

**Biological and Environmental Research Advisory Committee
(BERAC) Meeting Minutes
October 21-22, 2021
Remote Access Meeting**

BERAC Members Present

Bruce Hungate, Chair
Sarah Assman
Ann Barros
Bruno Basso
Julie Biteen
Katherine Calvin
Leo Donner
Matthew Fields
Robert Fischetti
Ann Fridlind
Kerstin Kleese van Dam
Sonia Kreidenweis
Maureen McCann
Gerald Meehl
Gloria Muday
Himadri Pakrasi

Kristala Jones Prather
James Randerson
Patrick Reed
Jeremy Schmutz
Daniel Segrè
Matthew Shupe
Huimin Zhao

Guest Speakers

J. Stephen Binkley
Julie Carruthers
Michael Cooke
Cynthia Friend
Jeffrey Miller
Renu Joseph
Nigel Mouncey

**Subcommittee Working
Group Speakers**

Crysten Blaby
Katherine Calvin
Himadri Pakrasi
Michael Gooseff
Kerstin Kleese van Dam
Maureen McCann
John Weyant

**Designated Federal
Officer**

Tristram West

Others

Todd Anderson, Biological Systems Science Division Director, Office of Biological and Environmental Research (BER), Department of Energy Office of Science (DOE, SC)
Gary Geernaert, Earth and Environmental Systems Sciences Division Director, BER, DOE SC
Sharlene Weatherwax, Associate Director, BER, DOE SC
Holly Holt, Science Writer, Oak Ridge Institute for Science and Education (ORISE)

Approximately 251 others were in attendance during the course of the meeting.

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

Thursday October 21, 2021

BERAC Chair, Bruce **Hungate**, called the meeting to order at 12:15 p.m. Eastern Time and welcomed attendees. He offered personal reflections on science's pivotal role in understanding and addressing climate change while acknowledging the struggle to live responsibly and to resist climate anxiety or despair. Hungate is examining the metabolic activity of nascent microbial communities in soil exposed by melting Antarctic glaciers. Whether carbon "stays" retained in the soil, or "goes" as released greenhouse gas is a vital question. Despite the challenges presented by climate change, Hungate is excited about the fundamental discoveries that science will reveal on the path to solutions and appreciates every day that he and colleagues continue to engage with climate questions of "staying or going."

News from the DOE Office of Science (SC) – Dr. J. Stephen Binkley, Acting Director

Binkley reviewed the status of political appointees and SC staff. Secretary Jennifer Granholm has been active in articulating the vision of the Biden-Harris Administration. Deputy Secretary David Turk is on board and has taken interest in SC activities. Geraldine Richmond and Asmeret Berhe are the nominees for Under Secretary for Science and SC Director, respectively. Both nominees had their confirmation hearings in August 2021 before the Senate Committee on Energy and Natural Resources and await being voted out of committee.

Chief of Staff Tanya Das recently took a position outside of government, and Dr. Adam Kinney is currently serving in this position on an interim basis. Mailinh McNicholas is a new Special Assistant to the SC Director.

Under the Biden Administration, the DOE Applied Energy Programs were returned to the purview of the Under Secretary for Science and Energy. This is an important move, offering a better venue for working closely with applied programs.

The FY22 President's Budget Request (PBR) seeks \$7.44B for the SC, which is a 5.89% (~\$400M) increase over FY21's PBR. The House Energy and Water Development Subcommittee issued a lower markup of \$7.32B. The Senate markup is higher at \$7.49B. Any increase will be to the overall budget, and increases will not be the same for every SC program.

SC activities are not covered in the Infrastructure bill, but the Reconciliation package provides uplift for the SC. Congressional negotiations are ongoing. Congress passed a continuing resolution (CR) before end of FY21 to keep the government running through early December of 2021. The debt ceiling vote is scheduled for early December.

Discussion

Replying to an inquiry about the timing of the FY22 and FY23 budgets, **Binkley** expressed hope that the FY22 conference will occur shortly. The SC completed preparation of the FY23 budget in September 2021 and met with an Office of Management and Budget (OMB) examiner. Following internal OMB deliberations, the budget will be returned between Thanksgiving and the middle of December 2021 for an appeals period. The FY23 PBR will likely be finalized in January 2022 and transmitted to Congress around the timeframe of the State of the Union address. The administration's priorities emphasize clean energy and climate, and the SC is optimistic that it will see increases tied to these initiatives.

Binkley was asked whether the reorganization of the DOE Applied Energy Programs foreshadows a more rapid transition of basic research to applied technology. **Binkley** confirmed. The current organization is similar to that in the second Obama term where it facilitated closer interactions between the SC and Applied Energy Programs.

News from the Office of Biological and Environmental Research (BER) – Dr. Sharlene

Weatherwax, Associate Director

[Presentation posted]

Discussion

A question was posed about deployment of the Climate Resilience Lab/ Centers. Since the SC is operating under a CR, **Weatherwax** replied that new initiatives cannot begin until there is a full budget or the calendar has passed the December 2021 mark. Fortunately, most of this project's pending activity is planning, and outreach is always ongoing. Many BER projects are branded as one thing, but projects actually have many components. BER is currently agnostic

about the number and size of the Centers; whether the result is one entity or distributed Centers, BER will ensure that all components speak to and learn from each other to guarantee that solutions are transferred and expanded upon. Community input will be captured through listening sessions, workshops and other outreach events over the next year.

In the context Urban Integrated Field Labs (IFLs), an individual asked about use of human trace data, the role of universities in supporting workforce education and SC strategy. **Weatherwax** explained that the integration of human-driven and physical data will be important for Urban IFLs; this was called out during earlier BER discussions for this initiative. While BER will present a series of driver science questions, the definition of urban employed as well as data use and/ or integration will ultimately be up to the proposer. This is an underrepresented area in climate modeling, and BER is hoping for many responses when the Funding Opportunity Announcement (FOA) is released. The workforce element is important and universities will play a critical role; they may propose individually or in partnerships with each other or DOE laboratories. There is also opportunity to incorporate citizen science in Urban IFLs to engage stakeholders and constituents in benefitting from IFL data. Regarding strategy, the DOE is a research organization, and the SC is increasingly considering ways to broaden and democratize the impact of its science and make data more accessible to others that might use it. The reorganization with Applied Energy Programs will help.

Attention was called to the role of the National Virtual Climate Lab (NVCL) initiative in the broader context of the already extant national and international research landscape. **Weatherwax** confirmed that BER views NVCL as an organizational umbrella to facilitate coordination of partnerships with national laboratories and to leverage funding across agencies and partners.

A committee member inquired about frameworks for respectfully reaching out to principle investigators (PIs) from Minority Serving Institutions (MSIs) to avoid *pro forma* interactions. **Weatherwax** said ongoing listening sessions are helping the SC understand the challenges small institutions like MSIs and Historically Black Colleges or Universities (HBCUs) face in transitioning from smaller, individual research efforts to the multidisciplinary space of climate research. The REaching a New Energy sciences Workforce (RENEW) program will help bring resources and capacity building to MSIs and HBCUs. Without replicating existing efforts and in the tradition of SC's user facilities, approaches could include supplying institutions with the resources to build infrastructure and the expertise to train faculty and students. The DOE is considering ways to reach new audiences, like community colleges, where DOE labs have had traditionally little or no footprint.

Questions were raised about Urban IFL research and joint calls with the National Science Foundation (NSF) about the built environment. **Weatherwax** clarified that DOE recognizes many ways to study the built environment, but an important component will be integration of research with modeling to improve predictive resolution. DOE does not want to remain siloed; future activities could include leveraging funds across agencies or joint PI meetings.

Weatherwax was asked about NVCL coordination in response to national emergencies to prevent duplication of effort among contributing institutions, agencies and academics. **Weatherwax** relayed that the NVCL will serve as an umbrella framework, and a lead DOE lab will assist in coordinating capabilities. The Biopreparedness Research Virtual Environment (BRaVE) will generate a capability matrix to facilitate coordination with other agencies like the National Institutes of Health (NIH). Early planning is drilling into SC capabilities through SC-wide workshops to understand how labs, user facilities and others came together to meet community needs during the COVID-19 pandemic. Once the DOE has developed its own framework, it will be easier to

coordinate with other entities. The goal is to have one point of contact that is aware of all DOE resources available for the response to different kinds of emergencies.

Conversation accentuated opportunities to democratize climate modeling by further opening up execution of models like the Energy Exascale Earth System Model (E3SM) to communities and institutions that have not traditionally had a role in setting simulations. This could enable focused studies on underserved populations. **Weatherwax** agreed.

With reference to earlier NVCL discussion, Weatherwax was asked about redirection of existing research efforts and resources towards understanding climate and mitigation, especially on the biological side. **Weatherwax** said the focus will be less on resource redirection and more on understanding and connecting existing capabilities. There are challenges inherent to knitting together communities, institutions and science at different scales. BER aims for a scientific continuum from genomics to earth system modeling with partnerships across scales. Some in BER are lucky to get funding from both ends of the continuum, but this is difficult. BER is always seeking ways to eliminate artificial disciplinary boundaries, taking guidance from its Committee of Visitors (COV) and other reports. Facilities Integrating Collaborations for User Science (FICUS) calls, for example, help build bridges across user facilities.

A concern was voiced about the U.S. and global precedence for transient scientific intervention in critical problems. It is important to avoid causing damage or creating a more transactional than synergistic situation. **Weatherwax** agreed. An important hallmark of BER and DOE science in general is funding duration. Modeling requires trends to be captured over time. The listening sessions are helping the SC understand what resources are wanted and capacity building will help to develop programs and harden institutional structures beyond BER funding time-scales. Throwing two years of funding at the issue will not fix the problem. BER understands that developing relationships and building such capacity takes longer-term engagement, as is reflected by many of BER's longer-term investments.

Pointing to political circumstances, further apprehension about the certainty of long-term investments in initiatives, especially those containing the word "climate," was expressed. **Weatherwax** stated there will always be a desire to spin activities as new. BER used to have a different name, and some of its divisions have been rebranded. BER's work has reflected different administrations' priorities, and Congress has responded in a bipartisan way because it understands the importance of basic research thanks to outreach done by scientists. BER's work is based on very foundational research that has received funding for a long time. Rather than turning activities on or off, rebranding builds on this foundation.

The need to engage younger generations in science was emphasized, and Weatherwax was asked about plans for workforce development. **Weatherwax** agreed about the importance of capturing young students' interest. Educational policy is not in the DOE's mandate, but there are outreach programs for undergraduates at community colleges or four-year institutions as well as faculty. The labs and user facilities also host outreach days that engage many children. BER counts on members at all institutions to do their share to reach broader demographics.

BERAC Subcommittee on International Benchmarking: Update and Discussion

[Presentation posted]

Discussion

In response to a question about the public Assessing the National and International Standing of BER Basic Research Request for Information (RFI) timeline, **West** said the deadline was

the end of October 2021. Anything sent after will be used as long as activities are ongoing, which is likely through the next two months.

A question was raised about synthesizing results across the working groups since each group is developing its own questions. **McCann and Reed** explained that each working group will draw hypotheses from question responses; group leads will participate in Subcommittee meetings to distill the common and distinctive elements from collective findings. Colleagues from the Integrative Science Working Group will assist. Unique elements can be addressed in a chapter- or mission-specific fashion. Also, the charge letter acts as a common starting point. Working groups will tailor questions as appropriate for the topic area and interviewees.

Requests were made for more information about methods for collecting publication data and evaluating user facility contributions. **McCann, West and Prather** said Office of Science and Technical Information (OSTI) experts with bibliographic software and query knowledge are compiling keywords and performing searches for BER- and U.S.-funded research and international comparisons. This approach may remove some of the bias inherent to individuals' partiality to certain topic areas. There is no way to obtain a perfectly accurate picture. For example, it is possible to query all BER grant numbers to find associated publications, but this cannot be done internationally. Consequently, much work has been dedicated to identifying keywords representative of Science Focus Areas (SFAs) and FOAs. Publication returns based on grant number searches will be compared to those using keyword searches, and representative keywords will be used to understand the international publication space. Another important analysis aspect is the 10-year retrospective search period. It will be easier to understand BER's current status with information about the past. Comparing these quantitative results, imperfect as they are, with individual experts' perceptions of change in their respective fields will also yield insights. It is possible to capture metrics for user facilities, but not so for comparable international facilities unless they encourage publications to flag facility use.

A question was asked about how gathered information will be used to address areas where BER shows less leadership. A related point was levied that examining BER's scientific leadership may not be enough. Investigation of the holistic enterprise may be needed to address key issues, like attracting and retaining a scientific workforce. For example, early career scientists face challenges in career paths and there are areas with surplus PhDs or postdocs. The proposed work offers a good foundation for addressing some of these issues. **McCann and Reed** commented that quantitative metrics are backwards looking; the interviews will be germane to addressing the forward-looking aspects of the points raised. The subcommittee is thinking about how to make recommendations and foresights actionable. An analogous report from the Basic Energy Science Advisory Committee (BESAC) Benchmarking Subcommittee also addresses concerns for supporting the workforce pipeline, especially for early and mid-career scientists. **Pakrasi** observed that initial and limited interviews with international leaders have yielded unexpected comments that BER is leading in the given topical area. This trend may not hold true for the remaining interviews or other topical areas, but initially suggests that extracting what BER needs to do to maintain a leadership position may be challenging.

DOE shows remarkable leadership in data availability, and a suggestion was made to incorporate the impact of DOE data on the community in the report. **McCann and Kleese van Dam** agreed, commenting on the potential to include this information as a case study in the report. OSTI may be able to identify queries to track DOE data, libraries, software, publications or other repository elements that have had a worldwide impact.

With reference to selection of thought leader interviewees, a BERAC member 1) cautioned that women are often underrepresented on influential scientific panels and 2) inquired about inclusion industry thought leaders. **McCann, Reed and West** concurred that women may be underrepresented on such panels, adding that other political factors may also play a role in shaping panel membership. Thought leadership is not confined to distinguished academics. A more expansive subject pool is being considered based on who the users of BER science are and how they benefit from basic research. The first ten interviews will generate hypotheses that will be tested with data acquired from additional interviews. Other examples of thought leaders that might not be recognized on wider stages include Early Career Research Program (ECRP) awardees. The RFI also broadens the scope for capturing multi-background and -level feedback beyond the subcommittee's interview capacity. This is a fairly unique opportunity for the general public to respond to an SC Director's charge to a FACA group. Collected information will inform follow-on interviews and additional perspectives on where BER science is and should go. **John Weyant** strongly endorsed broadening the interview pool. To date, efforts had focused more on obtaining views from all levels of the government. Staffers seem more interested in the science of climate, not just the politics, than they were five to ten years ago. Supply chain and finance industries have previously denied systemic issues for fear of being blamed, but now appear more interested in addressing issues. This is a megatrend here to stay.

Attention was called to the charge's request for the Subcommittee to distinguish between BER-specific contributions and U.S. contributions as a whole to topical fields in domestic and international arenas. **Fridlind, McCann and Prather** highlighted challenges with segregating BER- from U.S.-funding. Within some fields that receive funding from multiple agencies, it may be possible to parse BER-funded activities based on which agency's mission is being addressed by the science. Since the charge also mentioned cross-agency considerations, the Subcommittee's last chapter is dedicated to Integrative Science. It may also be difficult to obtain international perspectives since international thought leaders generally do not track U.S. researchers' funding sources. Working groups plan to be upfront about when such distinctions cannot be made. The Subcommittee has also discussed comparison of BER's operations to those of equivalent international funding agencies. This topic will be probed by asking international interviewees what they like about the funding structures in their countries to draw out points of U.S. comparison. These approaches are not perfect; the gathered data may be more subjective than many BER scientists are comfortable with.

A question was raised about capturing information about proposals that did not receive funding and the possible futures that scientists might wish to explore. **Reed and McCann** said if interview storylines address missed opportunities, there will be a basis for a related hypothesis or report highlight. An argument for more funding to prevent future missed opportunities could result.

The **Subcommittee** thanked BERAC for its input and encouraged responses to the RFI.

Hungate dismissed the meeting for a break at 3:26 p.m. and reconvened at 3:45 p.m.

Discussion

Friend was asked about the qualitative synthesis of interviews and for input on distinguishing between BER and U.S. metrics internationally. **Jeffrey Miller** offered the technical clarification that the BES Subcommittee conducted consultations, not interviews. Interviews require human subject approval. **Friend** said common themes emerged from the consultations. Having a mix of subject matter experts representing all topical areas on the BESAC Subcommittee was critical; they offered reality checks for off-base opinions. However, there were surprises. BES experts in one area thought the U.S. was doing better than it was. Evidence to the contrary first emerged from consultations and was subsequently supported by publication analyses. International leaders, especially those that have held administrative positions, brought important expertise to the Subcommittee. For example, individuals that served as directors of the RIKEN (Rikagaku Kenkyūjo) Center in Japan or the Helmholtz Association in Germany were included. Consultations were never published verbatim to protect interviewees. To distinguish international and U.S. contributions, the BERAC's Subcommittee defined the most important topical areas in a U.S. DOE context, and then examined who was working in these areas. This is done by identifying publication lead authors and where the work was conducted. BES citations were vetted to ensure that highly cited papers were published in important, valid journals. Thousands of citations emerged, lending strength to statistical analyses.

Additional information about addressing biases in conference and publication metrics was requested. Women, for example, may be less likely to be invited to present at conferences. **Friend** explained that the BESAC Subcommittee had enough publications that it was not concerned about gender or ethnic biases. However, a home-field advantage was observed in conference metrics, meaning the nationality of invited conference speakers was skewed towards the host country. Though the National Academy of Sciences (NAS) report recommends reviewing conference metrics, this approach is probably more flawed because numbers are smaller.

Inquiries were made about whether the BESAC Subcommittee discussed ways to implement their recommendations. Of particular interest were efforts to support postdocs to mid-career scientists. While more resources would help, a better community structure might attract talent and subsequently resources, leading to a virtuous cycle. **Friend** agreed that supporting these individuals is important. However, the Subcommittee did not try to engineer solutions. Universities play a big role in this area, and the DOE is not in a position to effect changes. This is a good topic for follow-on discussions with scholarly societies. However, the Subcommittee did suggest that staff scientists at facilities would benefit from more time to pursue their own work and develop their careers. The collaborative improvement of instrumentation is important. Remote work has further exacerbated the disconnection between staff scientists and those seeking analyses, placing staff scientists in a service role. This resource allocation issue is within the DOE's purview.

When asked whether the Town Hall webinars were beneficial, **Friend** emphatically confirmed that they were. The BESAC Subcommittee shared preliminary results, leaving room for community input. In some cases, discussion generated helpful side conversations. The feedback attained was essential. Leaving out this step would create turmoil later in the benchmarking process.

Diversity, Equity & Inclusion (DEI): Office of Science Activities – Dr. Julie Carruthers, DOE
[Presentation posted]

Discussion

BERAC applauded SC efforts to incorporate DEI into all aspects of its business practices. Conversation opened with inquiries about tracking award distribution and career advancement metrics at labs conducting BER research. It would be good to have a summary of who is receiving funding and who is not. Labs themselves do collect some statistics and are willing to help this effort. **Carruthers** said the SC's information on national laboratory metrics is incomplete because the Portfolio Analysis and Management Software (PAMS) has not been built out to incorporate inclusion of all awards. PIs for laboratory-only calls issued by the SC do have PAMS accounts, but all other research that is not openly competed across the labs is not entered in PAMS. It is very difficult to identify SC-only funded individuals at the labs because many PIs are funded by multiple sources. A data request for overall workforce demographics by job categories has been issued to the labs, but data on SC-funding sources have not been requested. PAMS users can no longer skip demographic questions in their profile, though individuals may decline to provide information. Some PAMS data is being used to create baselines, but the data is too incomplete for a comprehensive DEI assessment of application to award metrics.

A BERAC member asked if there will be a training program to support MSI engagement in review panels and proposal submission. Labs also have programs that lower barriers to proposal submission and awards, though funding amounts are often smaller. **Carruthers** stated there is a lot of helpful information from NAS reports and other studies. However, these findings are not specific enough for the SC to take targeted action. The SC is in an information-gathering phase. Listening sessions beginning in August 2021 and continuing at least through January 2022 are providing recommendations on how to help individuals and institutions overcome barriers. Suggestions received do include offering workshops.

A question was asked about implementing new review guidelines. The different community cultures and traditions of panelists and agencies impinge on the review process. Are there transition models from other agencies? **Carruthers** explained that the Diversity and Inclusion (D&I) Working Group has individuals from all program offices that understand the cultures of their respective research communities. The group aims to provide broad guidelines with the understanding that everyone's implementation will be different. Early guidance is being pilot-tested in focus groups to inform later implementation. Valuable insights have been obtained from NIH and NSF, but these agencies have more resources behind their activities. NIH has some similar practices, but they operate on a bigger scale; they have also been collecting data for much longer, enabling more data-driven action.

Discourse shifted to whether the SC's DEI effort is proportionally under-resourced compared with NIH and NSF implementation. If so, could the SC use these benchmarks to argue for additional funding to support these important initiatives? BERAC could also make a recommendation. **Carruthers** appreciated this dialogue, commenting that there is probably no SC office that feels like it has enough resources to carry out its mission. The Office of Diversity, Inclusion, and Research Integrity (DIRI) was behind the curve in getting staffed up, and the business systems have lagged in their sophistication, limiting data collection. Of course, more staff and resources would accelerate implementation.

The NSF requires universities to report investigator misconduct for post-award equity and fairness considerations. Is the DOE considering similar practices? **Carruthers** explained that

the NSF engaged the SC in discussion when the policy was released to keep the SC informed and assess whether other agencies might follow their lead. While the SC did discuss what implementation might look like, the SC is guided by the DOE financial assistance regulations and cannot implement this practice independently. The SC was an active participant in a prior administration subcommittee on safe and inclusive research environments that was moving towards a federal-wide solution. This process is no longer advancing. With the caveat that commitments cannot be made, the DOE is actively discussing this practice and moving through an approval process.

A BERAC member asked if any of the original 40+ recommendations generated by the D&I Working Group addressed issues of work-life balance, clear career pathways or graduate and postgraduate underpayment that might more deeply affect underrepresented groups and women. **Carruthers** said the working group focused on SC business practices and did not examine broader community challenges over which the SC has little control. However, with better PAMS data, it would be possible to examine disparities in salary and what individuals are requesting for support.

Hungate dismissed the meeting for the day at 5:20 p.m.

Friday, October 22, 2021

Hungate convened the meeting at 11:30 a.m.

BERAC Roundtable

Hungate invited new BERAC members to introduce themselves and for all committee members to share BER-relevant thoughts.

Contributions underscored urgency in addressing climate change while establishing that opportunities lie in integration. Grand challenges require the merging of expertise and methods across disparate research fields and translating basic discoveries into applied technologies. Success will necessitate bringing diverse resources and populations together to maintain U.S. competitiveness. Speakers highlighted leadership opportunities for DOE and BER.

Energy underlies all aspects of food and water supply as well as human and environmental health. There is a code red need to address carbon management in all facets of society. Decisions are being made now that will affect populations for centuries. For example, a special 2021 Science issue urged researchers to contend with harsh realities entailed by climate change, including the planned relocation of Jakarta, a megacity, possibly to Borneo. In recognition of the problem's pervasive nature and the need for equally wide-ranging solutions, the DOE might consider renaming itself the Department of Energy and Carbon Management.

BER's use of next-generation technology, from genomic sequencing to computational modeling, is supporting ever more complex studies that bridge scientific disciplines and better reflect the intricacies of biological and physical parameters across scales. Plant science studies examining protective pigments or genome copies will help future efforts to climate-proof crops and natural ecosystems. Integrating such discoveries within the broader context of the soil microbiome, land use and productivity, aerosolized bioparticles and their contribution to precipitation and other environmental qualities offers the chance to holistically understand the biotic and abiotic factors driving systems. By better managing system components, there are opportunities to reduce agricultural pollution and improve plant growth efficiency, reviving a more circular agrarian economy. Likewise, BER has the opportunity to contribute to the design

of effective natural climate solutions by supplying more nuanced methods for accurate carbon baselining and accounting. Other exciting research findings relate to studies of bacteriophages whose genetic alphabet diverges from that of other life on earth. These studies could lead to discovery of new organisms and future technologies.

Fresh opportunities also lie in bridging disciplines and technological innovations in the built environment. For example, rethinking the cement manufacturing processes could address 10% of the world's carbon dioxide emissions, and microbial-materials interactions affect the health and longevity of structures in addition to those that inhabit them. Future infrastructure could participate in carbon capture rather than act as a source of emissions.

Computational techniques interleave and bolster transdisciplinary studies. Significantly, two out of the three recipients of the most recent Nobel Prize in Physics are climate modelers. Klaus Hasselmann, one of the awardees, spawned an entire generation of scientists that used models to connect climate change to human activity. Meanwhile, natural language processing and other artificial intelligence/ machine learning (AI/ ML) techniques offer opportunities to distill relevant information from the global tidal wave of scientific publications. Extracted numbers, figures and text can be fed into code to prime models for analyses.

Tools that support research include the Advanced Photon Source (APS) at Argonne National Laboratory (ANL). Despite COVID-19 restrictions, APS continues to support structural biology and other experiments. Importantly, there will be 12-month period starting in April 2023 when APS will be shutdown to allow installation of a 4th generation storage ring that will be 100-1000x brighter than the current ring, enabling new BER science. Laurent Chapon will be taking over APS as the new director in January 2022.

Better integration along the spectrum from basic science to applied technologies will support future solutions. The April 2022 launch of the nonprofit innovation institute BioMADE (Manipulate, Accumulate, De-risk, Execute) will support bioindustrial manufacturing, an area where the U.S. is lagging internationally. There are opportunities for BER to enable basic research that will support leaps in technology development. Possible interfaces include the Bioenergy Research Centers (BRCs) and other elements in BER's portfolio.

Discussion also applied the lens of integration to scientific communities. The ability of researchers to step out of their comfort zones across disciplines to support the response to COVID-19 speaks to the resilience of the scientific community, even as it continues to adapt to ongoing changes. BERAC members expressed delight at being able to attend in-person meetings, heralding the return of interactive community science. Participants also spoke of mentoring young faculty members in grant writing and deriving hope from university students that self-organized to identify judges and solicit project feedback for an international competition. Fostering the inclusive and equitable involvement of diverse, young scientists is critical to future U.S. success. It is encouraging to see DOE efforts in this arena through RENEW and other programs. Another BERAC member drew attention to comments from Nobel Physics Prize winner Syukuro Manabe. When asked why he left Japan for the U.S., Manabe highlighted the open and collegial scientific environment in the U.S. while also underscoring research support.

Contrasting limited U.S. resources with the large investments that are enabling China to advance space technology, a BERAC member urged the creation of a pan-agency funding. Such an effort would identify where gaps and redundancies exist, leverage resources and pave the way for improved collaboration to meet growing challenges ahead. Related remarks reflected the need for better interagency collaboration to avoid reinventing wheels and pointed to opportunities for BER to make recommendations on other agency climate-related initiatives.

BER and the DOE may also look to other international organizations for integrative collaboration and funding models. Ideas exchange can expand BER's impact and scope.

Participants look forward to future integration across scientific disciplines and communities, as has been emphasized in other talks at this meeting and will be discussed in the final chapter of the BERAC Benchmarking Report.

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

Discussion

A BERAC member suggested that BER might be uniquely positioned to address problems with climate sensitivity in earth systems models due to cloud feedbacks. **Geernaert** agreed, relaying that the most recent Climate Modeling Summit could not reach consensus on the problem's cause. The Atmospheric Radiation Measurement (ARM) user facility and Atmospheric System Research (ASR) program do position BER to tackle this issue, but there may be opportunities to engage the National Oceanic and Atmospheric Administration (NOAA), National Aeronautics and Space Administration (NASA), National Center for Atmospheric Research (NCAR) and NSF. The White House is emphasizing the social cost of carbon, and is pointing to climate sensitivity as a component to correct.

Discussion shifted to urban studies incorporating multisectoral dynamics and integrated assessment modeling. Geernaert was asked to comment on the relationship between heat islands and socioeconomics as well as how modeling at this resolution intersects with policy questions at the center of political debates. BERAC appreciated the importance of these studies. **Geernaert** said a recent study found disadvantaged communities in Chicago tend to have less well-insulated buildings and parklands on average. Poor insulation means that air conditioners must be run more to cool buildings, creating higher external heat emissions. Combining these factors in nested models to get high spatial resolution has the potential to identify hot spots that are currently being overlooked. These are early studies and methods will get more sophisticated over time. Similar questions are being asked in other cities, like New York. This issue is receiving attention from the DOE, NIH and other agencies. An Urban IFL FOA that addresses these issues will be posted as soon as there is an appropriation.

In response to a question about planning processes, **Geernaert** highlighted areas being advanced in FY22. The Urban IFL FOA will be released with an appropriation and broadly issued to the community; labs or universities will be eligible to lead efforts. The NVCL will be an information portal tailored towards a broad set of stakeholders, mainly MSIs. ANL has been asked to lead portal development. The Climate Resilience Lab/ Centers have had a number of intentions since first conceived. This year is intended to be used for planning. BER anticipates appropriated funds in FY23 to build up centers and does expect MSIs to be major players. Outreach efforts have begun discussions with MSIs.

Biological Systems Science Division (BSSD) Update – Dr. Todd Anderson, Division Director
[Presentation posted]

Discussion

A BERAC member said an advantage of having long-term staff at user facilities is that DOE researchers are able to build collaborative relationships that benefit from staff's retained knowledge and experience. Such relationships have benefitted algal genome projects. Having long-term staff is less common in academic environments.

Questions arose about the origins of the common garden switchgrass project and whether studies will incorporate characterization of the soil microbiome. **Anderson** said the project began when the University of Texas proposed to sample switchgrass in common gardens across large transects in response to a Sustainability FOA. Other researchers associated with the BRCs organically formed research collaborations. **Schmutz** added that NSF originally funded the common gardens. BRC integration and large-scale sequencing of plants collected from multiple locations were enabled by Sustainability funding; these efforts dovetailed with the Joint Genome Institute (JGI) efforts to develop switchgrass resources to understand adaptation and selection. The data have revealed amazing insights about the adaptation of these complex plants over the 20K-year period post-glaciation. A component of the project is looking across common gardens and genotypes to examine microbial recruitment and the rhizosphere.

Hungate dismissed the meeting for a break at 1:43 p.m. and reconvened at 1:53 p.m.

BERAC Science Talk – Dr. Daniel Segrè, Boston University
[Presentation posted]

Discussion

A BERAC member suggested using ML to obtain parameters needed for the presented biophysical model. Incorporating explainable AI in ML models was discussed at a prior DOE workshop on AI/ ML. **Segrè** agreed.

In response to questions about the substrate experiment, **Segrè** said that growth was planktonic. He agreed that competition could have contributed to results, but it is unclear why the Type III pattern emerged when carbon sources were combined since one carbon source was capable of supporting so many species. A BERAC member hypothesized that population alliances may contribute to outcomes.

Segrè was asked about first steps for naturally assembled microbial communities using presented approaches. **Segrè** is contemplating phenotyping experiments in oceans because marine microbes are more diluted and sparse. Refactoring such communities to recapitulate major taxa would be an easier starting point than soil, though the rhizosphere is very interesting.

Office of Science User Facilities: Lessons learned from the COVID Era and Visions of the Future – Dr. Nigel Mouncey, Lawrence Berkeley National Laboratory
[Presentation posted]

Discussion

Conversation opened with discussion of additional DOE resources to support user facilities. Advanced Scientific Computing Research (ASCR) has a working group investigating

how to better integrate computing services across the DOE laboratories. Also, Stanford Synchrotron Radiation Lightsource (SSRL) pioneered remote access over a decade ago. Now, almost every structural biology beam in the country can be run remotely. When the pandemic arrived, operations continued to support users because remote processes were already developed. Many of the issues described in the report have already been resolved at these locations. Importantly, more staff, not less, are needed to fully automate and maintain beamlines. Staff are also needed for loading samples. A BERAC member added that the report's real-time capture of what is happening at user facilities may be useful to the International Benchmarking Subcommittee.

Replying to a question about travel resources, **Mouncey** said JGI used ~15-20% of the travel funds that would normally be spent in the last year. Some conferences charge registration fees. In the future, JGI will likely be more selective about travel if conferences provide hybrid options. The decision to travel will be informed by the value scientists gain by attending in person. Granted, there have not been many hybrid conferences yet, and anecdotal reports about such experiences have not been positive.

Answering an inquiry about limited user bandwidth and data, **Mouncey** acknowledged that it is much easier for users to log into systems onsite which provide ample bandwidth. Working with users remotely has been a challenge. JGI is considering centralized servers for users to run analyses.

Mouncey was asked how user facilities are prioritizing early career staff and users to help them recover from lost time. Where possible, **Mouncey** said JGI prioritized access for early career researchers, like postdocs, and is conducting frequent check-ins to ensure they have needed resources. Many of these individuals had to pivot their work to more computational analyses, and there have been changes in project scope. It has been difficult. Now that social distancing protocols have been lifted, JGI has been able to increase the hours that early career researchers can spend at the bench. Frequent communication between supervisor and staff members has been key in helping them with their work.

Public Reusable (PuRe) Data Resources Initiative – Dr. Michael Cooke, DOE
[Presentation posted]

Discussion

BERAC appreciated the PuRe Data Resources initiative and efforts to make data Findable, Accessible, Interoperable and Reusable (FAIR) as well as attain federal desirable characteristics. Concerns, however, were raised about funding sources and the associated burden of writing and reviewing data plans. Long-term curation of data is not cheap. Additionally, there has been a proliferation of grant writing and reviewing requirements. Several questions arose: 1) Will there be additional funding for data services achieving PuRe certification?; 2) Since 2004, the United Kingdom (UK) has supported a digital curation center that helps the community with techniques to produce, annotate, share and maintain data over time. Is DOE considering a similar enterprise?; 3) Did the existing PuRe resources volunteer or were they identified by the SC?; and 4) How will additional proposal requirements be balanced against the already heavy burden for applicants and reviewers? **Cooke** said sustained funding is worked out through discussions between a candidate resource and its respective program office; this is an important early step in the certification process to understand what resources would be needed to meet designation goals. The FAIR principles and desirable characteristics are meant to be aspirational goals and

not a threshold for PuRe designation. The aim is to include data science expertise as part of the review process, taking into account where the resource is on the FAIR principles and desirable characteristics spectrum, what the community needs are, and what next steps look like. Regarding data support tools, the PuRe initiative hopes that designated resources will serve as an information resource on approaches; while each community has distinct needs, effective data science approaches cross many disciplines.

To lessen the writing and review burden, a BERAC member suggested breaking the review process into two steps. The first step would evaluate proposals on scientific merits and the second confer funding after those select projects submit data plans for approval. Novel ideas for data plans could be submitted in the first step for peer review. This decoupled approach would still need to be well-funded. **Cooke** remarked that the PuRe designation process aims to be flexible. Minimum, reasonable requirements, like supplying Digital Object Identifiers (DOIs) must be met. However, the designation process may take factors presented by individual data resources, program offices and community needs into account with the ultimate goal of better serving the DOE community activities that address mission goals.

Hungate dismissed the meeting for a break at 3:36 p.m. and reconvened at 3:45 p.m.

Workshop Brief: NOAA-DOE Precipitation Processes and Predictability – Dr. Renu Joseph, DOE

[Presentation posted]

Discussion

A question was posed about verifying precipitation predictions. An article published a few years ago suggested that the best that could be done for decadal climate predictions would be estimating area averages over certain regions. **Joseph** stated that this is an area of active interest. Future explorations may focus on smaller time scales. Interagency modelling groups might come together for simple experiments.

Joseph was asked if extreme event prediction and kilometer-scale models are nearing breakthroughs. **Joseph** responded that precipitation presents a much more difficult challenge than large-scale features. Regarding extreme weather events, some features are getting better such as prediction of tropical cyclones, but it is too early to issue a general statement. It takes six months for High Resolution Model Intercomparison Project (HighResMIP) data to be released to the community; these results will indicate if there have been improvements.

BSSD Strategic Plan – Dr. Todd Anderson, Division Director

[Presentation posted]

Discussion

Conversation touched on use of bioenergy crops versus model/ platform organisms. It is much easier to answer genomic questions in model organisms. Also, transforming non-model organisms requires facilities and services; the process is expensive and difficult. University-based transformation facilities are suffering because staff are leaving to work for startups. DOE could strongly benefit plant science by providing a staffed user facility, even for a plant species that scientists already know how to transform. **Anderson** acknowledged BERAC's enthusiasm for a plant transformation user facility. BER is not averse to using model species like

Arabidopsis in some instances, but it does want to see connections to bioenergy crops. Last year, the BRCs held a workshop on plant transformation techniques. Interesting developments are expected.

Anderson was asked about the thrust of the microbial conversion program, connections with the Office of Energy Efficiency and Renewable Energy (EERE) and the use of algae. **Anderson** said BER has a small, focused effort using algae for air capture of CO₂ and its conversion to a range of products. The BER environmental portfolio could also encompass algae in the context of carbon- and nutrient-cycling in an environmental context. However, EERE has a large algae program, investing >\$20M. BER aims to work effectively in this area without overlapping. BER supports EERE through the JGI, which conducts algal sequencing. Ongoing discussions are exploring how BER's microbiome and imaging techniques can support EERE.

Public Comment

None.

Hungate adjourned the meeting at 4:51 p.m.

Respectfully submitted,
November 3, 2021
Holly Holt, PhD
ORISE