

## **Biological and Environmental Research (BER) FY 2023 RENEW Awards**

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### **Strengthening Education and Research Capacity for Bioenergy Science at Alabama A&M University through a Combination of Education, Research and Partnerships**

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1: Alabama A&M University, Huntsville, AL 35762

2: Joint Genome Institute, Berkeley, CA 94720

3: Hudson Alpha Institute of Biotechnology, Huntsville, AL 35806

4: Center for Advanced Bioenergy and Bioproducts Innovation (CABBI)/University of Illinois Urbana Champaign, Urbana, IL 61801

Alabama A&M University (AAMU) investigators have been conducting genetics and breeding research for a suite of related, model C4 bioenergy crops including Miscanthus and sorghum. The proposed research will leverage this strong foundation to enhance and build an up-to-date bioenergy science research and education program at AAMU. With guidance from collaborating partners, and new investments in modern research tools for high-throughput phenotyping, genomics, bioinformatics, and gene editing, AAMU students will be exposed to the available latest cutting-edge technologies. Specifically, the research will leverage the diverse and well-established populations of Miscanthus genotypes and ongoing sorghum projects at the AAMU's Winfred Thomas Agricultural Research Station (WTARS). Miscanthus field trials will be used to study genotype by environment (G x E) by incorporating high-throughput phenotyping in partnership with CABBI/University of Illinois Urbana-Champaign, through which 2 undergraduates will be trained each year. These Miscanthus trials also will be used to conduct microbiome wet-lab and bioinformatics studies in partnership with JGI, through which the project expects to train 2 undergraduates each year. A Sorghum Association Panel (SAP) planted at the WTARS will be used to study the effect of nitrogen deficiency, through which 2 undergraduate students will be trained each year; phenotypic and molecular characterization of gene-edit sorghum lines will be used to train 1 graduate student. The sorghum research and student training will be in partnership with CABBI/HudsonAlpha Institute for Biotechnology.

This research project aims to enhance bioenergy science program at AAMU, with the areas of high throughput phenotyping, omics and bioinformatic analysis, and plant genomics and biotechnology strengthened by our partnership with and receiving support from JGI and CABBI. The recruitment and training of a total of 18 undergraduates and 1 masters student in this Bioenergy Science program will establish a recruitment pipeline for the Bioenergy workforce and/or graduate training programs.

*This research was selected for funding by the Office of Biological and Environmental Research.*

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**Catalyzing STEM Training and Partnerships through Comparative Analysis of Transferable Watershed Function in East River and Southern California Watersheds**

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2: Lawrence Berkeley National Laboratory (LBNL), Berkeley, CA 94720

3: Stanford Linear Accelerator Center (SLAC), Menlo Park, CA 94025

This project presents a vertically integrated set of mentor-focused research and experiential training to provide career pathways for diverse students in fields of study in watershed analysis, while contributing to intellectual growth of Science, Technology, Engineering, and Math (STEM) communities at a notable Hispanic Serving Institution, California State University, Los Angeles (Cal State LA). The project aims to examine overall patterns of watershed and riparian function, including solute/nutrient flux and isotope hydrology along the course of the Los Angeles River and tributaries. The project also aims to understand how fire ecohydrology and extremes in flooding and drought affect chemistry and flows of the river. For enhanced intellectual growth, the project will leverage new capabilities and research directions within the Watershed Function Scientific Focus Area (SFA) in the East River watershed of the Upper Colorado River Basin. In addition, research activities will engage LBNL, SLAC, and Cal-State LA faculty and students in a team environment, fostering a sense of belonging while cultivating scientific identity through independent projects. These collaborative efforts will also lead to joint publications, where students will be co-authors and as appropriate, first-authors.

*This research was selected for funding by the Office of Biological and Environmental Research.*

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## **BER-RENEW iSAVe: New Energy Sciences Workforce to Advance Innovations in Sustainable Arid Vegetation**

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3: Pacific Northwest Laboratory (PNNL), Richland, WA 99354

The southwestern US is challenged by climate change, reduced water supply, and air pollution. As one of the strongest academic institutions in the region, San Diego State University (SDSU) has a collective mission to devise and implement solutions for local and global problems, supporting both the educational and economic development of historically excluded communities (HEC). This project will provide meaningful, equity-centered mentoring to HEC graduate students as they engage in cutting-edge research focused on developing novel climate-smart solutions for agriculture (with a focus on sorghum) in marginal soils with partnerships at Lawrence Berkeley National Laboratory (LBNL) and Pacific Northwest National Laboratory (PNNL).

The overarching goal of the research is to provide transformative solutions for current agricultural practices by delivering fundamental knowledge of plant-growth-promoting microbiome interactions, thus providing incentives for sustainable production while decreasing water usage and greenhouse gas emissions. HEC graduate students will play critical roles, with meaningful participation in all these culturally and socially relevant project areas. This integrative study represents a unique platform for interdisciplinary preparation in key areas of science, technology, engineering, and math (STEM) that will increasingly be called upon to solve many of humanity's environmental challenges. The research is designed to equip HEC graduate students with advanced experimental, computational, and mathematical skills and provide a modern-day biotechnology perspective that requires the integration of scientific discoveries with long-term social, economic, and sustainability considerations. These efforts will serve to create a robust pipeline for diversifying the biotech workforce of the future by developing interest in biotechnology and training SDSU students for rewarding careers in the rapidly emerging field of bio-based innovations. The research aims to fund the training of four graduate students.

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## **Applied Geospatial Data-science Initiative for Urban Climate Change Studies (AGDI-UCCS)**

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1: Alabama A&M University (AAMU), Huntsville, AL 35762

2: Oak Ridge National Laboratory (ORNL), Oak Ridge, TN 37830

3: Pacific Northwest National Laboratory (PNNL), Richland, WA 99354

Predictive understanding of the complex and interrelated urban processes in general, and more specifically their effects on heat build-up and local climate within rapidly growing cities at variable spatial scales and during specific heat events is of critical need towards achieving urban climate change resilience. This project aims to establish the Applied Geospatial Data-science Initiative for Urban Climate Change Studies (AGDI-UCCS). The overarching goal of AGDI-UCCS is to enhance collaborative research, education, experiential training, and professional development opportunities for students and emerging researchers from historically underrepresented minority communities. AGDI-UCCS research will focus on developing geospatial modeling applications by integrating remotely sensed data and products to achieve a predictive understanding of urban climate change impacts in general, and more specifically the dynamic processes of rapidly developing urban landscapes of mid-size cities and their suburban landscapes of the mid-south. Through proposed AGDI-UCCS activities, the project aims to expand and strengthen AAMU's collaborations with two national laboratories (NLs): Pacific Northwest National Laboratory (PNNL) and Oak Ridge National Laboratory (ORNL). The funded project addresses its science objectives in multiple ways: 1) research findings (i.e. development of the geospatial modelling framework, urban heat islands (UHI) simulations at variable scales, quantification and spatial modelling of UHI) will contribute to improve predictive capabilities of world research forecasting – urban canopy modeling (WRF-UCM) to advance scientific understanding of urban-climate interactions and their impacts on incidences of heat waves, heat stress, and energy demands in rapidly growing cities to help identifying potential adaptation and mitigation strategies towards achieving urban climate change resilience; 2) financial support will help alleviate existing barriers of AAMU for expanding the principal investigator's current research, teaching and student training capabilities; 3) the collaborations with the DOE's national laboratories will facilitate a two-way engagement between DOE funded research to facilitate the exchange of data, products, research and technical expertise; and 4) experiential learning opportunities will help students from traditionally underrepresented communities to develop research, technological skills (i.e., spatial modelling) and professional skills to enter DOE and STEM careers leading to enhanced diversity in future STEM workforce.

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## **Sub-seasonal to Interannual Variability and Predictability of Rainfall Over East Africa**

Dr. Ademe Mekonne<sup>1</sup>, Professor  
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The overarching objective of this project is to build capacity of the Atmospheric Science and Meteorology Program at North Carolina A&T State University (NCAT), a historically black colleges and universities (HBCU), through experiential training and mentoring of graduate and undergraduate students. The project aims to train NCAT students with advanced computation techniques and equip them with cutting-edge research with a new collaboration with PNNL's Water Cycle and Climate Extremes Science Focus Area (WACCES SFA). The partnership with WACCES SFA will fill a critical gap that involves high-end computational regional climate modeling. In addition, the partnership will provide an opportunity for a sustainable undergraduate and graduate education and research program in climate and environmental sciences, consistent with DOE's strategic plan through the Office of Science Biological and Environmental Research. The project will focus on two distinct but integrated areas of research: (i) intraseasonal to interannual variability of precipitation and its interaction with different types of moist convective processes and (ii) frequency and variability of extended wet and dry events within the rainy period and how they relate to intraseasonal modes of variability. The project expects to advance knowledge and understanding of the sub-seasonal to interannual variability of precipitation processes including the impact of intraseasonal modes on different types of deep convection, and diurnal rainfall cycle over East Africa. The project will accomplish its objectives through experiential learning and training of students and conduct deep observational and theoretical analysis, integrated with regional modeling. The project will address one of the most important concerns of the Nation: increasing participation of underrepresented minorities that have very little involvement in atmospheric sciences research and, thereby, increase a well-trained diverse workforce. This research and educational program will be impactful because it will fill a critical gap in climate science education and research through a lasting partnership with PNNL WACCES SFA in areas of shared interest. It will provide undergraduate and beginning graduate students' practical introduction to regional climate modeling at sub-seasonal to seasonal timescales, familiarizing them with high performance computing methods and tools.

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## **Bridging Disciplines, Empowering Students: A JGI-UC Merced Data Science and Genomics Training Program for the Energy Sciences Workforce**

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2: Lawrence Berkeley National Laboratory (LBNL)/Joint Genome Institute (JGI), Berkeley, CA 94720

The proposed UC Merced-JGI RENEW Internship Program is built upon a successful and established partnership between investigators. Since 2014, UC Merced (through Dr. Sindi) and LBNL/JGI (through Wang) have co-managed a Summer Undergraduate and Graduate Internship program. The program matches students with projects and mentor scientists at JGI that provide hands-on experience in cutting-edge genome research and apply experimental and computation tools to solve problems in computational biology and genomics. Initially, the program began with two graduate students, but in recent years has grown to an annual cohort size of 10. Since 2014, the program has supported sixty students who have contributed to approximately forty JGI projects.

This UC Merced-JGI training program will be expanded through Department of Energy's (DOE) Reaching a New Energy Sciences Workforce (RENEW) program in 4 innovative directions: (1) expanding our Summer internship to a year-long research & training program; (2) engaging the training program's Alumni both for workforce building & mentoring of new trainees (3) strengthening the research and scientific exchange between UC Merced and JGI; (4) employing data-driven assessment to improve the training program and to serve as a model for other DOE/academic partnerships.

The proposed program extends the activities between UC Merced and JGI from the existing Summer to throughout the entire calendar year. Graduate students will be supported to carry out their research during the academic year, providing continuity to their own work and increasing the opportunity for engagement with research from students at UC Merced beyond the supported cohort. Joint workshops and seminars continuously provide engagement and scientific exchange between UC Merced and JGI. As in the past, the research questions approached by trainees will be aligned with UC Merced and JGI's research to address important challenges in bioenergy and biosystems by using omics data to study microbial communities and critical species of interest.

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## Partnership for Fostering Graduate Training in Atmospheric Sciences at Texas Southern University

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2: Brookhaven National Laboratory (BNL), Upton NY 11973

Texas Southern University (TSU), a Carnegie R2 research institution and one of the largest Historically Black Colleges and Universities (HBCUs) in the nation builds a long-term and sustainable research partnership with the Brookhaven National Laboratory (BNL) to train graduate students in Atmospheric Sciences. Through the ongoing engagement with research activities in the DOE Science Focus Area (SFA) project “PASCCALS: Process-level Advancements of Climate through Cloud and Aerosol Lifecycle Studies” (<https://asr.science.energy.gov/projects/15588>), this project aims to expand existing research programs, develop new capacities at TSU, and provide additional exciting opportunities for research and hands-on training for underrepresented and underserved graduate and undergraduate students. The main goal of the proposed program is the creation of a positive and inclusive learning and research environment that will nurture the next generation of a scientifically and technologically savvy, globally competitive energy workforce. Towards this end, the project sets the following objectives: 1. Provide experiential training to graduate students from the Department of Physics, Department of Chemistry and Department of Environmental and Interdisciplinary Sciences (EIS) at TSU by leveraging existing collaborations with staff scientists in the Environmental and Climate Sciences Department at BNL, and through broadening mentoring, science and immersion opportunities coupled with curricular development. 2. Enhance research capabilities at TSU by fostering a sustainable partnership with the BNL research group with the goal of developing both theoretical physical models and computational chemistry models of particulate reaction formation and its interaction to the formation of cloud condensation nuclei (CCN). 3. Leverage the Department of Energy’s (DOE) Atmospheric Radiation Measurement (ARM) Facility by actively partnering on analyzing data from the Tracking Aerosol Convection Interactions Experiment (TRACER) campaign, and other ARM deployments, towards creating predictive models of critical aerosol formation and convective interactions in cloud processes, in conjunction with empirical statistical analysis methods.

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## Co-designing Foundational Capabilities to Diversify the Scientific Workforce

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As the United States (US) population diversifies, the environmental science workforce lags the inclusion of historically underrepresented minorities (URM). To address the scope and scale of the dual environmental crisis faced by people and nature, this project seeks to ambitiously transform the understanding of climate-relevant processes while increasing workforce-ready URMs inclusion in climate science. By creating a foundationally solid URM pipeline through effective mentorship, the project will increase diversity and chances of understanding the urban-rural impacts due to climate change in the US most populated cities, which is critical to preparing and protecting Earth from future hazardous scenarios. This proposed Office of Biological & Environmental Research Reaching a New Energy Sciences Workforce (BER RENEW) project is designed to create a Promote Inclusive and Equitable Research (PIER) plan that catalyzes partnerships with the Department of Energy (DOE) Earth and Environmental Systems Sciences Division (EESD) Offices address identified solvable historically black colleges and universities (HBCU) barriers. The project will accelerate inclusion and diversity of the US science and technology ecosystem to increase the future pool of young scientists with critical skills and expertise. In the long term, the overall goal of this project's motivation is for DOE labs to accelerate the ability to hire students out of these workforce ready programs which would further diversity DOE staff. The Program will be centered around Student First development and Student chosen research. By selecting a cohort of at least 3 students to be mentored in the development of DOE emerging and Critical Science Questions e.g., a required predictive capability as it is hindered by the strong heterogeneity of urban terrain, and the wide range of scales and processes that dictate how urban systems interact with the surrounding Earth system -- DOE need for the Urban Integrated Field Laboratories. The project objectives are to: i) broaden existing institutional capabilities, (ii) develop competitive advantages for experiential training opportunities, (iii) increase workforce ready URMs through effective individualized mentorship plans and PIERs. HBCU Barriers to funding will be addressed to bridge these gaps over the three-year term with in-person (tri-quarterly) and virtual (monthly) meetings with strong mentoring to accelerate workforce development. The project aims to educate and integrate URMs into DOE science with intentional inclusion in an equitable manor, through RENEW team members visiting each other's facilities (host site tours) to share science communications (oral and posters) that result in co-developed competitive proposals. Beneficial outcomes of this project will be new fundamentally inclusive partnerships with DOE and HU tasked to understand the urban-rural impacts due to climate change in the US, related to energy issues driven by heat stress and the energy cycle that can be scaled. The overall impacts of the RENEW will be in paving the way to ensure the inclusion of diverse voices to increase climate resilience with a transdisciplinary partnership that will minimize impacts on the most vulnerable communities while constraining barriers to HBCUs and URMs.

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