SELECTION LIST

FY10 Global Climate Change Education (GCCE): Research Experiences, Modeling & Data

NASA Cooperative Agreement Notice

NNL10ZB1011C

Selected proposals in Funding Category D/M: Using NASA Earth system data, interactive models and simulations to Strengthen Teaching and Learning about Global Climate

Project summaries are listed below.

Title	Institution	State	PI
DataStreme Earth's Climate System: Creating a Sustained Community of K-12 Educators who are Local Leaders in Climate Science and Global Change Issues	AMERICAN METEOROLOGICAL SOCIETY, INC.	DC	Brey
EdGCM: A Realistic Global Climate Modeling Experience for Educational Institutions	THE TRUSTEES OF COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK INC	NY	Chandler
Global Climate Change and Human Health Impacts: Investigation and Analysis in the Classroom using Innovative Technologies	INSTITUTE FOR THE APPLICATION OF GEOSPATIAL TECHNOLOGY AT CAYUGA COMMUNITY COLLEGE	NY	Coughlin
Climate Change Education: Engaging Teachers and Students and Correcting Misperceptions using NASA data	UNIVERSITY OF TOLEDO, THE	OH	Czajkowski
Down To Earth Climate Science: Engaging Tomorrow's Leaders Today	REGENTS OF THE UNIVERSITY OF CALIFORNIA AT RIVERSIDE	CA	Droser
Climate Literacy: Integrating Modeling and Technology Experiences (CLIMATE) in NC Classrooms, An Interdisciplinary, Global Climate Change Fellowship Program for NC High School Science Teachers	UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL	NC	Gray
Using NASA Data to Improve Climate and Science Literacy of Young Adults	FLORIDA ATLANTIC UNIVERSITY	FL	Lambert
Engaging Students in the Science of Climate Change: Using Earth Observing Data in the Classroom	UNIVERSITY SYSTEM OF NEW HAMPSHIRE	NH	Martin
Scaling from local to global: Teacher professional development to provide a	COLORADO STATE UNIVERSITY	CO	Moore

framework for classroom instruction on climate change and associated environmental consequences			
Collaborative Development of a Climate Change Curriculum for Classrooms in the Intermountain West	UNIVERSITY OF IDAHO	ID	Mulkey
CYCLES: Teachers Discovering Climate Change from a Native Perspective.	REGENTS OF THE UNIVERSITY OF MINNESOTA	MN	Roehrig
Climate Change Education: Science, Solutions, and Education in an Age of Media	UNIVERSITY OF MASSACHUSETTS	MA	Rooney-Varga
Data-enhanced Investigations for Climate Change Education (DICCE)	SRI INTERNATIONAL	CA	Zalles

Selected proposals in Funding Category R: Global Climate Change Science Research Experiences for Pre- or In-Service Teachers

Project summaries are listed below.

Title	**Institution**	**State**	**PI**
Climate Science Research for Educators and Students (CSRES): Understanding Sun/Earth/Atmosphere Interactions	INSTITUTE FOR EARTH SCIENCE RESEARCH AND EDUCATION	PA	Brooks
Data-model fusion and forecasting 21st-Century environmental change in northeastern North America	HARVARD COLLEGE, PRESIDENT & FELLOWS OF	MA	Ellison
Development of an Educator-Climatologist Learning Community (ECLC) using Web 2.0 and On-line, Process-Oriented Climate Change Research and Educational Experiences	UNIVERSITY OF NEBRASKA	NE	Gosselin
Researcher-teacher partnerships: making global climate change relevant in the classroom	OREGON STATE UNIVERSITY	OR	O'Connell

Summaries of Selected Proposals
Proposals are sorted by Funding Category and then proposal number.

Funding Category D/M Selections

10-GCCE-0014
Title: Climate Literacy: Integrating Modeling and Technology Experiences (CLIMATE) in NC Classrooms, An Interdisciplinary, Global Climate Change Fellowship Program for NC High School Science Teachers
Institution: UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL
State NC
PI Ms. Kathleen M. Gray

Summary: The University of North Carolina at Chapel Hill's (UNC-CH) Institute for the Environment (IE) will partner with the North Carolina Department of Environment and Natural Resources (NCDENR) Office of Environmental Education (OEE) to provide a long duration professional development experience for NC teachers on the topic of global climate change. Through this partnership, we will combine hands-on climate change science investigations with experiential learning in fragile ecosystem environments. Teachers will work alongside climate scientists, conducting inquiry-based science and participating in the development and dissemination of technology-focused curricula.

CLIMATE will engage 72 secondary science teachers, exposing them to global, regional and NC specific data on climate change science and impacts as well as effects of climate change from economic and social perspectives. NASA earth observation data and NASA earth system models will be incorporated into interactive and hands-on programming designed to enable teachers to experience these tools first-hand in the context of current research questions. Numerous scientists, from diverse disciplines, including many who utilize NASA data will be on hand to interact with participating teachers and discuss their research interests. These faculty members will be invited to share their expertise at both the local and global levels with teachers.

This fellowship program will have four main components: 1) six days of professional development comprised of one three-day intensive summer institute at UNC-CH and two, 1.5 day weekend retreats, one in the NC mountains and one at the NC coast (both in proximity to IE field sites, thus enhancing exposure to scientists conducting relevant research); 2) three academic year webinars designed to support classroom adoption of resources provided during the workshops; 3) maintenance of a blog and listserv to build an online community for sharing resources and ideas, and 4) development, evaluation and dissemination of lessons that incorporate NASA data/models. Teachers who complete all aspects of the program will be supported in sharing their lessons online via LEARN NC (http://www.learnnc.org/) and thus making lessons available to teachers across the nation. This program will be extensively evaluated upon the conclusion of each component above and will inform subsequent years of the program.

10-GCCE-0024

Title: DataStreme Earth's Climate System: Creating a Sustained Community of K-12 Educators who are Local Leaders in Climate Science and Global Change Issues

Institution: American Meteorological Society

State NC

PI Dr. James A. Brey

Summary: The American Meteorological Society (AMS) will nationally implement an innovative course for in-service pre-college teachers on the basic understandings and related aspects of Earth's climate system and climate change. Entitled DataStreme ECS (Earth's Climate System), the course will prepare teachers to lead and assist their students and teaching peers in recognizing and understanding the workings of Earth's climate system and the impacts and issues arising from climate variability and change. It shares NASA's goal of observing, understanding, and modeling the Earth system to discover how it is changing, to better predict change, and to understand the consequences for life.

Following the best practices of three highly successful AMS DataStreme teacher-enhancement courses, and using a textbook, investigations manual and course website created through NASA Grant NNX08AN53G Promoting Climate and Climate Change Literacy Through Pre-college Teacher Enhancement, the course will be delivered nationally via Local Implementation Teams (LITs). Central to the course will be investigations with components written in real time that employ the latest Internet-delivered environmental data and information (many based on NASA products). State University of New York's College at Brockport will award three hours academic graduate credit for successful course participation.

The ultimate goal is to develop an informed public that recognizes the relevance and impacts of climate and climate change to people's lives and the choices they can make to mitigate or adapt to adverse effects. Key to this will be promoting ongoing teacher, student and public access to NASA education resources by promoting e-Education as a principal learning support system.

10-GCCE-0028

Title: CYCLES: Teachers Discovering Climate Change from a Native Perspective

Institution: University of Minnesota

State MN

PI Dr. Gillian H. Roehrig

Summary: Building on three successful, established programs in northern Minnesota (gidaa, TRIBES-E, and RFTS) that foster Native American STEM education through both formal and informal education, we propose the CYCLES program to initiate a 3-year immersion of teachers into the study of global climate change. Challenges related to global climate change (GCC) are faced by all Americans. Native American communities are especially concerned about these challenges since changes in climate present challenges to land and water management, adversely affecting native communities whose ties to the land are both economic and cultural. Thus, CYCLES addresses the need for Global Climate Change Education (GCCE) with a focus on Native perspectives. CYCLES will develop an innovative approach to understanding and teaching about GCC that is native friendly, place-based, holistic and interdisciplinary,

technologically rich, and incorporates NASA data, models, and simulations.

Twenty middle and high school teachers from reservation schools will participate in the project that includes a two-week summer workshop each year. During the summer workshops teachers will be actively involved in doing GCC science, both in the field with local projects and working with existing National Center for Earth-surface Dynamics (NCED) and NASA data. Teachers will learn how to use NASA tools to visualize and model GCC change to answer questions about GCC. All activities will be modeled using inquiry-based pedagogy and the culturally responsive Seven Elements of STEM Learning. During the academic year, teachers will implement lessons and activities from the summer workshops in their classrooms with support from the CYCLES staff.

The CYCLES Project directly addresses all of the NASA GCCE project goals and in addition, supports NASA's cultivation of diversity as a core value for all NASA education efforts. The specific objectives for the CYCLES project are: 1. Strengthen teachers' understanding of fundamental Earth-System Science and Global Climate Change concepts; 2. Develop GCC teaching strategies that are culturally responsive; 3. Improve teachers' knowledge of and implementation of GCC education resources; and 4. Increase students' knowledge of GCC.

The CYCLES team includes leadership in teacher professional development and inquiry-based instruction (Roehrig), local cultural expertise in STEM instruction (Dalbotten and Gourneau) and GCC research (coordinated by Campbell through NCED). NCED is a consortium of eight partner universities, the Fond du Lac Tribal and Community College (FDLTCC), and the Science Museum of Minnesota (SMM). NCED faculty are involved in bringing together methods and understanding from ecology, geology, civil engineering, hydrology, and biology into a new interdisciplinary field of ecogeomorphology. NCED researchers combine field studies, laboratory research, and computational models to create a quantitative and predictive approach to Earth-surface processes. The project team also includes the Minnesota Planetarium Society (Halverson) and utilizes their ExlporaDome for 3D visualization of NASA data sets for both teachers during the summer workshops and students during the academic year.

10-GCCE-0051

Title: EdGCM: A Realistic Global Climate Modeling Experience for Educational Institutions
Institution: Columbia University
State NY
PI Dr. Mark A. Chandler

Summary: Many studies show that climate change has already begun to affect natural and societal systems, and even the most optimistic international agreements allow for continued greenhouse gas increases and significant future climate change. Ongoing climate impacts will be monitored by a growing array of observational systems, both space and land-based, while projections of impacts are made by complex global climate models. To advance the use of these "forecast" systems, colleges and universities are advancing the level of training in model development within traditional Earth and atmospheric science departments, and simultaneously expanding training in the use of climate models and model output to non-traditional areas --

biology and chemistry departments, centers of public health and learning science, and business and law schools.

To keep pace with this demand, climate modelers and educators need to transform the primary climate science tools for delivery to users well beyond the walls of climate research institutions. In the emerging economy it is critical that we prepare the next generation to make use of the tools-of-the-trade and the data they produce, because many professions will require a workforce trained to recognize climate impacts before they happen. This will help society adapt sensibly and efficiently to climate change, make responsible decisions about mitigation strategies, and avoid any disastrous consequences.

Our project will put NASA's functional climate models into the hands of educators and students who otherwise wouldn't have access to such advanced capabilities. To do this we will work with the NASA/GISS climate model development, several universities and community and technical colleges to upgrade and test a suite of Educational Global Climate Modeling software and associated curriculum materials. The project will allow students to:

1. Learn the fundamentals of how climate change projections are made
2. Setup and operate actual climate model experiments
3. Analyze the resulting data
4. Provide hands-on activities with real-world tools that are applicable to real world problems
5. Tie instruction to current events, local needs, and job opportunities, so students can appreciate the significance of the science
6. Take advantage of existing school computing resources, whether that is laptops, shared labs, or supercomputers.

10-GCCE-0056

Title: Scaling from local to global: Teacher professional development to provide a framework for classroom instruction on climate change and associated environmental consequences

Institution: Colorado State University

State CO

PI Dr. John C. Moore

Summary: We will provide innovative ways to teach about climate change and its consequences for the environment to middle school and high school teachers and their students. We will cover climate change at a global scale, regional, and local impacts on climate due to changes in land-use and water use along the Colorado Front Range. The project integrates Earth science content and NASA datasets (e.g., NDVI, EVI, snow cover, evapotranspiration, land surface temperature, etc.) into professional development workshops, instructional materials and course modules. Our model employs direct engagement of faculty, graduate students, and upper-division undergraduates with in-service teachers and K-12 students.

We will carry out the following project goals and objectives:
Goal 1) Improve the science content knowledge and preparedness of middle and high school

teachers.

Objective 1.1) Recruit teachers, students and research faculty to partner in workshops focused on climate change, NASA data acquisition, data analysis, and interpretation.

Objective 1.2) Provide summer research experiences for teachers that include working with NASA datasets in a research context.

Objective 1.3) Conduct workshops for teachers that focus on science inquiry and content, and effective uses of NASA datasets.

Objective 1.4) Develop a seminar series for the teachers, undergraduates and graduate students that stresses the implications of the climate on regional planning and public policy.

Goal 2) Increase the science content knowledge of middle and high school students.

Objective 2.1) Develop and infuse instructional modules based on the workshops, research experiences, and NASA datasets into existing courses.

Objective 2.2) Place graduate students in classrooms to work the teachers.

Objective 2.3) Work with school counselors to encourage student participation in challenging science courses.

Objective 2.4) Recruit middle and high school students into the existing enrichment programs at CSU.

Goal 3) Increase the awareness, opportunities and participation of middle and high teachers in content-based professional development activities.

Objective 3.1) Conduct grant writing workshops that partner K-12 teachers with graduate students and science research faculty.

Objective 3.2) Establish a clearinghouse of current research opportunities for K-12 school teachers to connect teachers to research opportunities.

Objective 3.3) Coordinate research funding requests to state and federal agencies to include K-12 school teachers as research assistants and fellows on research teams.

The project includes evaluation by the project leadership and external evaluation by a team with experience in evaluation of education initiatives. All elements will be aligned with Colorado science content standards and evaluated using measurable benchmarks.

10-GCCE-0061

Title: Engaging Students in the Science of Climate Change: Using Earth Observing Data in the Classroom

Institution: University of New Hampshire

State NH

PI Dr. Mary E. Martin

Summary: Human activities, including CO2 emissions, deforestation and other forms of land cover change exert substantial pressures on the Earth's climate system. Changes in climate that have already begun will likely unfold over decades to centuries and will be shaped by the decisions of future generations. Given the enormous importance of climate to human societies, interest in climate change and the need to understand how it works will be increasingly important to future generations. This will create a need for both better public understanding and for an educated workforce that can apply knowledge of the climate system to formulation of sound energy and land management policies.

The work we will carry out is designed to address these needs through development of student climate change curriculum materials that combine new resources from a GLOBE carbon cycle science education initiative with NASA Earth observation data. By addressing a critical component of the Earth system, the GLOBE carbon cycle project was intended to introduce students to important concepts in Earth System Science and to provide the underpinnings for future climate change education. Here, we carry this vision forward, with climate change as an explicit focus and NASA Earth observation data as a core component of student activities.

With a focus on terrestrial ecosystems, we will use data from NASA's MODIS/TERRA instruments as well as Landsat, combined with publicly available field data from our own research and other studies. By integrating these new materials with the GLOBE carbon cycle project, the climate change materials we develop will be highly relevant to GLOBE's upcoming Student Climate Research Campaign (2011-2012). Over 100 countries and 50,000 teachers currently participate in the GLOBE program. We have already begun planning with the GLOBE Program Office and we expect that many GLOBE schools will be interested in participating in our climate change activities. Our connection with such an extensive school network will ensure the widest distribution and broadest use possible of the materials we develop.

The work we do will have substantial broader impacts, beyond the immediate benefit of familiarizing students with Earth observation data and the science of climate change. Because climate change is a long-term process, and is subject to a myriad of misconceptions, this effort will help develop the knowledge and skills of future generations in an area that is becoming increasingly important to society. We have aligned our development plan with both the National Resource Council's National Science Education Standards and the US Climate Change Science Program's Climate Literacy Principles, which provide input to science education standards at local, state, and national levels, further insuring that our products will be useful teaching materials. Our effort will involve and be relevant to schools spanning a range of demographic and socioeconomic conditions, ranging from rural to urban environments.

Finally, our team brings together accomplished scientists and educators, including investigators from NASA's Carbon Cycle Science and Terrestrial Ecology programs, as well as educational outreach specialists with strong science backgrounds. We have also selected an external evaluator with a long history of evaluating science educational programs at both local and national levels.

10-GCCE-0067

Title: Global Climate Change and Human Health Impacts: Investigation and Analysis in the Classroom using Innovative Technologies

Institution: Institute For The Application Of Geospatial Technology at Cayuga Community College

State NY

PI Jessica M. Coughlin

Summary: This project will bring NASA climate change and other Earth system information to teachers and students, using a variety of motivating and interactive methods. These methods include the development and implementation of hands-on, climate change workshops for

educators, accurate and age-appropriate lesson plan development for the secondary level classroom, and the enhancement of a NASA 3D, visualization application, NASA World Wind, for communicating and accessing these data in an intuitive and engaging way.

Through a collaborative effort, the investigators will leverage the wealth of available climate change information, research, and related NASA resources, and transform it in a way that makes it relevant and accessible in an engaging form. IAGT will work with The Center for International Earth Science Information Network (CIESIN) within the Earth Institute at Columbia University. CIESIN works at the intersection of the social, natural, and information sciences, and specializes in on-line data and information management, spatial data integration and training, and interdisciplinary research related to human interactions in the environment. The center has a variety of climate change data holdings, including U.S. emissions data, climate estimates, and a number of human impact studies. CIESIN also hosts NASA's Socioeconomic Data Application Center (SEDAC) whose mission is to develop and operate applications that support the integration of socioeconomic and Earth science data and to serve as an 'information gateway' between the Earth sciences and social sciences.

The outcomes of this project will help attract and retain students in STEM disciplines, build partnerships that promote STEM literacy, and achieve excellence in STEM education. High achievement, awareness and understanding in these disciplines will facilitate the establishment of a knowledgeable generation that is equipped to manage the causes and effects of a changing global climate and the impact on human health.

10-GCCE-0071

Title: Climate Change Education: Science, Solutions, and Education in an Age of Media
Institution: University of Massachusetts - Lowell
State MA
PI Dr. Juliette N. Rooney-Varga

Summary: Climate change offers one of the greatest challenges yet faced by society and scientists. The scientific consensus is clear that climate change is occurring, its pace is accelerating, its impacts on human society will be largely negative, and it is mainly caused by anthropogenic greenhouse gas emissions. Yet, despite strong scientific evidence for the enormous challenges that society could face, scientists' attempts to disseminate that evidence beyond their peers has largely fallen flat. Indeed, in today's media world of blogs, YouTube video clips, and sound-bites, confusion over the scientific reality of climate change frequently dominates the discourse in classrooms and communities. Some of the unique challenges presented by climate change education include the complexity of the problem, the need for an interdisciplinary perspective, and the fact that scientists lack the training and incentives to explain their work in an accessible manner.

We will work to overcome these challenges by combining new and ongoing initiatives to create an approach to climate change education in which students gain an understanding of science and of the media through which they access information. Our goals are to:

- Use NASA data and visualizations to develop new approaches to integrating science and media through project-based learning and media documentation at the high school and

university levels.

- Reach beyond educational institutions by engaging the broader community through dissemination of media produced by students about climate change science and NASA's unique contributions in this area.
- Enhance existing NASA-supported climate change web resources with videos produced by students.
- Provide resources and social networking e-learning tools to launch online video-based conversations about climate change science and solutions, integrated with resources that are currently available and under development.

We plan to integrate the following program elements at the higher education, high school, and professional development levels in order to achieve our objectives:

- Development of new undergraduate- and graduate-level interdisciplinary courses and course modules in climate change at UMass Lowell that combine inquiry-based exploration of NASA's data and visualization tools, leveraging the Earth Exploration Toolbook (EET) and the EarthLabs climate change module under development by co-PI Ledley (TERC).
- Development of a new high school summer program in which high school students produce videos and animations on climate change science using CEA's state-of-the-art Media Arts Studio, lead by Co-PI Brisk. Students will learn about climate change science through exploration of NASA products via EarthLabs and EET and through on-camera interviews with UMass Lowell faculty who are experts on climate change.
- Dissemination of edited collections of student-produced videos through institutional events, community events, and television broadcasts.
- Enhancement of NASA-funded EarthLabs module by providing feedback on their efficacy and usability, and providing relevant video content that can be integrated into modules.
- Development of comprehensive online professional development resources and social media tools that enable teachers to inexpensively incorporate video into climate change education curriculum and enable their students to join an online conversation on climate change science and solutions.

We believe this project will open new avenues for communicating the complex science of climate change to students and the broader public. Videos produced by students will naturally incorporate their peers' questions, concerns, and perspective on this complex problem and the products of this work can be disseminated extremely broadly and used to enhance existing resources on climate change and, more generally, STEM, education. These features are key to the successful education of both students and the broader public in climate change science.

10-GCCE-0079

Title: Using NASA Data to Improve Climate and Science Literacy of Young Adults
Institution: Florida Atlantic University
State FL
PI Dr. Julie L. Lambert

Summary: Our team will include Julie Lambert, Associate Professor of Science Education at Florida Atlantic University, as principal investigator; Brian Soden, Professor of Meteorology and Physical Oceanography at University of Miami, as co-investigator; and Robert Bleicher, Associate Professor of Science Education, California State University, Channel Islands, as co-

investigator.

The overarching objective of our project will be to develop and implement modules that will enable students to analyze and use NASA data to address the public's questions and commonly held misconceptions/mistaken beliefs about climate change.

Our approach is not only to teach high school and undergraduate students how to answer these questions, but also to use the questions themselves and the arguments which underlie them as a basis for teaching the scientific processes that affect/contribute to/bring about/trigger climate change (i.e., develop hands-on modules that enable students to use NASA data and models to answer the questions for themselves, rather than simply reading other people's conclusions). In this way, the students are using science to actively acquire knowledge (constructivism). For example, in these modules, students would use NASA satellite and remote-sensing data and models to analyze short-term variability versus long-term temperature trends, natural versus human forcings of climate change, climate feedbacks, and the other processes related to climate change.

Our plan is to develop and test these modules in our own undergraduate-level classes in year one, then to conduct professional development for southeast Florida high school teachers and support the modules' implementation in year two, and finally to evaluate and finalize the modules in year three.

10-GCCE-0091

Title: Down To Earth Climate Science: Engaging Tomorrow's Leaders Today
Institution: University of California, Riverside
State CA
PI Dr. Mary L. Droser

Summary: "The Down to Earth Climate Science" project will: (1) help students understand climate science in the 21st century; and (2) provide educators a way to integrate NASA data and Earth Science models into a coordinated series of lessons about climate change issues. Many students leave college without the scientific tools to evaluate the claims of climate change skeptics or to understand the importance of climate change science for themselves. They not only lack understanding about specific climate change issues, but are even unaware of the tools needed for understanding or the importance of modeling as a guide to facing the impacts of climate change. Moreover, when first generation college graduates are asked by friends and family to explain climate change, they often cannot articulate the issues or the scientific findings.

"Down to Earth Climate Science" is a collaborative effort of the University of California, Riverside and the nearby NASA JPL. We will produce an innovative curriculum centered on data collections and Earth system models available from NASA and NASA data center web pages. Each week, the curriculum integrates an eclectic array of NASA-based data sources and modeling tools into a complementary lecture-lab to communicate and instruct about a variety climate change issues. Classroom lectures focus on ways that NASA observes the Earth; these prepare the student for labs that make use of graphical learning tools and out-of-class exercises that serve as tools for exploratory learning. Inherent in this synthesis of NASA tools, lectures

and exercises is a constant theme of thinking about Earth systems from a modeling standpoint. This approach prepares the next generation of students and leaders to understand and articulate issues. This is critical in a media-driven society that often considers "data models" pseudo-science.

All this is set at UC Riverside, one of the nation's most diverse public universities, and with K12 district partners whose student populations are composed mostly of members of under-represented groups and first-generation college attendees.

There are three main anticipated outcomes: (1) participants will acquire the tools to articulate their understanding of climate change to their communities; (2) they will become engaged by the innovative ways that NASA observes the Earth; (3) they will appreciate the viability and meaningfulness of Earth and climate science as a future career track.

We evaluate Down to Earth Climate Science using a triangulated set of quantitative and qualitative research methods. In this, we examine four factors that are significant in monitoring the change of perspective of students toward Climate Change issues: (1) content knowledge related to Climate Change; (2) attitudes towards the science of Climate Change; (3) attitude towards the scientific process in general as a way of generating information; and (4) awareness of career options related to Climate Change.

The Chairman of the Department of Earth Sciences at the University of California will serve as project PI and will be responsible for overall performance. Co-I and Academic coordinator will design integrated lab-lecture curriculum and manage integration into courses and web page design.

10-GCCE-0094

Title: Collaborative Development of a Climate Change Curriculum for Classrooms in the Intermountain West
Institution: University of Idaho
State ID
PI Dr. Stephen S. Mulkey

Summary: Although some of the most profound effects of anthropogenic climate change are apparent in the Intermountain West, the public, including Native peoples of this region, are largely uninformed about the science and impacts of climate change. In order to address this systemic lack of understanding of the science of climate change, we propose a program composed of three initiatives for collaborative teacher training and curriculum development. Teacher and student understanding of the essential principles of climate literacy will be the primary learning objectives of this project, and these standards will be used for evidence-based evaluation. The management team for this project includes experts in climate, social, and education sciences.

Initiative I: Faculty of select school districts in northern Idaho, northeastern Washington, Boise, and the Pocatello region will be engaged in the collaborative development of teaching/learning modules and a design for teacher training in climate change science. Graduate students and

experts will travel to workshops at these schools where teachers will be included as members of module development teams. The curriculum will explicitly include cultural and resource issues relevant to the local communities and to students of the Spokane, Nez Perce, Coeur d'Alene, and Shoshone-Bannock tribes. Initiative II: The curriculum created in the first initiative of the program will be adapted for use in distance learning environments and distributed throughout the secondary school systems of Idaho in collaboration with the state-sponsored Idaho Digital Learning Academy and the Idaho Education Network. The project will create an Internet community where teachers learn from each other and exchange teaching tools. Initiative III: The curriculum components from Initiatives I & II will be adapted for use in college freshman-level instruction, and instructors from regional community and tribal colleges will be trained at workshops in climate change science and instruction. NASA Idaho Space Grant will co-sponsor these workshops.

Curricular materials will be designed to meet state and national standards for STEM education, and teachers and students will be assessed for their understanding of standards for climate science literacy. Various NASA products will be used for the creation of: (1) model-based simulations of snowpack and regional hydrology; (2) model-based simulations of forest and shifting forest climate zones; (3) simulations of physical and biophysical changes regionally and globally; and (4) region-specific lesson plans. Some modules will involve a hands-on experience for estimation of greenhouse gas emissions and carbon footprints. Unique features that are central to the success of this program include: (1) the collaboration of teachers with scientists and graduate student fellows in climate science and related fields; and (2) the explicit inclusion of place-based resource and cultural issues relevant to the Native peoples of the region.

Evaluation of this program will be conducted according to protocols provided by an external evaluator. Teacher understanding of climate change will be evaluated for relevance to (1) standards for climate science literacy, (2) local and regional impacts of climate change, and (3) means of mitigation and adaptation.

10-GCCE-0122

Title: Data-enhanced Investigations for Climate Change Education (DICCE)
Institution: SRI International
State CA
PI Dr. Dan R. Zalles

Summary: A growing body of research is providing evidence of the effectiveness of hands-on geospatial technology in K-12 student STEM learning (Bodzin, 2008; Buss, McClurg, & Dambekalns, 2002; Connor & Prakash, 2008). Hence, greater use of the NASA mission data in high school classrooms for investigating local climate change can develop students' understanding of and interest in pursuing scientific inquiry into climate change. NASA's Goddard Interactive Online Visualization and Analysis Infrastructure (Giovanni) provides a pathway. Yet to be useful in high school classrooms, datasets such as those in Giovanni need to be connected to sequences of student learning activities (Committee on Science Learning, 2007) and be presented and explained to teachers in ways that increase their own knowledge about climate change and equip them with effective inquiry strategies and resources for teaching.

Innovations: We will develop a new pathway and online learning environment to support high school teachers in selecting data for students' climate change investigations and developing lesson plans for student data use. The pathway and learning environment for students will be unprecedented in that we will use principles of Universal Design for Learning (Rose & Meyer, 2002; Rose, Meyer, & Hitchcock, 2005) to design learning tools that scaffold inquiry with the data visualizations. Educational research points to the need to scaffold student inquiry (Davis & Miyake, 2004) to achieve an appropriate balance between structure and choice in student learning tasks (Dunkhase, 2003). Related projects have aimed to advance classroom uses of Earth observation data but not with the structures for integrating data and curricula that DICCE will bring, nor with the attention to climate change at the local level that DICCE will address. Distinguishing features: The project will design and pilot-test two interactive websites for high school classroom climate change investigations: DICCE-Giovanni (DICCE-G) and DICCE-Learning Environment (DICCE-LE). DICCE-G will enable high school teachers to assemble customized datasets about local climate change from NASA remotely sensed Earth observation mission data archived in NASA's Giovanni (http://disc.sci.gsfc.nasa.gov/giovanni/). We will also develop project templates that teachers will use to construct curricular activities that prompt their students' investigations of the data. These two interactive websites will be comprehensive in the way they incorporate forms of support for both teachers and students and thereby make use of the data more feasible in high school settings.

Anticipated outcomes and metrics for success: We expect increased learning and interest about climate change among diverse students in our pilot-test sites as well as greater pilot teacher capacity for and commitment to climate change education. Pre- and post-survey and assessment instruments will be used to measure the extent to which classroom implementation results in greater student awareness of the state of science about causes and effects of climate change, greater student interest in climate change research and policymaking, and greater teacher knowledge of the educational value of NASA resources. Then, through dissemination efforts, we expect eventual wide use of the DICCE-G tool and DICCE learning environment by U.S. high school students studying climate change.

Management: PI Dr. Daniel Zalles of SRI International and co-I James Acker of GES-DISC will lead a team of experts in climate change, high school STEM education, and software engineering, plus six high school science teachers teaching diverse students in three states.

10-GCCE-0128

Title: Climate Change Education: Engaging Teachers and Students and Correcting Misperceptions using NASA data
Institution: University of Toledo
State OH
PI Dr. Kevin Czajkowski

Summary: Through this project, an interdisciplinary group of faculty from across the University of Toledo including social and physical scientists will develop five stand-alone, online modules for grade 7-12 students to improve student (and teacher) learning of climate change topics by addressing common misconceptions. Constructivist theory says that misconceptions are a barrier to student learning and need to be addressed before students can

move on. The highly politicized topic of climate change has many misconceptions held by students (and teachers alike). One particularly pernicious misconception that haunts many a teacher and college professor is “The ozone hole is responsible for global warming.” Each module will address a misconception and have a driving question related to the misconception. The modules will span topics from the impact of greenhouse gases on terrestrial planets, impacts of climate change on local populations and ecosystems, short-term weather versus long-term climate change, economic risk: what are the consequences to doing nothing and reducing individual carbon footprints. Due to the interdisciplinary nature of the misconceptions and modules that we address, we expect teachers from subjects beyond science such as social studies to utilize these modules. This three year project will include development of the module using inquiry-based and critical thinking pedagogy, refinement with teacher involvement, piloting of the modules with Toledo area students focusing on economically disadvantaged and underrepresented groups and dissemination to the broader educational community. Through the modules, we will promote critical thinking by students using a Milne-type grid and counterfactuals to encourage students to use their creativity to conceptualize key concepts in climate change science. We will engage students in inquiry lessons utilizing NASA data, models and simulations including but not limited to EdGCM, My NASA Data, GLOBE observation protocols, planetary data sets from the NASA Space Science Data Center and satellite remote sensing data. The satellite data has been processed by our team for research projects and includes MODIS, Landsat, TRMM, and GRACE. The university’s Center for Curriculum Instruction (CCI), an award winning facility dedicated to incorporating innovative technology into the educational process, will design the web implementation of the modules. Formative assessment will be performed throughout the development process and summative assessment will be used to study the effectiveness of the program.

Funding Category R Selections

09-GCCE-0013

Title: Climate Science Research for Educators and Students (CSRES): Understanding Sun/Earth/Atmosphere Interactions

Institution: Institute for Earth Science Research & Education

State PA

PI Dr. David R. Brooks

Summary: This is a three-year partnership among the Institute for Earth Science Research and Education, Queens College (CUNY), and NASA's Aerospace Education Services Project (AESP) that will significantly raise the profile of climate science among secondary school students. The project is motivated by the observation that successful climate-related projects are conspicuously absent from high-level national student science competitions (Intel, Siemens, etc.).

The fundamental reason for this situation is that the support infrastructures already in place for science areas prominent in national student competitions do not exist for climate science, and that this infrastructure must be built before NASA can achieve its goals of improving public understanding of climate and building a workforce that is prepared to conduct climate science during the 21st century. This infrastructure consists of four components: professional development, expert mentoring, accessible equipment, and well-documented research ideas and protocols.

CSRES takes as its science and education focus the Earth's radiative balance, a topic that is fundamental to understanding Earth's climate. The interactions among the sun, Earth, and atmosphere are invariably summarized in graphics found in texts for Earth science courses. However, it is common knowledge that the details of these interactions (even something as basic as the cause of seasons) are poorly understood.

CSRES will develop a set of inexpensive monitoring instruments and experiment protocols that allow educators and their students to conduct many useful and interesting investigations that will provide the "data ownership" required to understand this complex but essential topic. These measurements include solar energy reaching Earth's surface, surface reflectivity, aerosol optical thickness, and surface thermal emissions. These measurements will be supplemented by NASA products such as global top-of-the-atmosphere radiative balance data available through the NASA Earth Observations (NEO) website and aerosol optical depth, water vapor, and insolation data from ground-based AERONET sites; these data provide frames of reference for interpreting local ground-based measurements in a global context.

CSRES will present its program through a series of professional development workshops for New York City teachers. NYC schools represent a large and very diverse student and teacher population but, even more important for CSRES, NYC is already implementing a major initiative in which science educators are responsible for helping students develop nationally competitive science fair projects. By providing science background, equipment, research opportunities, and mentoring, teachers will be able to conduct their own climate research and they will create the

level of support for climate science that is needed to increase the likelihood that students will choose climate-related research projects and, subsequently, climate-related STEM careers. Equally, important, CSRES will also increase teachers' confidence in their abilities to present climate-related topics in their classrooms.

To ensure a sustainable project, CSRES will work with AESP personnel. This long-running NASA national education outreach program reaches educators and students around the U.S. with a combination of "hands-on" contacts and online/distance learning that is ideal for bringing CSRES to a national audience. CSRES will provide travel support for four AESP educators to work with project personnel at Queens College workshops. CSRES has already identified a secondary school partner in Iowa to implement a pilot program under AESP guidance and AESP has committed to finding teacher partners in two more schools by the third year of this project. CSRES will also collaborate with an ongoing GCCE project at Drexel University.

09-GCCE-0035

Title: Data-model fusion and forecasting 21st-Century environmental change in northeastern North America

Institution: Harvard University

State MA

PI Dr. Aaron M. Ellison

Summary: This three-year GCCE experiential research and education program provides opportunities for undergraduates and K-12 teachers to work with remotely-sensed data, field data, and model-based analyses. The project relies on NASA-supported remote sensing assets and addresses NASA's goals of (1) improving the understanding of the structure and function of global terrestrial ecosystems, their interactions with the atmosphere and hydrosphere, and their role in the cycling of the major biogeochemical elements and water; and (2) exploration of how variability in terrestrial ecosystems and biogeochemical cycles respond to and affect global environmental change now and into the near future. This GCCE project will be integrated into a 25-year-old summer research program at Harvard University's Harvard Forest and provides substantial and sustainable leverage to federally-supported STEM education and research activities. The proposed activities will expand the intellectual scope and reach of the existing Harvard Forest Summer Research Program in Ecology by developing integrated research teams that will engage in cooperative research; enhance diversity in the STEM workforce through a formal partnership with a minority-serving, 1890 Land Grant institution; and enhance K-6 science curricula within the Massachusetts Curriculum Framework in Science and Technology/Engineering. This GCCE project has four measurable outcomes that will determine its success: (1) Students will work with research mentors to validate and enhance regional-scale models for forest response to climatic change (taking advantage of the fact that Harvard Forest is a Core Validation Site for NASA's Earth Observing System); (2) Student-faculty research teams will produce multi-authored integrated presentations at national meetings or multi-authored peer-reviewed publications; (3) The ethnic diversity of the Harvard Forest Summer Research Program in Ecology will be increased, and students from groups that are historically underrepresented in science will be placed into graduate programs or employment; (4) Methods of inquiry that take advantage of NASA data will be incorporated into lessons on climate change that fit within the Massachusetts Curriculum Framework in Science and Technology / Engineering. All GCCE

students and other students in the Harvard Forest Summer Research Program are mentored by faculty and senior scientists who together conduct ecological research at the Harvard Forest. This experiential research and education program includes not only research activities but also evening research seminars and weekly professional development workshops on topics such as: choosing and applying to graduate school; preparing scientific talks and papers; creative science writing, and careers in ecological and environmental science. By directly addressing GCCE Outcomes and Objectives, this program will generate greater intellectual capacity across K-16 education levels that will contribute to the development of a highly scientifically competent and diverse U.S. STEM workforce.

09-GCCE-0084

Title: Development of an Educator-Climatologist Learning Community (ECLC) using Web 2.0 and On-line, Process-Oriented Climate Change Research and Educational Experiences

Institution: University of Nebraska

State NE

PI Dr. David Gosselin

Summary: The ECLC project develops a community-focused, distance-based, professional development program that can provide a successful framework for refining and developing science educators' views about the practice and purposes of science and science's relationships with society. The specific objectives of this project are: 1. Teachers improve their abilities to think critically and evaluate information about climate change through an enhanced understanding of the process and nature of science; 2. Teachers become engaged information-evaluators and learners who create new understanding from knowledge through the use of integrative Web 2.0 technologies; 3. Create a sustainable, virtual learning community among educators, students and experts called the Teacher-Climatologist Educational Community. To accomplish the objectives, it brings together a virtual community of educators and scientists with expertise in climate modeling, drought, agriculture, soils, ecology, and brain-based learning. Climate-change issues serve as a context in which educators develop discrete, locally oriented research projects. Educators define a problem, analyze data, and develop conclusions with the potential to impact decision-making in their community. More importantly, participating educators will gain confidence and knowledge that will help them facilitate the development of similar skills in the young citizen-scientists within their classrooms. We will develop four on-line, distance-delivered, scientifically and pedagogically relevant educational modules to achieve the objectives. The modules will provide educators with opportunity to have an authentic experience with the process of science and reflect on the components of the nature of science in the context of the sociopolitical issues related to climate change. Over the three-year period of the grant, we will provide an online professional development experience for 30 K-12 in-service and 10 pre-service educators, who will, in turn, advance the cause of climate literacy among at least 6000 students. Each educator will be responsible for the development of at least one artifact of their research experience that will be disseminated to educators across country through a variety of mechanisms. The assessment program will document the effectiveness of our online educational model so others can replicate it. Through the development of an infrastructure to support the Climate Change-Focused Extended Inquiry Projects, participants will have an enhanced understanding of the process and nature of science in the sociocultural context of the climate change issue. As a result of conducting and reflecting on their authentic research activity,

participants will improve their skills to communicate, collaborate, inquire, integrate information and knowledge across disciplines, and apply knowledge in creative and innovative ways.

09-GCCE-0099

Title: Researcher-teacher partnerships: making global climate change relevant in the classroom
Institution: Oregon State University
State OR
PI Dr. Kari O'Connell

Summary: The project is designed on the principle that engaging teachers as active participants in the practice of science has a profound impact on their teaching practice. The primary goal of the researcher-teacher partnerships (herein shortened to RTP) project is to engage Oregon 7 - 12th grade teachers in professional development to (a) advance their personal knowledge of the fundamentals of global climate change; and (b) partner with scientists to research a particular focus area of global climate change; in order to (c) integrate this knowledge and experience into their classroom teaching.

The three-year RTP project will bring together science educators from the Oregon Natural Resources Education Program (ONREP), Oregon Sea Grant (OSG), and the Science Math and Investigative Learning Experiences (SMILE) Program and NASA-funded global climate change researchers to engage teachers in three-week summer research institutes. The institutes will include two weeks for participation in an intensive research experience and one week (split at the beginning and end) of training to introduce teachers to key climate change topics and support application of their research experiences to the classroom.

In the RTP project, researchers, teachers, and science educators will form working groups around global climate change topics. The working groups will create a "community context" to make each topic relevant for 7-12th grade classrooms (and/or broader audiences). Teachers will be supported by science educators in using the working group discussions, content from invited speakers and research experiences, ideas for education tools from the professional development parts of the experience, and applicable state standards to develop and implement thematic units that promote students' understanding of global climate change.

We will recruit for project participants through multiple statewide networks and most heavily in Oregon Title I schools and school districts where 40% or more students are enrolled in the free and reduced lunch program and those districts with high percentages of English as a Second Language students.

The long-term impact of changing teachers' practice is significant. The three-year project will have statewide impact by providing professional development for up to 30 teachers, who have the potential of reaching 4,500 or more Oregon students each year of the project. An expected long-term outcome for the proposed project is for teachers to change their teaching practice and incorporate projects that promote understanding of global climate change with students year after year. This project is a partnership between teachers and researchers. Researchers will have opportunities to learn from teachers about the translation of research to the classroom and

improve their communication skills with the general public while teachers will have opportunities to increase their knowledge about science content and the processes of scientific inquiry.

We will work with an external evaluator to measure success of the project using a variety of data sources such as demographic information, survey tools, observations, workshop descriptions, teacher reflections, teacher artifacts, and interviews.

The PI, Dr. Kari O'Connell of the ONREP will lead the development and implementation of the proposed project in coordination with key project partner Nancee Hunter, OSG, and a planning team. The planning team will consist of the PI, Co I Nancee Hunter and one science Co Investigator who will rotate serving on the planning team each year of the project.