

Cyberinfrastructure Development for the Western Consortium of Idaho, Nevada, and New Mexico

Year 2 Annual Report (2010/2011)

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A. Executive Summary

Vision, Goals, and Objectives of Project

The **vision** of the Western Consortium for Cyberinfrastructure Development is *to transform communication, climate change science, and education in our tri-state (ID, NV, NM) region*. Moreover, a key outcome will be sustained partnerships among our jurisdictions that will enhance our competitiveness for research funding and enable us to better address 21st-century, grand scientific, and societal challenges.

The overarching **goal** of the Consortium's Track 2 RII is *to promote knowledge transfer to scientists, educators, students, and citizens within and beyond the Consortium by enhancing state cyberinfrastructure (CI) and to enable the community science that is required to address regional to global scientific and societal challenges related to climate change*. To meet this goal, there are three primary **objectives**:

- 1) Promote communication and collaboration by increasing connectivity and bandwidth (*Connectivity Component*);
- 2) Promote discovery by supporting community-based climate change science through enhanced interoperability between models and other software components, providing improved access to and usability of Consortium data products by adopting standards-based data management and access models, and supporting new data assimilation, analysis, and visualization capabilities (*Interoperability Component*); and
- 3) Utilize CI to integrate research and education (*Cyberlearning Component*) by: focusing on graduate student, postdoctoral researcher, and faculty development; extending science education into middle and high schools; and improving outreach to business and industry.

A team has been formed to carry out the activities tied to each of the objectives above. These components—Connectivity, Interoperability, and Cyberlearning—form the organizational structure of the project as a whole.

Efforts and Key Accomplishments

Intellectual Merit

Year 2 of this project has continued and expanded the efforts begun in Year 1. The key accomplishments summarized below and described more fully in the body of this report will enable researchers from many disciplines in each of the jurisdictions to more effectively share data and models and to integrate their products into other national and international systems and projects (such as DataOne, Geospatial OneStop, NBII, and GEOSS). Improved connectivity will facilitate and enable data-intensive research, collaborative development, distributed experiments, grid-based data analysis, high performance networking, social networking and cyber-enabled learning. Improvements in connectivity and enhanced interoperability and accessibility of data and models will enable the Consortium to realize its community science objectives and transform the way the three states do research.

Broader Impacts

From its inception, the proposed CI investments in the Consortium were designed to achieve broad impact and to add value by leveraging existing resources and infrastructure within the institutions, jurisdictions, and regions. The Consortium has further developed its commitment to increasing the diversity of the STEM workforce through the development of a Tri-State Diversity Plan, which is being implemented in all three states. The Consortium's investment in improved connectivity benefits rural institutions and those that serve Hispanic and Native American students and faculty. The project will make high-quality environmental data, information, and models available for STEM education and outreach, including classroom and laboratory use and student research. The Consortium's Cyberlearning activities will have long-lasting effects by training the next generation of scientists and targeting a range of geographic and cultural populations. Furthermore, we are preparing the future scientific workforce with better-developed quantitative reasoning, data analysis, and modeling skills. Cyberlearning activities support educational activities at all educational levels, including the development and dissemination of educational materials for middle school and high school students with large numbers of Hispanic and Native American students. New activities in Year 2 have broadened the project's impact to include rural, small business entrepreneurs.

The Western Tri-State Consortium has organized project activities into three components, based on its three primary objectives: Connectivity, Data and Model Interoperability, and Cyberlearning. A summary of the project's efforts and key accomplishments in *research, cyberinfrastructure, and workforce development* are presented below as they align with these three components.

Connectivity

- Upgrading connectivity to two major research stations, at Hagerman and Kimberly, Idaho.
- Upgraded networking connectivity in Nevada (at the north end) to 10GBps.
- Installation of networking and video connectivity within Nevada complete; system is in use.
- Completed installation of 20 education portals (Gateways) across New Mexico; training for usage underway.

Data and Model Interoperability

- Continued development of each state's data portal with shared interoperability standards; data portals in NM and ID are operational and NV is in internal testing.
- Identified a wide range of open interoperability standards for CI development for data access and visualization, metadata and catalog services and connectivity with national programs and networks.
- Developed a model for data synchronization that is mediated through use of ISO 19115-2 metadata; an initial test of the model is planned for completion by the end of the project year.
- Collaborated with numerous CI programs/networks for exchange of technical information and data/metadata.

- Developed a new landscape evolution model in Matlab.
- Continued development of the Demeter framework to use web services for data exchange and model execution.
- Developed required specifications needed for developing a coupling framework for integrating the WRF model with a subset of surface models.

Cyberlearning

- Provided information and funding for CI-related training for graduate students and faculty.
- Coordinated and hosted a 3-day workshop in Parallel Computing with the NCSI.
- Created a leadership team in Nevada that meets bi-weekly to direct K-12 Cyberlearning activities.
- Developed four curriculum modules to support a teacher summer science institute in Nevada.
- Collaborating organization, McCall Outdoor Science School, developed a cyberlearning website and is working to enhance site content and HIS database interface.
- Developed a program to integrate cyberlearning into STEM classes at an Idaho charter school to enable students to communicate with STEM professionals nationally.
- Funded three new Supercomputing Challenge teams and three new teams in Project GUTS (Growing Up Thinking Scientifically) in New Mexico.
- Evaluated and organized on-line resources for climate data, visualization tools and tutorials.
- Developed a web framework to allow teachers to use web-based instructional tools in their classrooms.
- With partners, provided CI-related teacher professional development.
- Initiated collaboration with FastForward NM to provide internet training to small business entrepreneurs in rural NM communities.

Cross-Component Accomplishments

Efforts that focus on *diversity, outreach and communication, evaluation and assessment, and sustainability* cross each of the components and are coordinated by project leadership.

Year 2 efforts and key accomplishments in these areas include:

- Created and are implementing a Tri-State Diversity Action Plan that identifies six strategies for broadening the participation of underrepresented minorities (URM) and women in STEM.
- Developed and launched a Consortium website (www.westernconsortium.org).
- Held the Western Tri-State Consortium Annual meeting for 200 participants; agenda included workshops, keynote speakers, a student poster competition and 15 research and education sessions.
- Underwent a review by the External Advisory Committee.
- Hired Lisa Kohne as the new External Evaluator upon the resignation of the former external evaluator.
- Funded four tri-state Innovation Working Groups.

- Hosted a meeting of representatives of the governing councils from the three states to discuss opportunities for continuing collaborations beyond the period of this award.

Management Structure

The project *management structure* is designed to encourage interaction among the three states and the various components; a representation of the structure is on page 29. The State Directors, PI, Co-PIs, Project Administrators, and Education, Outreach, and Diversity Coordinators form a Management Team. Each Component Team has an overall component lead supported by state leads and team members from each of the three states. An External Evaluator and an External Advisory Committee provide evaluation and assessment to the project management. Each component team has monthly meetings to coordinate activities and chart progress towards objectives. Finally, to encourage effective project management, the PI, Co-PIs and Component Leads hold monthly Leadership meetings. Most meetings have occurred online via Webex or GotoMeeting.

Response to External Advisory Board Report

The Consortium's Track 2 project has a seven member External Advisory Committee (EAC) consisting of internationally and nationally recognized experts in the project's focus areas. The EAC met with the project's leadership and team members on February 18, 2011 at the Center for Advanced Energy Studies in Idaho Falls, ID. Based on presentations made by the project team, the EAC reviewed progress toward achieving outcomes of the project, made constructive suggestions for improving and/or changing the direction of the work underway, and provided suggestions for collaborations within and outside the Tri-state region, as well as suggestions for funding opportunities appropriate to our project focus. The EAC summarized their comments and recommendations in a report to the Consortium. The project team responded to each recommendation with strategies on how we will incorporate the recommendations into the project. The 2011 EAC report, with project team responses embedded, as well as the meeting agenda and materials can be found online at: <http://www.westernconsortium.org/DrawOnePage.aspx?PageID=194>.

Response to Year One Evaluation Report

The project's Year One external evaluator, Dr. Rose Shaw, submitted the Year One Evaluation Report to the project leadership. Component leads and the Management Team reviewed the recommendations in the report and made minor adjustments to some program activities, but these adjustments have not resulted in any major changes in the long-term project goals, objectives and desired outcomes. After completion of the Year One Evaluation Report, Dr. Shaw withdrew from the project. Dr. Lisa Kohne of SmartStart Educational Consulting Services has been hired as the external evaluator for the remainder of the award period. This change was communicated to the Track 2 NSF EPSCoR Program Officer.

B. Detailed Report

1. RII participants and participating institutions

See Fastlane entries for Idaho, Nevada, and New Mexico collaborative awards. In year two, the total number of participants in the Track 2 Tri-State Consortium including faculty, staff, and students, was 58 an increase of 15 from Year 1. Of the total, 29% were from Idaho, 36% were from Nevada, and 34% were from New Mexico. The percentage of women, underrepresented minorities (URM), and persons with disabilities in the Consortium was 36%, 10%, and 2%, respectively.

Demographics of Western Tri-State Consortium Participants, Year 2

Institution	Male		Female		Totals	URM	Disability		
Idaho									
University of Idaho	8		2		10	1			
Idaho State University	3		2		5				
Boise State University	1				1				
MOSS			1		1				
Total	12	71%	5	29%	17	1	6%		
Nevada									
DRI	2		1		3				
UNR	8		2		10				
UNLV	2		1		3				
NSHE	1		4		5	2			
Total	13	62%	8	38%	21	2	10%		
New Mexico									
UNM	8		5		13	1		1	
NMT	4		2		6	2			
NMCAC			1		1				
Total	12	60%	8	40%	20	3	15%		
All Three States	37	64%	21	36%	58	6	10%	1	2%

2. Program/Project Description

Research Accomplishments and Plans

Specific research accomplishments and plans are provided for the project's three primary objectives: 1) Connectivity; 2) Data and Model Interoperability; and 3) Cyberlearning.

Connectivity Component

In year 2 the Connectivity Component has focused on finishing the upgrades prescribed in the proposal so that they can be used by the other components and Track I researchers.

Idaho

In Idaho the connectivity upgrades are almost finished. Networks were upgraded to key researchers and their labs in year 1, and this year the connectivity to two major field stations is underway. Contracts for the connectivity to these stations (Hagerman & Kimberly) have been issued and the networking should be installed and operational before the end of this grant year. Idaho State University will also have connection to the Idaho Regional Optical Network.

Nevada

In Nevada the connectivity upgrades are finished. Networking connectivity into the state (in northern Nevada, as described in the proposal) has been upgraded to 10Gbps and networking and video connectivity upgrades within the state has been installed and is in use.

New Mexico

In New Mexico 20 of the portals have been installed at various campuses across the state and usage and training for use are underway.

Data and Model Interoperability Component

In Year 2, the efforts of the Data and Model Interoperability component became increasingly integrated across all three states with coordination provided by the CI Working Group that was established through the Consortium's RII (Track 1) projects with representation from all 3 states. Coordinated model and data interoperability activities for the Tri-State Consortium focused on two primary sets of activities:

- Interoperable data portal implementation
- Model components and interoperability framework specification and development

In addition, work has focused on laying the groundwork for integrating the consortium's capabilities with other national and international programs and networks. These integration efforts have concentrated on the development of capabilities directly aligned with the CUAHSI HIS system and with other national networks (i.e. DataOne, Geospatial One-Stop, NBII, GEOSS) that implement the interoperability standards supported by the Tri-state consortium.

Interoperable Data Portals

During Year 2 of the EPSCoR Track 2 project, significant progress has been made in the development of the individual data portals within each state, all of which share a common constellation of interoperability data standards that have been identified as target standards for all three states (Figure 1).

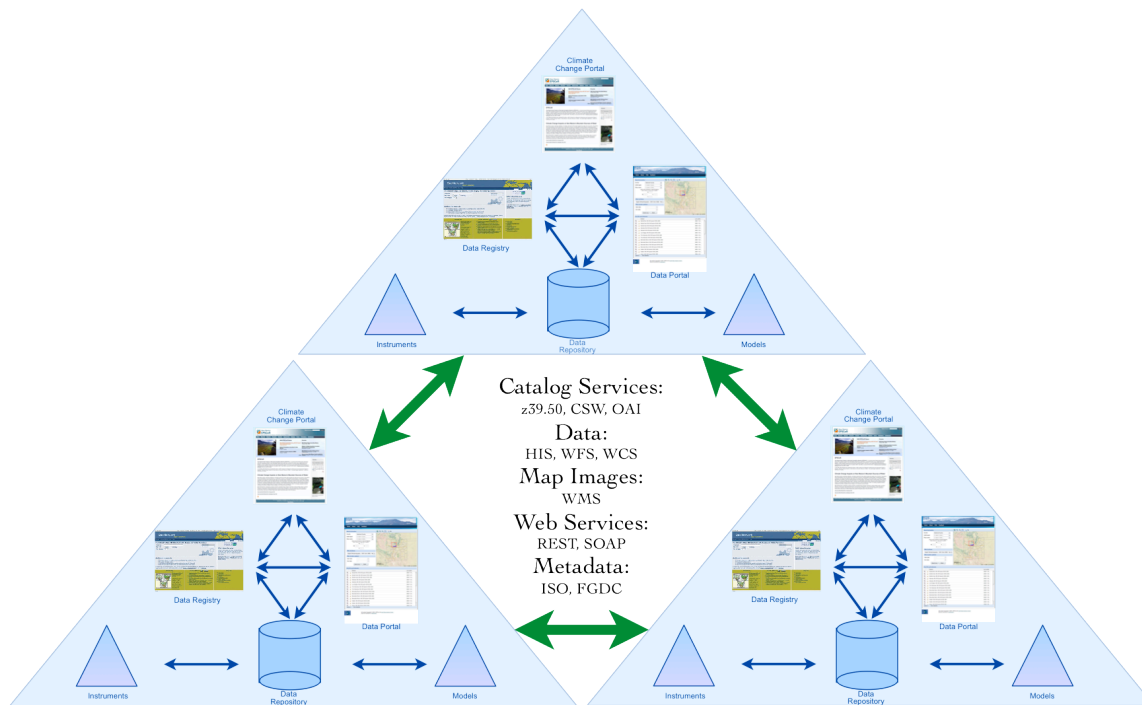


Figure 1. Conceptual diagram representing the standards-based connectivity between the Tri-state data portals

In an effort to maximize the impact of EPSCoR data and CI investments both within and beyond the EPSCoR project, a wide range of open interoperability standards have been identified (as a cooperative activity within the Tri-State CI working group) as target standards for CI development. These standards related to three broad areas of interoperability: data access and visualization, metadata and catalog services, and connectivity with other national networks and programs. The specific target standards that have been identified include:

- Open Geospatial Consortium (OGC) Web Map Service (WMS) – data visualization through the delivery of map images
- OGC Web Feature Services (WFS) – data delivery focused on vector data (points, lines, polygons) and their associated attributes. Point observational data are included in this particular data model.
- OGC Web Coverage Services – data delivery for gridded data such as elevation models, flow surfaces, remote sensing data, and model outputs
- ISO 19115, 19115-2, 19139 – international geospatial metadata standard
- Federal Geographic Data Committee CSDGM – US Federal geospatial metadata standard
- OGC Catalog Services (CAT/CSW) – catalog services standard
- Z39.50 – catalog services standard
- CUAHSI HIS – a standard data model, metadata content model, and set of service requests developed by the hydrologic community for the discovery and exchange of point-observation data
- Representational State Transfer (REST) web services model – general purpose web service model based upon the hypertext transfer protocol (HTTP, from the IETF)

These standards have been implemented in New Mexico and Idaho. NV anticipates that WMS, WFS and WCS will be completed by January 2012 and FDGC/ISO metadata and CSW by March 2012.

In addition to facilitating data exchange between the Tri-State EPSCoR collaborating states, the implementation of the above standards, specifications, and protocols is informed by, and will enhance the ability of Tri-state EPSCoR collaborators to integrate their products into other national and international systems and projects (such as DataOne, Geospatial OneStop, NBII, and GEOSS).

The portal implementations in each are state-specific to that state, with the portals in New Mexico and Idaho leveraging ongoing state geospatial clearinghouse programs (Inside Idaho [<http://insideidaho.org/>], but moving towards a more integrative data portal, the Northwest Knowledge Network, NKN, and the New Mexico Resource Geographic Information System [<http://rgis.unm.edu/>]). Nevada's portal developed from the ground up as a tightly integrated climate change portal within which both data and other information are available. At this time, both New Mexico (<http://nmepscor.org/dataportal>) and Idaho (http://insideidaho.org/webapps/search/epscor_browse.aspx) have operational data portals, while the Nevada portal is in internal testing.

As additional component of the interoperable Tri-state portal development activity is the initial implementation of a metadata replication, and targeted data replication model between the three states. In consultation with external experts from USGS, NOAA, DataOne, and the Oak Ridge National Laboratory, the Tri-state CI working group has developed a model for data synchronization that is mediated through use of ISO 19115-2 metadata, with the involved metadata being maintained and updated through a version control system (SVN) hosted by New Mexico (at the Earth Data Analysis Center). An initial test of the model is planned for completion by the end of the project year.

The development of the Tri-state data portal capabilities has also been informed by interaction with external projects and programs, either in the form of technical exchange, or through design for integration through implemented standards.

Data/metadata Exchange and Technical Information Exchange

Areas of interaction with other CI activities outside the Tri-state consortium include both integration in the areas of data and metadata exchange and technical interactions.

Following are some examples of these areas of interaction:

- The development team (providing the lead in the CI development efforts for the RII-3) at the Earth Data Analysis Center (EDAC) and Idaho's INSIDE Idaho have contributed metadata to the NBII network, EDAC has developed and hosted a number of clearinghouse nodes within the Federal Geospatial Data Committee's (FGDC) network, and provided some of the earliest web accessible metadata records into the Geospatial OneStop.

- New Mexico and Idaho have established HIS instances for the capture and documentation of point time-series data into the HIS service model. These HIS services provide for publication and discovery through the CUAHSI network.
- New Mexico has completed the initial ingest of historic SNOTEL data from the NRCS servers (representing over 32 million individual observations), providing data download of individual station data via web interfaces. These data will periodically be harvested into the New Mexico EPSCoR data portal, through which they are republished using the enhanced services available through the portal.
- New Mexico's EDAC was one of the early recipients of funding from the FGDC CAP program for the development and delivery of metadata training and has continued to provide training for over 15 years.
- Karl Benedict (Director of EDAC, and CI lead for NM'S RII-3 Track 1 project and for the Tri-State Track-2 project) serves as EDAC's representative to the Open Geospatial Consortium, and the Federation of Earth Science Information Partners (ESIP Federation, for which he currently serves as Vice President, and has previously served as chair of their Information Technology and Interoperability Committee)
- Idaho's Greg Gollberg and New Mexico's Karl Benedict both serve as members of the DataOne Data User's Group (DUG)
- Developers of New Mexico EPSCoR CI capabilities have met with members of the LTER Network Office (at UNM) staff in exchanging information about evolving geoportals technologies, particularly in the area of integration of geospatial application components into the Drupal content management system.
- Through face-to-face meetings at the bi-annual meetings of the ESIP Federation and the first meeting of the DataOne DUG Karl Benedict has had extended discussions with the developers of NEON's CI, both about their planned development and deployment efforts, but also about service models that would facilitate the integration of NEON data products and services into broader networks of users.
- Through a Tri-state IWG (executed late in Year 1, after the previous annual report had been submitted), CI leaders from all three states met with the OpenTopography and Kepler developers at the San Diego Supercomputing Center to discuss the capabilities of both systems.
- Researchers in Idaho have submitted LiDAR data to OpenTopography for hosting and delivery through OpenTopography's web services and interface. Additionally, Idaho State University's Boise Center Aerospace Laboratory (BCAL) has developed a collaborative proposal with OpenTopography that has been submitted to NSF's Division of Earth Sciences (EAR)

In addition to CI-focused exchanges and interactions with external networks and programs, the Tri-state CI team also organized a second IWG (see p. 17) in which three one-day workshops (one in each of the Tri-state states) were held. These workshops consisted of an exchange between Tri-state researchers and CI team members with a focus on defining new CI-enabled research topics that could be pursued by new collaboration teams, and to inform continued development of CI capabilities within the current EPSCoR Track 1 and 2 projects. The workshops included 32 participants from 8 separate research institutions and

resulted in an initial list of potential projects and solicitations that might be targeted for those projects. The dialog between researchers and CI developers from the Tri-states was continued at the annual Tri-state Meeting (see p. 15-16, 19-20) in which an additional 2-hour workshop was held with additional researchers.

Model Components and Interoperability Development

Model component and interoperability development activities have focused on three areas:

- Development of new model components for integration into climate modeling systems;
- Development of a web-services enabled interoperability framework for data processing in support of model execution; and
- Development of a visual model coupler (VMC) for linking the WRF model with surface modeling systems.

Developing Model Components

Model component development efforts are focused around modeling the interactions between landscape and climate across spatial and temporal scales. For instance, LEMming is a new numerical landscape evolution model (LEM) written in Matlab by University of NM EPSCoR postdoctoral fellow Dylan Ward. It allows rock type and coarse rockfall debris to be explicitly included in simulations, two factors that are not included in most LEMs. Because it is written using Matlab, it is easily extended by researchers with a variety of backgrounds, and can generate colorful, informative images and movies of landform change that are superb educational tools. Ward's work is scheduled to be published in an upcoming issue of *Earth Surface Processes and Landforms*.

Ongoing development of model components includes explicit treatment of climate in two ways: 1) direct input of spatial patterns of rainfall through time, either idealized or generated as output from Weather Research in Forecasting (WRF) model runs; and 2) integration with the GC2D glacier simulation (Kessler et al., 2006), with which it is designed to share a basic data format to streamline such integration. The ultimate goal of this integration is to be able to explore how synergy between the geological system (variations in rock type) and the climate system (variations in precipitation and temperature) affects landform change through fluvial and glacial erosion. The New Mexico modeling team is presently developing test cases for this modeling effort through geomorphological study of natural-experiment sites in Hawaii and Chile.

Model code development for landscape and glacier models will be incorporated into the Community Surface Dynamics Modeling System (CSDMS; <http://csdms.colorado.edu>); current versions of LEMming and GC2D are already a part of this system. The CSDMS facilities allow for archiving of progressive versions during code development along with examples of input and output. Archived code is publically and freely available, and can be integrated with a multitude of other models that are also part of the CSDMS.

Web-services Enabled Interoperability Framework

The development of the Demeter framework by Eric Fritzing (University of Nevada Reno) has been substantially shaped by interaction with collaborators in Idaho (Dan Ames) and New Mexico (Karl Benedict), as well as through IWG workshops. The framework makes use of web services for data exchange and model execution. It is based upon the workflow metaphor and includes a graphical user interface using the Silverlight framework and a Python scripting language environment. The development sequence for the framework has evolved based on feedback from Tri-state researchers and EPSCoR External Advisory Committee members and currently consists of:

- Visual programming environment interconnecting models (since October 2009)
- Focus on making use of web services (since April 2010)
- Specific focus on data consolidation, conversion, and utilization (since November 2010)

Currently, the framework has the ability to read/write NetCDF files, can execute defined workflows, can access Web Feature Services, and retrieve data from those services. Current work is focused on:

- Completing Web Feature Services implementation through integration with other framework components
- Accessing Web Coverage and Web Processing Services
- Improving the user interface
- Improving the execution run-time
- Working on integrative scenarios with ID and NM

Visual Model Coupler

Researchers at the University of Nevada Reno have been working on the development of the visual model coupler (VMC) for the WRF model. They have focused on developing the specifications needed to develop a coupling framework for integrating the WRF model with a subset of surface models. Thus far, the VMC development effort has completed:

- A WRF usability analysis
- An analysis candidate model characteristics, resulting in a model matrix report
- The development of a VMC concept document
- VMC software requirements specification
- VMC system design document

With the above listed specification documents completed, current work is focused on:

- Development of a web-based prototype
- VMC prototype testing
- Extending the VMC with a notation and interface for visual scripting of data conversions

Cyberlearning Component

Activities in the Cyberlearning component continue to provide CI-related educational opportunities at all educational levels. Year 2 activities continue to make progress toward the project goal of integrating research with education. Primary activities were:

- Offer and support CI training related to computation and climate change for graduate students, post-doctoral researchers, and faculty;
- Develop and disseminate educational materials for K-12 students, both in-school and extra-curricular;
- Provide training that connects small business owners with CI capabilities in New Mexico.

CI Training

The Cyberlearning Component team developed a listing of available CI-related trainings and continued to use the protocol they developed for graduate students, post-doctoral researchers, and faculty to apply for travel awards to attend trainings. Each state announced the CI training opportunities on their web site and used an internal process to make travel awards. After attending a workshop or conference, participants completed a survey that was designed by the External Evaluator to assess the impact of the training.

CI-training was also provided at the Tri-State Annual Meeting. Twenty-two consortium participants attended a half-day workshop on Hydrologic Information System (HIS) presented by Interoperability Component team member, Dan Ames. Darko Koracin, a team member of the Cyberlearning Component, led a one-day workshop on Climate Modeling that was attended by 20 participants.

Following a recommendation from the External Advisory Committee, the Cyberlearning Component Lead worked to coordinate a one-week Introduction to Parallel Programming and Cluster Computing Workshop in collaboration with the National Computational Science Institute (NCSI). Eighteen researchers from the NM, NV and ID are registered to attend the workshop, which takes place June 26-July 1, 2011 in Pocatello, ID.

K-12 Educational Materials

Nevada

Nevada has created a project development leadership team that includes faculty, students, and representation from the Curriculum and Professional Development Division (CPDD) of the Clark County School District (CCSD). The leadership team has been meeting biweekly to plan activities. For Year Two, the Nevada group are building four cyberlearning curriculum modules to support a teacher professional development summer science institute. The summer science institute is an annual offering by CPDD-CCSD. Climate change is the topic of the institute and CPDD is anticipating approximately 50 middle and high school teachers. Teachers are funded through CPDD and the primary activity is a fieldtrip experience to Death Valley, CA to study the historical impact of climate change on that region. The topics of the four modules under development are:

1. Earth - Geologic Time - Environment of Formation - Students examine how energy environments govern the type of rock formation and rock features indicate environment.

2. Earth - Continental Drift - Location of Formation - Students examine how the movement of continental plate can affect climate.
3. Regional - Cycles and Regional Environment of Formation- Students examine how small changes in environments can be recorded within the rock record.
4. Local - Evidence of Environmental Changes with Climate - Students use the Pinon-Juniper forest as a model for examining how the rate of climate change can be used to predict future environments.

Idaho

The Consortium continues to collaborate with the McCall Outdoor Science School (MOSS) in Idaho to further develop a Cyberlearning website. In Year 1 of the project, MOSS developed Phase I of a Cyberlearning website (<http://mossi.tfhsbruins.com/index/index/>) to get students and teachers connected to concepts that EPSCoR scientists are studying related to "water resources in a changing climate." The site includes background information about climate models, water resources, scientists working on the EPSCoR grant, and an interface for uploading hydrologic data to the CUAHSI HIS database. For the next development phase, a five-person team will collaborate to further develop the CUAHSI HIS database interface and content pieces for the site. The team includes a MOSS graduate student, an Environmental Science teacher from Twin Falls High School, a Technology teacher from Twin Falls High School, and a graduate student in Dan Ames' (Idaho State University) lab.

Plans for further development of the site include visualizations of Idaho specific climate and water related data (using an interface like Google Public Data Explorer), an interactive map embedded with water related data and videos of field data collection, and classroom lesson plans that utilize the site as a learning tool.

The data upload interface will be enhanced and made fully functional by the end of Year 2 of the project. MOSS developers will get feedback on the site at two summer teacher institutes (2011) and plan to pilot test activities at their July 2011 Geospatial Tools workshop for teachers.

Dr. Rita McNeil, a professor at Idaho State University (ISU) in the Human Resource and Training Development department, and Chad Majeske, a middle-school technology education teacher at Idaho Science and Technology Charter School (ISTCS) and graduate student in the Master of Training and Development (MTD) program at ISU, received funding from Idaho EPSCoR Track 2 to integrate cyberlearning into the ISTCS STEM classroom. The project utilizes cyber-technology in the ISTCS STEM class to become linked (in real-time) with professionals throughout America and beyond in the professionals' real-world STEM settings.

Using WebEx, an online video chat, students are connected to professionals worldwide and conduct discussions with the "guest speakers" regarding their professions and their impact upon our world. The cyber-technology provides the opportunity for teachers to be able to arrange these cyber-sessions in order to facilitate discussions between students and STEM professionals on climate change and other topics of interest. These cyber-sessions are then recorded, catalogued, and shared with the Idaho Education Network (IEN), allowing

teachers from schools who do not have the connectivity equipment to have the live presentations streamed into their classrooms, giving Idaho students from rural areas the opportunity to learn from career professionals and to complete student inquiry- and problem-based projects.

Through the shared resources, teachers statewide can initiate further projects in which students will identify and share strategies for their personal involvement as stewards in the protection of our environment and in the advancement toward environmental science.

New Mexico

In Year 2, the Consortium funded three new student teams in the Supercomputing Challenge (SCC)--from schools in Bernalillo, Albuquerque, and Picacho. For over 20 years, the Supercomputing Challenge has provided experiences in computing that far exceeds what most schools in NM are able to provide. The SCC is a year-long experience that provides CI training for teachers as well as students. As part of starting the teams, funding was used to send teachers to the Summer Teachers' Institute (STI), which provided professional development in computer modeling and project-based learning that enabled the teachers to support a challenge team in the coming year. They also hosted a Summer Roundup, if necessary, which allows teachers who are unable to attend STI to receive similar professional development. At the start of the school year, teachers and students from the new teams attended a Kickoff during which the students receive instruction in programming, data analysis, and the chosen SCC topic for the year (in this case, climate change). At this year's Kickoff, Lorie Liebrock, NM Cyberlearning team lead, presented a session instructing students in visualization and data analysis using tools and data from NMT's EPSCoR website. Throughout the school year, consultants visit the students and their teachers to assist with the student projects and provide coaching for teachers. Midway through the school year, teams present their work-in-progress to judges and receive feedback and assistance in how to complete their projects. The competition culminates in the SCC Expo, where the students present their finished work to judges and students are given prizes, scholarships, and awards for their work.

NM EPSCoR also funded three new teams in Project GUTS—Growing Up Thinking Scientifically. These three teams were from schools in Rio Rancho, Gadsden, and Las Cruces. EPSCoR funding allowed these schools to start their Project GUTS clubs; send teachers to the SCC Summer Teachers' Institute and other professional development workshops throughout the year; have Project GUTS facilitators visit the schools throughout the year to help teachers with further professional development and students with project development, computer modeling, and programming; and fund the two 10-week units for Project GUTS as well as two fieldtrips, two roundtables, and the necessary supplies and club materials.

After receiving EPSCoR startup funding in Year 1, the Artesia and Las Vegas Project GUTS clubs have continued to participate in Project GUTS this year. Similarly, the Edgewood and Quemado SCC teams have continued their participation in the challenge this year. The

teacher of the club that could not continue participating with a high school team in the SCC from last year, Deming, is pursuing a middle school SCC team in Deming as well as working with middle and high school teams in Hatch. Additionally, the previously supported teachers in Deming and Quemado are leaders in the new Computer Science Teachers Association NM chapter.

NM EPSCoR hired four undergraduate students to assist in the assessment, aggregation, and sorting of links relating to climate data, visualization tools and tutorials, grants, scholarships, and EPSCoR-related training opportunities. The students will be assisting in the creation of a new course aimed at preparing educators to teach their own AP Computer Science program, which will be run initially in the fall of 2011 or spring of 2012. They are assisting in creating supplementary materials for published curricula from NMT's MST program to prepare it for dissemination. They will also be attending and assisting at this year's Summer Teacher's Institute and Kickoff so they can serve as mentors to Supercomputing Challenge students throughout the upcoming academic term.

For the EPSCoR Tri-state Meeting in April, the undergraduates prepared climate change visualizations from the data and visualization tools accessed via links on the NMT EPSCoR web page. They shared insights into the climate change datasets they discovered using the visualizations. The students had no prior training in climate change or in analyzing climate change data. After these visualizations were presented at the Tri-state Meeting, students were asked by the Supercomputing Challenge to present these experiments to the SCC/GUTS participants. The students will demonstrate how to go from climate change data sets to insight via visualizations to the Supercomputing Challenge participants at the SCC Kickoff in October.

In NM, the Cyberlearning component is also partnering with NM Tech's Masters of Science Teaching Program, by supporting teachers to create educational materials. Six teachers are currently engaged in these activities; three are URM. Of these teachers, 3 have already submitted drafts of their curriculum and 5 are expected to finish before the end of year 2. Some examples from these drafts include:

- Jerry Esquivel's "Advanced Smartlab" curriculum includes the use of current SmartLab technology and project-based learning where students research, devise, and execute their own environmental projects and report on and present their results. This year's projects focused around saving the planet by exploring projects that include both physical and computational experiments.
- Valerie Salas' "Climate Change and the Consequences for Man" curriculum includes activities like "Ecosystem Design," where students design, model, and present their own ecosystem including the complex web of interdependencies of the organisms in their ecosystems. The students then explain the direct and indirect impacts that climate change will have on the organisms and how it will affect these interdependencies.

Connecting CI and Business

In the original proposal, NM committed to broadening the impact of the Consortium's investments in CI to the business community in a model program that could be considered for adoption by the other two Consortium states. After several stakeholder meetings, the consortium leadership from NM determined the most effective strategy would be to focus on rural, small business entrepreneurs, a business segment that can play a significant role in the state's economic development yet generally lacks expertise in CI. In NM, these businesses are frequently related to art and culture. NM decided to partner with Fast Forward NM (FFNM), a program of the non-profit Global Center for Cultural Entrepreneurship (GCCE) for this work. FFNM had already invested over one year in developing materials and processes for delivering training workshops for small business entrepreneurs. These workshops introduce the entrepreneurs to basic web services and tools that can be used to increase their productivity and market their products. In addition, FFNM provides extra training and consulting services for selected cooperatives in using internet technologies for product development, marketing plans and sales.

The EPSCoR Track 2 project provides support for FFNM to offer these workshops in three communities in rural New Mexico--Española, Silver City and Crownpoint; these communities are also the focus of CI investments through NM's C2 project. EPSCoR support enables FFNM to partner with community based organizations to bring trainings and individual support to small business owners and entrepreneurs. A key element of the program is the extensive grassroots outreach and partnership building they conduct. To date they have created partnerships in each of the communities with myriad organizations including: Navajo Technical College, Thoreau Community Center, Sacred Wind Communications, Northwest New Mexico Council of Governments, Mimbres Region Arts Council, Silver City Small Business Development Center, Silver City Arts and Culture Council, Silver City Public Library, Northern New Mexico Connect, Ohkay Owingeh Public Library, Regional Development Council, Northern New Mexico College's Northern Pueblos Institute, REDI, and various small businesses.

Fast Forward NM has scheduled the training series to launch in Crownpoint on June 15th. Classes will be held on Wed/Thurs/Friday. They will offer two classes per week for eight weeks. They are identifying individuals from the community who will become long-term trainers and will participate in a Train the Trainer program. Lead Trainers have been contracted. They have a start date of August 1 for trainings in Silver City. Trainers have been contracted. Española area trainings begin October 3rd.

Diversity and Broadening Participation, including Institutional Collaborations

Diversity and Broadening Participation

The Consortium is committed to improving access to CI for underrepresented groups and geographically disadvantaged populations. Overall, the project encourages broad participation by students from community colleges, women, underrepresented racial/ethnic minorities (Hispanic/Latino; American Indian or Alaskan Native; Black or African American, and Native Hawaiian or other Pacific Islander), people with disabilities and first-generation/low socioeconomic status students.

A Western Consortium Tri-State Diversity Working Group was formed at the 2010 Tri-State annual meeting. The Education, Outreach and Diversity Coordinators from all 3 states successfully proposed and organized a Tri-State IWG focused on Diversity (see p. 16) which was convened in the fall of 2010. The IWG produced a Tri-State Diversity Strategic Plan in which six strategies are detailed with action items and timelines for each; the full plan is available on the Western Consortium website (see Resources at www.westernconsortium.org). The six strategies are:

1. **Engage Interest Early:** Engage the interest of URM students and women by providing information that allows them to explore and prepare for a career in the field.
2. **Early Research Experiences:** Enhance the retention and advancement of URM students and women by ensuring early research experiences, utilizing a reward system for students and faculty based on an analysis of their needs.
3. **Social Networking:** Facilitate the recruitment, retention, and advancement of URM students and women by designing, developing, and maintaining a social networking system that provides academic and social support for these students.
4. **Mentoring:** Develop the capacity of faculty members to be successful mentors for URM students and women by supporting professional development activities and by sponsoring appropriate rewards to recognize faculty contributions.
5. **Best Practice Research:** systematically research approaches and best practices for under-prepared STEM-interested students and use data-driven analysis to better understand potential barriers for STEM-interested students
6. **Coordinated Efforts:** Facilitate coordinated action in the recruitment, retention, and advancement of URM students and women through a state (then regional) hub.

A Diversity Working Group session at the 2011 Tri-State Annual Meeting revisited the plan and reported progress made in each of the six strategies. Progress to date includes:

- Development of a searchable database in NM that lists STEM programs, opportunities and events for students, teachers and members of the community; the database is modeled after the Idaho STEM Pipeline.
- Launch of social networking tools, including Facebook, for various programs in all three states.
- Development of a collaborative website to share resources and best practices for engaging and retaining URM and women in STEM.

Members of the Diversity Working Group continue to meet virtually to facilitate further implementation of the plan.

In addition, each state is working to broaden the participation of URM and women in CI and, more broadly, STEM, through the activities of the Cyberlearning component.

Nevada

In Nevada, the goal of increasing diversity and broadening participation is addressed primarily through the composition of the project leadership team (faculty, students, collaborators) and the recruitment of a diverse group of teacher participants that work in ethnically diverse schools that serve large numbers of Hispanic students. For year two, we have also included a collaborator (Mynster) who also works as a content developer on the Climate Adaptation Mitigation e-Learning (CAMEL). CAMEL is developing an extensive, high quality, vetted collection of climate related educational materials that incorporate a broad array of cyber content types. The goal of CAMEL is to provide the opportunity for every college student to become educated about climate change and the personal, professional, and societal options for meeting the major challenges posed by this urgent problem. CAMEL is created by the Council of Environmental Deans and Directors (CEDD) of the National Council for Science and the Environment (NCSE) and supported by a grant from the National Science Foundation, Division of Undergraduate Education (NSF GRANT 0950396).

In addition, Green Valley High School (GVHS) in Henderson, Nevada serves as a formative evaluation site for cyberlearning materials that are developed in Nevada. Over the first two years of this project, five different science teachers (including one special education teacher and a student teacher) and approximately 500 students from GVHS have participated. GVHS has a 41% minority student population with 17% of all students qualifying for free/reduced lunch and 8% with documented disabilities. GVHS has been ranked in the top 5% in Newsweek Magazine's "America's Top Public High Schools" for the past 7 years.

New Mexico

Through our partnership with the Supercomputing Challenge and Project GUTS, NM has been able to support teachers and students who wouldn't otherwise be exposed to the development these programs have to offer. Additionally, NM is working closely with NMT's Masters of Science Teaching (MST) program to offer professional development through the Summer Teacher's Institute and through a new AP Computer Science course development class. Four new teachers are in negotiations to begin work on EPSCoR-related curriculum for year 3. All of these curricula will be disseminated via NMT's EPSCoR website.

NM is also developing a class for teachers in NMT's MST program to prepare them to teach an AP Computer Science curriculum at their schools. This includes the topics of computational thinking, computational problem solving, and teaching programming and debugging in the Java programming language. Development of the course will be completed by the end of year 2 with execution and initial assessment coming in the fall of 2011 or spring of 2012. The MST program is estimating, based on inquiries from teachers, that

approximately 30 teachers from throughout New Mexico will attend this professional development. EPSCoR will be supporting the initial execution of the professional development class and the MST program will be taking over the support afterwards.

Institutional Collaborations

The project has engaged in institutional collaborations both within the Consortium and with institutions outside the Consortium.

Collaborations among Consortium Institutions

The project was set up with a management and research structure that facilitates collaborations among faculty from the different Consortium campuses (see diagram below in Management section). For example, researchers in Idaho, Nevada, and New Mexico have developed strong collaborations between UNM, UNR, UNLV, DRI, NMSU, NM Tech, ISU, UI and University of South Carolina through the collaborative work in the *Interoperability* Component on model and data interoperability and the infusion of time series data products into the systems for both delivery and capability testing.

Collaborations have also been fostered through the *Cyberlearning* Component. Institutional collaborations in Nevada involve the Curriculum and Professional Development Division of the Clark County School District (CPDD-CCSD), the Southern Nevada Regional Professional Development Program and select schools from with CCSD. As of 2006, CCSD served a K-12 student population numbering more than 300,000 and ranked 5th largest in the United States. CCSD covers nearly 8,000 square miles (including the greater Las Vegas metropolitan area) and includes rural, suburban, and urban schools. In 2007, Hispanic student enrollment in CCSD reached majority status at 40%. The Southern Nevada Regional Professional Development Program (SNRPDP) is a state supported program responsible for the design and delivery of professional development to teachers throughout the state of Nevada. The mission of CPDD-CCSD is to provide leadership and guidance for all stakeholders to increase student achievement through standards-based curricula, professional development, and educational support.

In New Mexico, the Supercomputing Challenge and Project GUTS are partnered with Sandia and Los Alamos National Labs, NMT, UNM, NMSU, New Mexico Highlands University, Eastern New Mexico University, NMSU-Dona Ana Community College, Northern New Mexico College, San Juan College, Santa Fe Community College, Computer Science Teacher's Association, and the New Mexico Network for Women in Science and Engineering. The first five institutions of higher education listed above are all Hispanic Serving Institutions.

In Idaho, MOSS is partnering with Idaho State University and two Twin Falls School District employees as well as the College of Southern Idaho and University of Idaho Extension. MOSS works with dozens of school districts in Idaho that involve hundreds of K-12 students each year in hands-on science learning experiences.

The Consortium has incorporated four other mechanisms to promote collaborations among the Tri-State Institutions: 1) Annual Tri-State Consortium Meeting; 2) Cyberinfrastructure

Working Group; 3) Innovation Working Groups; and 4) Junior Faculty Leadership workshop.

Tri-State Meeting

Each year the Western Tri-State Consortium conducts an annual meeting of current NSF EPSCoR participants. The primary purpose for this meeting is to foster collaborations among the NSF EPSCoR RII projects and participants in our respective states and to identify common challenges and solutions related to the themes of our states' RII programs. The meeting agendas and presentation formats, facilitated sessions, working group breakouts, etc., are specifically and carefully developed to spur collaboration among program directors, cyberinfrastructure scientists, research scientists, education professionals, and outreach and diversity program coordinators. The meeting rotates among the three EPSCoR jurisdictions.



Figure 2. Attendees of the 3rd Annual Tri-State Meeting listen to keynote speaker Craig Allen.

Nearly 200 researchers and educators from New Mexico, Nevada, and Idaho gathered for the 3rd Annual EPSCoR Western Consortium Tri-State Meeting at the Hyatt Tamaya Resort Hotel and Spa, Santa Ana, NM on April 6-8, 2011. The theme of this year's meeting, "Collaborations Connecting Climate Change Science, Education, and Policy," highlighted the connections that have been developing across institutions and disciplines throughout the consortium.

Researchers shared the outcomes of their work, discussed implications and possible synergies between their efforts, and clarified questions that will guide their work into the future. The three-day meeting featured 15 concurrent sessions, keynote speakers and a student poster competition; the full agenda is available in Appendix W. In addition, there was a half-day workshop on Hydrologic Information Systems and a day-long Climate Modeling workshop.

Cyberinfrastructure Working Group

The CI Working Group was formed in 2008 to leverage existing CI resources and expertise both nationally and in the tri-state region, to support climate change research, and to identify and evaluate interoperability standards and solutions that can be deployed regionally. Details on Year 2 accomplishments of the CI Working group are described in the Research Accomplishments section above.

Tri-State Innovation Working Groups (IWG)

Another mechanism for facilitating collaborations is the Tri-State's Innovation Working Group (IWG) Program, which supports collaborative, trans-disciplinary work by the three member states. The IWG provides a venue for engaging scientists and educators, along with key nationally and internationally recognized experts, to address the grand challenges that can transform science and education. This program supports week-long working group activities that are modeled after those hosted by the highly successful NSF-supported National Center for Ecological Analysis and Synthesis (NCEAS). The IWGs that convened during the performance period are described here:



Figure 3. Participants in the Western Tri-State Consortium IWG.

Increasing the Diversity of the Western Tri-State Consortium. Leads: Michele Casella, NV EPSCoR, Mary Jo Daniel, NM EPSCoR, Sarah Penney, ID EPSCoR

The purpose of this IWG was to develop a comprehensive strategic action plan that can be implemented throughout the Consortium to increase participation of and support for underrepresented minorities and women in EPSCoR scientific research and, more broadly, in STEM disciplines. The IWG drew upon research, best practices, and the initial work of the Consortium to answer the question: What can Idaho, Nevada and New Mexico EPSCoR projects do that will have a significant impact on the recruitment

and retention of underrepresented minorities and women in STEM?

Outcomes: During the meeting, working group members participated in several full group and small group sessions and came to consensus on six core strategies that would increase the participation of and support for URM students and women in EPSCoR scientific research and, more broadly, in STEM disciplines and produced a detailed report that outlines the six core strategies. This Diversity Strategic Plan is available on the Western Consortium website as well as on each state's EPSCoR website.

EPSCoR CyberScience: Lead: Dr. Karl Benedict, University of New Mexico

This IWG focused on the collaborative development of new CI capabilities (with funding obtained through new grant proposals) in support of mountain hydroclimate research, and the development of documentation (through published papers) of science problems and related workflows that may be enabled through the targeted application of CI capabilities. The purpose of this IWG was to engage in structured dialog with researchers in all three states in the Tri-State Consortium to identify specific research processes, data management and analytic tools, barriers and limitations to successful execution of those processes, and ultimately the CI capabilities that can enable those processes.

Outcomes: To facilitate further coordination between the participants in the workshops in the development of follow-on products, a collaboration site has been established with EDAC's Basecamp site. This site will be used



Figure 4. Participants of the Cyberscience IWG, Nov 2011.

to collaboratively develop White Papers defining collaborative research topics, research proposals, and materials for publication in appropriate peer-reviewed journals.

Additionally, based upon feedback from the workshop participants, the Tri-State CI team plans on continuing the dialogue between researchers and CI specialists through sessions in the annual Tri-State meetings and other venues as the opportunities arise.

Identifying complementary indicators of ecological thresholds in a changing climate. Lead: Dr. Robert Heinse, University of Idaho

Ecosystems respond nonlinearly to environmental stressors, which can lead to drastic and irreversible change. This Innovative Working Group (IWG) met to identify cross-disciplinary approaches for detecting trends of ecosystem response amidst natural variability via complementary and quasi-orthogonal indicators. We convened a cross-disciplinary group of researchers to explore a collaborative process of model development including a wide spectrum of metrics. The interdisciplinary nature of the problem suggested a unique opportunity to leverage efforts across disciplines and apply it to study risks in coupled ecosystem-human interactions. IWG participants represented ecology, hydrology, socioeconomics, sociology, statistics, and remote sensing, with foci's integrating across different spatial and temporal scales.

Outcomes: The IWG enabled the team to brainstorm and formulate new ideas regarding the identification of key gaps in the current knowledge of ecological drivers, triggers, responses and thresholds. The major outcome was development of a framework to move beyond traditional conceptual models towards quantitative models that integrate the complex and nonlinear relationships among drivers of critical thresholds. Proposals based on this IWG are being prepared for submission to the NSF Dimensions on Biodiversity and USDA-AFRI Thresholds in Agroecosystems programs.

Mountain-to-Valley Ecohydrology at Multiple Spatial and Temporal Scales. Lead: Alexandra Lutz, DRI

This IWG addressed a unique confluence of new observatories, improved modeling capability, remote sensing data, planned field experiments, and proxy records of environmental change. Challenging research and management questions that the group explored included: (1) What is the contribution of mountain ecosystems to groundwater recharge in arid to semi-arid, topographically complex environments? and (2) How can disturbances (e.g., wildfire, insect outbreaks) in a changing climate affect mountain ecosystems and their contribution to carbon and water cycling? Such questions were addressed with a focus on the critical zone (i.e., the layer bounded by the top of the forest canopy and the base of the weathering horizon).

Outcome: The IWG was held in Reno on from May 24 to May 26 and consisted of a group of scientists representing various disciplines from three states and government agencies. Common research goals were realized within the group and we outlined a collaborative path forward.



Figure 5. Participants in the 2011 JFL Workshop discuss mentoring.

Junior Faculty Leadership Workshop

The third annual NM EPSCoR Junior Faculty Leadership workshop continued a track record of success in providing training for early-career faculty and post-docs that enhances their leadership skills and increases their competitiveness for national-level funding opportunities. The three-day workshop, January 4-6, 2011, focused on improving the communication skills and productivity of the participants. This year's agenda continued and

expanded the highly successful “Communicating with Media” interactive session from past years and included additional sessions on effective teaching and mentoring as previous attendees requested. There were sixteen participants from nine different institutions across the Tri-State Consortium. The workshop was held at the Valles Caldera National Preserve Science and Education Center in Jemez Springs, NM. The remote location and residential program allowed for extensive informal networking and new collegial synergies among participants.

Collaborations with Institutions Outside of the Consortium

Consortium researchers collaborated with faculty from several universities and organizations outside the Consortium, including: U. South Carolina, U. Texas Austin, U. Texas, El Paso, and NCAR. The Model and Data Interoperability component team members have established numerous collaborations with agencies and institutions; these are listed in that portion of this report (pages. 4-6).

Workforce Development

The Consortium’s key *workforce development* efforts are being made through its *cyberlearning* activities at the K-12 and post-secondary levels. The Consortium is providing outreach and training in CI, which is enhancing research capabilities and workforce development in the sciences necessary for analysis and understanding of climate change. These activities are described in the *Cyberlearning* section, under Research Accomplishments and Plans section above.

Cyberinfrastructure

The Tri-State Cyberinfrastructure (CI) Working Group met in Albuquerque on the day preceding the Tri-State Consortium Meeting, April 5, 2011 and hosted a full day of sessions for the broader Consortium community on the first day of the Tri-State meeting. The CI Working Group was formed in 2008 to leverage existing CI resources and expertise both nationally and in the tri-state region, to support climate change research, and to identify and evaluate interoperability standards and solutions that can be deployed regionally. Twenty people attended the CI Working Group meeting in 2009; participation grew to 55 faculty, postdocs, and graduate students at the 2010 meeting and broadened to include additional researchers and educators in 2011. The CI Working Group sessions at the Tri-State Meeting were:

Cyberinfrastructure Working Group

This session was an “open” working meeting of the CI collaborators from all three states. The agenda for the meeting focused on our primary work areas:

1. Model interoperability framework (software development, deployment, and user interaction)
2. Interoperable data portals (distributed search and data sync)
3. Integration with national networks/initiatives (HIS, DataOne, others?)

In all three instances we will review (relative to our current project plan) progress to date, work plans through the end of the current project year (for both Track 1 and

Track 2), and anticipated work plans and deliverables for next project year (for both Track 1 and Track 2).

The session also addressed the development of revised metrics for measurement of "impact", strategies for increased interaction/input from stakeholders, and relationship of our work to other CI development activities (e.g. LTER, NEON, DataOne, CUAHSI) as these have been significant and recurring themes in our feedback from our external advisors.

Cyberinfrastructure (CI) and Research

This session aimed at continuing engagement with the researchers that participated in the Tri-State "Cyber-Science" workshops in November and bringing in additional researchers. In particular, the session focused on efforts to:

- 1) Initiate proposal development on at least two topics that came out of the workshops
- 2) Define working groups for developing 1-2 page white papers for at least 2 other topics as the foundation for future proposal development

Data Portals for Research and Education Users

This session provided overviews of the capabilities, interfaces, and use of the data portals being developed in each state. Following a brief overview of key interoperability standards that are supported within the data portals that are under development, each state provided a 15-minute demonstration/presentation with a focus on use of the portal followed by questions/discussion. The two-targeted outcomes for the session were:

- 1) User familiarity with the interfaces and capabilities being developed in the three states so that users are in a position to make use of the capabilities being developed (discovery, access, use of published services)
- 2) Gather feedback from science, education, and policy users relating to additional features/capabilities that should be considered for further development of the portals.

In addition, the Cyberlearning component has made contributions to the Consortium's CI, which also contribute to our communication and outreach efforts.

In Nevada, the cyberlearning portal (<http://climatechange.education.unlv.edu>) continues to be used in the research and development of curriculum materials. The courseware site (<http://climatechange.education.unlv.edu/moodle>) hosts high school courses that are using the materials, offers open-access to developed materials, and serves as a dissemination point for project materials and scholarship.

In New Mexico, the NMT EPSCoR website (<http://www.cs.nmt.edu/~epscor/>) serves as a clearinghouse for cyber-education links to climate change datasets, visualization and data analysis tools and tutorials, grants, scholarships, and training opportunities. The site also serves as the focal point for disseminating the curricula developed by EPSCoR-supported MST students and the classroom management web framework currently under development. The framework will allow teachers to utilize the additions to the CI in NM to manage their classes from the web. While extensible in multiple ways, it maintains a low

barrier to entry by requiring no programming to set up or operate. The framework is being designed to work with Google's free App Engine infrastructure. By utilizing Google's App Engine, teachers from schools without the necessary hardware and support to host course infrastructure will be able to deploy and use it with no cost. This framework will be available from NMT's EPSCoR web site and an announcement will appear on the web site as soon as it is available.

Outreach and Communication

The Consortium has a number of outreach and communication mechanisms. These include the Annual Tri-State Consortium Meeting, Cyberlearning activities, each state's EPSCoR web site as well as the newly launched Western Consortium website and presentations made at national scientific meetings.

A centerpiece for communication and outreach is the annual Tri-state Consortium meeting, which facilitates collaboration and information sharing between our states and was described above. This year's meeting also provided an opportunity to introduce the newly developed Western Consortium website to the tri-state community. The new website, linked to each state's individual website, provides information about Consortium activities and opportunities as well as an archive of Consortium accomplishments, presentations, and products. The Tri-state annual meeting also provided an opportunity to pilot a meeting blog on which participants were invited to discuss their experiences at the meeting as well as their research interests more broadly. The outreach coordinators for each state are further studying the use of blogs and other social networking tools for Consortium outreach and communication.



Figure 6. Screen shot of the Western Consortium website

Outreach and communication is embedded in all of the *cyberlearning* activities described above under the Research Accomplishments and Plans section. This includes outreach to middle and high school teachers, stakeholders, RII participants, and underrepresented groups through the CI Training program, the development and dissemination of educational materials (e.g., through the MOSS and UNLV programs), and through CI extracurricular programs (e.g., GUTS, National Supercomputing Challenge). In addition, the Idaho Cyberlearning state lead will participate with NASA's Spaceward Bound to educate teachers in the field about earth science and remote sensing in summer 2011. She will focus on remote sensing, and especially LiDAR, research.

Presentations

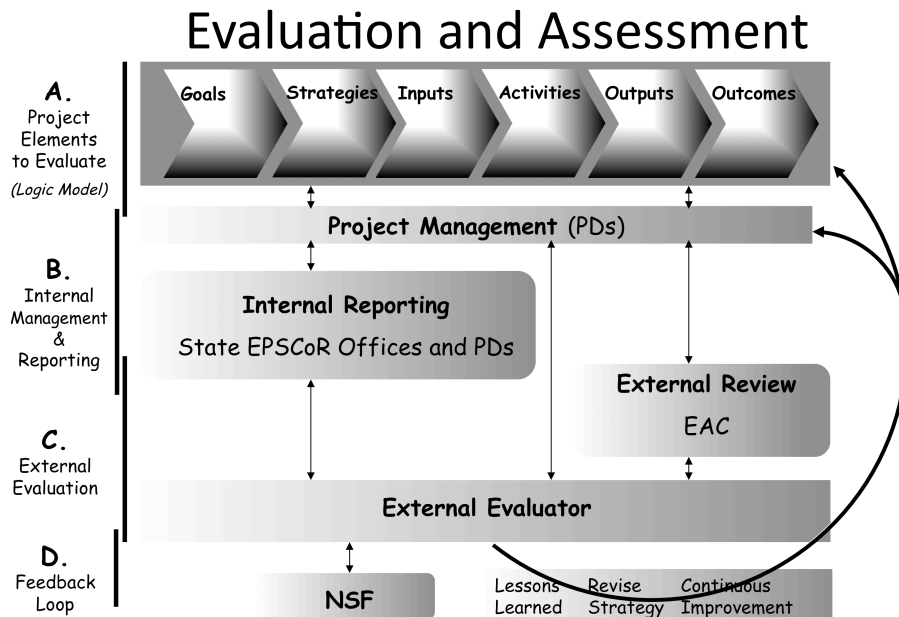
The table below lists many of the numerous presentations Consortium researchers and educators made of their work throughout the year. **Not** included are the more than 70 presentations and 40 student posters from the Tri-State meeting; information about these are available on the Consortium website at (<http://www.westernconsortium.org/>).

Year 2 Presentations				
State	Presentation Type	Presenter(s)	Event	Title
ID	Cyberseminar	Torgrimson J, Ames, D., Eitel, K.B.	Seminar to all Idaho Track 1 and Track 2 participants	Cyberlearning activities at MOSS
ID	Presentation	Glenn, N.	American Geophysical Union Annual Meeting	Lidar for Analysis of Earth-Surface Processes
ID	Presentations and Poster	Ames, D.	American Geophysical Union Annual Meeting	HIS Systems and Components
NM	Poster	Brown, S., Coonrod, J., Benedict, K., Sanchez-Silva, R., Barrett, H.	Cyberinfrastructure Summer Institute for Geoscientists (CSIG)	New Mexico Hydrologic Information System (NMHIS)
NM	Poster	Brown, S., Coonrod, J., Benedict, K., Sanchez-Silva, R., Barrett, H.	US Committee on Irrigation and Drainage (USCID), Emerging Challenges and Opportunities for Irrigation Managers	New Mexico Hydrologic Information System (NMHIS)
NM	Poster	Brown, S., Coonrod, J., Benedict, K., Sanchez-Silva, R., Barrett, H.	Rocky Mountain Section American Water Works Association (RMSAWWA) Student Research Conference	New Mexico Hydrologic Information System (NMHIS)
NM	Poster	Brown, S., Coonrod, J.	Conference on Hydrologic Data and Information Systems	Converting a large archive hydrologic dataset from flat file to relational database using CUAHSI-HIS
NM	Oral Presentation	Sanchez-Silva, R.	NMGIC Fall Workshop and Meeting	The Open Source Technology behind New RGIS
NM	Oral Presentation	Sanchez-Silva, R.	New Mexico Geospatial Advisory Committee	New RGIS Site, New GSTORE Geoplatform
NM	Paper Presentation	Benedict, Karl	NM Geographic Information Council	Advanced Cloud Computing for Geospatial Applications
NM	Paper Presentation	Benedict, Karl	International Society for Remote Sensing of the Environment	Key Interoperability Standards for Earth Science Research and Applications
NM	Workshop	Benedict, Karl	Federation of earth Science Information Partners Summer Meeting	Interoperability 101: OGC Standards

NM	Paper Presentation	Benedict, K., Hudspeth, W., Morain, S. & Budge, A.	International Society for Remote Sensing of the Environment	Delivery of Relevant Remote Sensing and Model Outputs to Public Health End Users Through International Interoperability Standards
NM	Paper Presentation	Benedict, K., Yang, P., Huang, Q.	American Geophysical Union Fall Meeting	Environmental Model Interoperability Enabled by Open Geospatial Standards - Results of a Feasibility Study
NM	Paper Presentation	Benedict, K., Yang, P., Huang, Q.	International Congress on Environmental Modeling and Software	OGC Web Coverage and Web Feature Services (WCS & WFS) for Enabling Nested Environmental Modeling
NV	3D Videos	Moore, C., Ehinger, S., Glenn, N., Mannel, S.	Bingham County Historical Society presentation	Using 3D visual tools with LiDAR for environmental outreach
NV	Paper Presentation	Skaza, H., Stave, K., Crippen, K.J.	National Association of Research in Science Teaching (NARST) Annual Meeting	Assessing the Effect of Systems Simulations on Systems: Understanding in Undergraduate Environmental Science Courses
NV	Paper Presentation	Archambault, L.M., Tsai, W.T., Crippen, K.J.	Society for Information Technology & Teacher Education (SITE) International Conference	Exploring Cyberlearning: Inquiry-Based Mashups Combining Computer Science with STEM
NV	Paper Presentation	Carroll, K., Crippen, K.J., Kern, C., Ebert, E.	National Science Teachers Association (NSTA) National Convention	Using Inquiry with Web-based Tools to Teach Science Meaningfully
NV	Paper Presentation	Crippen, K.J., Archambault, L.M., Kern, C.	National Association of Research in Science Teaching (NARST) Annual Meeting	Examining the Use of Laboratory Activities in Secondary Science Online
NV	Poster	Moore, C., Glenn, N., Anderson, J., and Busche, C.	EPSCoR Third Annual Western Tri-State Consortium Meeting	Using 3D Visualization for Environmental Outreach

Evaluation and Assessment

The project's management team works in concert with the External Evaluator (Lisa Kohne) and an External Advisory Committee to monitor how well the project is moving towards its goals. The External Evaluator uses formative and summative evaluation processes and provides an annual evaluation report to the project management team. In addition to the external evaluator, our project's *evaluation* and *assessment* component includes an eight member External Advisory Committee (EAC) that meets annually. The second EAC meeting took place on February 18, 2011 in Idaho Falls, ID. A summary of, and outcomes from, the meeting are detailed above in the Executive Summary section "Actions resulting from site visits, reverse site visits, evaluation and assessment reports, advisory committee visits." A schematic of the project's evaluation and assessment program is shown below.



Sustainability and Project Outputs

Sustainability efforts are being accomplished in several ways. The first is by commitments to long-term support by individual states and institutions for Track 2 activities. The connectivity and broadband improvements accomplished in year one are being maintained by each state/institution.

The second way is through development of new proposals that make use of and provide continued CI support. Several proposals have been submitted, or are in the process of being submitted this year. Proposals submitted by Consortium members in Year 2 are shown below.

Year 2 Proposals Submitted				
Funding Agency	Title	PI/Co-PI	Amount	Status
NSF - EHR-Cyberlearning: Transforming Education	Designing Effective Web-based Simulations for Sustainability Learning and Engagement	Stave & Crippen (UNLV)	\$550,000	Pending
NSF - EHR-Discovery Research K12	Collaborative Research: Web Application Composition to Power Up CSTA Curriculum	Tsai, Chen, & Archambault (ASU); Crippen (UNLV)	\$1.9 Million	Pending
NSF - EHR-CyberInfrastructure TEAM demonstration project	Collaborative Research: Adventure Learning through Water and MOSS	Miller, Eitel, Eitel (University of Idaho); Veletsianos (UT Austin)	\$250,000	Pending
National Science Foundation Geomorphology and Land Use Dynamics Program	Geomorphic Constraints on the Climate History of the Arid Chajnantor Plateau, Northern Chile: Interactions between regional subtropical climate and high-altitude glacial landscapes	Galewsky (UNM)	\$275,000	Pending
National Science Foundation	Collaborative Research: CI-Team Diff: The Virtual Learning Commons: STEM Research Communities Learning about Data Management, Geospatial Informatics, and Scientific Visualization	UTEP, Benedict (UNM)	\$133,923	Pending

The third mechanism for sustainability is through creation of new partnerships and strengthened collaborations. Collaborations within the Consortium have been greatly strengthened as the result of the Annual Tri-State Meeting. Some of these collaborations have led to successful Innovation Working Group projects, and proposal development and

submissions to Federal agencies. Other collaborations are detailed above in the Institutional Collaborations section. National partnerships developing in year two include NSF-funded programs CUASHI, CREST, and CYBER-ShARE.

Sustainability of CI developments relating to the *interoperable* data archive in New Mexico have been accomplished in close collaboration with New Mexico's Resource Geographic Information System (NM RGIS), the geospatial data clearinghouse for the state of New Mexico. NM RGIS has a long-standing history (18 years) as the state clearinghouse and is a stable platform through which the science data products of the EPSCoR project will be continuously published beyond the funding window provided by NSF for the current RII. This partnership and integration of science data into the RGIS system will provide long-term sustainability for availability of products for years to come. Also, the development of the www.hydrodesktop.org web site – where all hydrologic information systems-related development associated with this project is being presented in an open source fashion – is focused on fostering collaborative development of the system with expected long-term sustainability by building a large group extending beyond the EPSCoR team.

Sustainability of the *Cyberlearning* Component has focused on development of partnerships and strengthening existing partnerships for leveraging activities. For example, we have developed a partnership with MOSS in developing and disseminating educational material that will be leveraged to increase additional support of activities in the future. We have also strengthened the partnership with the Supercomputing Challenge and Project GUTS to incorporate CI materials into an existing program, which will sustain the impact long after the end of this project.

Seed Funding and Emerging Areas

Seed funding to develop interdisciplinary and inter-institutional proposals and publications across states is being funded by the Consortium's Innovation Working Group Program. This program, and groups that received IWG funding in year one are described above in the Institutional Collaborations section of the report. Seed funding is incorporated into the Cyberlearning Component through the sponsorship of CI training support for Consortium participants, which is described in more detail above in the *cyberlearning* part of the Research Accomplishments and Plans section.

Human Resources Development

The project's human resources development activities and outcomes include recruitment and retention of new postdoctoral fellows, students, and technicians, workforce development, and workforce and education activities. These activities are described in detail in prior sections of this report.

Leveraging NSF Programs

Linkages, coordination, and collaboration with other NSF-funded programs are occurring at the component level of the project. Primary leveraging in the *Interoperability* Component is through our involvement in the NSF-funded Consortium of Universities for the Advancement of Hydrologic Sciences (CUAHSI) Hydrologic Information Systems (HIS)

project, which we are using extensively to support the point observation data interoperability work in this project. Also, the *Interoperability* group is leveraging EDAC's emerging collaboration with the CYBER-ShARE program at the University of Texas, El Paso, which has created a connection with NSF's CREST program, as CYBER-ShARE is funded through this program. As noted above, this collaboration is also leading to new proposals to NSF programs that provide support for semantic annotation of scientific workflows and products.

Each of the states is also leveraging their RII C2 awards for improving intra and inter campus connectivity.

In *Idaho*, the C2 grant is resulting in improved connectivity at several 2-year and 4-year colleges, including Lewis-Clark State College, North Idaho College, and College of Southern Idaho. The improved internet and video infrastructure provided by the C2 grant, as well as EPSCoR-catalyzed collaborations, are making it easier for university faculty involved in both Track 1 and Track 2 RII activities to work with college faculty to integrate water resources and climate change research topics in educational activities. The participation of College of Southern Idaho faculty at the recent Tri-State meeting has further encouraged synergy among our projects and institutions.

New Mexico has focused its C2 efforts on improving connectivity at three undergraduate institutions--two regional colleges and a tribal college. The Track 2 activity connecting the state's CI to industry through collaboration with Fast Forward New Mexico (described above, p. 11-12) specifically targets the communities in which these colleges are located. Additionally, the education outreach efforts of the NM C2 award focus on increasing the use and providing content for the educational gateways that were installed as described in the Connectivity component.

Nevada's C2 major connectivity improvements are scheduled to be installed summer 2011. These improvements build on those funded by the Track 2 project with upgrades that increase bandwidth in key locations of the system, and by leveraging Track 2 training programs in high performance computing. Together, C2 and Track 2 connectivity and broadband enhancements will promote communication and collaboration within Nevada as well as the Western Tri-State Consortium. In addition, a MacBook Learning Lab, purchased with Nevada C2 funds, is being used by 200 students at Green Valley High School in Henderson NV to access the Climate Change Cyberlearning Curriculum Development (C4D) website - developed as part of Track 2 - to investigate the impacts of climate change on the Great Basin region and to understand sustainable living.

Management Structure

EPSCoR governing committee meetings and relevant actions

Idaho

The Idaho EPSCoR Committee annual meeting was held in Boise, Idaho on August 31-September 1, 2010. The PI presented the Committee with an overview and update of progress on the Track 2 RII. No official actions relevant to the Track 2 RII were needed or taken.

Nevada

The Nevada EPSCoR Advisory Board met on October 5, 2010 and heard an update on all Nevada's NSF EPSCoR programs by Project Director, Dr. Gayle Dana. They also discussed the Nevada Science and technology Plan. The Board also met on March 22, 2011 and heard an update on all Nevada's NSF EPSCoR programs by Dr. Gayle Dana, as well as an update on Nevada's NASA EPSCoR programs. They also reviewed various initiatives related to research and economic development and the legislative process. There were no specific action items resulting from these two meetings. The next Board meeting is scheduled for June 28, 2011 where a key agenda item will be discussion of upcoming NSF EPSCoR proposal development activities (Track 1, Track 2 and C2). The Board will be expected to provide direction on proposal topics and development process.

New Mexico

The New Mexico State EPSCoR Committee met in September 2010 and April 2011. At both meetings they reviewed Track 2 progress to date as well as feedback from external advisory and evaluation reports. Plans and timelines for development of the next RII proposals were discussed.

All

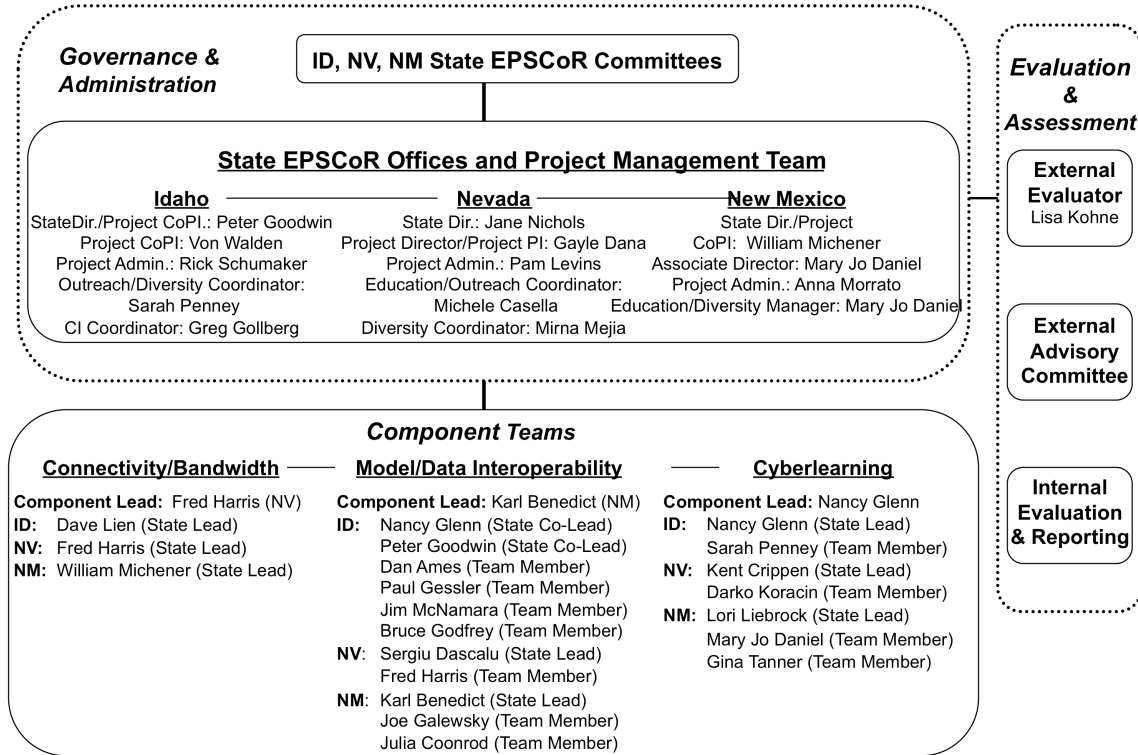
State Committee members supported plans to hold a special session at the upcoming National EPSCoR Meeting in Fall 2011 for representatives from the tri-state governing committees to discuss opportunities for continued collaboration beyond the period of this award.

EPSCoR Management Team Meetings and Actions

Describe any major changes in personnel and/or succession plans for key personnel.

The project *management structure* (shown in the diagram below) is designed to encourage interaction among the three states and the various components. It includes the Management Team (State Directors, PI, Co-PIs, Project Administrators, and Education, Outreach, and Diversity Coordinators), the Component Team (Component Leads, State Leads, and component members), and Evaluation and Assessment (External Evaluator, External Advisory Committee, and Internal Reporting). To encourage effective project *communication* and *management*, there have been monthly Leadership meetings (consisting of the PI, Co-PIs and Component Leads), as well as monthly meetings of Component members. Most meetings have occurred online via Webex or Go to Meeting. In

year 2, New Mexico and Nevada have added communication specialists to their staff to assist with public outreach activities and NV has employed a Diversity Coordinator. Idaho has hired Luke Sheneman as Data Manager and Greg Gollberg as CI Coordinator as a result of the Track 2 project.



Institutional Affiliation and Demographics

The project’s leadership and management structure consists of state EPSCoR and NSF EPSCoR Project Directors, Track 2 Project PI and Co-PIs, Component Leads, and State-Specific Component Leads. The state breakdown is: ID (6), NV (7), and NM (5). The leadership and management team is distributed among eight institutions: University of Idaho (7), Idaho State University (1), Nevada System of Higher Education (3), Desert Research Institute (1), University of Nevada, Reno (2), University of Nevada, Las Vegas (1), University of New Mexico (4), New Mexico Tech (1). Females make up 50% of the leadership and management team. There is one Native American and the rest of the leadership and management team are White. Please see the table below for a detailed breakdown.

Institutional Affiliation and Demographics of Track 2 Leadership and Management Team						
Title	State	Name	Institution	Male	Female	Ethnicity
State Director	Nevada	Jane Nichols	NSHE		1	White
Project Director and Project PI	Nevada	Gayle Dana	DRI		1	White
State and Project Director Model & Data Interoperability State Co-Lead	Idaho	Peter Goodwin	UI	1		White
State and Project Director Connectivity State Lead	New Mexico	William Michener	UNM	1		White
Associate NSF EPSCoR Director	New Mexico	Mary Jo Daniel	UNM		1	White
Project Co-PI	Idaho	Von Walden	UI	1		White
Project Administrator	Nevada	Pam Levins	NSHE		1	White
Project Administrator	Idaho	Rick Schumaker	UI	1		White
Project Administrator	New Mexico	Anna Morrato	UNM		1	White
Education, Outreach & Diversity Administrator	Nevada	Michelle Casella	NSHE		1	White
Education, Outreach & Diversity Administrator	Idaho	Sarah Penney	UI		1	Native American
Connectivity Component and State Lead	Nevada	Fred Harris	UNR	1		White
Connectivity State Lead	Idaho	Dave Lien	UI	1		White
Model & Data Interoperability Component and State Lead	New Mexico	Karl Benedict	UNM	1		White
Model & Data Interoperability State Co-Lead Cyberlearning Component and State Lead	Idaho	Nancy Glenn	ISU		1	White
Interoperability Co-Lead	Idaho	Greg Gollberg	UI	1		White
Model & Data Interoperability State Lead	Nevada	Sergiu Dascalu	UNR	1		White
Data Manager	Idaho	Luke Sheneman	UI	1		White
Cyberlearning State Lead	Nevada	Kent Crippen	UNLV	1		White
Cyberlearning State Lead	New Mexico	Lori Liebrock	NMT		1	White

Technical Assistance by other outside agents, e.g. consultants

Idaho

The University of Idaho utilized a consultant with the Idaho Regional Optical Network (IRON) for recommendations, networking design, and engineering services related to the proposed connectivity improvements at Kimberly and Hagerman Idaho that would allow the university to access these sites in cooperation with the IRON. This work was completed

during the current award period and led to implementation of sustainable connectivity improvements at the proposed research facilities. Idaho is also the lead state for contracting with SmartStart for external evaluation of the Track 2 project.

Nevada

There was no technical assistance by other outside agents in year two.

New Mexico

There was no technical assistance by other outside agents in year two.

Jurisdictional and Other Support

Idaho

In Idaho, the ID EPSCoR staff administers the NSF EPSCoR projects, including this Track 2 award. A portion of the staff effort is provided through non-federal state support for the Idaho EPSCoR program. Idaho EPSCoR resources for office space, communications, and videoconferencing are also provided.

Nevada

Financial and administrative assistance to the project is provided by the Nevada EPSCoR Office (NEO), which administers all of the state EPSCoR programs. Key personnel within the Administrative Management Team include: Pamela Levins (full-time NSF EPSCoR Project Administrator) responsible for budget administration, coordination with the NSHE institutions' research offices, collecting baseline information, documenting accomplishments of project milestones, and general administration of sub-awards; Michele Casella (full-time NSF EPSCoR Research Administrator) coordinates RII evaluation activities, education outreach programs, and statewide student solicitations and works with faculty to increase diversity for project components; Mirna Mejia, full-time Diversity Coordinator; and full-time Communications Specialist, Martha Delgado, responsible for information and updates for the Web developer, designs brochures for specific projects, works with the NSHE PR office for all press media relations, and works with the campus PR staff to incorporate NSF EPSCoR highlights for faculty, staff, and students. Other full-time NEO staff involved in project management include: Al Hardimon - financial administration; Lori Brazfield - sub-award preparation and monitoring; Angela Poole and Karen Liedke - financial and credit card transactions, travel coordination, and general administrative support; Laura Mercer—website and survey development. NSHE provides offices and secretarial support for all project participants. Video conferencing facilities are available to facilitate project meetings. Additionally, NSHE has video conferencing facilities that also allow file sharing and display of software presentations simultaneously between parties remotely located.

New Mexico

In New Mexico, the NM EPSCoR state office administers NSF EPSCoR programs. The State Office provides meeting and collaboration space, including access to video and web conferencing facilities.

Jurisdictional support for the individual project components include:

Connectivity Component: Strategic planning began at the jurisdictional level before this RII was funded and will continue to be supported after the project is completed through a variety of means. In *Nevada*, assessment of needs was performed by the universities and NevadaNet. In *New Mexico*, it was done by the New Mexico’s Computer Applications Center (NMCAC) and in *Idaho* it was done by the state EPSCoR committee in collaboration with the Higher Education institutions.

Data and Software Interoperability Component: The *Idaho* research team continues to make extensive use of the facilities at the Department of Energy sponsored Center for Advanced Energy Studies in Idaho Falls, ID. *New Mexico’s* team makes continuing use of the computational resources housed at the Earth Data Analysis Center, and New Mexico’s Computer Applications Center (NM CAC, a State owned supercomputer resource upon which climate models are being run by researchers at UNM). The Computer Science Department at UNR in Nevada provides office and laboratory space for faculty, postdocs, and graduate students involved with Track 2.

Unobligated Funds

	Awarded	Obligated	Unobligated	%Unobligated
Idaho	\$666,666	\$666,666	\$0	0%
Nevada	\$666,667	\$614,946	\$51,720	8%
New Mexico	\$666,669	\$609,865	\$56,804	9%

3. Award Specific Terms and Conditions.

The Consortium’s Track 2 project has two award specific terms and conditions.

1. Obtain from the school board or comparable authority responsible for the schools considering participation in the project, written approval prior to involvement of pre-college students in pre-college education research and development, pilot-testing, evaluation, and revision of experimental and innovative pre-college curriculum.

Not applicable in year two.

2. Include in every publication, testing, or distribution agreement involving instructional materials developed under this award (including, but not limited to, teachers’ manuals, textbooks, films, tapes, or other supplementary material) a requirement that such material be made available within the school district using it for inspection by parents or guardians of children engaged in educational programs or projects using such material of that school district.

Not applicable in year two.

4. Experimental/Computational Facilities

No equipment was acquired in year two. There have been no usage fees paid with NSF RII money for accessing other NSF-funded shared facilities and networks in Nevada, Idaho or New Mexico.

5. Publications

See Fastlane for submission of each state's publications.

Okamoto, S., Fritzinger, E., Dascalu, S. , Harris, F.C., Latifi, S., and MacMahon, M.	Towards an Intelligent Software Tool for Enhanced Model Interoperability in Climate Change Research	Proceedings of the World Automation Congress (WAC-2010), Sept. 2010, Kobe, Japan
McMahon, M., Dascalu, S. , Harris, F.C., Strachan, S. and Biondi, F.	Architecting Climate Change Data Infrastructure for Nevada	Proceedings of the International Workshop on Systems and Software Architecture (IWSA-2011), London, UK, June 2011
Dascalu, S., Fritzinger, E. , Okamoto, S. and Harris, F.C.	Towards a Software Framework for Model Interoperability	Proceedings of the IEEE International Conference on Industrial Informatics (INDIN-2011), Lisbon, Portugal, July 2011
Crippen, K. J. , Archambault, L. M., & Kern, C. (in press)	Using Scaffolded Vee Diagrams to Enact Inquiry Based Learning	In A. Hirumi (Ed.), <i>Designing online and hybrid learning environments: A grounded approach to facilitating e-learning</i> : International Society for Technology in Education (ISTE)
Skaza, H., Stave, K., & Crippen, K. J. (under review)	Assessing the effect of systems simulations on systems understanding in undergraduate environmental science courses	<i>Journal of Computers in Mathematics and Science Teaching.</i>

6. Honors and Awards

The following awards and honors were given to RII participants in year two:

Kent Crippen (NV) was recognized by the International Association for K-12 Online Learning (iNACOL) with the 2010 Online Learning Innovator Award for Important Research by an Individual, Team or Organization.

Sergiu Dascalu (faculty member) - UNR Donald Tibbitts Distinguished Teacher Award 2011

Sergiu Dascalu - UNR Outstanding Undergraduate Research Faculty Mentor Award 2011

The Fast Forward New Mexico program, having been delivered in seven communities to date, received the 1st Place Technology Based Program Award at New Mexico Rural Economic Development Alliance in April. Additionally, they have been nominated for the New Mexico Tech Council's Tech Excellence Awards.