

**Biological and Environmental Research Advisory Committee
(BERAC) Meeting Minutes
October 19-20, 2023
Remote Access Meeting**

BERAC Members Present

Bruce Hungate, Chair	Ann Fridlind	Jeremy Schmutz
Maureen McCann, Chair	Jorge Gonzalez-Cruz	Daniel Segrè
Pro Tempore (day 2)	Randi Johnson	Matthew Shupe
Caroline Ajo-Franklin	Kerstin Kleese van Dam	
Cris Argueso	Sonia Kreidenweis	Guest Speakers
Sarah Assmann	Xiaohong Liu	Colleen Iversen
Ana Barros	Gerald Meehl	Jason Pruet
Bruno Basso	Gloria Muday	Margaret Torn
Sen Chiao	Dev Niyogi	
Leo Donner	Himadri Pakrasi	Designated Federal
Matthew Fields	Kristala Jones Prather	Officer
Robert Fischetti	Gemma Reguera	Tristram West

Approximately 119 additional people were in attendance virtually during the course of the meeting.

All presentations are posted to the BERAC website:
<https://science.osti.gov/ber/berac/Meetings/BERAC-Minutes>

Thursday, October 19, 2023

Welcome

BERAC Chair, Bruce Hungate, called the meeting to order at 12:00 p.m. Eastern Time and welcomed attendees. Hungate shared a story about his late great-uncle Frank, who studied the effects of low dose radiation. Reflecting on these memories in relation to the current BERAC charge around creating an impactful low dose radiation research program, Hungate realized having strong feelings around science – when seen clearly – might make the results better.

Department of Energy (DOE) Introductory Remarks – Dr. Asmeret Asefaw Berhe, DOE Office of Science (SC) Director

Berhe recently visited the Spruce and Peatland Responses Under Climatic and Environmental Change Experiment (SPRUCE) site in Minnesota, as well as the Atmospheric Radiation Measurement (ARM) user facility and Next-Generation Ecosystem Experiments (NGEE) Arctic sites in Alaska. These large-scale projects demonstrate the importance of Biological and Environmental Research (BER) efforts in addressing climate change.

SC priorities for FY2024 include the Energy Earthshots Initiative; the Affordable Home Energy Shot was announced in October 2023 as the eighth and newest in the initiative. The de-

velopment of a vibrant and diverse workforce that looks like the American public is another priority, with a major push for inclusive and equitable practices and community engagement across the SC portfolio.

Other highlights include BER participation in a number of cross-agency efforts, including initiatives around the Executive Order (EO) 14081, Advancing Biotechnology and Biomufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy. Additionally, the DOE Energy Exascale Earth System Model (E3SM) was named a finalist for the Gordon Bell Prize for Climate Modeling.

Discussion

A BERAC member asked whether the Energy Earthshots Initiative will be run by the SC. **Berhe** saw basic science as central to all of the Earthshots and the SC will engage when there is a need for relevant research.

Guidance was sought on how DOE plans to partner with other agencies on EO 14081. **Berhe** expected this engagement to involve collaborations between the SC, DOE applied offices, and other agencies. There are existing climate-related templates for collaborations that can be used as guidance in this area, but there are details around the EO that must first be clarified.

An attendee brought up the European Union's (EU) Destination Earth (DestinE) project and its efforts to create a digital twin of the planet. Has there been any discussion on creating something similar in the U.S.? **Berhe** recognized the need to push for innovative collaborations like this and encouraged BERAC members to advise BER staff on areas that would benefit from additional focus.

News from the Office of Biological and Environmental Research (BER) – Dr. Todd Anderson, Acting Associate Director
[Presentation posted]

Discussion

Clarification was sought around the status of the Bioenergy Research Centers (BRCs) and how they will integrate with the Clean Fuels & Products Energy Earthshot. **Anderson** saw opportunities for research from the BRCs to be translated over to the applied sciences realm in relations to the Earthshot.

An attendee inquired about the ability of DOE laboratories to function during a government shutdown. **Anderson** explained the laboratories can operate for a limited time beyond a shutdown as long as DOE headquarters remain open; however, the timespan the laboratories would continue to operate beyond a government shutdown is unknown.

A BERAC member questioned whether the Office of Science Graduate Student Research (SCGSR) program might be opened to those on student visas to broaden participation. **Anderson** explained BER does not run the program, but would follow up with those who do.

Curiosity was expressed around how BER is engaging with the United States Department of Agriculture (USDA) on soil carbon storage research. **Anderson** mentioned some existing connections with USDA colleagues in this area, as well as those working on plant transformation capabilities.

An individual wondered whether BER investments in coastal science would be expanded to the Gulf Coast. **Gary Geernaert** cited an upcoming workshop to address this issue.

Update on Earth and Environmental Systems Science Division (EESSD) – Dr. Gary Geernaert, Division Director
[Presentation posted]

Discussion

A BERAC member asked for insight around the process of creating the EESSD Strategic Plan. **Geernaert** explained the yearlong process, where the division looks at workshop reports to find growth areas and determine the biggest challenges, while examining potential collaborations within DOE and beyond. For the most recent plan, biochemistry and the Arctic emerged as unifying themes; for the upcoming plan, potential areas of emphasis include crosscutting areas, the implications of more powerful models, edge computing, and quantum Light Detection and Ranging (LiDAR) and Radio Detection and Ranging (RADAR).

Excitement was expressed for the deployment of the ARM mobile facility in the Bankhead National Forest in northwestern Alabama. Also, the research presented on rainfall extremes from the Calibrated and Systematic Characterization, Attribution, and Detection of Extremes (CASCADE) project called to mind the science coming out of the Surface Atmosphere Integrated Field Laboratory (SAIL). **Geernaert** appreciated these comments.

A participant sought more information on how edge computing might affect those running E3SM. **Geernaert** cited efforts to apply machine learning (ML) to E3SM and noted the use of edge computing to make data classification and storage more efficient at ARM as an example.

No mention of digital twins or monsoon were made in the presentation; was there are reason why? **Geernaert** confirmed BER's interest in digital twins, which will be used in smaller, more practical applications like the Urban Integrated Field Laboratories (IFLs). Monsoons are also of interest and feedback was welcomed for how the topic might be prioritized.

Update on Biological Systems Science Division (BSSD) – Dr. Dawn Adin, Acting Division Director
[Presentation posted]

Discussion

An attendee was appreciative of BER's support for the Overcoming Barriers in Plant Transformation Workshop. **Adin** said the workshop was an eye-opening experience.

Further details were requested about the work being done on temperature-jump X-ray crystallography, led by Dr. Michael Thompson of the University of California, Merced. This project is newly funded through the Funding for Accelerated, Inclusive Research (FAIR) program. **Adin** will share the project's abstract when available.

Hungate dismissed the meeting for a break at 2:04 p.m. and reconvened at 2:15 p.m.

The AmeriFlux Network at 25: Innovation, Discovery, and Community – Dr. Margaret Torn, Lawrence Berkeley National Laboratory (LBNL)
[Presentation posted]

Discussion

An attendee commented on the challenges of research assessments and urged BER to recognize and reassess the scientific importance of projects outside of metrics like h-index.

AmeriFlux seems an ideally placed program to reach out to underserved communities and minorities; how much of outreach this has happened and how many primary investigators (PIs) are part of minority groups? **Torn** explained efforts to make a network that is more inclusive, through supporting fellowships for travel and data maintenance. Urban IFLs and urban fluxes in general might be a great opportunity in this area. The number of minority PIs is unknown.

A BERAC member suggested collaborating with the Baltimore Social-Environmental Collaborative (BSEC) Urban IFL and the Molina Center for Energy and the Environment (MCE2). **Torn** appreciated these suggestions and shared that Erik Velasco from MCE2 gave a talk on urban fluxes at the 2023 AmeriFlux Annual Meeting.

AmeriFlux involves many contributing their time for free; have there been any efforts to estimate the value of the hours that have been donated? **Torn** said this has not been done, but liked the suggestion. While time is being freely contributed, the hope is the collaborations and data provide value in return; nevertheless, the AmeriFlux community greatly amplifies DOE's investments in the program.

An inquirer asked about where disruptive research might emerge in the program. **Torn** saw opportunities around technology; constraining the N₂O cycle is a potential major breakthrough, along with a system's ability to be rapidly deployed with its own power supply. Similarly, new researchers are approaching flux data and are thinking innovatively about it, which the AmeriFlux Management Project (AMP) will continue to encourage.

It was suggested that flux data might be linked to Climate Resilience Centers (CRCs) in disadvantaged communities. **Torn** acknowledged this suggestion.

Mentions of the N₂O cycle were encouraging, in light of mining- and agricultural-related concerns around nitrate pollution. Is AmeriFlux instrumentation located in the right places to monitor this? Are the N₂O sensors commercially available? **Torn** shared agricultural sites are the most common locations for AmeriFlux equipment. When combined with remote sensing tools, the capability to produce this type of data is steadily increasing. N₂O sensors are commercially available but remain cumbersome, so testing is ongoing to determine the best solution.

A participant encouraged creating a mechanism for the processing, maintenance, and quality control of AmeriFlux data. **Torn** mentioned the data team, which look at the long-term record of every site from a quality control perspective; however, costs are increasing, so these efforts are being stretched.

Insight was requested on the impetus for sites to share their data with AmeriFlux; are there elements that could be duplicated in other programs? **Torn** said AmeriFlux is moving towards an open data policy, encouraging collaborations. Those who share their data receive more citations, but more work needs to be done on getting credit for that fairly.

Building a Culture of Safety and Trust in Team Science – Dr. Colleen Iversen, Oak Ridge National Laboratory (ORNL)

[Presentation posted]

Discussion

A BERAC member asked how to expand this work on safety and trust beyond the Arctic and have it permeate through other parts of the research apparatus. **Iversen** said efforts to make sure people feel safe is transferrable everywhere. This requires clear communication from leaders who model and talk about its importance.

These conversations about culture are not always easy to have and are often met with resistance. What can be done to make sure these conversations are both respectful and rigorous? **Iversen** stated the importance of setting expectations for how people should treat each other, which is easier to do from a position of leadership. Individuals will often meet the high expectations that are set, but should also be given the chance to change if those expectations are not met.

A participant questioned the process of reporting issues when multiple institutions are involved. **Iversen** saw this as something that requires open communication and navigating boundaries with each institution, sharing an example where all science was stopped until the involved individuals' institutions were consulted and a resolution was found.

What is a good framework for data sharing and co-authorship; should teams develop it specific to their project or should it be a more top-down approach? What about data attribution when local communities are involved? **Iversen** saw both approaches as useful; leaders should set clear expectations and have a continuing conversation specific about what makes most sense for each project. Up to this point, communities have not expressed interest in being involved in papers, but are curious to hear about the results of the research.

An inquirer was curious about what might be done to protect the interests of early career scientists. **Iversen** would like to formalize this in the NGEE Arctic code of conduct; it requires leadership being involved in the conversation and trying to give the benefit of the doubt, as the prevailing culture does not typically have the best of interests of early career scientists in mind.

An attendee asked the process of engaging the community as part of scientific discovery and encouraging their participation and co-creation. **Iversen** emphasized showing and listening to the community; relationship development is key. BER was commended for funding long term projects where this can occur.

An individual asked whether NGEE Arctic's psychological safety handbook is accessible to others. **Iversen** confirmed that it was and encouraged reaching out directly so further context can be provided alongside the document.

BERAC Discussion – Dr. Bruce Hungate, BERAC Chair

Hungate encouraged BERAC members to reflect on the needs of BER, giving license to ask questions and think broadly about this mission.

An attendee emphasized digital twins and the need for BER's involvement in this area. In response, another participant stressed the similarities between numerical modeling and digital twins; it would be worth evaluating everything that is going on in the field and how BER is positioned in that context.

A BERAC member was struck about the value of AmeriFlux research from a relatively modest investment; a discussion around data integration and the value received from the initial investment would be fruitful. **Hungate** agreed and emphasized the culture change around data ownership and credit as well.

A workshop around the climate science of extremes, ranging from high resolution modeling to the cascading effects felt in communities, was suggested.

Hungate dismissed the meeting for the day at 4:06 p.m.

Friday, October 20, 2023

West convened the meeting at 9:00 a.m. and shared that Bruce Hungate was ill; Maureen McCann served as the designated chair for the day. **Anderson** acknowledged the passing of David Galas and Michelle Broido and remembered their contributions to BER and BERAC.

BERAC Science Talk: A Day and a Night in the Life of a Photosynthetic Diazotroph – Dr. Himadri Pakrasi, Washington University in St. Louis
[Presentation posted]

Discussion

A BERAC member asked for comments on the differences in transcript and protein abundances of nitrogenase and why there appears to be more fine grain controls on the protein abundance level. **Pakrasi** explained not all proteins degrade simultaneously, with two of them becoming more abundant during the light phase. The reasons behind this are currently unknown, but genetic tools will be able to provide more information moving forward.

One individual noticed the cyanobacteria genomic regions where kaiA genes cluster with pilin proteins and wondered whether there could be a rhythmic expression in these pilins. **Pakrasi** said the data for that is not currently available, but previous research on *Synechococcus elongatus* PCC 7942 has shown that the majority of genes (including pilin) are controlled by the clock. Similarly, another non-diazotrophic *Synechococcus* has been found to be motile and the pilin proteins cycle depending on the clock as well.

A participant wondered whether adding these diazotrophs might bring a nitrogen charge to crops or less controlled, more heterogenous environments. **Pakrasi** saw more immediate potential in using them to make barren lands fertile, but hoped to see further studies around applying them directly to crops. Stanford University researchers have studied a similar nitrogen fixing *Synechococcus* in open nature and over different day lengths.

An attendee was curious about the minimum amount of darkness these cyanobacteria need to fix nitrogen. **Pakrasi** stated the organisms can be trained to grow under 24 hours of light, but fix nitrogen at a much lower rate. The genesis of these studies came from determining whether within a mixed culture, one set of *Cyanothece* 51142 cells is fixing nitrogen and another is fixing carbon or if these processes are cooccurring within the same cells. The same attendee followed up and wondered if there was more heterogeneity in a population than expected, which **Pakrasi** confirmed.

From the perspective of large-scale climate models, what aspect of nitrogen has been overlooked based on this research? **Pakrasi** appreciated this question and emphasized the enzyme necessary for biological nitrogen fixation does not function when temperatures are very high. There should be a continuing conversation between biologists and modelers on these topics.

An inquirer asked about the knowledge level of structural proteins of these cyanobacteria. **Pakrasi** referenced research done on the kaiABC system, where the clock function was created in a test tube driven by phosphorylation and dephosphorylation. In other cyanobacteria, there are different copies of the kaiABC system with different compositions, which may be a line of research for structural biologists.

A final question asked whether the transcription factor is regulating the nitrogen fixing genes. **Pakrasi** affirmed this; these findings have led to further questions on the other effects on photosynthesis, for which research is ongoing.

Workshop Briefing: Artificial Intelligence (AI) for Science, Energy, and Security – Dr. Jason Pruet, Los Alamos National Laboratory (LANL)
[Presentation posted]

Discussion

What are the data volumes needed to train foundation models and what type of environment is needed to access them? **Pruet** emphasized the need to move from a compute-centric to a data-centric paradigm in light of the need for hundreds of petabytes (PB) of data. Alongside the need for hardware, there will be a need for data policies and FAIR (Findable, Accessible, Interoperable, and Reusable) data principles.

A BERAC member sought comment on workforce development strategies for universities and DOE laboratories in the face of growing AI demands. **Pruet** estimated the need for approximately 1,500 people across the DOE laboratories for a national AI initiative. There will be difficulties to attract this talent to the laboratories; as universities will likely have an easier time hiring this workforce, collaboration between the two will be vital. Universities can provide the expertise in data curation and reinforcement through human interactions, while the laboratories can provide a greater scale of compute and data access. A new DOE initiative called Frontiers in Artificial Intelligence for Science, Security, and Technology (FASST) for the Nation proposes a hub model where such collaborations can occur.

A participant explained the problem of serious out of sample issues within earth systems and climate models; what can we learn about reliability in this area? **Pruet** agreed that reliability and extrapolation are central problems across many fields. Verification and validation are an open area of research; using highly faithful models and building up from there is one of the richest areas of study.

Did the mentioned reports explore the standards and risk management issues for AI from the National Institute of Standards and Technology (NIST)? **Pruet** believed the report predates NIST's work in this area, but mentioned draft legislation from the U.S. Congress to develop a comprehensive model and infrastructure for AI risk management.

An attendee asked about strategies to keep AI experts in the academic and research sectors, as the private sector is often more attractive. **Pruet** shared the difficulty of getting support from AI experts in the laboratories and suggested the model of AI as a service. A large-scale national AI initiative is needed to tackle these issues.

McCann dismissed the meeting for a break at 1:46 p.m. and reconvened at 1:55 p.m.

Unified Data Subcommittee Update – Dr. Kerstin Kleese van Dam, Brookhaven National Laboratory (BNL)
[Presentation posted]

Discussion

A BERAC member asked about strategies to ensure unified data structures are interoperable on a global scale. **Kleese van Dam** suggested building on existing international data efforts, while showing the benefits of working together and doing targeted outreach to get new communities to participate.

Multi-dimensional climate data sets are increasingly including human-centric data; how can this type of data collection be encouraged during field campaigns and subsequently shared

and protected? **Niyogi** saw these new types of data underlining the need for a new unified data approach, with this BERAC report as an important tool to voice these concerns. **Fridlind** suggested using the socioeconomic data being generated by DestinE as a resource for answering this question.

A participant emphasized workforce development in this area and sought suggestions on how beginner-level trainees might be prepared to navigate new methods of data management. **Kleese van Dam** suggested engaging with educators around the tools that are needed to create a stepwise training program. Powerful tools can be made easier to use, but trainees must be aware of what they are using and will need to validate the data coming out. AI will likely be very helpful for data validation in these areas.

The importance of long-term observational data sets was stated; how can this data be curated in perpetuity and not lost? **Kleese van Dam** said data is cheaper to store over time if it does not need to be accessible, but the larger task is keeping data relevant in light of changes in tools over time.

An attendee asked about the challenges of getting established professionals to change their workflows and embrace new approaches to data. **Kleese van Dam** emphasized the need for incentives to generate excitement around new data infrastructure. **Schmutz** stressed the number of different cultures in how data is used and shared; greater value is needed beyond a mandate to make sure these changes are adopted. **Niyogi** saw program- and project-level changes as more likely areas to be successfully implemented around new data approaches, especially when individual PIs are resistant.

Low Dose Subcommittee Update – Dr. Gemma Reguera, Michigan State University
[Presentation posted]

Discussion

An inquirer questioned the exclusion of the effects of low dose radiation on microbes, plants, and other organisms. **Reguera** found resistance to these lines of research, which emphasized how stagnant the field has become. There are many possibilities beyond cancer epidemiology and the report will attempt to stimulate interest in broadening the research areas. Technology and experimental systems have advanced significantly in recent years and could play a major role in low dose radiation research.

Microbiomes influence human health significantly and might be an area to explore. Additionally, radiation can vary temporally and in intensity; will the report consider this? **Reguera** agreed and emphasized addressing the gaps in knowledge around the connections between physics and biology.

A BERAC member wondered whether the funding of epidemiological modelling through the Biopreparedness Research Virtual Environment (BRaVE) initiative might be leveraged; this is sponsored by the SC Advanced Scientific Computing Research (ASCR) program. **Reguera** saw this as a possibility, but consensus needs to be reached to better define the research directions of low dose radiation.

A participant suggested approaching microbes as intermediaries between the molecular and the cellular as a way to fit them into the report. The differences in radiation dose and dose rate were also emphasized; these are not well-characterized and should be explored. **Reguera** concurred and expressed concern around how guidelines might be created to encourage this research, as so much is still unknown.

Benchmarking of low dose radiation exposure to building occupants based on location might be a fruitful area to explore; did this subcommittee discuss this? **Reguera** acknowledged the need for benchmarking, but saw the challenges in doing so in different environments. Benchmarking approaches are heterogenous based on the numerous types of radiation exposure, which makes this especially challenging.

Did the subcommittee consider a different name that might be used for low dose radiation to make it more publicly appealing? **Reguera** saw this as a good idea to explore further based on the best research paths encouraged in the report. Another BERAC member suggested discussing the potential benefits of low dose radiation as a similar exercise.

BERAC Discussion – Dr. Maureen McCann, BERAC Chair Pro Tempore

Open discussion among BERAC members addressed several topics.

A number of BERAC members reflected on the meaning of scientific community after Dr. Colleen Iversen’s presentation from the previous day. Emotional safety and trust are as important as physical safety, but have not been given the attention necessary to produce an environment where equitable and inclusive science are possible. Both a top-down mandate from the DOE, universities, laboratories, and other institutions, as well as a grass-roots effort to create communities where trust and respect are present are vital. One individual wondered whether DOE might track failures in equity and inclusion similar to how safety incidents must be reported. Others pondered the role of a funding agency like the DOE in light of these types of incidents; universities are likely better equipped to handle them, but the DOE should create standards and expectations within its capabilities.

AI and large-scale integrated research systems raise questions around data attribution; commingling many data resources and programs presents a major challenge in creating a mechanism to give credit fairly. Similarly, a participant reflected on other potential impacts of AI and how responsible use of these tools might occur. Another attendee interjected about the importance of strategic partnerships in these areas in light of a changing landscape.

Digital twins were highlighted; one BERAC member saw an urgent need to increase these projects within the BER portfolio. Another called for a concrete plan for the creation of a national digital twin capability toolkit, with the intention to turn data from models like E3SM into a usable roadmap for U.S. infrastructure and agricultural planning.

The communities benefiting from scientific research must be expanded to become more localized and inclusive, especially in light of the emerging hazards from climate extremes. Likewise, two participants agreed on the need for a greater focus on monsoons.

Public Comment

None.

McCann adjourned the meeting at 4:07 p.m.

Respectfully submitted November 1, 2023,
Drew Nitschke
Science Writer, ORISE