Data Enhanced Investigations for Climate Change Education

Year 1 Annual Report (November 1, 2010 - October 31, 2011)

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A. PROJECT ACTIVITIES OVER THE PERIOD OF PERFORMANCE OF THE COOPERATIVE AGREEMENT

We have carried out the following activities aligned to our project timeline:

A1. Conduct first focus group with the six participating teachers to gauge climate education needs and preferences.

On January 22, the first meeting was held between project staff (Co-Investigator Jim Acker from the NASA Goddard Earth Sciences Data and Information Services Center, consultant Jose CdeBaca from New Mexico Highlands University and collaborators Ruth Krumhansl and Kathy Paget from Educational Development Center) and the six teachers from Maine, New Hampshire, California, and New Mexico who will pilot test DICCE. The meeting was led by PI Dan Zalles. The first objective of the meeting was to present some examples of data representations about the northern New Mexico area that can be generated from some of the data products available in Giovanni. Representations presented to the teachers for feedback included MERRA surface skin temperatures, Willmott-Matsuura surface rainfall maps, GLDAS rainfall and snowfall, TRMM rain map, and AIRS relative humidity atmospheric profiles. These images were selected for the range of representational data formats that they exemplify (e.g., time series, two-dimensional remote-sensing maps, vertical atmospheric profiles) and illustrate special capabilities such as modifying default map scale specifications in order to enable better comparisons across different months of data in a given geographic region. The teachers provided feedback about these images.

The second objective of the meeting was to give the teachers the opportunity to introduce themselves to each other, tell the group about what they currently teach about climate change, and describe their schools, students, and courses. Details about the wide diversity became evident in this discussion. For example, there are 11th and 12th graders in a special dropout prevention program that combines math and science, 9th graders in an integrated general science course, students in grades 10-12 in a course that integrates constructivist pedagogy and an Earth systems perspective, and 11th and 12th graders in a class called Environmental Science and Society. There is wide diversity in student ethnicity and academic achievement, and there are students with learning disabilities.

The third objective of the meeting was to discuss and plan for future milestones. It was decided that there would be follow-up meetings in May and June to get the teachers’ feedback about a prototype that Zalles and Acker would develop in the interim. One of those was to be a face to face project meeting at New Mexico Highlands University in late May.

A2. Use focus group input to begin development of DICCE-G and DICCE-LE

After the meeting, Dan Zalles and Jim Acker talked regularly to collaborate on the design of the two DICCE interfaces, DICCE-Giovanni (G) and DICCE-Learning Environment (LE). Key to this co-development was the populating of a matrix that identifies specific data sets from the Giovanni data products by their relationships to each other, by their topics, and by the broad Earth system phenomena they belong to (e.g. physical
atmosphere, chemical atmosphere, physical land, land biosphere, physical ocean, ocean biosphere, energy). Eventually, this matrix is to be made available to users as a guiding document for their quick and informed access to data sets they are interested in using with their students. It will be accompanied by explanatory information about what are the properties of the data sets (e.g., how they are collected, when they are collected, and how long they are collected) what phenomena they measure, and why they are important to the topic of climate change. Currently, Zalles and Acker are working on identifying which data sets fit into which of three categories: from most basic for understanding climate change, conceptually speaking, to contingent on more complex scientific understandings. This categorization scheme will be useful for teachers who need to make data selections relative to the time constraints of their curricula and their students’ capacities to understand the data.

Zalles also worked with DICCE evaluator Kathy Haynie to articulate a project logic model (see Figure 1).

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A3. Conduct first project face-to-face meeting

By the time a prototype of DICCE-G and a storyboard of DICCE-LE were ready to present, PI Zalles on June 2 and 3 held the first project face-to-face meeting. Co-I Jim Acker and consultants Ruth Krumhansl and Jose CDeBaca attended. The meeting took place at New Mexico Highlands University in Las Vegas New Mexico on June 2 and 3. We discussed upcoming milestones and made some important project decisions. For example, we discussed what would be appropriate scaffolding strategies to execute that would help the teachers make best use of the Giovanni data. Examples of such scaffolding include:

- making available to the teachers assessment rubrics that they can use to score their students' investigations of the Giovanni data
- providing access to the NASA Earth Observatory Glossary (http://earthobservatory.nasa.gov/Glossary/index.php?mode=alpha&seg=f&segment=h)
- providing matrix tables, which differentiate Giovanni data products by degree of prior scientific knowledge needed for understanding, and in addition other information that will help teachers make decisions about which data product maps and plots to present to their students about their local climate

The face-to-face meeting was also an opportunity to get together with New Mexico Highlands University science faculty who are involved in the University's Gear Up program, which provides science education activities for teachers and students in the greater Las Vegas New Mexico area. There is interest among the Gear Up staff to introduce DICCE to a wide range of high school science teachers and students within
their service area. The two New Mexico teachers who will be piloting DICCE also attended. In total, there were 13 people present. The parts of the meeting attended by the teachers were feedback opportunities.

Zalles and Acker presented a demo of DICCE-Giovanni (DICCE-G) and DICCE-Learning Environment (DICCE-LE) to get feedback from the teachers and the others. Zalles also introduced to the attendees the NASA Global Climate Change web site (http://climate.nasa.gov/) as an excellent resource to provide students for an introduction to basic information about what is climate and what characterizes current trends in climate change at the global level. Lastly, Ruth Krumhansl overviewed of her Foundation Earth Science curriculum about climate and climate change, for which she will be building connections to DICCE.

**A4. Conduct second focus group with the six teachers to get their reaction to the DICCE-G and DICCE-LE designs and curriculum project authoring system**

The meeting was followed by a Web conference the following week with three of the other teachers in the piloting: the two from New England and the one from San Diego California. The sixth teacher, the one from San Jose California, was unable to attend the webinar so he met face-to-face with Zalles at SRI International the following week. The purpose of the webinar and the follow-up meeting with the San Jose teacher was to get their feedback on the same demos that Zalles and Acker presented at the New Mexico face-to-face meeting. Suggestions from teachers included providing a set of fundamental questions about climate and climate change that teachers can select from and can serve of as informative of what data and data representations to make available to the students, plus an assessment rubric that could be available to students throughout a project so that they can see the rubric to gauge their performance, plus ways for teachers to share their multimedia images. We are following up on all these recommendations. For example, we devised the following high level research questions that will help teachers make data selections.

1. What are the key oceanographic, topographic, and atmospheric influences on the local climate?
2. From where do the local weather systems originate?
3. Which Giovanni land cover data confirm what we know about how the local biosphere changes through the seasons of a typical year?
4. What other Giovanni data confirm what we know about how the local climate changes through the seasons of a typical year?
5. What is there in the temperature data about our local area that supports the notion that global warming is occurring?
6. What theories about impacts of climate change (such as impacts of increased temperatures on extreme weather events or droughts) are supported by what we notice in our local data?
7. What data provide evidence that there are microclimates in the local area?
8. Each Giovanni data set is limited by its spatial resolution, the number of times the data are collected, and how long ago the data started being collected. What are the limitations of the different data products and how can they be triangulated to yield
for the students, at their level of knowledge, the most comprehensive examination of the local climate.

After the meeting, we found an additional resource that will be helpful for the teachers to understand their own local climates better and properly plan the selection of data sets. This resource is a NOAA NCDC website that provides state-by-state climate overviews (http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl).

A5. Revise DICCE-G and DICCE-LE as needed following focus group input

After these meetings with the teachers, Acker continued developing explanations of the nature of each Giovanni data product that the teachers will have available to them. These texts will constitute a layer of DICCE-G enhanced help to which the teacher can link from a main DICCE-G data query selection window. For the initial rollout for the teachers, we decided to limit our attention to "basic" data sets we will make available through DICCE-G (shown below in their Earth System domain classification):

A. Physical ocean
   1. Euphotic depth
   2. Sea surface temperature
B. Ocean biosphere
   3. Chlorophyll
C. Physical atmosphere
   4. Cloud fraction
   5. Carbon dioxide fraction
   6. Relative humidity
   7. Temperature profile
D. Atmospheric gases
   8. Aerosol optical depth
   9. Deep blue aerosol optical depth
   10. Total column ozone
E. Precipitation
   11. Global Precipitation Climatology Project (GPCP)
   12. Wilmott-Matsuura ground station precipitation
   13. Global Land Data Assimilation System (GLDAS) rainfall rates
F. Energy
   14. Net longwave radiation
   15. Net shortwave radiation
   16. Photosynthetically available radiation
G. Physical land
   17. GLDAS average surface temperature
   18. MODIS land surface temperature
   19. GLDAS near surface air temperature
   20. MERRA surface skin temperature
   21. Near surface wind magnitude
   22. Snowfall rate
Most of the Giovanni data are monthly. When a user queries for a time series showing the monthly data for a selected region over time, monthly values are generated and displayed on a graph. When instead the user queries for a map, the underlying Giovanni query engine automatically aggregates means across the months that are displayed by color codes over the map's various regions. After generating the data representations, the user has the option of importing them as layers into Google Earth, saving them as image files to be importable into DICCE-LE, or producing an ASCII text-delimited file of rows and columns that can be used for manipulation and further data analysis in a spreadsheet program such as EXCEL or statistical program such as SAS or SPSS.

We (Zalles, Krumhansl, and Acker) are collaborating to make certain that the enhanced help texts for the data sets available in DICCE-G are as succinct and accurate as possible for the high school student and teacher audience. For these audiences, the texts must provide sufficient conceptual information about the types of data, with a minimum of difficult technical terminology. We will in addition leverage the existing NASA resource Earth Observatory glossary (http://earthobservatory.nasa.gov/Glossary/) to provide hotlink access to key terms brought up in the enhanced help. The list of hotlinks currently includes the terms albedo, aerosols, kinetic energy, data product, data parameter, geographical degree, phenologist, photon, phytoplankton, phytoplankton nutrient, remote-sensing, runoff, and variable.

Concurrently, Zalles has been working with programming staff from SRI International to develop DICCE-LE from a storyboard that he prepared and demonstrated to the six participating teachers in the spring meetings. Zalles and staff decided to leverage Wordpress, an existing open source software development package for designing websites with user multimedia sharing and publication capabilities. Zalles and the programmers formulated ways to configure the Wordpress options to meet the design needs expressed in the DICCE-LE storyboard. In July, the programmers readied a first draft of the DICCE-LE interface. Zalles met several times with them to give them feedback, make decisions for how to design within the constraints of WordPress, and conduct quality assurance testing to fix bugs and note unanticipated interface problems that needed to be rectified.

We are still in the midst of doing final tweaking of the interface before making it available to our six teachers in the fall. For this final tweaking we are benefiting from the fact that in late August Ruth Krumhansl conducted a usability study about the current drafts of the DICCE-G and LE interfaces with one of the teachers in a face-to-face situation. In this usability study, Krumhansl deliberately avoided conducting any training of the teacher, in order to see to what extent the interfaces were intuitive. The teacher had participated in an earlier focus group where she viewed a prior version of DICCE-G and saw the DICCE-LE storyboard, but had not yet experienced hands-on time with the
software. She provided very useful feedback that we are currently following up on in our continued designing of the software. For example, she expressed some confusion trying to figure out how to author an activity for a curriculum project after she entered project level information. The difficulties she encountered were due to a constraint concerning navigability between the different authoring templates. After getting this feedback, Zalles asked the SRI programming staff to come up with some changes to the DICCE-LE software to enable more transparent navigability between the templates.

Figures 2-7 illustrate the current state of interactive components of DICCE-G and DICCE-LE, subject to further refinement as needed.

![DICCE-G](image)

Figure 2. **DICCE-G.** This is an example of teacher selection of a region along the Pacific Coast that then becomes the area of interest that is queried when the teacher selects data sets and data representations for their students' climate change analyses.
Figure 3. DICCE-G. This is an example of teacher query selection options for the selected region. Enhanced will be accessible by clicking each type of data listed under the data domains.
Figure 4. DICCE-G. This is an example of resultant image generated from a query about land surface temperatures along the Pacific Coast.
Figure 5. This is an example of the resultant image from Figure 4 imported as a kmz file into Google Earth and appearing there as a layer with locational geo-referencing. The user can adjust the opacity of the layer and various standard Google Earth tasks, such as drawing and measuring transects, creating polygons, annotating locations with multimedia, viewing elevation profiles, and conducting fly-throughs.
Figure 6. DICCE-LE. This is an example of a teacher-authored activity about climate change along the California Coast that is centered on map analysis.
Figure 7. DICCE-LE. This is an example of a teacher-authored activity about climate change along the California Coast that is centered on analysis of time series data that corresponds to the maps in Figure 6.

Conduct first test of the teacher project development authoring process and create first prototype local climate change investigation (for the San Jose, CA, area) with the help of the participating teacher from San Jose

Starting in October, we will work with all six of our teachers to use templates in DICCE-LE to author their own local climate change projects. To scaffold this process, we are developing templates for local climate change investigations in which the teachers can plug their own data representations about local climate. Also, as promised in our timeline, we will in the Fall also conduct some usability tests with small groups of students in the San Jose teacher’s classes. The usability testing will be to determine the extent to which students can navigate the DICCE-LE learning activities their teachers put together using the DICCE-LE curriculum authoring tool. Given the fact that students will input answers to teacher developed questions on paper and pencil forms rather than within the DICCE-LE learning environment, the usability testing will strictly be for making sure the students can navigate the data representations, questions, and help features that they will be able to view electronically.
B. PROJECT ACCOMPLISHMENTS MEASURED AGAINST THE PROPOSED GOALS AND OBJECTIVES

This paragraph in our proposal described our goals and objectives:

We aim to meet Goals 2 and 1of the CAN, to “increase the number of people, particularly high school students, using NASA Earth observation data, Earth system models, and/or simulations to investigate and analyze global climate change issues” and to “improve teaching and learning about global climate change.” We will do this by developing, piloting, and disseminating a new interactive pathway and online learning environment that support high school teachers in selecting NASA satellite mission data for students’ climate change investigations, developing curricula for student data use, and using these resources to increase their students’ learning about climate change. We will pilot professional development resources and processes to help teachers use these resources with their students. Our project aligns primarily with CAN Objective 2.3 in its focus on creating new classroom resources and also with Objective 2.1 in its focus on 3 years of partnering with six high school teachers.

The activities described in the prior section of this report were the ones in Year 1 that we pursued to meet our eventual goals of improving teaching and learning about global climate change. We are leveraging NASA resources to create new classroom resources that enable new pathways for this learning, especially at the local and regional level. The NASA resources we are leveraging include the Goddard Interactive Online Visualization and Analysis Infrastructure (Giovanni), the NASA Earth Observatory Glossary, and NASA's Global Climate Change website. As promised in the proposal we are partnering with a set of six high school teachers to use our materials to develop, pilot test, and share classroom curriculum resources that use our materials. As promised, our first year was primarily devoted to developing our resources and our second and third years will be devoted to working with our teachers to utilize those resources in their classrooms.

C. EVIDENCE OF HOW PROJECT ACTIVITIES HAVE FURTHERED STAKEHOLDER PRIORITIES

We mentioned in our proposal that our project was going to address this NASA K-12 STEM priority, as expressed in documents referred to on p. 5 of the CAN: "Through hands-on interactive educational activities, NASA will engage students, educators, families, the general public, and all Agency stakeholders to increase Americans’ science and technology literacy (NASA Strategic Management Council 2006, p. 6)." We have early evidence from teacher stakeholders that they will find the DICCE-G and LE resources useful and we look forward in Year 2 to working with them individually to facilitate their increased effectiveness as facilitators of greater student climate change understanding of their students. Eventually, we want our impact to spread beyond the six pilot teachers and their students in order to make an impact on the greater groups of stakeholders identified above. We will do this by making DICCE-LE and DICCE-G publicly and freely available for other teachers to use to create their own climate change investigations. In addition we are setting up DICCE-LE to allow the entire set of quality
teacher created curriculum resources to be shared. These shared resources will include the teachers' curriculum projects and learning activities within those projects plus the archive of data representations that they create in DICCE-G and embed in their learning activities. DICCE-LE will be designed to permit all users of the system to use data representations by themselves or in the context of the activities for which they were created by the individual teachers.

D. EXTENT TO WHICH COLLABORATIONS AND/OR PARTNERSHIPS HAVE EVOLVED

A new partnership has evolved by virtue of the IGCCE awarding in 2011 to California State University Channel Islands of the grant "Promoting Educational Leadership in Climate Change Literacy (PEL)." As a result of this grant, SRI will be providing DICCE to the PEL project as one of three different curriculum resources that CSU Channel Islands will implement with teachers from five high schools in Ventura County during the 2012-13 academic year and during the fall semester of the 2013-14 academic year. The other two resources are "Using NASA Data to Improve Climate and Science Literacy of Young Adults" and "Carbon Connections."

PEL’s first year parallels the DICCE development project’s third year, so DICCE will have already undergone the first round of implementation among the DICCE-funded teachers in Maine, New Hampshire, New Mexico, and California and will be awaiting the second and final round of implementation. Broadly speaking, SRI will function as a trainer and consultant on PEL tasks related to DICCE. All labor-intensive tasks (evaluative data collection and analysis, teacher staff development and monitoring) will be carried out by other PEL staff.

As described in the first section of the report, we have also developed a relationship with various science faculty at New Mexico Highlands University and administrators as well as with teacher professional development providers of the University’s Gear Up program. We hope that this relationship culminates in DICCE reaching a wider group of teachers in that area through professional development and coaching that will be made possible if the Gear Up program receives another round of funding starting in the Fall.

Many of the students of the teachers we hope to reach through PEL and Gear Up have Hispanic or American Indian backgrounds, thus increasing our outreach to diverse underrepresented groups.

E. PLAN OF ACTIVITIES FOR THE NEXT YEAR

Next year will be our first year of working intensively with the teachers to develop and pilot curricula using DICCE-G and DICCE-LE. After we have completed a workable version of DICCE-G and DICCE-LE, we plan to create climate change investigation templates that make use of the data products available through DICCE-G then work with the teachers one-on-one to adapt these templates for their students' local climate change investigations. Subsequently, we will track their implementation during the first round of pilot testing, which will occur during the 2011-12 school year. Following this first round of pilot testing, we will utilize what we learn about how the teachers use our resources to
develop a bank of assessment items that the teachers will be able to pick and choose from depending on what learning activities they implement. We anticipate that the assessment items will require the students to apply analytic skills they exercised in the instructional activities to the climate of another local area that we specify. This assessment component of the project will commence in Year 3. The reason we do not want to jump into the assessment component yet is because as a matter of efficiency, we want to make sure that the assessment tasks we develop align as much as possible to the teachers' curricular choices, which will become apparent during the first round of piloting.

There will also be external evaluation work in Year 2. The goal will be to gauge impacts of DICCE on the professional development of the six DICCE teachers for using the DICCE technology and data for teaching topics of their choice with their students. The project staff will ask teachers through the year to express reflections about what they are doing and want to do with the DICCE resources. Then, toward the end of the year, after the teachers have completed teaching with the DICCE materials and collected student outcomes of their use of these materials in their classes, the external evaluator Kathleen Haynie will study what the teachers have reported and prepare a set of interview questions designed to gauge their professional development over the course of Year 2. After Zalles and Krumhansl sign off on the interview protocol, Dr. Haynie will then interview each teacher and write a report of the results. The theoretical framework that will drive this articulation of questions will be the growth of pedagogical content knowledge in the context of the utilization of the DICCE technology in the classroom.

At this juncture, our primary challenge is to maintain teachers' interest and involvement by not overwhelming them with too much technological and conceptual complexity. We are challenged to provide easily learnable technology resources and sufficient scaffolding and support about the data and the underlying Earth system relationships that the data reveal. We aim to do all we can to help teachers and their students make effective and enthusiastic use of our resources and eventually through the assessment components, provide a way for student learning to be ascertained that is responsive to the opportunities to learn that each individual teacher provides their students.