

SUMMARY OF FY2002 PROGRESS SOUTH DAKOTA SPACE GRANT CONSORTIUM

<http://www.sdsmt.edu/space/>

Throughout the 2002 project year, the South Dakota Space Grant Consortium (SDSGC) progressively continued to leverage our growing resources through linkage of educational outreach, research, and public service efforts. Many of the goals and planned projects described in our FY2002 Program Plan a year ago were successfully reached and are described in more detail below in the following six categories: Research Infrastructure, Higher Education, K-12 Outreach, Other Public Service, Fellowships and Scholarships, and Administration. In addition to frequent collaborations between SDSGC headquarters at the South Dakota School of Mines & Technology (SDSM&T) and institutional members at SD State University (SDSU), Augustana College, and the USGS EROS Data Center, many of SDSGC's 31 members and affiliates in higher education, government and industry work well together in promoting and conducting education and research at the university and K-12 levels.

In addition to this Progress Report, a valuable database of SDSGC goals, efforts, and activities is available at the SDSGC website <http://www.sdsmt.edu/space/>.

1. Research Infrastructure

As a "capability enhancement" state in NASA's Space Grant Program, development of research infrastructure within South Dakota continues to be one of the six focus areas of SDSGC activities mentioned above. Highlights in research areas over the past year include the following.

- South Dakota's NASA EPSCoR Program <<http://www.sdsmt.edu/space/nasaepscor/>> continued to improve research infrastructure within the state and collaboration with NASA Centers and staff through use of resources available in the core grant titled "The Use of Remote Sensing for Monitoring, Prediction, and Management of Hydrologic, Agricultural, and Ecological Processes in the Northern Great Plains". Work continued on the following two NASA EPSCoR research projects:

A) "Leaf Area Index for Fire Chronosequences of the Black Hills and Southern Siberia: A Comparative Study" (PI - Dr. Lee Vierling of SDSM&T).

Update of 2002 work: The South Dakota NASA-EPSCoR research effort includes an investigation entitled "Leaf Area Index for Fire Chronosequences of the Black Hills and Southern Siberia: A Comparative Study". This project is being carried out jointly between personnel at the South Dakota School of Mines and Technology, Augustana College, EROS Data Center, and NASA's Goddard Space Flight Center. During 2002, significant progress has been made towards achieving the goals of this project, including site selection and extensive field data collection at the Black Hills sites, analysis of early results and incorporation into manuscripts submitted to peer-reviewed journals (Chen et al., in prep., Toomey and Vierling, in review), and data processing of MODIS, IKONOS, and Landsat 7 data collected over Siberian field sites, for comparison to the Black Hills sites. In addition, a research-grade pneumatic boom has been transferred from Donald Deering's laboratory at NASA-GSFC to SDSM&T and refurbished to support data collection at the Black Hills field sites. A further significant collaboration that has arisen from this work is a partnership with Horizon's, Inc. of Rapid City, SD to quantify forest leaf area index and other biophysical properties using a laser altimeter (see presentations and papers section for list of relevant activities in this area). In addition to the joint participants listed above, Augustana College reported that they had 2 faculty members and 3 undergraduate students participate in this collaborative, State-wide NASA EPSCoR project. Augustana College participants included faculty members Dr. Daniel Swets, computer science and Dr. Steve

Matzner, Biology. Undergraduate student participants were Ms. Olga Degtyaryova, computer science, Ms. Katharyn Derr, biology, and Mr. Jacob Quail, biology.

B) "Cross-Calibration of Landsat and IKONOS Sensors for Use in Precision Agriculture" (PI - Dr. Dennis Helder of SDSU).

Update of 2002 work: SDSU reports that Year 1 of the project has been completed and participation in the steering committee took place. Coordination of multidepartmental researchers took place. Site specific farm, or 'precision agriculture' requires accurate, moderate resolution, up-to-date, geo-located information. Remotely obtained data from satellite or aircraft sensors are generally accepted as the primary source for developing the requisite GIS (ground information system) to support precision agriculture. In the case of satellite imagery, however, the absolute radiometric accuracy of the datum is not always well established. From the user's point of view, as data from different platforms is incorporated into the GIS, the ability to 'seamlessly' incorporate this multi-sourced information requires a detailed cross-calibration of the attendant instrumentation set. Also, in comparing ground based and space based instrumentation, atmospheric effects introduce another calibration issue. A transfer function from ground crop spectral feature to top of atmosphere (TOA) banded spectral feature must also be developed if data comparison is to be valid. The cross-calibration aspect of the project includes: An equipment base, protocols, models, and results analysis. The project's first focus was to validate SDSU's ground based standards set. To radiometrically calibrate the satellite imagery, temporally coincident reflectance measurements of large (multi-pixel) targets were taken at ground level. The targets included vegetated areas, calibrated reflectance standards (including two 20m square 'standard' targets on loan from Stennis Space Center), and sharp reflectance transition regions. Ground data was taken with a wide array of instrumentation that included both hyperspectral spectroradiometers and banded instruments. Concurrent down-welling radiance measurements were performed to provide parametric input to standard atmospheric models. During the summer of 2002, the SDSU group attempted 18 ground data collects. Of these, eight are characterized as good, one fair, one marginal, with the remainder characterized as 'busts' due to weather (cloud cover moving in at overpass). Of particular interest in this phase, was the establishment of the cross-correlation between the ground based reflectance instruments, primarily a banded Cropscan 2 instrument and an ASD FR Fieldspec spectroradiometer. Significant differences were found, resulting in procedure changes along with a renovation and recalibration. Models for data reduction and analysis were developed and the summer's data is subsequently being analyzed. Analysis efforts will include modeling to produce atmospheric transfer functions, which will then be used to produce in-band (TOA) at sensor radiances. Once this is achieved for both the Landsat and Ikonos sensors, then a quantitative cross-calibration and identification of crop spectral features can occur.

The SD NASA EPSCoR strategic plan is guided by the following desirable actions:

- To establish new contacts and strengthen existing linkages with NASA Centers, NASA researchers, and the USGS EROS Data Center.
 - To promote participation from the State's major research institutions, State agencies, and relevant businesses in SD that are interested in strengthening our scientific and technological enterprises.
 - To develop the State's scientific talent and infrastructure for enhanced competitiveness in research, development, and technology-based economic development.
 - To encourage greater participation by under represented groups, especially Native Americans, in scientific education and research.
 - To build greater public and political support in SD for the overall science, engineering, and technology enterprise.
 - To communicate the benefits of current and future NASA programs to the progress and development of SD, the Northern Great Plains Region, and the Nation.
- SDSGC continued to pursue efforts within and outside the state of SD regarding the proposed National Underground Science Laboratory at the Homestake Mine.

A 5-year, collaborative proposal has been submitted to the National Science Foundation to convert the Homestake Gold Mine in Lead, South Dakota, which closed in December 2001, into a National Underground Science Laboratory (NUSL) <<http://mocha.phys.washington.edu/NUSL/>>. During the past 30 years, scientists have developed an amazing way to view the Universe with deep underground neutrino "telescopes". Results from the first solar neutrino experiment, which was initiated by Dr. Ray Davis and his colleagues over 30 years ago with a neutrino detector 4,850 feet underground at the Homestake Mine, have stimulated the "solar neutrino problem" and multiple investigations worldwide. Dr. Davis shared the 2002 Nobel Prize in Physics for his efforts in the solar neutrino experiment at Homestake. The results obtained from this growing cadre of underground detectors now promise new insights into the Standard Model of Elementary Particles and Forces. In addition to subterranean physics, a whole range of "underground science" has become evident during the past few years. Specific subterranean research topics include solar, atmospheric, long-baseline, supernova and high energy astrophysical neutrinos, double beta decay, and dark matter searches; precision and sensitive assay of radionuclides (with applications to enforcement of disarmament treaties and environmental effluent studies); materials science and engineering; nuclear astrophysics cross-section measurements; hydrology, seismology, rock mechanics and other topics in geoscience; microgravity experiments via long drop tubes; and the study of the evolution and subsistence of biological organisms under extreme environmental conditions. There is also considerable industrial interest in underground laboratories because of materials activation issues, cosmic-ray-induced error rates in microelectronics, quantum computing, and the production and storage of ultra-pure materials.

With proximity to Mt. Rushmore and the fact that most people find understanding the Cosmos so exciting, NUSL has the potential to interest many Americans in science and engineering. In addition to an extensive outreach program for tourists, if NUSL were to become a reality, it could potentially provide on-site and distance education curricular experiences for K-Ph.D. students, distance education opportunities for the general public, astrophysical data outreach to scientists around the world, and special participation opportunities for individuals and institutions in regional and national EPSCoR states and Puerto Rico. In its interpretative activities, NUSL could recognize the special significance of the Black Hills to the Native American community and could use both its special place and the excitement of its science to reach out to all communities, especially those underrepresented in U.S. science and technology. The existing outreach network contained within the National Space Grant College and Fellowship Program and the NASA EPSCoR Program will be relied upon extensively for this purpose.

A series of four White Papers were prepared in 2002 in the area of Outreach, in follow-up to a conference on underground science opportunities at the proposed NUSL that was held in Lead, SD in October 2001. White papers were prepared in the areas of: 1) K-12 education at NUSL, 2) undergraduate research, 3) Educational and Research Opportunities for Young Scientists at NUSL, and 4) NUSL Visitor Experience Center.

SDSGC Director Dr. Sherry Farwell attended and participated in the International Workshop on Neutrinos and Subterranean Science held in Washington D.C. in September 2002.

- SDSGC awarded an SDSGC Program Initiation Grant titled "Homestake Mine Cosmic Ray Background Study" (of about \$4,000) to Tom Campbell, Astronomy Instructor at SDSM&T for an experiment is to determine the impedance of cosmic rays by the Earth's crust within 7,400 feet of the surface in the Homestake mine in Lead, SD. Although detectors have not yet been installed, the intent is to install detectors on two levels within the mine and establish the impedance at these levels. It is hypothesized that a 7,400 foot thick slab of the Earth will impede cosmic ray penetration significantly. Five students, 2 graduate and 3 undergraduate, are involved in the experiment with Tom Campbell.

- SDSGC Director Dr. Sherry Farwell continued to provide assistance to the Western Research Alliance (WRA) <<http://w-research-alliance.org/>>. The objective of this broad based organization is to provide a regional forum for academic researchers, entrepreneurs, state and federal agencies, and local economic developers who are interested in the promotion of research, technology transfer, and business development. A meeting was held on April 6, 2002 focusing on “value added” ideas relating to manufacturing and processing of products. A WRA Workshop was held on October 12, 2002 to include New Research Opportunities in Western South Dakota with a goal to create an organization that will marshal the administrative and financial support that can carry these research projects into viable commercial enterprises.
- Technical and financial support was provided for GIS-remote sensing and image processing laboratories at member universities and educational affiliates, including Native American Tribal Colleges. This support is for research and educational projects involving GIS and remote sensing curriculum development, precision agriculture, algorithm development for NDVI data, plant science, climate change, and land surface processes. These projects involve interaction with the USGS EROS Data Center (EDC) located in South Dakota.
- SDSM&T investigators continued both basic and applied research into carbon sequestration. The South Dakota Carbon Sequestration Project provides a traceable method to determine the Carbon Emission Reduction Credits (CERCs) for registered land.
- Badlands Observatory in Quinn, SD <<http://www.sdsmt.edu/space/bo.htm>>, an educational affiliate of SDSGC, successfully continued its Near Earth Object (NEO) asteroid observations and identification in participation with the international Spaceguard Foundation. Participating observatories around the world are cataloguing all of the NEO’s that may represent a global impact hazard to the Earth. The dark skies in western SD, combined with the extremely sensitive research-grade telescope at Badlands Observatory, places the observatory in the company of some of the world's best astronomical research facilities. It is host to an f/4.8 Newtonian Telescope with a 26" diameter mirror, the largest telescope in the local three-state area. Observations are reported to the Minor Planet Center at the Harvard-Smithsonian Center for Astrophysics. See the educational project Badlands Observatory titled “Dark Skies & Bright Minds” that was funded in 2002 described in the K-12 Outreach section of this report.
- SDSGC funded the curriculum development of a Spring 2002 course offered by SDSM&T and Badlands Observatory titled “Advanced Observational Astronomy” (Physics 385).
- Professional and financial support for the new biocomplexity research theme, which is part of South Dakota’s EPSCoR program.
- SDSGC provided limited funding to stimulate the publication of scientific papers and for presentations at research conferences.
- Funded and proposed space-related research activities reported by Dr. Christopher Jenkins at SDSM&T:
 - Pappa, R.S., Caldwell, D.W., Jenkins, C.H., Mortari, D., Blandino, J.R., Robson, S., Shortis, M.R. (2002), “Optical Diagnostics Systems for Solar Sails,” \$2.3M to NASA (in review).
 - Jenkins, C.H., Allen, C., Anderson, A., and Sears, J. (2002), “Free Form Functionally Graded Materials,” \$596,598 to NASA (in review).
 - Jenkins, C.H. (2002), “The Evaluation of the Perimeter Truss Support System for Membrane Applications,” \$30,000 to TRW Inc. (funded).
 - Fard, A. and Jenkins, C.H. (co-PI) (2002), “Innovative Coating Design to Shape Compliant Optics into a Parabolic Net-Shape,” \$100,000 to AFOSR (funded).

Note 1: These examples of outside funding and the new projects associated with the funding are a good measure (metric) and example of our success in building educational, research, and public service projects in SD.

Note 2: SDSM&T's Dr. Chris Jenkins also served as Faculty advisor for the following KC-135 student space activities: 1) 2002 KC-135 Student Flight Project "Photon Propulsion for a Gossamer Spacecraft", and 2) SOLAR Alpha, NASA solar sail nanosat student team (proposal accepted for 2003 KC-135 flight program)

- Augustana College Research Projects (in addition to NASA EPSCoR project listed at the top of this section):
 - "NDVI Smoothing and Land Cover Analysis, University of Mauritius," Fulbright grant awarded and taken by Dr. Daniel Swets, 2002. NASA Space Grant supported activities by Dr. Swets that led to the receipt of this grant. While on the Fulbright experience in Mauritius, Dr. Swets participated in the regular course load at the University of Mauritius, initiated a collaborative research group in image processing and remote sensing, and developed a mentoring relationship for operations research with members of staff at the University of Mauritius. These ties will allow Dr. Swets to expand research capabilities both at Augustana College and at the University of Mauritius, and pursue further funding for such research and this relationship.
 - "Use of Satellite Imagery to Document Timber Harvest Activity and Other Land Cover Changes in Northwestern Montana," NASA Space Grant project at Augustana College, Dr. Craig Spencer, PI. This project involved faculty mentor Dr. Craig Spencer, biology, and undergraduate students Mr. Jason Smalley and Mr. Matt Buckrey. This project was interested in using satellite imagery to monitor timber harvest activity in Northwestern Montana. Until recently, most timber harvest in Montana has involved large clearcuts, which are visible on MSS images. Natural clearings such as alpine meadows are also quite noticeable on satellite images. The present project was initiated to see if we could accurately characterize clearcuts as well as other land cover types through satellite image analysis. The work is part of a larger effort evaluating the impact of timber harvest on erosion and water quality in Montana.
 - "Cluster Computing for Seasonality Metrics," NASA Space Grant project at Augustana College, Dr. Daniel Swets, PI. This project involved faculty mentor Dr. Daniel Swets, computer science, and undergraduate student Mr. Tim Stavenger. This project analyzes several parallel implementations of one such smoothing technique to achieve real-time results on global data sets. NASA data archived at the USGS EROS Data Center were used on an NSF-funded parallel processing lab to analyze the relative merit of using the parallel approach for this smoothing mechanism. By dividing the full data set into smaller sections and breaking down the overall algorithm into smaller computational tasks, we were able to parallelize the windowed weighted linear least squares smoothing algorithm. First, we used a Windows-based cluster using the Parallel Virtual Machine (PVM) package from Oak Ridge National Labs to develop a distributed processing algorithm. By focusing on separating the disk operations from the smoothing computations in addition to the parallelization of the computations themselves, inefficient CPU usage was reduced. This yielded a runtime 22 times faster than the serial implementation when run on a cluster with thirteen nodes. Working more closely on finer-grain parallelization of the computations, our second approach involved the use of the POSIX threads (PThreads) software package on both Windows 2000 and Linux machines to develop multithreaded algorithms for use on single machines, yielding an eleven-fold runtime improvement.
 - "Recycled computers," NASA Space Grant project at Augustana College, Dr. Daniel Swets, PI. This project involved faculty member Dr. Daniel Swets, computer science, and undergraduate students Mr. Cory Ranschau, Mr. Rob Terrel, and Mr. Levi Bard. The proliferation of inexpensive computing equipment has rendered a glut of well functioning, older, slower computer hardware. Is our only recourse for this equipment the trash heap? This project involved the use of this older hardware to determine the functionality of existing hardware, create a network infrastructure for implementing a cluster computer concept with the older equipment, and analyze the relative time difference between runs on a current, state-of-the-art machine versus a cluster of older

networked computers. We were able to determine that in many applications, a cluster of less than ten 486-class machines produced the same throughput as a Pentium 4-class workstation.

- “Seasonality metrics for phenology and drought analysis,” NASA Space Grant project in conjunction with a USGS EROS Data Center project, Dr. Daniel Swets, Space Grant PI; Dr. Brad Reed, USGS PI. This project involved faculty member Dr. Daniel Swets and undergraduate student Ms. Karen Wanderscheid. This project continues previous work begun with the Co-PIs on smoothing NDVI signals to use this same technique for extraction of seasonality metrics, such as start-of-season, end-of-season, cumulative NDVI, and NDVI-to-date. These metrics are used in many applications, including weather models, land cover analysis/land cover change, urbanization, and leaf area index calculations.
- “Monthly fractional green vegetation cover associated with land cover classes of the conterminous USA,” NASA Space Grant project in conjunction with a NOAA project, Dr. Daniel Swets, Space Grant PI; Dr. Kevin Gallo, NOAA PI. This project involved faculty member Dr. Daniel Swets and undergraduate student Mr. Aaron Cushner. In an effort to further understand vegetation patterns, scientists at NOAA gathered the percent fractional green vegetation cover (fgreen) for each of the top 3 most dominant land cover types within 20 km by 20 km square regions. These grid cells checkerboard the conterminous United States along with parts of Canada and Mexico. For each 20 km grid cell, data was gathered pertaining to the three most dominant land cover classes, together with the fractional area and the monthly fgreen values associated with each of the classes, and the fractional area covered by water. This data has been archived in 79 raw image files, with each data set equating to a specific piece of information. Using these archives, we developed a Java applet to extract and display the data in a textual and graphical format to enable its viewing and study by vegetation change researchers. The interface is a point-and-click map of the research area, producing a breakdown of all land cover type and fgreen information, along with the coordinates of the grid selected. This applet is available on the Internet to provide the widest availability to worldwide researchers in land cover/change analysis. This research was possible through collaborations with NOAA and USGS scientists, and funding from both NASA and NSF.

- Augustana College reported that 2002 marked an increase in collaborations among researchers at member institutions, due in large part to the new NASA EPSCoR projects in place throughout the State. Augustana has collaborated on research projects such as the “Leaf Area Index for Fire Chronosequences of the Black Hills,” and on workforce development projects that are developing tighter relationships among the member institutions, particularly the industrial and governmental affiliates.
- Augustana College summary and statistics of faculty and student research support through Space Grant (Augustana was able to support 11 undergraduate students for projects, 27% of whom were women):

Projects:	7	
Faculty supported:	3	Dr. Daniel Swets Dr. Steve Matzner Dr. Craig Spencer
Undergraduate students:	11 (3/11 or 27% female)	Ms. Olga Degtyaryova Ms. Katharyn Derr Mr. Jacob Quail Mr. Jason Smalley Mr. Matt Buckrey Mr. Tim Stavenger Mr. Cory Ranschau Mr. Rob Terrel Mr. Levi Bard Ms. Karen Wanderscheid Mr. Aaron Cushner

Disciplines represented:	2	Computer science Biology
Agencies involved	6	Augustana College NASA USGS EROS Data Center NOAA NSF Fulbright Foundation

Note: Mr. Aaron Cusher applied for the NASA Academy in 2002.

- SDSU and SDSM&T continued active participation in the Upper Midwest Aerospace Consortium (UMAC) activity with precision agriculture and remote sensing and in the Public Access Resource Center (PARC) project. Scientists from SDSGC were involved in the Educational PARC (EdPARC) components of this NASA-funded project by providing two teacher-training workshops in GIS, GPS and remote sensing technology in June 2002 in Box Elder, SD at Douglas High School and in Sioux Falls, SD at the USGS EROS Data Center. The workshops were titled "Earth Science Tools for Educators". The Box Elder workshop included a field trip to the Ameriflux Tower research site in the Black Hills. In addition to the EdPARC workshops, SDSU continued participation in the UMAC activity with precision agriculture and remote sensing.
- SDSU participated in Raytheon funded Team Express project through UMAC in which farmers were able to download imagery of their farms via PCDirect and apply these data through various techniques.
- SDSU was a successful recipient of an IFAFS/USDA project in collaboration with Montana. This project is entitled "Modeling and Visualizing Remote Sensing and Terrain Data for Research and Education in Precision Agriculture".
- SDSU participated in ESIPS project on mapping weeds in soybeans.

2. Higher Education

- SDSM&T Publications/Presentations supported by Space Grant:

Ash, J.T., Cross, W.M., Svalstad, D., Griswold, C., Kellar, J.J., and Kjerengtroen, L., 2002, "Finite Element Evaluation of the Microbond Test: Meniscus Effect, Interphase Region and Vise Angle" Presented at 2002 Gordon Conference on Composites, January, 2002, Ventura, CA.

Ash, J.T., Cross, W.M., Griswold, C., Henderson, B., Kellar, J.J., and Kjerengtroen, L., "Interphase Evaluation and Analysis in Polymer Matrix Composites," Presented at Society for Experimental Mechanics Annual Meeting, Milwaukee, WI, June, 2002.

Ash, J.T., Jenkins, C.H., Marker, D.K., and Wilkes, J.M. (2002), "Shape Achievement of Optical Membrane Mirrors using Coating/Substrate Intrinsic Stresses", 3rd Gossamer Spacecraft Forum, 43rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Denver, CO.

Chen, X., Vierling, L., Rowell, E., and DeFelice, T. Comparison of vegetation coverage estimates from IKONOS and Landsat 7 ETM+ with airborne scanning LIDAR and forest inventory data in a ponderosa pine forest. In preparation for submission to *Remote Sensing of Environment*

- Chen, X., Vierling, L., Dykstra, D., Rowell, E., and Capehart, W. "Assessing fractional tree coverage using IKONOS, Landsat 7, and LiDAR data in a ponderosa pine forest via sub-pixel interpretation." Presented at the Ecological Society of America annual meeting, Tucson, AZ, August, 2002.
- Chen, X., Vierling, L., Rowell, E., Dykstra, D., Capehart, W., and DeFelice, T. "Relationships Among IKONOS Imagery, Airborne Scanning LIDAR, and Ground-Based Tree Inventory Data in a Ponderosa Pine Forest: A Multiple Endmember Approach." USGS/NIMA/NASA High Spatial Resolution Commercial Imagery Workshop, Reston, VA, March, 2002. Oral presentation.
- Cross, W.M., Johnson, F., Mathison, J., Griswold, C., Kjerengtroen, L., and Kellar, J.J., "The Effect of Interphase Curing on Interphase Properties and Formation," *Journal of Adhesion*, 78, pg. 1-21, 2002.
- Glasson, G., Frykholm, J., and Vierling, L. "Development of an Elementary Earth Systems Science and Mathematics Curriculum." Association for the Education of Teachers in Science Annual Meeting, Charlotte, N.C., January, 2002. Oral presentation.
- Glasson, G., Frykholm, J., and Vierling, L. "Earth Systems Science: Crossing Cultural Borders." Presentation at the Mid-Atlantic Association for the Education of Teachers of Science, Natural Bridge, VA, October, 2002.
- Glasson, G., Frykholm, J., and Vierling, L. Using Traditional Ecological Knowledge to Develop an Earth System Science Elementary Curriculum. To be published in *Proceedings of National Association for Research in Science Teaching*, March, 2003. (peer reviewed)
- Jenkins, C.H. and Schur, W.W. (2002), "Gore/Seam Architectures for Gossamer Structures", *AIAA J. Spacecraft and Rockets* **39(5)**, 669-673.
- Jenkins, C.H., Invited Keynote Lecture, European Space Agency Workshop on Inflatable Space Structures, ESTEC, Noordwijk, the Netherlands, 2002.
- Jenkins, C.H., Invited Panelist, Gossamer Spacecraft Forum, AIAA SDM Conf., Denver, CO, 2002
- Rowell, E., Vierling, L., Dykstra, D., and Chen, X. "Small footprint LiDAR estimates of canopy gap structure in a ponderosa pine forest." Presented at the Ecological Society of America annual meeting, Tucson, AZ, August, 2002.
- Schur, W.W. and Jenkins, C.H. (2002), "Deployment Destiny, Stable Equilibria, and the Implications for Gossamer Design", 3rd Gossamer Spacecraft Forum, 43rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Denver, CO.
- Toomey, M. and Vierling, L. A synthesis of developments in remote sensing of leaf area index for arboreal studies. *Ecology*, in review.
- Vierling, L., Frykholm, J., and Glasson, G. 2002. The earth systems connections elementary curriculum: a world of contexts for teaching and learning remote sensing. IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Toronto, Canada, *Proceedings of IGARSS '02*.

Vierling, L., Rowell, E., Chen, X., Dykstra, D., and Vierling, K. 2002. Relationships among airborne scanning LiDAR, high resolution multispectral imagery, and ground-based inventory data in a ponderosa pine forest." IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Toronto, Canada, *Proceedings of IGARSS '02*.

Vierling, L., Rowell, E., Smith, R., Chen, X., and Toomey, M. "From surface to satellite: using remote sensing to measure and monitor forest ecosystems." South Dakota Association of Environmental Professionals 6th Annual Conference, Rapid City, SD, October, 2002.

Vierling, L., Rowell, E., and Dykstra, D. "LiDAR: A promising approach to estimating Western forest fire susceptibility." Presented at the ESRI User's Conference, San Diego, CA, July, 2002.

Vierling, L., Frykholm, J., and Glasson, G. "The Earth Systems Connections Elementary Curriculum: A World of Contexts for Teaching and Learning Remote Sensing." Presented at the IEEE International Geoscience and Remote Sensing Symposium, Toronto, Canada, June, 2002. Oral presentation (invited lecture).

Vierling, L., Rowell, E., Chen, X., Dykstra, D., and Vierling, K. "Relationships Among Airborne Scanning LiDAR, High Resolution Multispectral Imagery, and Ground-Based Inventory Data in a Ponderosa Pine Forest." Presented at the IEEE International Geoscience and Remote Sensing Symposium, Toronto, Canada, June, 2002. Poster presentation.

Vierling, L., Frykholm, J., and Glasson, G. "It's elementary, my dear! Earth systems science and mathematics lessons for K-5 inquiry." National Science Teachers Association annual meeting, San Diego, CA, March, 2002. Oral presentation.

Vierling, L., Frykholm, J., and Glasson, G. "Global Greenup: An interactive elementary level earth system science and mathematics lesson." National Science Teachers Association annual meeting, San Diego, CA, March, 2002. Oral presentation.

Note: These 24 publications and significant presentations are a measure (metric) and example of enhanced research productivity and capabilities that have benefited from SDSGC and EPSCoR support.

- SDSM&T student John Keefner (undergraduate Geological Engineering major) participated in NASA's Undergraduate Student Research Program at Johnson Space Center over the Fall 2002 semester. He worked with Dr. Douglas Ming in the Astromaterials Research and Exploration Science (ARES) group on the Mars Soil Genesis program. John prepared Martian analogue soil samples collected from Puu Poliuhu on Mauna Kea, Hawaii for X-ray diffraction mineralogy identification. The identification was to verify ground based and remote sensing data collected by AVIRIS (Airborne Visual and InfraRed Imaging System). The truth testing is used as part of a procedure for identifying Martian mineralogy in the upcoming Mars Reconnaissance Orbiter mission of 2005, where an instrument similar to AVIRIS will be employed. Several samples were separated into size fractions from very coarse sand to treated clay sized particles and were analyzed using a Scintag X-ray diffractometer.
- SDSM&T student John Keefner (undergraduate Geological Engineering major) traveled to the University of Minnesota from May to July 2002 for an internship with the Planetary Geology and Geophysics Undergraduate Program. His mentor was Dr. David Kohlstedt, a professor at the university that runs a research lab actively investigating shear melt banding in two phase systems as applied to the upper mantle. John's research involved developing a low temperature two phase system composed of aluminum and tin. If successful, a low temperature two phase system would be

analogous to the current olivine/basalt system with potentially more reproducible results. The results of the research showed that a low temperature tin aluminum alloy could not reproduce melt banding, agreeing with calculations. Other independent research included developing a Pallasite Main Group (PMG) meteorite analogue to investigate diffusion, olivine buoyancy, and kink banding effects. One analogue PMG was made, cut, polished, and observed under an optical microscope.

- Eric Rowell was designated by SDSM&T (Dr. Lee Vierling) as UMAC Graduate Scholar. UMAC Graduate Scholars are selected from UMAC participants to foster collaborations among graduate students at UMAC universities. The UMAC graduate student is the lead for organizing participation by his or her university. (See May 13, 2002 UMAC e-mail titled "Student Collaborations"). Dr. Vierling chose Eric to fill this role for the first year due to his position with Horizons, Inc., his collaborations with Dr. Vierling, Paul Gessler and Aaron Smith from U. Idaho, and his past UMAC experience (he attended the last UMAC meeting at UND).
- SDSM&T student Kevin Baker (undergraduate Physics major) attended Summer 2002 USRP program at Marshall Space Flight Center where he worked in the Space Science Department (Science Directorate) in plasma physics under the mentorship of Paul Craven. Mr. Baker indicated that he had a very positive experience and is considering possibly applying for the GSRP program. SDSGC plans to incorporate Mr. Baker in our workforce development efforts related to the NASA pipeline. Note: Mr. Baker was provided \$5,000 from NASA USRP to support his Summer 2002 internship. None of his stipend came from SDSGC funds, but his work is nevertheless reported here.
- SDSGC again supported a team of undergraduate students from SDSM&T in the 2002 KC-135 NASA Reduced Gravity Student Flight Opportunity Program. Seven of the nine student team members and Tom Durkin, SDSGC Deputy Director traveled to JSC in July 2002 where the students successfully flew an experiment titled "Photon Propulsion for Gossamer Spacecraft" aboard the KC-135A aircraft <<http://www.solarvision.org/sdsmt/>>. The propulsion of gossamer spacecraft is one critical issue that is being investigated by NASA for advanced propulsion methods to be used in future space missions. Visible wavelength light and microwaves are two types of photon energy that are being investigated. Due to the force of gravity, photon propulsion demonstrations and experiments on Earth destroy delicate sail material and skew any results. The objective of SDSM&T's research project was to compare two different solar sail systems. To achieve this objective, the team designed and constructed a sail made of a material that could be propelled efficiently by microwaves and another sail that was propelled by high-powered incandescent light. In each case, the sails were deployed in separate evacuated chambers to remove the air resistance and simulate a space environment. Both sail systems were designed to minimize mass, reduce the effects of radiation-heat transfer, offer trajectory control and maximize energy use. The team's research plan compared the acceleration potential of each system in a simulated space environment, aboard the KC-135. The experiment apparatus measured sail motion and the relative vertical acceleration of the experiment frame. Specifically, a novel new type of sail material, node bonded carbon fiber microtruss, was propelled in two different experiments by the SDSM&T team using 2.45 GHz microwaves and an incandescent halogen light. In each experiment, a microsail measuring 12 centimeters across was propelled up an evacuated chamber (to -25inHg) and guided by a monofilament. In the 1kW microwave experiment, consideration was given to the electromagnetic characteristics of the materials and geometry of the entire system to maximize the energy delivery to the sail. In the incandescent experiment, a 0.65kW lightbulb against an aluminum baseplate radiated light in a hemisphere. An accelerometer attached to the experiment frame measured vibrational and static accelerations while a video camera measured the sail's motion. The microwave experiment failed due to a snag in the evacuated chamber despite attempts to free it inflight. The incandescent experiment showed mixed modes of acceleration, the two mostly likely candidates were friction and microaccelerations. The forces acting on the sail could not be resolved with the data collected. Future experimentation will include a method for correlating accelerometer data and video data. A significant outreach component of the project continues to be conducted. The final report on the project is on the web at <http://www.solarvision.org/sdsmt/SDSM&TFinalReport.pdf>

- In July 2002, SDSGC submitted a \$91,882 Workforce Development proposal to NASA and in September 2002 was selected for full funding. SDSGC's program will enlarge and enhance the resource pool, or "pipeline," of well-prepared higher education graduates and faculty that stay connected to or become involved with NASA as employees, contractors, or principal investigators. This will be achieved by involving a broad range of SDSGC members and affiliates to attract and inject highly qualified individuals into the pipeline. It will be accomplished through educational enrichment experiences for undergraduate and graduate students (from SDSGC member institutions, including those SD Tribal Colleges and Universities that have a strong interest in working on NASA-related SMET), university staff, and secondary teachers through course work, workshops and internships. SDSGC's university and college members will establish expanded student and faculty internship programs with three key pipeline organizations: 1) the USGS EROS Data Center, 2) Goddard Space Flight Center, and 3) Horizon's, Inc. Work was begun in 2002 to establish collaborations and internships with these organizations.
Note: This example of SDSGC's full funding from NASA for our workforce development proposal is a good measure (metric) and example of SDSGC's continued success in building educational, research, and public service projects in SD.
- SDSGC representatives and faculty from SDSM&T GIS lab's NASA Center of Excellence met with representatives of Sinte Gleska University (a tribal university on the Rosebud Reservation in Mission, SD) in November 2002 to assist them in planning and developing a GIS lab at their institution.
- SDSGC's Deputy Director Tom Durkin agreed to assist James Rattling Leaf of Sinte Gleska University in the planning and organization of an Intertribal GIS Council conference in Rapid City in June 2003. Likewise, James Rattling Leaf agreed to help plan the Western Regional Space Grant Meeting to be held in Rapid City in September 2003.
- SDSGC representatives attended a "NativeView" <<http://www.sinte.edu/nativeview/>> forum at EROS Data Center in October 2002. NativeView is a partnering and merge of Western Geo-Science and empirical Native American knowledge. NativeView is a coordinated and sustained Tribal College initiative with Federal, State and Industry partners for a geospatial education effort spearheaded by the AmericaView consortium and the United States Geological Survey. Sinte Gleska University is the lead for the Tribal College NativeView initiative to integrate Earth Science technologies for the benefit of: Education, Agriculture, Resource Management, and Economic Development. Driven by relevant needs, NativeView is an innovative approach to technology-transfer and empowerment within Indian Country through access to geo-spatial/ spectral data and existing research. Tom Durkin agreed to serve as an SDSGC representative on a working group to pull together a Tribal College Consortium for the NativeView initiative.
- Dr. Sherry Farwell and Tom Durkin of SDSGC attended a workshop titled "Building Effective Government and Business Relations with Indian Tribes" at Black Hills State University on Nov. 13-14, 2002 to help improve collaborative efforts with Native American Tribes and organizations in SD.
- Augustana College began to develop an ongoing relationship with Oglala Lakota College (OLC) in 2002. OLC is one of the Native American Tribal Colleges in South Dakota and an educational affiliate of SDSGC. Augustana College would offer classes that would be available to Tribal College students and OLC would offer classes that would be available to Augustana College students. This arrangement is at the very beginning stages, but will continue to develop.
- SDSU was a successful recipient of a "SouthDakotaView" (SDView) project through the USGS and AmericaView. The project will develop a plan to index and provide for distribution of remote sensing data to SD users. On Oct. 9, 2002, SDSU's Mary O'Neill held a meeting in Sioux Falls on SDView, a component of AmericaView, to start formalizing the SDView consortium. SDSM&T representatives attended the meeting and Tom Durkin represented the SDSGC. AmericaView is a consortium to

expand remote sensing education through a network of numerous state consortia. South Dakota is a charter member of the newly formed AmericaView organization. AmericaView is a locally controlled and nationally coordinated program to advance the availability, timely distribution, and widespread use of remote sensing data and technology through education, research, outreach, and sustainable technology transfer to the public and private sectors. The vision for the pilot model consortium (OhioView) was to propagate the pilot into a national program by identifying organizations that require delivery of natural science data in near-real-time and ensuring the infrastructure is in place to support such a program. These goals were accomplished for Ohio in 2000. For AmericaView, the customers are state-based consortia for which formal agreements have been made. The USGS in conjunction with the AmericaView Consortium is leading the national expansion of this Program focusing on the growth of remote sensing. Educating consortium members and the public on remote sensing and its applications will continue to provide dividends in the future as uses for satellite information continue to expand. Individual consortia focus on promoting the use of satellite and geospatial data through research, curriculum development and outreach, while USGS ensures affordable satellite data in user friendly formats (GIS ready) with increased and simplified access to remote sensing data.

Note: This example of outside funding and the SDView project associated with it is a good measure (metric) and example of our success in building educational, research, and public service projects in SD.

- Funds were made available by SDSGC to help support expenses associated with augmenting an experimental Spring 2002 course at SDSM&T entitled "Advanced Observational Astronomy" taught through the Physics Department as Physics 385. Funds provided helped support instructor stipends, stipends for guest speakers, and travel to Badlands Observatory enabling students to perform astrometry research on asteroids (NEO's).
- Tom Campbell, SDSGC Workforce Development Coordinator, traveled to Goddard Space Flight Center in September 2002 to meet with Dr. Ted Gull to discuss possible collaborative education and research efforts with him and other Goddard staff. Potential research efforts include use and interpretation of Hubble Space Telescope (HST) and other NASA mission data along with possible astronomical research that could be performed in conjunction with the proposed underground science lab at Homestake. Educational efforts include a jointly prepared and implemented IDEAS proposal submitted to the Space Telescope Science Institute in 2003 along with his involvement in education and outreach efforts associated with SDSM&T astronomy courses and SDSGC sponsored Earth and Space Camps for secondary school students and educators. Dr. Gull visited SDSM&T in November of 2002 to give a presentation on his research related to the HST to Mr. Campbell's Introduction to Astronomy course (Physics 185) and to Ms. Judi Tiller's Astronomy course at Central High School. Dr. Gull will also be providing input related to the use of HST data in astronomy courses at SDSM&T and Black Hills State University.
- SDSGC maintained its "Educational Opportunities (Higher Ed.)" website. <<http://www.sdsmt.edu/space/EdOpp-HigherEd.htm>>

FACULTY and STAFF TRAVEL SUPPORT

SDSM&T

- Tom Durkin, SDSGC Deputy Director, Joint Conference of the SD Science Teachers Assoc. and SD Council of Teachers of Mathematics, Huron, SD (February 7-8, 2002)
- Tom Durkin, DENR Environmental & Ground Water Quality Conference, Pierre, SD (March 6, 2002)
- Tom Durkin and Sherry Farwell, SD Space Days 2002, Brookings, SD (April 4-5, 2002)
- Tom Durkin, SD Hall of Fame Presentation on Space Grant, Chamberlain, SD (May 21, 2002)
- Kris Jensen, SDSM&T Graduate Student in Electrical Engineering and SDSM&T's Project Manager for FIRST Robotics Program attended FIRST Regional Competition, St. Louis, MO (April 2002) and Championship Event in Orlando, FL.

- Tom Durkin, "Starting Student Space Hardware Programs: A How-To Workshop", Boulder, CO (June 20-22, 2002)
- Tom Durkin, SD Space Grant Consortium Workforce Development Meeting at EROS Data Center, Sioux Falls, SD (July 10, 2002)
- Tom Durkin, Johnson Space Center for SDSM&T's 2002 KC-135 Flight Program, Houston, TX (July 20-26, 2002)
- Tom and Melissa Campbell were selected to go to GSFC for two weeks in July 2002 as part of NASA's Education Workshops (NEW).
- Tom Durkin, Western Regional Space Grant Meeting, Big Sky, MT (Sept. 25-29, 2002)
- Tom Campbell, SDSGC Workforce Development Coordinator, Goddard Space Flight Center (September 2002)
- Dr. Sherry Farwell, SDSGC Director, National Council of Space Grant Directors Spring Meeting, Washington D.C. (March 2002)
- Dr. Sherry Farwell, SDSGC Director, National Council of Space Grant Directors Fall Meeting, Dorado, Puerto Rico (September 2002)

SDSU Faculty and staff travel support:

- Dr. David Galipeau to attend an instrumentation conference in Orlando, FL
- Charnel Petersen to attend FIRST Regional Competition near St. Louis, MO
- Dr. Alfred Andrawis to attend a fiber optics meeting in Boston, MA
- Kevin Dalsted to discuss NASA BAA for potential geospatial specialist in Storrs, CT

Augustana College

- Marlys Van't Hul and Karen Wanderscheid, SD Space Day 2002.

- SDSU held SDSU/EROS meeting to discuss additional collaboration between the institutions and organized a meeting for June Thormodsgard, EROS, to speak to SDSU Deans, Directors, and Department Heads to encourage SDSU faculty to develop linkages to EROS scientists.
- Outside funding received by Augustana College for Higher Education:
 - Val Olness, NIH, \$85,000, to provide science teachers in rural schools faculty development opportunities.
 - M. Hanson, G. Earl, NSF, \$34,876 to purchase instrumentation to augment the polymer chemistry laboratory
 - B. Murtha, Xcel Energy Foundation, \$1,000 to fund a scholarship for students majoring in science, math, a technical or environmental area.

Note: These examples of outside funding and the new projects associated with the funding are a good measure (metric) and example of our success in building educational, research, and public service projects in SD.

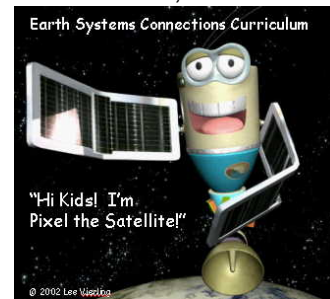
3. K-12 Outreach

The Consortium's full-time Deputy Director/Outreach Coordinator at our lead institution (SDSM&T) and part time Outreach Coordinators at SDSU, Augustana College, and the USGS EROS Data Center develop and coordinate the Consortium's K-12 programs. Highlights from the past year include:

- South Dakota Space Day 2002 was held on the campus of SDSU on April 5, 2002 where thousands of K-12 students visited numerous exhibits on space science, earth science, and technology and listened to former Skylab Astronaut Dr. Ed Gibson talk about his experiences in space as a NASA astronaut. The event was held in conjunction with the Eastern South Dakota Science and Engineering Fair. More info in SD Space Day 2002 is on the web at <http://www.sdsmt.edu/space/SpaceDay2002Home.htm>

- SDSGC maintained "Educational Opportunities (K-12)" website for SD teachers, students, and parents <<http://www.sdsmt.edu/space/EdOpp-K-12.htm>>.
- In cooperation with UMAC and NASA's EdPARC program, SDSGC helped organize and present two, intensive one-week teacher-training workshops titled "Earth Science Tools for Educators" held at Douglas High School in Box Elder, SD and the USGS EROS Data Center in Sioux Falls, SD. About 60 teachers attended the two workshops in June 2002. The workshops focused on GIS, GPS, Remotely Sensed Imagery (Satellite and Aerial), and Curriculum Integration and Standards. Instructors from SDSGC (SDSU and SDSM&T) and several K-12 teachers combined to team-teach these well-received workshops.
- The collaborative project titled "Earth Systems Connections" <http://www.tandl.vt.edu/esc/> continued to develop curriculum for students in grades K-5. This project is funded by NASA's Earth Science Enterprise and co-developed at SDSM&T, Virginia Tech, and the University of Colorado. The educational goal is to show that the Earth's physical, chemical, biological, geological, economic and cultural systems are intimately intertwined. Earth Systems Connections is a hands on, multifaceted, interactive mathematics, science, and technology curriculum where elementary students are challenged to explore how many of the Earth's systems operate and connect with one another. SDSM&T's Dr. Lee Vierling, the PI of the project, has incorporated Little Wound School (Kyle, SD) and Woodrow Wilson Elementary School (Rapid City, SD) into the project as pilot schools. To motivate children to learn about satellites and remote sensing, Dr. Vierling developed a cartoon character named "Pixel the Satellite" (see image at right) and has produced 10 short animated features for teachers and children to view in concert with or independently of the curriculum. SDSGC provided funds for the addition of Native American video clips into the curriculum of this project, an exciting way to include Lakota culture into a nationally-available curriculum for elementary children.

Note: This example of NASA funding outside of Space Grant for the "Earth Systems Connections" project is a good measure (metric) and example of our success in building educational, research, and public service projects in SD.
- Augustana College's annual Science Day - Augustana was able to provide a day filled with the pursuit of science to 285 students, 8% of whom were Native American students. Augustana's Science Day provides high school juniors and seniors a day filled with hands-on science opportunities and experiences. The day is designed to encourage students to study and understand the sciences and to eliminate the fear that the word "science" sometimes portrays. A special invitation went to Native American and female students. To entice these targeted groups to attend, Augustana College waived the tuition normally associated with student attendance. As a result of this event, two students receive \$8,000 scholarships to attend Augustana College and to major in the sciences. Twenty two Native American student participated in the 2002 event, or 8% Native American involvement. Augustana representatives also met with some leaders of a tribal high school who expressed interest in pursuing an entry in the FIRST Robotics competition in 2004, which Augustana would mentor.
- As evidenced by extensive participation in the 2002 "Student Signatures in Space" Program, enthusiasm for the space program remains very high among SD's K-12 school students with an estimated 2,800 signatures by students, teachers, and parents. Schools in New Holland, Sisseton, Bison, and Sioux Falls, SD took part in the 2002 program.
- SDSGC continued to support "Scientific Knowledge for Indian Learning and Leadership" (SKILL) Program on SDSM&T's campus. Native American SKILL students often come from affiliate Tribal colleges with articulation agreements with SDSGC's lead institution, SDSM&T. Additionally, Tom Durkin assisted SKILL representatives through a GK-12 grant committee to develop a proposal to enhance K-12 science and mathematics education by creating dynamic learning environments and



partnering SDSM&T graduate and advanced undergraduate students in science, mathematics, engineering, or technology (SMET) with teachers, administrators, and students in three South Dakota school districts. SDSM&T also supports student participation in the local chapter of the American Indian Science and Engineering Society (AISES).

- SDSGC maintained working relationships with the two NASA Educator Resource Centers (ERC's) in South Dakota to help assure their continuing use by teachers and students. One ERC is located at Black Hills State University's Center for the Advancement of Math and Science Education in Spearfish and the other at the Kirby Science Center in Sioux Falls.
- SDSU's Aerospace Career and Education (ACE) Camp 2001 was held in July with 22 high school participants.
- SDSGC supported the SDSU/Flandreau Indian School Success Academy in which the freshman and sophomore classes came to SDSU six times during the Spring Semester for various science and technology half day workshops, a meal, and a fun evening activity. SDSU currently plans to have both the freshman, sophomore, and junior classes from Flandreau Indian School come to SDSU this spring.
- In April 2002, after several months of preparation, nine (9) high school teams from South Dakota traveled to St. Louis, MO to compete in a regional event for the first time in the FIRST Robotics Competition, an exciting, nationwide competition that teams professionals and young people to solve an engineering design problem in an intense and competitive way. The following 9 high school teams from SD were mentored by SDSGC university institutional members SDSM&T (3), SDSU (5), and Augustana College (1): Rapid City Central, Rapid City Stevens, Sioux Falls O'Gorman, Sturgis, Sisseton, Brookings, Woonsocket, Watertown, and Volga, SD. After developing competition strategies, each team designs their robots using high-tech computer design software. They then gain mechanical skills and learn invaluable lessons on teamwork during construction and competition. South Dakota's participation in the program was funded by a \$100,000 grant from NASA and FIRST, administered through the SDSGC. The FIRST Robotics Program gave the students from these nine high schools an excellent appreciation of the importance of science, engineering, and technology, and of how mastering these subjects benefits society. Two of the nine teams traveled to Orlando, FL for the FIRST Robotics finals. SDSGC is proud to support this unique educational program and we have submitted a proposal to NASA to continue doing so in 2003, with perhaps a tenth team being added. Additional details are on the web at <http://www.sdsmt.edu/space/first.htm>. Brookings worked toward hosting a "stream-lined" event in 2003 in lieu of the various regional events around the region, but it was cancelled due to low registration.

Note: This example of outside funding and the new projects associated with the funding are a good measure (metric) and example of our success in building educational, research, and public service projects in SD.

- In the summer of 2002, SDSGC was successful in obtaining \$23,784 in State funds from the Governor of South Dakota, Governor William J. Janklow in support of a project titled "Dark Skies & Bright Minds". This project provides for modifications of the 26-inch telescope located at Badlands Observatory in Quinn, SD that will enable it to be used online, via the internet as an educational and research tool. After a pilot project is completed, Observatory Director and Owner Ron Dyvig will be able to determine the maximum number of schools that can be allowed remote access to the telescope during each academic year. SDSGC agreed to provide \$5,000 per year in co-funding to help participating schools pay the use-rate costs for remote operation of the telescope. The SDSGC will also continue to serve as the host for The Badlands Observatory's website www.sdsmt.edu/space/bo.htm. This website can be accessed at any time for detailed information about astronomy, the Badlands Observatory, and the astronomical research conducted there. The capabilities of this website will be greatly improved after a gateway to remote operation of the telescope is added, the appropriate equipment and software are installed, and the pilot project described in the funded proposal is activated. A Space Grant fellowship for an SDSM&T student for

the Fall '02 and Spring '03 semesters will allow the student to work with Ron Dyvig in support of the telescope project. This project will take advantage of the common attraction that most students have toward space, astronomy, and the study of the universe. NASA and the South Dakota Space Grant Consortium have used the "attention grabbing effect" that space science offers to students as a platform for teaching math, science, engineering, and technology. This program will also take advantage of the dark skies in western South Dakota and Ron Dyvig's extremely sensitive research-grade telescope, which places Badlands Observatory in the company of some of the world's best astronomical research facilities. For these reasons, the educational opportunities potentially available to students within South Dakota through this program are both unique and exciting. Ms. Ashley Nord, a Rapid City Steven's High School student, provides a recent example of how effectively Badlands Observatory has interfaced with students. Ashley was awarded the top prize at the March 2002 High Plains Regional Science and Engineering Fair for her project that involved astronomical observations performed at the Badlands Observatory. This allowed her to compete in the Intel International Science and Engineering Fair in Louisville, KY where she faced the world's best science-fair projects and was a finalist. As a result of her success at the Intel International Science and Engineering Fair, she was honored by having an asteroid named after her. See details at <http://www.sdsmt.edu/space/boNordAsteroid.htm>. Allowing other students to experience the excitement of conducting their own astronomical observations at Badlands Observatory via the Internet will provide them with similar opportunities to expand their scientific interests beyond the classroom.

Note: This example of outside funding for the telescope project is a good measure (metric) and example of our success in building educational, research, and public service projects in SD. It is also a good measure (metric) of our success in building partnerships with State Government and the Governor's Office.

- Tom Durkin presented PowerPoint talk on space and space technology (satellite remote sensing) to about 70 youths at Custer Youth Correctional Facility - March 13, 2002.
- Tom Durkin gave presentation to 75 NASA Honors Program students (grades 8-12) at SDSM&T on June 10, 2002 about space, satellite remote sensing, KC-135 program, and SDSGC. These students were Native American students participating in a summer program at SDSM&T.
- Tom Durkin presented several talks on space to St. Elizabeth Seton grade school classes.
- SDSM&T provided broadcast of Earth-Sun Day 2002 "Celebrate the Equinox" NASA webcast from Goddard Space Flight Center, including segments on Native American, Lakota star knowledge on March 20, 2002.
- Tom Durkin judged High Plains Regional Science and Engineering Fair at SDSM&T, March 22, 2002.
- Ashley Nord of Steven's High School in Rapid City won first place in the High Plains Regional Science and Engineering Fair on March 22, 2002 for her project on the size of, and distance to, the Andromeda Galaxy, allowing her to compete in the Intel International Science and Engineering Fair in Louisville, KY where she faced the world's best science-fair projects and was a finalist. The astronomical observations for this project were conducted at Badlands Observatory (educational affiliate of the SDSGC) under the supervision of Ron Dyvig. As a result of her success at the Intel International Science and Engineering Fair, she was honored by having an asteroid named after her. See <http://www.sdsmt.edu/space/boNordAsteroid.htm>.
- Tom Durkin presented a talk on SDSGC, satellite remote sensing, and space to 14 teachers at the UMAC EdPARC "Earth Science Tools for Educators" Workshop on June 4, 2002 at Douglas High School. SDSM&T Graduate Student and Space Grant Fellow Pat Kozak also presented at this workshop on the use of remote sensing and GIS in regard to his thesis project in Death Valley. Mary O'Neill of SDSU and others organized and taught the workshop.

- Dr. Lee Vierling and Tom Durkin assisted in a field trip for the UMAC EdPARC “Earth Science Tools for Educators” Workshop on June 5, 2002 to the Ameriflux Tower in the Black Hills. Teachers were exposed to the use of GPS equipment and engaged in hands-on activities and field data collection with help from workshop instructors.
- Tom Durkin gave presentations on space to about 15 K-1st graders at YMCA’s summer “Zoo Crew” Program and about 40 elementary grade students at Knollwood School’s summer Discovery Center program on June 17, 2002.
- SD Space Grant Consortium agreed to provide a \$200 scholarship to Jessica Weidenbach, a H.S. student in Armour, SD, to attend a summer 2003 Space Camp in Huntsville, AL. Ms. Weidenbach attended ACE Camp at SDSU in summer 2002, which inspired her to seek more direct contact with NASA through the Huntsville Space Camp in 2003.
- SDSGC supported a visit by Dr. Ted Gull of NASA Goddard Space Flight Center to the Rapid City area in November of 2002 in which he gave a presentation on his research related to the Hubble Space Telescope to Ms. Judi Tiller’s Astronomy course at Central High School, along with speaking to Mr. Tom Campbell’s Introduction to Astronomy course at SDSM&T.
- To increase and promote community awareness and interest in Earth science and astronomy, SDSGC supported a project titled “Secondary School Earth and Space Camps for Educators and Students” at SDSM&T in the summer of 2002. Many teachers in South Dakota that are trained in other disciplines teach science courses. Most of them do not have the background to do so, especially for the newly mandated state standards that include Earth science and astronomy. Through this project, a series of multicultural Earth and space camps were developed and initiated to target middle school students in SD.

4. Other Public Service

- Support was provided to the Black Hills Astronomical Society (BHAS) and related summer Star Parties open to the public at Hidden Valley Observatory and Badlands Observatory. SDSGC created and maintains public service websites for BHAS, <<http://www.sdsmt.edu/space/BHAS.htm>>, Hidden Valley Observatory, and Badlands Observatory <<http://www.sdsmt.edu/space/bo.htm>>.
- Dr. Bob Polcyn of Hot Springs, SD was extremely busy as South Dakota’s Solar System Ambassador in 2002. He was appointed by NASA’s JPL Solar System Ambassador Program in early 2002. Dr. Polcyn presented 14 talks throughout the Black Hills area on specific NASA missions (Galileo, Cassini), astronomy, the mathematical aspects of astronomy, the first human landing on the moon, black holes and the birth and death of stars, the solar system and the cosmos. Presentations were made to the general public, various groups such as the Black Hills Astronomical Society and the Custer Youth Correctional Facility, and high school, middle school, and elementary school children (which included an exhibit and teacher training workshop on the Galileo Mission at Space Day 2002 in eastern SD). Classroom groups averaged about 25 students and other groups ranged from about 8 to 65 people in attendance.
- Tom Durkin presented a PowerPoint talk on SDSGC, space, and space technology at South Dakota Hall of Fame on May 21, 2002.
- Tom Durkin gave a talk on SDSGC talk to the “Leadership Rapid City” class on Oct. 17, 2002.

- SDSGC continued its support of StarDate, a daily PBS radio broadcast in South Dakota as part of the McDonald Observatory astronomy program. This broadcast provides a very effective means of informing the public about the Consortium's resources.
- Numerous notices and various informational presentations about Consortium activities, noteworthy celestial events, aerospace programs, etc. were published and presented to the general public.

5. Fellowships and Scholarships

SDSGC supported a number of graduate and undergraduate students through fellowships, scholarships, and assistantships. We have established a Diversity Enhancement Fellowship program to provide research and educational opportunities for faculty and students at Tribal Colleges and other Native American institutions in South Dakota. The total amount of Consortium support for faculty and students through these avenues exceeded the minimum required amount of \$50,000 over the project year.

SDSM&T Graduate and Undergraduate Student Fellowships:

- Patrick Kozak - SDSM&T Geological Engineering graduate student sponsored by Space Grant. Specialty: remote sensing using Landsat and AVIRIS, field spectroscopy. Presented several papers at professional conferences throughout the year.
- Tom Campbell, SDSM&T Graduate Student in Geology also working as SDSGC Workforce Development Coordinator.
- Kristopher Jensen – SDSM&T Electrical Engineering graduate student sponsored by Space Grant. SDSM&T's Project Manager for FIRST Robotics Project. Specialty: control systems.
- Chad Griswold - SDSM&T Materials, Engineering and Science (MES) graduate student sponsored by Space Grant. Specialty: Composite materials.
- John Keefner – SDSM&T Geological Engineering undergraduate student sponsored by Space Grant. Student Team Leader for SDSM&T's Summer 2002 KC-135A flight project titled "Photon Propulsion for a Gossamer Spacecraft". Mr. Keefner also participated in Summer 2002 USRP, funded by USRP funds.
- Charlie Senn – SDSM&T Computer Science undergraduate student sponsored by Space Grant to assist with Badlands Observatory telescope project "Dark Skies & Bright Minds".
- Judith Buckley – Undergraduate student from Sinte Gleska University supported in Summer 2002 to assist SDSM&T graduate student T. Bull Bennett with field work.

T. Bull Bennett – SDSM&T AEWB graduate student sponsored by Space Grant. Specialty: Ungulate interactions in managed short grass prairie systems using remote sensing and GIS. Although Mr. Bennett did not receive a fellowship directly from Space Grant, he was supported in 2002 through a NASA Earth Systems Science Fellowship in the amount of \$24,000.

SDSM&T Graduate Student Summer 2002 Fellowship at USGS EROS Data Center:

- Patrick Kozak - SDSM&T Geological Engineering graduate student. Specialty: remote sensing using Landsat and AVIRIS, field spectroscopy.

SDSU Graduate Assistantships* and Undergraduate Summer Research Positions**:

- Corey Mettler (EE, remote sensing and calibration)*
- Charnel Petersen (Rural sociology/AEWB, outreach education coordinator)*
- Sara Landau (Physics) **
- Sherrilyn Stormo (Electrical Engineering) **
- Josh Boysen (Electrical Engineering) **

SDSU Faculty Summer 2002 Fellowship at USGS EROS Data Center:

- Alex Moutsoglou, Mechanical Engineering, professor, who worked on ModTran modeling software.

Augustana College Fellowships and Scholarships:

- Matt Buckrey, undergraduate assistantship, "Use of Satellite Imagery to Document Timber Harvest Activity and Other Land Cover Changes in Northwestern Montana," with Dr. Craig Spencer, Augustana College.
- Jason Smalley, undergraduate assistantship, "Use of Satellite Imagery to Document Timber Harvest Activity and Other Land Cover Changes in Northwestern Montana," with Dr. Craig Spencer, Augustana College.
- Tim Stavenger, undergraduate assistantship, "Cluster Computing for Seasonality Metrics," with Dr. Daniel Swets, Augustana College
- Cory Ranschau, "Recycled computers," with Dr. Daniel Swets, Augustana College.
- Rob Terrel, "Recycled computers," with Dr. Daniel Swets, Augustana College.
- Levi Bard, "Recycled computers," with Dr. Daniel Swets, Augustana College.
- Karen Wanderscheid, "Seasonality metrics for phenology and drought analysis," with Dr. Daniel Swets, Augustana College, and Dr. Brad Reed, USGS EROS Data Center.
- Aaron Cushner, "Monthly fractional green vegetation cover associated with land cover classes of the conterminous USA," with Dr. Daniel Swets, Augustana College, and Dr. Kevin Gallo, NOAA.

6. Administration

- SDSGC's Director or Deputy Director attended all National Council of Space Grant Director's meetings during 2002.
- SDSGC held two meetings of institutional members and several workforce development meetings since the last reporting period, and several affiliate members often attended these meetings. We continued to focus on competitive allotment of SDSGC funds and the goal of nurturing projects that can attract external support.
- SDSGC's Deputy Director, Tom Durkin, gave formal slide presentations on the SDSGC to: 1) conferees attending the Annual SD Dept. of Environment and Natural Resources's Environmental and Ground Water Quality Conference in March 2002 in Pierre, SD (talk titled "Space Grant and Satellite Remote Sensing"), 2) UMAC EdPARC teacher-training workshop in June 2002 in Rapid City, 3) the "Leadership Rapid City" group in October 2002, 4) South Dakota Hall of Fame in May 2002, 5) about 70 incarcerated youth at the Custer Youth Correctional Facility in March 2002, 6) about 75 NASA Honors Program students (Native American students participating in a summer program at SDSM&T) in June 2002, and 7) several school and YMCA groups.
- SDSGC's Director and Deputy Director were successful in adding the following two new affiliates to the Consortium in 2002, bringing total membership up to 30 organizations:
 - Northern State University in Aberdeen, SD (Educational Affiliate)
 - National Weather Service Forecast Office in Aberdeen, SD (Government Affiliate)
- With the additional funding for Workforce Development, SDSGC brought on board Mr. Tom Campbell to serve as the SDSGC Workforce Development Coordinator.