would have a significant impact on the way they did business in the future. Dr. Remington responded yes to the latter. She said

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for the former, that the steering group was looking at the application of science and trying to make the best use of the data that they had and not specifically addressing the economics of that underlying infrastructure.

Dr. Stacey discussed the fact that they would be having two discussions at the BERAC meeting about the charge letter from Dr. Brinkman dealing with technology. He noted that he was concerned about how they were going to structure the discussions and the process for obtaining outcome. He asked that if any other members had any idea how they should structure this discussion or guide them during the talks about how to optimize the time period.

Dr. Raymond Wildung noted that when he read the charge letter he was somewhat confused. He said he had difficulty understanding what the definition of 'tool' was and also there were a series of statements in the letter that were vague. He stated that he would like to have some of these things defined before they began the discussions.

Dr. Weatherwax stated that the charge letter was specifically vague because she thought that the word 'tool' meant different things to different scientific communities and having that discussion was important to lay out the definitions because if they were building tools that would bridge biology and climate they would need to understand each other's space. She thought that there should be some discussion about how each of them saw 'tools' and what it would mean to them.

A member asked, what is a tool? Another member responded that traditionally they thought of tools as being instrumentation and ways to get at specific analytical issues but he thought it was also important to broaden the definition to include more experimental systems but also networks of experimental observatories as tools to observe the environment and to judge the effects of particular perturbations on the environment as a way to inform better process-based modeling that would then scale up to and improve their models of biosphere processes ranging from climate to trace gas production for example. He stated that he wanted the definition of tool not be so specific that it would be limited to particular types of instrumentations.

A member stated that one of things being done by bioenergy centers was pipelines for analysis. She said they had many nodes along the pathway but she thought the concept of a pipeline would be a tool.

Dr. Zhang thought it was the infrastructure that would be used to support the research for the DOE missions and that it should include the measurement of facilities, the data archive as a way to analyze the data and then computing facilities as well.

A member said he did a quick scan of the long-term vision document and did a search for the term 'tool' and when it was used and the context. He stated that he was surprised at how little association there was with infrastructure and how much more association there was with software data manipulation, data archiving, moving data and trying to understand data. He considered it a reasonable definition of a

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tool for him, not traditionally what some may think of as a tool. He said the term was used vaguely in the long-term vision as well.

Dr. Joyce Penner stated that she wanted to add computational tools as the whole climate modeling enterprise was built upon tools built in ASCR that the scientific community used for analysis.

A member stated that she hoped that the discussion of the term 'tool' would be done within the context of their long-term vision report which had a strong emphasis on complex systems and scaling and looking across different types of systems. She thought talking about the term in isolation of a particular problem or a science goal would not be as effective as defining a few science goals that BER was poised to tackle.

A member stated that he thought of several things, one that the tool was driven by the biological question. He stated the second as where the excitement came from bringing a tool from outside of your own area and applying it to your specific area because you could then see paradigm-shifting discoveries. He stated that the third was that they had an opportunity for the group within the context of their mission, to be integrative in their discussion.

A member agreed with what Dr. Penner talked about in terms of computational resources that they would need for climate modeling and she emphasized not just computers but software development and a common framework to help facilitate the development of different types of models.

A member added the ability to integrate measurements and observations with the computational side and that there needed to be a bridge built between the next generation of observations and the next generation of models.

A member thought it was important to have some kind of standardization of the formats that would be generated in many different fields.

A member stated that in reviewing the letter it stated, "tools in the context of technology needs" which meant that they were not going to try and reinforce existing tools unless it represented a major scientific challenge. He said that he thought they needed to be thinking in terms of new challenges and new obstacles that needed to be overcome rather than trying to augment existing tools.

Dr. Stacy stated that his view was that they were asking for something that was forward-looking. He added that no one had answered his question which was, how do we structure the discussion? He noted that he could envision talking about tools in relation to sub-disciplines, talking about climate, subsurface and so forth. He stated that he could think in terms of structuring it based on tool types, so some discussion on computational tools, instrumentation, measurement and then a separate discussion on integration. He asked for their comments on what would be the most effective way to discuss it.

A member thought it might be best to start with what the problems were relevant to DOE that they thought they could solve in 20 years or with a goal to solve in 20 years and discuss the problem in the

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context of the these solvable problems. She thought that way they would be more integrated from the beginning.

Dr. Stacy asked if they should focus the tool development on the issue of temporal and spatial scales and start thinking about tools that would get them from the minute to the massive.

A member responded that she did think temporal and spatial scales were a big part of it but they needed to narrow it down to a few specific questions or systems or it might be hard to have a concrete examples of tool development.

A member suggested that it be organized by process: acquisition, simulation and information analysis. He thought that a great challenge was how did they know what was out there? And how would they use what was out there in terms of analysis and information?

Dr. Stacy asked of all the approaches brought forward which one would they consider the most effective for their discussions? A member added one more point which was design. A member asked if the terms would be done in isolation of each other, not with a particular science goal.

Dr. Stacy responded that each member of the committee would be talking about it in the context of some example. He noted that for example, when they would speak about acquisition, the need for certain acquisitions one might think what kind of data would be needed to acquire to understand subsurface environment.

Dr. Stacy said that they should consider their charge over the break and lunch leading into the afternoon discussion and to be thinking of some grand challenge or climate examples that could serve as a platform on which to talk about these aspects of tool development. He added that they would try to structure the discussion so he asked could they please think about acquisition, simulation, data analysis and design. He added the fifth would be the integration aspect.

BREAK

The Biological and Environmental Research Advisory Committee recessed for a 15 minute break.

CLIMATE AND ENVIRONMENTAL SCIENCES DIVISION UPDATE

Dr. Gary Geernaert, *Director, Climate and Environmental Sciences Division*

- Noted that the presentation content was challenging as they had put a solicitation out to the program managers for highlights and as it was an extremely productive year they had no less than 50 highlights that managers wanted included.

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- Explained that a meeting was held to narrow the field and tell a story based on where they hoped to go and what would be the best highlights to illustrate that narrative. Stated that the presentation was essentially on behalf of the division itself.
- Stated some of the challenges during the past year:
 - Sense of the nation's need for climate science.
 - Importance of the DOE becoming more visible in organizations like the USGCRP (United States Global Change Research Program) as the major coordinating body across the federal government.
 - Need to build a more coherent strategy of the division which would exceed what previous strategies had focused on. This would be an actionable strategy that could be developed including not just the science but also the funding instruments to maximize a return.
- Stated that their goal was to advance science to increase system predictability. Noted that within the goal they established some unifying themes:
 - The concept of extremes, thresholds and tipping points.
 - Attribution to anthropogenic versus naturally varying signal.
 - Sensitive geographies.
 - Higher resolution with uncertainty characterization.
 - Science gaps that limited predictability:
 - Hydrology: clouds, aerosols, precipitation, drought, ecology.
 - Clouds, aerosols
 - Cryosphere
 - Carbon, heavy metals
 - Data/model management: testbeds, diagnostics, UQ (Uncertainty Quantification)
- Detailed the strategy principles:
 - Exploit unique DOE assets (ARM, EMSL, (Environmental Molecular Sciences Laboratory) HPC (High Performance Computing), national laboratories.
 - Tap into the largest talent pool possible.

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- Leverage other agency assets where possible.
- Use the USGCRP where they can to advance their goals.
- Create career opportunities for staff.
- Provided some management updates.
 - Facility review for ARM in the spring of 2011 that turned out well.
 - A data quality workshop for ARM in November 2011
 - EMSL review taking place in October 2011.
- Discussed the USGCRP and noted that they helped to create another vice chair position (Gary Geernaert) and principal (Mike Kuperberg).
- Noted that in response to their own agenda they had to have a stronger presence at the major conferences. Explained that it formed part of how they developed their strategy and program portfolio. Named several such as the ESA (Ecological Society of America) town hall in August 2011, AGU (American Geophysical Union) town halls in December 2011 and AMS town hall coming up in January 2012. Wanted to establish the DOE as a much more visible player.
- Noted that they had had SFA (Scientific Focus Area) reviews recently and they included SLAC National Accelerator Laboratory (SLAC) subsurface, PNNL (Pacific Northwest National Laboratory) subsurface and LANL (Los Alamos National Laboratory) COSIM (Climate, Ocean and Sea Ice Modeling).
- Noted that the NGEE (Next Generation Ecosystem Experiment) Phase 1 proposal was accepted with revisions.
- Reviewed the status of solicitations for TES (Terrestrial Ecosystem Science), SBIR (Small Business Innovation Research), Early Career, SciDAC and AmeriFlux.
- Discussed the CESD Recovery Act Projects which included purchases for the: Atmospheric Radiation Measurement Climate Research Facility; Environmental Molecular Sciences Laboratory; and Integrated Assessment Research Program which he stated were 99 percent completed.
- Provided some science updates (research highlights) which reflected where the division was going:
 - A slide was shown and discussed illustrating Arctic Sea Ice Extent or retreat for the summer of 2011 which was mirroring a similar occurrence in 2007.

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- He described some of the modeling activities in the Arctic with the Regional Arctic System Model (RASM). Noted that they had a broad climate prediction project with 13 organizations involved. They used it as a means to build a multi-agency DOE lab modeling frame in the Arctic.
- Discussed NGEE. A multi-laboratory (led by ORNL) proposal was submitted to the DOE. It covers a ten-year period and the current proposal covers the first three years.
- Discussed the new thinking on soil carbon, the traditional view of soil carbon and the recent analytical advances which disputed the assumption. Stated the new understanding was that the persistence of soil organic carbon is more at an ecosystem level than at a molecular mechanistic level.
- He reviewed a study on soil warming and carbon-nitrogen interactions.
- He reviewed a study on a global methane emission model and predictions.
- He discussed a study on hydrology and projections of future drought in the Continental United States and Mexico.
- He discussed integrated assessments and climate projections. He talked about where the integrated assessments program was heading.
- He discussed ARM and showed a slide showing where the ARM program has or had sites and where it will be going in the future. He showed the sites on a world map.
- He talked about some of the work of ASR (Atmospheric System Research) and in particular determining how realistically shaped ice crystals scatter radiation. He also reviewed a second study concerning observations of anvil clouds of Tropical Mesoscale convective systems.
- Another hydrology themed study was one on pollution from China concerning the increased cloud droplet numbers and how it suppressed rain over the East China Sea.
- He discussed the results coming out of an EMSL study which focused on experimentation and simulation used to understand the surfactant properties of sea salt particles.
- He discussed a study with DMS (dimethyl sulfoxide) and its effects.
- He discussed the ARM/NASA campaign and noted that the key accomplishment was the collection of an important multi-platform, multi-agency dataset over a variety of conditions that would be useful for improving the representation of convective clouds in large-scale models.
- He discussed the ARM Mobile Facility and the Ganges Valley aerosol experiment with its objective to measure clouds, precipitation and complex aerosols to study their impact on cloud

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formation and monsoon activity in the region. The aerosol measurement sites will go from January to March 2012.

- He discussed a study going on in Asia called DYNAMO, a study of the Madden-Julian Oscillation and how it couples to El Niño.
- He talked about a new project with an ARM climate research facility. It is a mobile facility looking at the western coast of the U.S. with an objective to understand and parameterize clouds and precipitation, aerosols and radiation and the interactions among them. There was also a study in Cape Cod investigating aerosol indirect effects and a future study called GOAmazon with an objective of examining the coupling of land and atmosphere in the tropics.
- He advised that Dr. Dave Bader of LLNL had developed a proposal which set the stage and accelerated climate modeling to tackle some big questions facing some high priority topics in the division such as numerics, testbeds and uncertainty quantification. The CSSEF (Climate Science for a Sustainable Energy Future) proposal had three components: atmosphere, land and ocean and sea ice. Three research directions were established: hydrologic simulation improvement; variable-resolution numerical methods; and carbon cycle uncertainty reduction. He reviewed some of the early results.
- He discussed a study concerning hiatus periods in climate models.
- He showed some slides with high resolution of ocean eddies.
- Reviewed the recent and upcoming activities at EMSL including 2011 meetings and workshops, new instrumentation arriving in fall/winter of 2011. Provided details of HRMAC (High Resolution and Mass Accuracy Capability) development project. Noted that the EMSL "Quiet Wing" was near completion.
- Detailed the next steps and he stated that they had a strategic plan with specifics. Noted that major projects integrated across the division. Added that there was concrete science and capability targets to guide investments and that the objective was to be a serious player in USGCRP.

BIOLOGICAL SYSTEMS SCIENCE DIVISION UPDATE

Dr. R. Todd Anderson, Acting Director, *Biological Systems Science Division*

- Advised that for the last 4 months he had the privilege of serving as the Acting Division Director for Biological Systems Sciences Division (BSSD) so he noted he was pleased to provide the update.
- Advised that they were in the process searching for a new division director for BSSD and it was advertised and closed on September 9, 2011. Noted that the process was proceeding.

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- Advised that they were bringing in a national laboratory detailee joining in October 2011 as a part-time detailee to assist with the Genomic Sciences Program and that is Dr. Michael Thelen from LLNL.
- Discussed completed programmatic activities:
 - The Genomic Sciences Notice was completed having been issued in 2010. Proposals were reviewed in early December 2010. They could not be processed or the awards given until they had a budget. Reviewed 138 proposals and made 28 awards. General topics of research included bioenergy-related and environmental processes-related areas of research.
 - The USDA-DOE plant feedstock genomics for bioenergy 2011 awards were completed. This was also a notice sent out in 2010 delayed due to budget issues. The objective of the notice was fundamental research to enhance translation of genomics information into cultivar improvement for bioenergy crops and phenotyping plant germplasm collections and advanced breeding lines in public breeding programs of bioenergy crops. They made 10 awards and the funding was divided between the DOE and the USDA. The subject of research was a variety of bioenergy plants.
 - Three reviews of SFAs (Science Focus Areas) at the national laboratories. They reviewed low dose SFAs at the PNNL (Pacific Northwest National Laboratory) and LBNL and the foundational Genomic Science SFA at PNNL.
 - There were two workshops, one on the applications of future DOE national beamline user facilities for biology and the other on biosystems design.
 - They hosted a Committee of Visitors Review in mid June 2011.
 - The Human Subjects Protection Program reviews have been going on at LLNL, LANL and ANL (Argonne National Laboratory) since September 2010.
- Discussed upcoming programmatic activities:
 - Annual BRC (Bioenergy Research Centers) reviews are coming up. A review of the Joint Genome Institute is planned for December 2011 and the Human Subjects Protection Program reviews are continuing at the national laboratories.
 - They are in the process of planning the next Genomic Science Principal Investigator's meeting in February of 2012 in Maryland and for the USDA-DOE Plant Feedstocks Genomics for Bioenergy in January of 2012.
 - They will be posting one notice in the division, the next DOE-USDA Plant Feedstock Genomics Notice in mid November 2011.

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- Detailed attendances at recent symposia/conferences taking place at IMAG (Interagency Modeling and Analysis Group Grantees) in October 2011 and at the PittCon in March of 2012.
- Noted there was a new award for a new SFA for the DOE Systems Biology Knowledgebase. Stated that it was their effort to make genomic information more available to researchers. Advised the award was made to LBNL and Adam Arkin was the lead PI for the project and the three Co-PIs were Rick Stevens at ANL, Robert Cottingham at ORNL and Sergei Maslov at BNL.
- Stated the objective of the systems biology knowledgebase was to develop a cyber infrastructure needed to support the creation, maintenance and use of predictive models and methods in the study of microbes, microbial communities and plants and demonstrate the utility of these tools in advancing DOE goals in bioenergy, carbon cycle research and environmental microbiology.
- Advised that what they would do was tap into some of the larger genomic databases, sequence databases and metadata and bring it together in a way that makes it easier for biologists and researchers to take a more innovative approach to the systems biology research.
- Discussed some of the science highlights published in the Bioenergy Research Centers:
 - The BRCs have a goal to use a systems biology approach to lay the foundational science underlying the development of biofuels to secure a source of energy for the nation. He discussed work at ORNL's BioEnergy Science Center (BESC) to improve the bioprocessing efficiency of converting plant biomass conversion to ethanol. He discussed their approaches and the results, one specifically being the identification of a key ethanol tolerance gene.
 - He discussed the work of the Great Lakes Bioenergy Research Center (GLBRC). The objective was to evaluate insecticide use and insect pest pressure in expansive monoculture cultivated landscapes to inform sustainable bioenergy practices. He discussed their approach and results. The results provided correlative evidence of a relationship between landscape simplification, insecticide use and pest abundance using data from the entire Mid-Western U.S. farming region and showed the implications for forecasting bioenergy crop production and management practices.
 - He discussed the research at the Joint Bioenergy Institute (JBEI) at LBNL. One of their main objectives was the modification of plants and organisms to produce biofuel compounds. The manuscript appeared recently in Nature Communications. He discussed their approach and result or impact which was the first demonstration of microbial synthesis of a high energy content, low toxicity biofuel from simple sugars.
- Discussed some of the highlights from the Genomic Sciences Program:

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- Described a manuscript that came out of the University of Michigan using a systems biology approach for terrestrial carbon and nitrogen cycling. They had noted that in some northern forest ecosystems an increased nitrogen input resulted in a net increase in storage of recalcitrant organic carbon in forest soils. Their objective was to obtain an answer to the question of how is the structure and function of microbial communities related to this phenomenon. He discussed their approach and results.
- The Genomic Sciences program at the Berkeley lab developed a new microfluidic device for the identification and quantification of environmental microbes. The objective was to obtain a high throughput identification and quantification of functional classes of microbes in environmental samples containing low amounts of biomass. He discussed the approach and results. The results identified the compounds in the samples and illustrated that the technique provided a powerful tool to estimate population levels of microbes performing important functional processes in the environment.
- The University of Tennessee group and Oak Ridge were working on an interesting project with Correlating Experimental Measurements with Computational Simulations. The objective was to correlate biomolecular structural changes from kinetic experiments with computer simulations of the process. He discussed the approach and the results.
- Discussed highlights from the Radiochemistry Program, the Low Dose Program and Structural Biology:
 - Discussed a project from BNL. The group has a history in developing radio tracers for use in medical devices like PET-scan imaging. They are using this expertise and are branching out using short half-life chemical tracers into different types of plant signaling compounds to track processes in real time with plants. They are using C-11 auxin and tracing it in damaged plant roots and looking at how the plant signaling compound is transported within plants. He discussed their approaches and results.
 - The Low Dose Program has as its objective the study of dose-dependent kinetics of a radiation-induced biological effect important in cancer risk. He discussed their approaches and results.
 - Discussed a highlight from the structural biology component of the division concerning investigation of how viruses work. He described the process of the maturation process of a viral capsid. He described their approach and results. This work provided insight into the mechanisms of how viruses work of interest of those interested in interrupting that process. Noted that Professor Hiro Tsuruta was involved in the work and had recently passed away. It was noted that those involved in that research field would miss his expertise.
- Commented on the news from the Joint Genome Institute (JGI) with the 2011 community sequencing programs. Noted that JGI received 52 Eukaryotic proposals and accepted 14 for

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sequencing. Advised that they looked at 75 Prokaryotic proposals and accepted 27 for sequencing. Commented on upcoming activities and sequencing capacity of JGI.

- Highlighted the JGI list of selected high impact publications, totaled 102 articles since March 2011.

COMMITTEE DISCUSSION

A member complimented both Dr. Geernaert and Dr. Anderson for the great presentations. He commented first about tools and mentioned that one area suggested was a problem area for DOE and the other was key technical requirements. He added that both groups had conducted strategic planning exercises and programs that measured uncertainty and allocated uncertainty. He asked where they saw the major areas for what new tools would be required. Dr. Anderson said that the K-Base capabilities that were coming on in the division would be of enormous benefit and had potential for advancing systems biology science. He added that coupling what they knew about genomics and bringing together the data was important. He added also bringing together that data with metadata was important.

Dr. Geernaert added that uncertainty characterization was a huge priority for the climate modeling community and he thought that if there were uncertainty characterizations or quantification methodologies that they should explore what had the ability to interface with uncertainty quantification methodologies. He noted that the ARM program went through a renovation with the ARRA instrumentation built in with radars and LIDARs building a three dimensional imaging capability which he felt lent itself to the opportunity to do some online processing. He felt that could lead to a processing challenge and an archiving challenge. He thought new ways to approach that could be a challenge. He mentioned the subsurface and suggested the development of new types of sampling technologies.

A member asked if there was a boundary between the tools for biology and climate modeling in terms of ASCR. He asked how they would figure out on how much computing capability, storage capability and data handling capability we had in BER versus depending on ASCR to assist on this type of tool.

Dr. Weatherwax noted that ASCR queries their stakeholder communities asking about their data needs and they regularly communicate with the scientific divisions. She noted that they would be thinking about the two major capabilities which would be the ability to handle more processing simultaneously and also handle more data in general.

Dr. Mace asked about the fact that they had a lot of new radars but did not have the infrastructure to maintain them. He noted they had 25 new radars and right now there were two full-time engineers to maintain the systems. He noted Dr. Geernaert's comments about multiple three-dimensional images of the earth's system and asked how that would be possible without the ability to maintain them. He asked what the plans were to keep those types of systems running for the long term. Dr. Geernaert responded that the ARM facility was a huge priority for their division so even in terms of trying to project their

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investments in the future of the ARM program, it was a priority. He noted that the facilities tended to get a significant priority.

LUNCH

The Biological and Environmental Research Advisory Committee recessed for lunch for one hour.

"GEOPHYSICAL SIGNATURES OF SUBSURFACE MICROBIALLY-MEDIATED PROCESSES: TOWARD QUANTIFICATION OF IN-SITU ECOSYSTEM FUNCTIONING"

Dr. Susan Hubbard, *Lawrence Berkeley National Laboratory*

- Discussed the research being done by her group and stated that their key thrust was using a variety of geophysical approaches to understand flow and transport in the subsurface geared towards remediation.
- Advised that in her presentation she would be focusing on using time-lapse geophysics to understand microbially-mediated processes. Noted that it was exciting to see how the microbial activities played out in the subsurface in natural environments.
- Stated that microbes catalyzed a lot of the important energy and environmental processes that they focus on in the DOE and in BER. Advised she would be discussing contaminant remediation, enhanced oil recovery and soil carbon cycling.
- Noted that in BER there was a wide range of spatial and temporal scales and this also applied in the subsurface going from cellular function to community function to soils and plants and then to a site or ecosystem. Described the slide concerning subsurface microbial communities in detail.
- Discussed the BER grand challenge concerning the measurement of microbial processes and interactions in the real world. Stated there was a need to develop ecosystem-observing systems to monitor biogeochemical cycles and to estimate critical process parameters in terrestrial biospheres. Noted that until such processes were understood then the ability to understand, predict and manipulate the types and rates of ecosystem responses and feedbacks would be a challenge.
- Advised that she would provide some geophysical background, review three geophysical methods for quantifying microbially-mediated processes in the subsurface: environmental remediation; microbial enhanced hydrocarbon recovery; and terrestrial ecosystem carbon cycling.
- Described first the geophysical background:
 - Seismic methods were discussed including compressional (sound) waves, seismic velocity and seismic amplitudes. Noted that it was a paradigm shift not using geophysics in a traditional

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sense for mapping but using the methods in a time-lapse sense and how they will respond to the microbially-mediated reactions that they are trying to induce or are being induced naturally.

- Complex resistivity or spectral induced polarization was discussed as another method. She stated that this required putting electrical signals into the ground and recording potential difference at other electrodes, which provided information on electrical conductivity, salinity etc. This method could also be used to determine what is going on in phase responses and the sensitivity to interfacial processes.
- She discussed the conventional subsurface measure approach of drilling wells and collecting samples. She stated that geophysics gives extensive spatial information.
- She described three key steps to understanding how microbes are reacting and they are: petrophysical relationships that links the geophysical signatures to biogeochemical transformations; field imaging/scaling that asks about the macroscopic geophysical signatures of microbially-mediated processes; and integration with methods to fuse disparate datasets.
- The advantage of time-lapse geophysical imaging was discussed giving the advantages and the disadvantages.
- Discussed environmental remediation:
 - The DOE legacy waste stewardship obligation was discussed. The DOE has an obligation to locate, clean-up and monitor contaminants in the subsurface. Most of the contaminants are related to the Cold War development of weapons and energy. She reviewed many of the sites and noted it was a significant problem.
 - The contaminants at DOE sites are long-lived and many are in storage tanks and seepage basins. There has been some seepage into ground waters. The problem is exacerbated by the inaccessibility and heterogeneity of the subsurface.
 - Two examples were given in the environmental remediation field and both have to do with using geophysics in the context of monitoring biostimulation. It concerns the use of indigenous microorganisms to remediate the contaminant uranium. She also discussed the contaminant Cr(VI) and remediation process. The results and some difficulties were discussed.
 - She described their approach which was to take samples from the field into the laboratory. Their field geophysical characterization and three year monitoring was discussed and the diagnostic geophysical signatures of biostimulation. They found that their lab-based approaches were consistent with their field-based responses.
 - Discussed ongoing work on uranium contamination using biostimulation at the Rifle IFRC (Integrated Field Research Challenge) site in Colorado. She stated it was an old contaminated

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uranium mill tailing site. She stated that the team had been trying to understand the metabolic potential of the Rifle flood plain and the implications would be.

- In connection with reaction network and end-products she noted that three major microbially-mediated reactions are induced through acetate addition: iron, sulfate and uranium reduction. The reactions lead to the formation of precipitates.
- Geophysical signatures of iron bioprecipitates and column experiments were discussed and geophysical signatures of calcium precipitates with column experiments were also discussed. Based on those experiments they developed a petrophysical model.
- She described the Bayesian approach to integrate different types of data, time-lapse geophysical data, dynamic petrophysical model data and concentrations from aqueous effluent samplings and an example and results were discussed.
- Field imaging and geochemical monitoring was discussed. The illustrative slide showed how geophysical methods remotely traced onset and evolution of remediation-induced transformations.
- Discussed microbially enhanced hydrocarbon recovery:
 - The use of microorganisms to alter interfacial properties (viscosity and tension and wettability) and flow paths (dissolution and bioclogging) was discussed. She said that there was a lot that was not understood. The Energy Biosciences Institute out of BP had funded her group to do some work and some examples were noted.
 - The biodegradation of organic-rich permafrost soils was reviewed. The issue causing concern is that permafrost thawing will expose buried carbon making it susceptible to biodegradation and potentially causing the terrestrial ecosystem to transition from a GHG sink to a source.
 - Slides dealing with geophysical signatures of freeze-thaw transitions and laboratory scale experiments were discussed. A group trip and work being done in Barrow, Alaska was reviewed. Slides showing field sites were shown and descriptions of some of the collection of data.
- Stated that she hoped gaining an understanding of the in-situ microbial reactions in the subsurface was a prerequisite for not only gaining a predictive understanding but also being able to manipulate it or control it, whether it be for environmental stewardship or sequestering carbon.
- Thanked the DOE and her colleagues in the LBNL Environmental Geophysics group and the PIs and the various sites.

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COMMITTEE DISCUSSION

Dr. Stacey asked if any of the technology could be used to look at active root growth in soil. Dr. Hubbard responded yes and that people were starting to think about that. She stated that there were many environments where things are changing and if they had a dedicated activity for which they were trying to understand the geophysical responses and quantify them they would have a lot of room.

Dr. Wall asked if she could repeat what the depth was that they were able to query in the field. Dr. Hubbard stated that it depended on the method and the acquisition parameters. She said of the methods she had discussed she noted that seismic methods were used in oil company exploration, so kilometers and even deeper. She said it depended on your acquisition parameters and source. She said of the three methods, electrical, seismic and radar, the radar was the most limited as far as depth.

A member noted he was up on the North Slope for a while and said it was an arid system and you get less than a couple of inches of incoming precipitation. He noted that she did not mention the hydrologic cycle and he thought her group might have been interested in trying to quantify that and its effect. He asked when the lakes or ponds are drained were they recharged. Dr. Hubbard responded it was not so much precipitation and redistribution of the moisture. She said that they were collecting data and it happened to be the week that the active layer was freezing and she noted you could see the changes going on. She said that soil moisture and its distribution and drainage was a critical process.

Dr. Leung asked what the potential was for the method she had talked about in terms of detecting the ground water table or the bedrock on a larger scale. Dr. Hubbard responded that the groundwater table was a common geophysical target. Dr. Leung asked on what kind of spatial resolution or scale could that be detected. Dr. Hubbard said it depended on a variety of factors and much of it was site specific, for example what kind of material it was and how deep it is. She added that if it was a reasonable geophysical target as long as you could move the sensors out along the surface you could measure it.

BREAK

The Biological and Environmental Research Advisory Committee recessed for a 15 minute break.

OFFICE OF SCIENCE UPDATE

Dr. William Brinkman, *Director, Office of Science*

- Noted that there was a lot going on in the growing and fascinating field of synthetic biology, real biology and plant biology.
- Stated that the Department was very much about climate and it appeared that there was not a strong connection between climate and energy, a research area in which many other parts of the

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DOE were involved. Stated that they were trying to organize a group of people from different organizations to see if they could make that statement real. Considered the initial meeting good because his impression was that their community was heading more towards regional climate predictions as opposed to global climate predictions.

- Discussed the dilemma that the Office of Science was facing in Congress with respect to the budget. Noted the Senate mark was good at \$621 million but the House mark was down at \$17 million and this was the result of the anti-climate lobby in the House that pushed the number down. Stated that discussions would go on in the committee and adjustments would be made but amounts cut in various departments might be substantial. Commented that he brought the subject up because they know Congressmen and Senators and if they are on the appropriations committees he thought it might be very helpful to give them their individual views.
- Discussed the new charge for the BERAC. The charge is:

BERAC Charge

A recognized strength of the Office of Science, and BER is no exception, is the development of tools and technologies that enable science – from synchrotrons to genomic sequencing to nano centers. The [December 2010] BERAC report identifies technology needs that will be important for BER to achieve the scientific grand challenges outlined in the report. These ranged from the development of new observational technologies for biological systems, climate model integration and energy sustainability to the application of advanced computational and analytical capabilities to characterize network interactions.

- Commented that he was interested in finding out what the community would need for the future in terms of tools, equipment, laboratories, and what the community would consider important for the next 30 or 40 years. Noted that BER did not appear to be a large science group and although they had ARM they did not have anything on the scale of the physicists or materials scientists. Stated his point in saying that was that he did not know the scale that they needed tools, equipment and laboratories etc. but he wanted to be informed specifically about their needs. Explained that was why the charge asked about the development of new tools that were only briefly mentioned in the long-term vision report.
- Stated that he wanted them to identify linkages between new tools and existing resources. Thought one of their strong interests was databases and suggested that this be one of the areas that they discuss.

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COMMITTEE DISCUSSION

Dr. Washington noted his comments on the global versus regional. He said his point was that the global numbers, the globally-averaged temperature had not changed too much. He added the models have improved and various groups had been aiming to improve their regional information whether using regional models or global models at a higher resolution. He noted that that was where the field was going. He added what was complicating that was that the computer time increased and the models had become more complex and they were introducing more physics, more chemistry and biology into the models so the computational needs for the future would be substantially larger than the current needs. Dr. Brinkman stated that was good to know and stated that BER would probably be a participant in the use of exascale computing. He stated that they were moving to exascale by the year 2021. Dr. Brinkman said they had formed groups that would be trying to figure out ways in which to take a particular subject and interface it to the mathematics and computer science aspects of the big machines so that when you wanted to calculate something you did not have to learn everything.

Dr. Brinkman added that it was not clear to him how the evolution of computing would go in the next decade in the sense that they had 10 and 12 petaflop machines that were going to be delivered but they did not have a 100 or 200 petaflop machine that was reasonably designed. He thought that they had a way to go and it would be a big challenge to figure out how to get into that regime.

A member asked about the linkage between climate and the DOE mission and noted that many people considered that as weak but he thought that energy and climate were so closely related from the perspective of the use of energy not just in the U.S. but in other countries and would definitely affect the climate and climate affects how people use energy. He asked what kinds of things he thought the committee could do to send this message. Dr. Brinkman stated that it wasn't that people in the energy world weren't thinking about climate and CO₂ but the question was could we make our programs more useful to them. He said they understood a lot about what energy, what emits CO₂ and many of the debated issues and they were familiar with that research. He stated the question was could we get predictable as far as regional climates so they could help think about where one could locate things.

Dr. Stacey commented that another way to think about it was trying to convince the applied offices in DOE that the climate prediction outputs were valuable to them in making portfolio decisions and he noted that Dr. Brinkman had facilitated a meeting they had recently to try to get the different parties together to build a coordinated strategy or a coordinated forum to address the issues.

A member asked about hydrology as a growing area and what the DOE's perspective was on water as part of the bill of health of energy technologies like they had been envisioning carbon. Dr. Brinkman stated that he thought there was a strong recognition of the problem, that water was very, very important as well as capturing CO₂ out of the air. He thought that was something that was well recognized in the department but what were they doing about it though, not that much.

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Dr. Stacey stated that it surprised him in an era where science and technology was impacting our lives so strongly and yet every year more and more they seemed to be having a progressively harder time convincing people of the importance of science, reflected by allocating resources to it. He thought that there was hostility toward science in general. He asked if he had similar thoughts. Dr. Brinkman responded no to that statement. He explained that most budgets in the government were going down and the Office of Science budget had stayed fixed and the thought it was because of the many people on the Hill who felt science was an important function of the federal government.

A member remarked about the charge asking what tools and needs, and he asked what scale were they talking about? Dr. Brinkman said that he was leaving that to the committee to decide, other committees were not afraid to propose grand-scale projects so they should decide on their proposals.

Dr. Wall commented about the emphasis on variability in climate predictions. She thought the government was in a position of having to respond to disasters which was more expensive than if they invested in predictability. Dr. Brinkman agreed that investing in predictability was considerably cheaper than responding to disasters.

NEW CHARGE – TECHNOLOGY IMPLEMENTATION FOR LONG TERM VISION

Dr. Stacey made some comments regarding the discussion:

- Indicated that they would now talk about the new charge that Dr. Brinkman had introduced to them, the technology implementation for long term vision.
- Noted that previously the consensus was that they would try to structure the discussion around the issue of acquisition, data acquisition, simulation, data analysis and design.
- Read the letter given regarding the charge. "Expand on the development and use of new tools that were only briefly mentioned in the long term vision report. Identify the development and use of new tools and their linkage to existing or new user facilities. Identify linkages between new tools and existing resources, new resources and to diverse scales of time and space. And then expand on the concepts of virtual laboratories and collaborative tools including a discussion on how to facilitate these concepts and interactions."

Dr. Stacey in keeping with their outline said that he said he would like to open the discussion to initially focus on the issue of data acquisition.

A member asked for some clarification, did their choice of tools have to reside within the traditional equipment or tools that resided within BER? Dr. Stacey responded no. His view was that they had a lot of very learned people and they were being asked to be very forward-looking and for that reason they should not limit their discussion. He emphasized that they were advisory only and they had some discretionary freedom to express relevant recommendations.

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A member stated that they heard that one of the premier satellites in the A-train died the previous night and NASA (National Aeronautics and Space Administration) had abdicated the responsibility of putting up the next generation A-train. He asked if BER could become involved in the next generation.

A member said that that this might have possibilities and when they talked about climate modeling they had gone full system and the emphasis was on the system itself and how the atmosphere interacted with the land and the ocean. She said in terms of measurements they were still very much atmospheric and eco-system. She stated that even though they had a good effort right now with the GoAmazon where they are thinking about how they could combine measurements for the atmospheric program with the eco-system program, she thought that kind of effort could lead to a better understanding of the system.

Dr. Stacey stated that one of the things that came out of a recent summit he held was the idea that they needed more of the long-term ecological research sites which he thought lent themselves to that type of integration more so than a short-term project.

A member commented on community resources, databases, the K-Base and community models. She thought that climate did well with that and community testbeds and those kinds of resources would go a long way.

A member wanted to put forward the idea that they should focus on the gaps, the missing parts in the portfolio that they had. He stated that they had genomic information, soil information, terrestrial information on plants, atmospheric information but not the entire picture. He thought that they inferred things for genomes for example so he suggested that they think about what tools and new things that would allow them to bridge the gaps.

A member referred to Dr. Geernaert's presentation where he commented on some of the science gaps like in CESD and ASR molecular chemistry to aerosols to clouds which she considered a route where there might be a fair number of gaps, tools, approaches and understandings. Ecosystem declinement and microbiology, synthetic biology to bio-fuels were also identified, that they might study and be better aligned with their BER mission areas that might help to fill in the gaps. She wondered what would be better, considering tools that would assist them or more major community tools.

Dr. Stacey responded that it might be how they would package it. He thought a large sum of money might be requested but it did not all have to go to a single thing as long as a good focus was provided for that monetary investment.

A member asked about oceans and climate change. She commented if there was going to be a significant change in the temperature of the oceans then there might be a danger of the mobilization of the gas hydrates which would release enormous amounts of methane. She

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wondered if they had the information that they needed about ocean floors and the deposits of the hydrates and something that they could quantify. She said that she had heard about one program but she asked how many did they have, generation one, two or three or just one. She wondered if they should be asking about the mapping of the oceans as well as looking at their terrestrial areas to see what exactly they might have to deal with in the future. She wondered if they should ask for the ability to do that exploration and to know what was there in the microbial sense as well as the chemical deposits.

A member noted that gas hydrates were potential new fossil fuels and he thought that there might be other areas within the DOE that were looking at that and maybe they could consider working with them to ensure that they took climate issues into account.

A member commented on the topic of hydrates and she noted that the part of the DOE that dealt with that was fossil energy and so she thought that there were aspects of the area to which they could contribute and noted that their tools/mapping might be significant. She also said that it would also concern NOAA (National Oceanic and Atmospheric Administration) and there might be sufficient tools in use.

A member noted that they already had some investments in gas hydrates by geochemistry at Berkeley going on right now under the climate modeling program. He thought that NOAA was the correct agency to do the mapping of the oceans and he thought also the navy.

A member asked if they would also be doing the microbiology. Another member responded that NOAA was doing some of that but he thought that most of the talent looking at this in terms of modeling the risk was out of Berkeley.

In response to a member's introduction of this area, Dr. Stacey brought up the recent plant summit and noted that one of the things that came out was the issue of genotyping or looking at genetic diversity. The new sequencing tools had solved this problem and he gave an example in the area of agriculture you could now get a genotype for corn for \$10. He thought that the idea of looking at geno-diversity from a technical standpoint had been solved. He thought the problem was the ability to associate phenotype or adaptation or plasticity to that genetic diversity. He thought that area needed to be researched.

Dr. Randall brought up the issue of high resolution climate modeling as opposed to regional and noted that there was an established consensus in the U.S. and internationally that there was potential to increase the reliability and utility of climate change simulations by going to a much higher resolution. He thought that if the resolution was increased gradually the results would gradually improve. He also said that there was a certain threshold and if one went past that threshold things would improve substantially. He stated that the threshold was about four kilometers where they could not presently simulate climate but could do weather. He said although

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they might get there in the next decade right now there was not a defined project to get there and he considered it feasible. He also thought they could get there faster if they could plan and identify it as a goal, formalize it and the cost might be about \$100 million a year, reasonable compared to some other costs, and worth it considering the cost of climate change on the economy.

Dr. Stacey asked what would be required. Dr. Randall responded an order of magnitude exa-flop, maybe a bit less than that. He thought they needed to identify a goal that was doable as soon as possible. He thought data acquisition was important. He thought there were both technological and economic obstacles and he thought that they could expedite it. He thought that DOE had been a leader in climate computing for decades and he thought it would make sense for DOE to take it on.

Dr. Stacey asked the committee members to give some additional thought to specifics.

Dr. Gilna suggested setting up a series of regional areas for the growing of crops concerning biofuels and feedstocks in controlled environments.

A member brought up the issue of the ARM climate research facilities. He thought they had been successful but had limited locations. He thought there were other areas where they needed data and observations which could also be coupled with satellite observations.

A member brought up the issue of data and the large amount of it that they had. He noted their inability to analyze the data in such a way that it would inform or improve models. He thought that a technological challenge they had not overcome as yet was to be able to parameterize the physical processes. He thought the data at the ARM sites and the need to develop new parameterizations would go hand in hand but they needed a knowledge base. He said they did not have something like that in the ARM program or atmospheric sciences at all.

Dr. Zhang commented that it was important to allocate resources to maintain the instruments that they currently had including the cost of improving models.

A member said that BER had a unique opportunity to bring two concepts together, the interaction of soil with the atmosphere and he thought that they could have a facility that combined the genomics of the soil and plants living in a particular area and how they reacted to the atmosphere and how they responded to changes in the atmosphere and climate. He thought it was possible to go from a genomic level to a macroscopic level.

A member suggested a biotron, a facility, where one could look at root soil, microbial interactions under different experimental and plant conditions, for example, under combinations of different climates. He said that there was no facility like that in the U.S. currently. Dr. Stacey agreed that it was a completely new frontier developing an understanding of what was going on underneath the surface in the soil.

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Dr. Stacey said that he was feeling a consensus that one of the major recommendations was a push toward a high resolution global climate modeling and all the specifics that go into it.

NEW BUSINESS AND PUBLIC COMMENT

No new business was brought forward and there was no public comment.

ADJOURNMENT

The Biological Environmental and Research Advisory Committee adjourned for the day at 5:00 p.m. The committee will reconvene tomorrow, Friday, October 7, 2011 at 8:30 a.m.

FRIDAY, OCTOBER 7, 2011

REVIEW OF THE BIOLOGICAL SYSTEMS SCIENCE DIVISION – COMMITTEE OF VISITORS REPORT

Dr. Daniel Bush, *Chair of COV, Chair, Department of Biology, Colorado State University*

- Advised it was a substantial report and that he would try to highlight some of the key things as they reviewed it.
- Advised that the charge for the committee asked them to review a variety of things:
 - For the national lab awards and university grants they were asked to assess the efficacy and quality of the review process. That included looking at the total proposal process and how the program managers engaged the larger research community. That included looking at awards and projects.
 - They were asked within the mission and funding of the DOE to review the portfolio elements and the quality of the national and international stature.
 - For the Bioenergy Research Centers to look at the management and oversight of science and operations including progress towards scientific deliverables.
 - For the JGI user facility to look at the management and oversight, facility operations, tracking and review and user proposal solicitation, review of recommendation procedures.
- Advised that the COV consisted of 17 scientists, 9 from universities, 4 from national laboratories and 4 from other agencies.

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- Commented that the COV process with its three-year cycle might be more frequent than it needed to be. Noted that the program managers were very responsive to what happened in the agency and assembled effective programs and scientific reviews.
- Advised that for the review the committee was broken down into three different sub-committees. One handled genomic sciences and biology research centers and it was the largest component of their review. Stated that the second group looked at low dose radiation and radio chemistry and imaging and the third group reviewed the JGI along with the artificial retina and structural biology.
- Stated that he as Chair rotated among the three groups. Noted that the COV had access to all the paperwork available in the programs including areas such as decision-making, requests for funding opportunities, pre-proposal processes, the review panels and recommendations.
- Detailed their review of the first part of the charge:
 - For the most part impressed with the quality of the process and what they do in BSSD for the most part due to their engagement with the community.
 - Their perception was that the processes were fair and equitable and had adhered to the standards for the competitive funding community. They had good, knowledgeable scientists to participate on grand panels to advise them and did thoughtful reviews of the advice and responded accordingly in terms of funding decision.
 - For the first part of the charge they had some recommendations:
 - They endorsed the pre-proposal concept and thought it helped both trim down the number of proposals and allowed for a more focused effort and would take the burden off the review community. One of the questions that came up asked what are the criteria for the pre-proposals so they are suggesting that they include more verbiage on that and this might be useful for the PIs.
 - They were impressed by many of the programs of genomic sciences and recommend that some of the other programs use their tracking systems for how they put together programs, monitor the panels and make decisions. They suggested that it might be used as a model for standard operating procedure.
- Detailed their review of the second part of the charge:
 - The COV felt that the BSSD does an outstanding job with this area, they are tackling very important questions and are using experimental approaches, engaging PIs that are leaders in their fields and so they thought that the programs had engagement at both national and international levels in terms of stature and visibility.

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- One of the things that they felt was important for the division in terms of getting their job done and maintaining that level of being at the forefront in the questions that they're using is that the program managers are very proactive at outreach to the research community. At the beginning of new initiatives they run workshops to engage the community to help define the questions and define the leading approaches to solve the questions.
- Detailed their review of the third part of the charge:
 - He noted that one of the areas in which the BSSD has a significant footprint was the bioenergy research centers.
 - One of the areas they were tasked with was to ask about the management and oversight of the science and operations and progress towards key milestones. They felt that the management of the BRCs was very effective. There was dynamic interaction between the program managers and the leadership of each of the research centers. The communication was frequent and included regular reports. They have annual reviews from outside committees. They thought that management took a proactive approach to keep in contact with the direction of the BRCs and where their successes are and monitoring areas that are not as successful and taking necessary actions.
 - The BRCs were tasked with dealing with high-risk, high-yield projects so not all would be successful so dynamic leadership is needed to ensure that progress continues and when something is not successful funds are moved into another area.
 - There were some recommendations for the BRCs:
 - They felt they have a big footprint in bioenergy right now and they felt it might be useful to have more ties and openness between the BRCs to whatever extent possible. There would always be common areas but they could also take a coordinated approach. They said this with the understanding that there would possibly be some complexity involved with Intellectual Property (IP).
 - They thought that the BRCs could do a better job with communicating to the larger research community.
 - They thought their web pages could be improved to provide relevant research information for colleagues within the constraints of IP control.
 - They noted that the BRCs in 2012 were coming up for renewals. They thought their attention should be drawn to the fact that this is an important juncture for them. They need to look seriously at what they are doing and continue to pursue high-risk, high-return kinds of approaches. They thought it might be a good time for the leadership to bring key persons

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- from each BRC together and the research community and have a workshop and have a discussion of what has been achieved and what is taking place in the larger bioenergy community.
- Detailed the review of the third part of the charge:
 - They considered that the JGI has done an outstanding job addressing the needs of the larger research community. It has a significant interaction with the BRCs. They considered that the JGI has been doing some exciting work and have contributed substantially to the research community in terms of bioenergy and the environment. They think the overall management with the program managers in BSSD is very inactive and effective.
 - They consider that as with the BRCs they think the JGI is at a critical juncture. They feel the rapid advances in sequencing hardware over the last few years as well as the development of sophisticated bio-informatics software brings challenges and opportunities for the JGI. They think that it is a time for the JGI to think about where it is going and how it will continue.
 - Their recommendations for the JGI are:
 - They think that it might be a great time for the BSSD to put together some workshops to bring together big thinkers in terms of genomic technology with representatives from JGI to discuss the future.
 - They thought it might also be a good place to have a standing or External Advisory Panel to provide continuous technological evaluation of the strategic plan and advise the BSSD program staff in the future planning. The JGI should consider expanding BSSD's partnership in feedstock genomics with the five new USDA-ARS Biomass Research Centers. The ARS BRCs are using "genotyping by sequencing" to genetically identify genes that control feedstock yield, composition and biomass conversion, efficiency to biofuels.
 - Noted that there had been a BER management change in its management of research at national labs. Where previously individuals or small groups were funded for specific areas, now they went with the SFA approach where large groups were funded through a laboratory. Stated that the COV thought it was an important time to set standard operating procedures as some of the program managers had clearly set out plans and others did not. Stated that they thought a system should be put into place to ask questions like was this an improvement and was this change of individuals to a larger program center approach giving as much value for the funding provided. Stated the COV considered it important to have a retrospective analysis of major changes in structure.
 - Summarized the comments of the COV:

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- Overall they were impressed the processes used to solicit, review, recommend and monitor grants and program activity with program managers doing an outstanding job using the best practices of the competitive funding community to maintain an effective program.
- They endorsed the program managers' use of workshops and PI-driven workshops and symposia where outside speakers to keep themselves at the leading edge of their fields.
- They consider the two cornerstone programs right now in BSSD are the JGI and BRCs have outstanding records of achievement and they consider them well-managed. They also consider both at important junctures for different reasons and the next few years are critically important to engage the community and consider their next steps forward.
- They consider that the programs managers do an excellent job running large and complex programs with minimal administrative support.

COMMITTEE DISCUSSION

Dr. Stacey thanked Dr. Bush and stated that he had read through the report. He commented about the idea of transparency in the way pre-proposals were judged. He said some of the other agencies in D.C. were also moving toward that type of structure. He said one did not like to think that program managers were picking what they would consider winners and losers but were deciding based on specific criteria. He stated for that reason he liked the idea that he discussed the need for transparency in his review. Dr. Bush stated that they had considered the issue of PIs asking for feedback from program managers about why pre-proposals might be rejected. Dr. Bush felt it could sometimes create uncomfortable situations but could also be constructive for applicants for their future submissions.

Dr. Stacey also commented that he liked the idea of the communication between K-Base and the user community. He thought it was important to create tools for the user base in mind and would probably create the situation where that user base would make use of the tools.

A member noted that he mentioned an issue of overlap in the SFAs between institutes that were involved and within the BRCs but he didn't see any recommendations with respect to that issue. He asked was that healthy? Dr. Bush responded that overlap and duplication was not bad and he said that was why the COV did not have specific outcomes but just an acknowledgement of its existence.

A member said it was interesting where they had suggested that the BRCs should be more transparent with each other and she thought that at the end of the next five years that would probably be a healthy thing to do. She asked if there was a community sense that there would be an automatic exchange with the plant feedstock genome program as well for transparency or synergy. Dr. Bush responded that the feedstock program was different in that it was a competitive program that had individual groups or individuals funded. He said they have a PI meeting every year and there was a lot of interaction as well.

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Dr. Stacey asked about a point on page 18. He said he was under the impression that any sequencing done at JGI went into the public database immediately and he said that the COV seemed to suggest that the BRC had some kind of agreement with the JGI where they hold their sequences for six months. Dr. Bush responded that there was some concern and he said that that data came in separately. What the COV's concern was, was that it was neither under JGI per se and the BRCs and that the release of the data might be lost in the wash and there was no evidence that the data was getting out as quickly as it should have been. He thought it could have been a misconception by the COV. He said that JGI generated data that was independent of the BRCs. He added that some of the data from the BRCs had IP implications as well. He added that there had been extensive discussion over the past year with JGI and there was now a model in place where the data would go out automatically in six months. The BRCs would be alerted shortly before that deadline was about to expire.

A member noted he was also pleased with the transparency within the pre-proposals discussion and it was good as opposed to the impression of a pre-selection. He asked if the COV had considered any other models to selecting pre-proposals than simply program manager filters. He noted that some programs used peer-review for the process. Dr. Bush responded that they did not discuss alternative models; it was more a discussion of the existing process and determining if the procedures were being carefully followed.

Dr. Stacey thanked Dr. Bush and his team for the effort of the review and producing a thorough report. He stated that they now needed to do a formal vote to accept the COV report. A first motion to accept the report was given and it was seconded by Dr. Wall. Dr. Stacey took the vote and the report was accepted unanimously.

DISCUSSION OF NEW CHARGE (BERAC) – CONTINUED

Dr. Stacey stated that this was the second part of their discussion to consider tools related to technology. He stated that the summary on October 6 and the idea of high resolution climate mapping was one of the consensus areas that came out. He noted that there was also considerable discussion around phenotyping, subsurface activities, and the need for dealing with large datasets. He asked the members what were some of the other themes that arose.

Dr. Wall stated that in the biological area she thought that they were still constrained by the annotation of genomes and having an understanding of the functions of all the genes. In relation to this she asked if it would be possible to set up a laboratory or virtual laboratory that would centralize biochemistry and set up high-throughput biochemistry assays.

A member agreed with that and thought it was important to capture in the database all the biochemical and proteomics data currently missing and he elaborated. Dr. Stacey thought that the informatics people could assist with some of this, of how to use an informatic approach to define protein function.

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A member stated that the issue of properly annotating had been around a long time and she thought as a result of some of the issues they had been talking about earlier in terms of there being a lack of a standard nomenclature for protein space and for genes in various genomes and various communities using different languages. She noted that this all contributed to the databases having conflicting information and wrong information. She said it relied on a community effort on standardization in cleaning this up. She thought that there were ways to facilitate it with informatics tools and community-building tools.

A member stated that she could not think of a tool that would help them to get from genotype to phenotype and she thought it was the context of cellular environment and the organismal environment that they had to figure out how to analyze. She thought spatial and temporal information was critical for that.

Dr. Stacey noted that he would like to get back to the phenotyping idea and the thought about measurement. He said you would want to measure that temporarily, spatially and then in a high-throughput fashion. He noted that the instrument might not be the same used for each but you would want the capability of doing that under all those types of conditions. He thought that might be a grand challenge to get the physicists, chemists, engineers, mathematicians and computational people together and decide what the critical measurements would be needed to be able to do temporarily and spatially and in a high-throughput manner, that they would begin a dialogue that eventually would take them to that point.

A member thought that getting a group to agree on the critical thresholds at each spatial scale would be very valuable. He thought that at the larger megascale he thought it would be worth having a discussion of where those break points were. He thought it was important to expand scales but more efficient to find the thresholds of where they would reap greater understanding that would inform scales above and below.

A member brought up the issue multi-scale modeling because she stated the thread of the discussion was similar to the types of things they wondered about with clouds, the strato-cumulus clouds. She stated that there was a huge set of scale issues and the tools available for looking at those issues might not be made general enough so they could cross fields. She wondered if those kinds of tools might be created to build a more unifying program around.

A member suggested listing the important processes to follow relative to climate change like nitrogen fixation or carbon sequestration or aerosol deposition and then see what tools you would need to measure those. She stated they should establish what were the important processes in climate change?

Dr. Stacey stated that along the same lines he was thinking about the whole issue of nutrient cycling so he stated that that might be part of the answer. He asked about other important measurements. A

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member responded respiration, transference, things that might affect the water cycle. A member stated gene flow might also be a physical transfer across landscapes that would parallel nutrient cycling.

Dr. Zhang said that within BER there was an integrated assessment program and he thought it could be augmented to include a modeling for the impact of climate change and also the current variability of environmental conditions on energy use. He thought that was an opportunity to better link climate and energy. He stated it was like developing a model of energy use especially the impact of environmental conditions and also on the other side to look at the source of emissions like the use of energy on greenhouse emissions.

Dr. Stacey stated that when they had discussed previously how to structure this they had talked about acquisition of data, simulation, data analysis but also there was a suggestion to talk about design. He suggested that the issue of design had not been discussed. He asked if the person who had brought it up would like to elaborate.

A member said that they knew how to model things but they should be able to improve, to make things better and he noted he was thinking of processes like bioenergy production. He also talked about microbes that would have enhanced capabilities in meta reduction. He thought there were many areas but they had to understand processes and then be able to model them and last of all design a system that could function better than nature. A member agreed and said they should exploit natural variation.

A member remarked that there are a lot of challenges with integrated assessment modeling when integrating human activities with natural processes. The scale was massive, and yet the human activities can be on a fine scale. She remarked that a key challenge was the question of what design approaches could span these varying scales. Further to this a member later suggested looking at a series of field research sites worldwide that would provide a focus for these efforts, there would be an opportunity here to bring everything all together.

A member suggested the concept of sustainability research centers. He thought a lot of the areas that had been discussed fell within that realm. Another member suggested that perhaps this concept is too broad, perhaps just energy sustainability would be more relevant.

A member remarked on how important it is to work on the gap so that experimental results are incorporated into their still developing models, and that these then go on to inform experimentation.

A member commented on the usefulness of better climatological modeling on a finer scale, even in the context of some political opposition to climate research, there were pressing concerns with short term extreme weather conditions that were relevant on a more immediate political time scale.

A member commented that the fundamental scientific tenet of repeatability was being lost in some of the research being done. He suggested one principal that should be required is that new tools and resources are developed in such a fashion that the data, the conclusions would be made available to the

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point that if questions were asked or needed to be called upon to go back to the original source of the data in order to repeat or validate or test the assumptions made, that the information would be there.

Dr. Stacey asked that they discuss two aspects of their charge that had not been discussed. He said the first one was to identify linkage between new tools and existing resources and the other was to expand on the concepts of virtual laboratories and collaborative tools including a discussion on how to facilitate the concepts and interactions.

A member suggested that the climate earth system model was a good example and it involved approximately 300 scientists and was jointly supported by the DOE and the NSF and it also provided downloadable versions of models freely to researchers.

A member suggested that they had experts in specific areas in biochemistry and it would lend itself to having a virtual network set up.

Dr. Stacey said that the NSF had a new program where they would give money for you to build a community around a particular topic. He stated they would give money for people to come together, have a meeting and try to develop a community around certain topics, for example carbohydrate enzymes which would be relevant to the biofuels mission.

Dr. Zhang stated that ARM was a good example of a virtual program from the daily operations to the data access to the program design which always involved multiple laboratories and universities. He thought that in the integrated assessment areas the activity program could be expanded. He also noted that it was his understanding that the model was going to be community based in the future.

A member stated that they had talked in ASR and ARM about having a virtual laboratory that would integrate the observations of the ARM program. He said the foundation was there in that they had the ARM archives and sites but working from home involved many difficulties. He stated if they had a virtual laboratory where the data and models of various scales were available there where you could integrate measurements, you could make progress.

Dr. Stacey stated that he thought it could be part of K-Base.

Dr. Leung stated that an important part of a virtual laboratory would be some sort of workflow because both models and data were getting more and more complicated and she asked if they were really reproducible if they were being done on different platforms or done with departure of standard ways so having that type of workflow developed for both data management and modeling would be important.

Dr. Stacey stated that they would not be able to generate a report out of their two discussions. He thought that there were some consensus areas that could be built upon. He stated that they would be setting up a sub-committee and he said that Dr. Zhang, Dr. Mace and Dr. Braam had agreed to serve on the sub-committee. He stated that he also would serve on the sub-committee. He asked other members

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to contact him if they were interested in serving. He stated they would have a series of conference calls and report to them all at the next BERAC meeting and then have the report by winter of 2012.

ASCR OVERVIEW

Dr. Daniel Hitchcock, *Acting Associate Director, Advanced Scientific Computing Research*

- Advised that ASCR was about delivering applications on today's large computers and also about developing the next generation of computers. Stated that these new computers would be very different from what existed today and this would have implications for what they would do and the data they would move around. Stated that it was important to get ready for that.
- Stated that ASCR did the following:
 - Provide high-end facilities that many people in the climate and biology communities use.
 - They invest in the future facilities for future computers.
 - They invest in the ESnet that hooks a lot of the laboratories and universities together.
 - With NERSC (National Energy Research Scientific Computing) he stated that they have detailed requirements processes with the offices they deal with to ensure that they have an understanding of where their data is coming. He explained that if a facility is located in a specific area they have to ensure that the network exists there. They ask about requirements so they can plan accordingly.
- Described the Energy Sciences Network and he explained the new testbed which was running and had the first coast to coast link on October 6th. Stated that the normal technology that one could buy ran at 10 Gbps per color on the fiber and this would run at 100 Gbps per color and so this would mean that you could send ten times as much data on the existing fiber. Explained some of the challenges related to this.
- Noted that they also have a substantial research program in applied mathematics, computer science, SciDAC and the Next Generation Networking for Science. Noted that the Next Generation Networking for Science had built things in collaboration with BER such as the earth systems grid.
- Stated that they looked at two different viewpoints: what were the needs of offices and what applications would they need today and what offices would need in terms of mathematics and computer science in a decade because that research had to be begun today for the software to be ready ten years down the road.
- Stated that in the future they would have processors that would have hundreds of processors on a single chip. Stated that they have done a lot of things to get ready for this challenge of the future.

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- Discussed the SciDAC institutes:
 - He explained that previously in SciDAC they had 12 institutes and centers and it often caused confusion for people trying to access information. Noted that as a consequence they are funding fewer institutes with an improved interface to the rest of the community.
 - He noted that this time they funded three institutes and they have gone out with a call again for a data management one.
 - He said that one was FASTMath (Frameworks, Algorithms and Scalable Technologies for Mathematics) which is everything about applied mathematics for large-scale computations. He stated that this was used for a meshing problem or a linear algebra problem. Topic areas include: structured and unstructured mesh tools, linear and nonlinear solvers, eigensolvers, particle methods, time integration and differential variational inequalities.
 - QUEST (Quantification of Uncertainty in Extreme Scale Computations) he explained was the evolution of a decade of basic research in quantification of uncertainty in extreme scale computations. Topic areas include: forward uncertainty propagation, reduced stochastic representations, inverse problems, experimental design and model validation.
 - SUPER (Institute for Sustained Performance, Energy and Resilience) he explained was all about making your code run faster. Topic areas include: performance engineering, energy efficiency, resilience and optimization.
- Stated that they were changing the way that they did partnerships with the offices. Stated that they went to all the ADs over the last year and asked them to identify a few areas where a partnership between ASCR and your office would allow them to do something strategic for their program over the next three years. Stated that in BER they chose topics of dynamics of atmosphere, oceans and ice sheets as well as including uncertainty quantification in them in a fundamental way to improve the state of the art. Stated that in BES (Basic Energy Sciences) they decided on especially excited states of atoms and molecules where none of their existing theoretical methods worked very well. Stated that those funding opportunities were out on the street.
- Stated that the future was all about energy efficient computing. Stated that a MW (mega watt) cost a million dollars a year. Noted that today's petaflop machines used about three MW and stated that if you built an exaflop in 2018 it would use 200 MW. Stated that their goal was to deliver 1 exaflop in 2018 at 20 MW.
- Explained the complexities of how data movement becomes relatively more energy expensive than operations.
- Discussed approaches:

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- Locality of data and computation is important and the way you do multi-physics might change.
- He stated you would have 'billion way concurrency' and a lot of the concurrency would be on the node.
- You can add uncertainty quantifications into your code.
- He said that you would need to figure out in collaboration with the vendor how you would use the silicon area they have in the best possible way.
- Discussed the co-design centers:
 - The centers have as a goal trying to understand how to allocate complexity between hardware, systems software, libraries and applications.
 - Modify application designs at all levels.
 - Understand reformulating as well as re-implementing tradeoffs.
 - They have three centers started, one in materials science, one in nuclear energy and one in combustion. They cover a broad range in types of applications.
- Discussed the future of data driven science:
 - All of the trends impact data-driven science.
 - Data from instruments is on an 18 to 24 month doubling because the detectors on CMOS feature size path.
 - 100 Gigabit per second per lambda networks on the horizon.
 - Disk read and write rates will fall further behind processors and memory.
 - Significant hardware infrastructure needed to support this which probably will not be replicated at users' home institution.
- Described an ASCR-BES workshop on data called "Data and Communications in Basic Energy Sciences: Creating a Pathway for Scientific Discovery" on October 24-25, 2011 at Bethesda, MD. Discussed the goals and objectives with Co-Chairs Peter Nugent, NERSC and J. Michael Simonson, SNS.
- Reviewed an organizational chart of ASCR at a glance with relevant website addresses.

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- Stated that in ASCR they considered carefully how you would think about where you invest to have the largest impact on science. Noted that they did this through workshops and other areas. Provided some examples of how they would look at improvements in various areas and the consequences.

COMMITTEE DISCUSSION

A member asked about the next generation of computers which would have the GPU processors in them and said when they use Fortran-type language he thought that they didn't have a way to get access to those computers and make efficient use of those fast processors. Dr. Hitchcock responded that they had done work on making access to GPUs easier from Fortran. He said that there were reasonable Fortran compilers for the NVIDIA computers. He went on to give several other examples.

A member asked how ASCR interacts with the other units within SC. He referred to the slide regarding the workshop that ASCR did with BES. He asked what other ways did this interaction occur. Dr. Hitchcock responded that they have discussions with the other offices asking what the two or three most valuable things that they could do together over the next year. He said they then do a joint workshop or panel, whatever would be of the highest value for both.

A member asked what kind of discussions then he might have had with regard to K-Base. Dr. Hitchcock responded with details about staff members discussing K-Base and also noted that some of the Magellan hardware is going to support K-Base. He elaborated on some of the interactions between ASCR and BER.

BREAK

The Biological and Environmental Research Advisory Committee recessed for a 15 minute break.

BER WORKSHOP REPORTS

APPLICATIONS OF NEW DOE NATIONAL USER FACILITIES IN BIOLOGY

Dr. Roland F. Hirsch, *Biological Systems Science Division*

- Provided some background on the BER structural biology activities. Stated that many of the facilities that began in the 1990s for the Advanced Light Source and Advanced Photon Source were operational.
- Stated that the BERAC sub-committees provided input with reports in 1992, 1995, 1997, 1998 and 2003.

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- Stated that they now had five new major facilities or upgrades in various stages ranging from just opened, under construction and in stages of planning.
- Stated that BER was considering the role it should play in ensuring that the biological community could take advantage of the new capabilities offered by these facilities.
- Stated that over the past three years there had been meetings and workshops jointly with NIH and other agencies involving leaders in the biological sciences to consider how best to coordinate investment in the National Synchrotron Light Source II.
- Noted that BER held a workshop that looked at all of the facilities in a coordinated way.
- Explained the two basic purposes for the workshop were: one to identify capabilities with potential for high impact in life sciences at the five new and planned DOE national user facilities and secondly, to identify major needs in biology for advanced facility-based instrumentation beyond what already existed and what the five new facilities currently planned to offer.
- Commented on the workshop plan which began earlier than January 2011. Reviewed each stage of planning for the workshop as follows:
 - The recruitment of scientists with expertise in biophysics and technologies for biology plus major BER biological research fields
 - Laboratories hosting the facilities submitted two ten-page papers, one on the facility capabilities and the other on potential applications in biology
 - The panel met to discuss the facilities and developed a report; each laboratory sent a delegation that met with the panel and at the end of the meeting working groups prepared chapters on each facility
 - The facility chapters were prepared and discussed and edited
 - During September to November 2011 the report is being prepared.
- Reviewed the membership of the panel including experts in technology and management.
- Commented on slides that they had on each of the five facilities with some comments and noted that it was not a peer review or a comparative review but an effort to identify benefits that each of the facilities could offer.
- Reviewed the Advanced Photon Source Upgrade and noted that the upgrade would improve operating characteristics of the light source and it would enable significant advances in biologically-important technologies.

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- Reviewed the Linac Coherent Light Source and noted it is just now operational and there had been several publications from the AMO station that had received high visibility.
- Reviewed the Next Generation Light Source at the Berkeley Laboratory which would be a companion to the LCLS at the lower energies of free-electron laser at lower energies.
- Reviewed the National Synchrotron Light Source II, a facility under construction with commissioning planned for 2014.
- Reviewed the Spallation Neutron Source at Oak Ridge which had just opened. Stated that the MaNDi (Macromolecular Neutron Diffractometer) would be completed by 2013.

COMMITTEE DISCUSSION

A member asked how many members from BERAC had used these sources in their research. He received the response that there was a few.

A member stated that he participated in the workshop and found it a very useful exercise because he had the chance to talk with other teams and learned how the facilities could contribute to BER.

DOE-BER BIOSYSTEMS DESIGN WORKSHOP

Dr. Pablo Rabinowicz, Program Manager (IPA), Biological Systems Science Division

- Advised that the workshop was organized under the Genomic Science Program which supported the fundamental systems biology and genomic research on plants, microbes and microbial communities.
- Stated that the goal was to gain a predictive understanding of complex systems.
- Noted that the objectives of the program were:
 - To understand genomic properties and regulatory networks that rule biological systems.
 - To develop the technologies both experimental and computational needed to achieve a genome-based, dynamic system-level understanding of organism and community functions.
 - To develop the knowledge base, computational infrastructure and modeling capabilities to advance the understanding, prediction and manipulation of biological systems.
- Stated that the workshop was conceived taking into account the BERAC 2010 Long-Term Vision Report which highlighted the importance of systems biology and the use of systems biology knowledge for the design of complex systems and also highlighted the importance of computational biology.

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- Advised that the workshop took place in July 2011 and he reviewed the workshop team.
- Stated that the purpose of the workshop was to reach out to the community in order to identify what research needed to be done in order to gain a comprehensive understanding of complex systems in order to be able to manipulate them. Stated that initially they wanted to identify which were the fundamental design principles for biological systems and also to discuss the tools and technologies that are needed in order to construct new functions and new biological entities at multiple scales.
- Noted that the participants were in the process of writing the report and described the process.
- Provided the list of agencies that observed at the work at the workshop.
- Described the structure of the workshop which was made up of a plenary session and then breakout sessions concerning:
 - Biological design principles
 - Strategies, methodologies and approaches for the design of biological systems
 - Predictive biology at the system level.
- Stated that then they had presentations from the breakout leads. Noted that the writing session was completed by the Co-Chairs.
- Outlined the charge questions relating to each of the breakout sessions.
- Described the discussion topics in each of the breakout groups.
 - For the Biological Design Principles they discussed molecules, modules, organisms and communities.
 - For the Biological Design Strategies, Methodologies and Approaches they discussed design from scratch, combine parts and modules, model systems and computational biology.
 - For Future Perspectives they discussed systems biology knowledgebase and sustainability of synthetic systems.
- Confirmed that the report would be available in early 2012.

COMMITTEE DISCUSSION

A member asked if there were any preliminary conclusions. Dr. Rabinowicz responded that no, there were none available at the time.

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Dr. Stacey noted that he was at the workshop and it was run in an excellent way and was very interesting. He thought that what was interesting was that the breakout groups stayed together for the entire meeting and basically addressed the questions so a dynamic developed within the breakout groups. He said that when the breakout groups came back and reported out they reported from a very different perspective.

GOAMAZON2014 / GREEN OCEAN AMAZON 2014

Dr. Dorothy Koch, Program Manager, Climate & Environmental System Sciences Division

- Stated that Wanda Ferrell was not well and that she would be presenting on her behalf. Stated that it was more than a workshop report, it is more of a story of what GoAmazon was all about.
- Confirmed that it started as a field deployment for the ARM mobile facility and grew into something bigger, into a division-wide effort.
- Stated that GOAmazon stood for Green Ocean Amazon and noted that it would be a field deployment in 2014 right in the middle of the green ocean, so in the tropical rainforest of the Amazon.
- Stated the reasons why they were interested in the Amazon Basin:
 - Stated that they are interested in that area because it is the heat engine of the tropics. Noted that the tropical rainforest pumps energy out of the tropical region at higher latitudes which helps keep the climate of the earth moderated. Noted that it was also very vulnerable to climate change like many regions of the earth so that was why they had a particular interest there.
 - Stated that tropical deep convection is poorly understood and modeled with insufficient observational data sets for model constraint.
 - Future climate scenarios show that there is a potential for the Amazon to dry and so they want to learn as much as they can as it is now.
 - Aerosols strongly influence cloud processes and the radiative balance in the Amazon. They form a link between the biosphere and the vegetation in the Amazon to the atmosphere in the cloud processes.
- Noted that in 2010 ARM approved the proposal to send the ARM mobile facility into the Amazon. Noted that the PI for the project was Scott Martin from Harvard University.
- Stated that they realized that this project presented the opportunity for their division to take on this problem with a much broader set of instruments, including the atmospheric sciences and climate

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modeling so it became a more integrated activity. Noted that it would go during the whole year in 2014.

- Noted that the scientific focus was on atmospheric, terrestrial ecosystem, carbon cycle and coupling questions dealing with tropical systems in the Amazon. Noted that the experiment was being designed to study how aerosols and surface fluxes influence cloud cycles under clean conditions as well as how aerosol and cloud life cycles, including cloud-aerosol-precipitation interactions are influenced by pollutant outflow from a tropical megacity.
- Described the observing systems, the ARM mobile facility, an aircraft and their aerosol observing system. EMLS would provide mass spectrometers and laboratory study support and then the Terrestrial Ecosystem Science program would provide carbon cycle instruments.
- Described the coordinated set of research efforts to support the observations. Noted they would be planning joint solicitations including modeling, atmospheric system research and terrestrial ecosystem science programs.
- Noted that part of the planning was a workshop that took place in July 2011 and they brought in a variety of experts across a range of disciplines. Advised that the charge was to identify gaps that they could take on with the project and the format was mainly breakout with a few plenary presentations.
- Described the workshop goals in identifying important unresolved science questions concerning relationships between aerosols and cloud properties under pristine and polluted conditions in the target region and secondly, identify and discuss observational and modeling strategy to address gaps in understanding.
- Noted that a workshop report came out of the workshop.
- Described inter-agency coordination and said that a May 2nd meeting took place with program managers from NSF, NOAA and NASA to let them know about the activity and to encourage them to participate and provide research dollars for the effort. From these discussions she advised that:
 - Scientists will submit a proposal to NSF requesting the deployment of their S-Pol radar.
 - NSF will accept proposals from scientists to conduct research using the data.
 - NASA has entertained discussions with PIs concerning NASA support.
 - Discussions with NOAA are ongoing.

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- Stated that international participation was critical especially from Brazil and they had been very active partners. Described what the government of Brazil would be providing. Described German participation in the project.
- Described further outreach actions taking place with ASR, Terrestrial Ecosystem Science and Climate and Earth System Modeling.

COMMITTEE DISCUSSION

Dr. Leung first endorsed their approach looking at both the atmospheric and terrestrial systems. She stated that usually when there are field campaigns like this there are usually some modeling activities that are sponsored. She asked if they had thought about more outreach or linkages to the climate modeling program to take advantage of this approach. Dr. Koch responded that to some extent that would be happening within the context of solicitations that she hoped they would put together across the divisions.

Dr. Washington noted that it sounded like a very interesting experiment. He wondered if there would be ecological measurements taken. An audience member responded and stated that yes, BER had a solicitation specifically targeting this deployment and were intending to do more solicitations.

Dr. Dickinson asked about the data system and if it was going to be a separate data system or built into ARM. A person responded and said it was going to be the ARM data system.

A member noted that ARM was doing two of those types of deployments per year and every one was different and every one required special treatment. He said having these deployments that had to be supported in a flat budget situation concerned him and as ARM continued to do them but how would they support the data management, the modeling activity plus all of the ongoing activity that ARM required. He was concerned about the funding unless there was an infusion of money. A person responded that if they had to reduce the number of campaigns or sacrifice quality, they would not sacrifice quality. He noted that the goal is whatever they deployed would lead to the best possible science, such that the entire database would be available to the community.

A member asked about the fire effect, Dr. Koch remarked that this was far enough north where fire didn't make an impact.

A member asked whether the Amazon project was observational or hypothesis driven, Dr. Koch said it was a bit of both.

PUBLIC COMMENT

Dr. Dubey, Los Alamos National Laboratory

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- Commented that he was part of GOAmazon and thought it was a fascinating campaign.
- Said that NASA was launching satellites and noted that some of the sensors were past their age and were not functioning.
- Commented on the cost of satellites and the imbalance of funding for many of the DOE programs.

ADJOURNMENT

The Biological Environmental Research Advisory Committee adjourned for the day at 12:15 p.m.