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MRI: Acquisition of Interactive Visualization Tools for Supercomputer Models

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Final Report for Period: 09/2008 - 08/2009**Submitted on:** 11/11/2009**Principal Investigator:** Segee, Bruce E.**Award ID:** 0619430**Organization:** University of Maine**Submitted By:**

Segee, Bruce - Principal Investigator

Title:

MRI: Acquisition of Interactive Visualization Tools for Supercomputer Models

Project Participants**Senior Personnel****Name:** Segee, Bruce**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Fastook, James**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Xue, Huijie**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Koons, Peter**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Bhaganagar, Kiran**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Zhu, Yifeng**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Provided expertise in selecting requirements for disk array, PVFS, configuration, and troubleshooting. Supported by University of Maine.

Name: Koskie, John**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Systems manager for the UMaine Supercomputer, systems administration, support, PVFS setup and technical expertise. Supported by the University of Maine.

Name: Bronder, Justin**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Systems manager for the UMaine Supercomputer, systems administration, support, PVFS setup and technical expertise. Supported by the University of Maine.

Name: Dickens, Phil**Worked for more than 160 Hours:** No**Contribution to Project:**

Grid computing expertise

Post-doc

Graduate Student

Name: Blanchette, Roger

Worked for more than 160 Hours: Yes

Contribution to Project:

Tiled visualization wall.

Name: Albee, Emily

Worked for more than 160 Hours: No

Contribution to Project:

Educational outreach.

Name: Bourgoin, Nathan

Worked for more than 160 Hours: Yes

Contribution to Project:

Helped develop system to remotely tie visualization hardware to in-classroom K-12 laptop walls. Created large, permanent visualization wall.

Name: Withee, Jason

Worked for more than 160 Hours: Yes

Contribution to Project:

Helped develop system to remotely tie visualization hardware to in-classroom K-12 laptop walls. Created large permanent visualization wall.

Undergraduate Student

Name: Cousins, Steve

Worked for more than 160 Hours: Yes

Contribution to Project:

Systems administration and disk selection and configuration, selection and setup of visualization server and software. Supported by the University of Maine.

Name: Bane, Joseph

Worked for more than 160 Hours: No

Contribution to Project:

Technical assistance.

Technician, Programmer

Name: Cousins, Steve

Worked for more than 160 Hours: Yes

Contribution to Project:

Systems administration and disk selection and configuration, selection and setup of visualization server and software. Supported by the University of Maine.

Name: Koskie, John

Worked for more than 160 Hours: Yes

Contribution to Project:

Systems manager for the UMaine Supercomputer, systems administration, support, PVFS setup and technical expertise. Supported by the University of Maine.

Name: Bronder, Justin

Worked for more than 160 Hours: Yes

Contribution to Project:

Systems manager for the UMaine Supercomputer, systems administration, support, PVFS setup and technical expertise. Supported by the University of Maine.

Other Participant

Research Experience for Undergraduates

Organizational Partners

Other Collaborators or Contacts

The Jackson Laboratories, The University of Southern Maine, Maine Department of Education, especially the Maine Learning Technology Initiative, and Maine Mathematics and Science Alliance.

Activities and Findings

Research and Education Activities:

This MRI grant is for the purpose of adding visualization infrastructure to the University of Maine Supercomputer. This in conjunction with higher bandwidth connectivity has allowed us to reach out, particularly to the Maine middle schools in which every student has a laptop computer. The equipment purchased with this award have been instrumental in supporting an NSF ITEST award in which middle school teachers use supercomputing and visualization in the classroom. It has also been instrumental in supporting an NSF REU site in supercomputing.

Findings:

We have found a tremendous interest in middle school teachers and students in computer modelling and visualization. We have submitted an NSF ITEST to further this activity. This ITEST has been awarded and the first cadre of teachers is currently going through. The REU site has been awarded and the first cadre of undergraduates is going through. The visualization equipment is key to the success of both of these endeavors.

Training and Development:

The visualization tools have allowed improved use of multiple laptops in the classroom. 'Collaborative visualization' allow student teams to pool their compute resources to provide a larger display. Computer models are rendered to animations that can be viewed using Google Earth software.

We have advanced the body of knowledge in the area of high performance visualization, by building and documenting our visualization walls.

Most importantly, we have achieved our stated goal of improving collaborations between different modelling groups at the University of Maine and across the state.

Outreach Activities:

We are actively engaged in reaching out to the middle school teachers and students with school visits as well as on-campus workshops. In addition to ITEST and REU activity, we have hosted the M-STEM conference for the previous two years for over 600 middle school teachers and students and participated in the 'Integrating Science and Mathematics Education Research into Teaching' conference in June 2008.

We have created collaborations with other organizations in the state for research and educational outreach.

Journal Publications

Books or Other One-time Publications

Xiongyi Liu, Bruce Segee, Peter Koons, Molly Schaffler and Yifeng Zhu, "Using Inquiry-based Applications of Supercomputing to Enhance Science Education in Middle Schools", (2008). , Published

Bibliography: the 19th International Society for Information Technology & Teacher Education, Las Vegas, Nevada, USA, March 3-7, 2008

Samuel A. Winchenbach, M. Clayton Wheeler, Mauricio Pereira da Cunha, Bruce E. Segee, "Demonstrating A Novel Approach To The Control Of Microhotplate Sensors Utilizing A Distributed Computing Approach And Numeric Modeling", (2007). , Published

Bibliography: Proceedings AICHE Annual meeting, Salt Lake City Utah, November 2007

Bruce Segee, Mary Jane Perry, Caleb Carter, Roger Blanchette, Samuel Winchenbach, "Visualization Of Large Scientific Data Sets On A Parallel System With A Tiled Display", (2007). , Published

Bibliography: Proceedings of The 19th IASTED International Conference on Parallel and Distributed Computing and Systems PDCS 2007, Cambridge, MA, November, 2007

Kiran Bhaganagar, Ryan Beaumont and Bruce Segee, "Flow characterization in stenotic coronary artery using Direct Numerical Simulation", (2007). , Published

Bibliography: Proceedings Biomedical Engineering Society Annual meeting, Los Angeles, CA, September 2007

Roger Blanchette, "Hardware and Software Solutions for Low Cost Distributed Visualization", (2008). Thesis, Published

Bibliography: Master's Thesis, University of Maine

Caleb Carter,, "High Resolution Visualization of Large Scientific Data Sets Using Tiled Displays", (2007). Thesis, Published

Bibliography: Master's Thesis, University of Maine

Web/Internet Site

Other Specific Products

Contributions

Contributions within Discipline:

This multidisciplinary work seeks to improve cooperation and communication across disciplines by providing visualization tools to allow for more natural processing of computational output.

Contributions to Other Disciplines:

This work is inherently cross disciplinary. In light of research it ties ocean, land, atmosphere and polar ice modelling together. In light of education, it allows a natural way to understand the output of computer models.

Contributions to Human Resource Development:

We have trained students and teachers in the use of technology

Contributions to Resources for Research and Education:

The MRI funding is primarily for physical resources that will be used for research and education at the University. It is significant that these resources will also be used in K-12 education. At the University of Maine, the research findings and concepts are being incorporated into two innovative NSF-funded education programs to provide college undergraduates as well as middle-school teachers and their students firsthand experiences in scientific computing. (1) The Supercomputing Undergraduate Program in Maine (SuperMe), funded by a \$300,000 grant from NSF, is an opportunity for 10 UMaine undergraduate students to spend the summer conducting the kind of sophisticated, meaningful scientific research that is usually reserved for more advanced students. (2) With a separate \$1.2 million NSF grant, another three-year program aims to integrate supercomputer modeling into the Maine middle-school science curriculum. Called Inquiry-based Dynamic Earth Applications of Supercomputing (IDEAS), the program will allow 20 middle-school teachers and 60 of their students each year to explore the myriad intricacies of UMaine's climate computer model by accessing the supercomputer with their state-issued laptops. This equipment is made vastly more valuable by recent networking investments by the State of Maine, improving connectivity across the state.

Contributions Beyond Science and Engineering:

We are making contributions to K-12 education that will promote the public welfare.

Conference Proceedings

Categories for which nothing is reported:

- Organizational Partners
- Any Journal
- Any Web/Internet Site
- Any Product
- Any Conference

Acquisition of interactive visualization tools for supercomputer models

The purpose of this MRI was to provide visualization tools necessary to improve the understanding of computer models, by the researchers intimately familiar with the computer models, by the researchers in other fields, and by laypeople. The goals were outlined in the proposal, the Intellectual merit and Broader impacts sections of the project summary are included below:

Intellectual Merit: The ability to view massive data sets quickly and easily provides a means of assimilating data like no other. It allows data to be explored in a far more natural and efficient manner and allows a fuller understanding of data, particularly when the data has a physical interpretation, such as the movement of polar ice. Perhaps the greatest intellectual merit, however, is the vastly improved ability to communicate results to others in the same field, and more significantly, to those in different fields and to students throughout the state.

Broader impacts: The broader impacts of the proposed visualization equipment flow very naturally from the intellectual merit. As is evidenced by the broad spectrum of co-PIs, senior personnel, and supporters of this proposal, the benefits of visualization of computer models will be of tremendous benefit across the research, educational, and business spectrum. Visualization allows one to convey information quickly, easily, and effectively to people having different backgrounds and brings the computer model closer to the real world. We believe that the proposed equipment is the single most important tool to advance research using numeric modeling, to foster interdisciplinary research, and to effectively bring research results into K12 classrooms, by leveraging on the state's success of the student laptop computer program.

We have been entirely successful in attaining our stated objectives. We have put in place shared infrastructure that is being used by a highly diverse set of people for research, education, and communication. We have supported numerous NSF sponsored projects and fostered state and regional collaboration.

An example of a successful outcome is our being invited to present at the Education Technology Showcase in Washington November 3-4, 2009. The photograph shown below, in Figure 1, shows our posters demonstrating the usage as well as a wall of laptop computers (the wall was 4X4 although the photograph cuts part off) similar to those in use in Maine classrooms. The graphical rendering is being done in Orono, Maine.

Following figure 1 is a series of images relevant to this project.



Figure 1: Snapshot of the practice session at NSF for the 2009 Education Technology Showcase in Washington, D.C.



Figure 2: A 100 TByte disk array to support modeling and visualization



Figure 3: A SGI Altix 3700 compute system

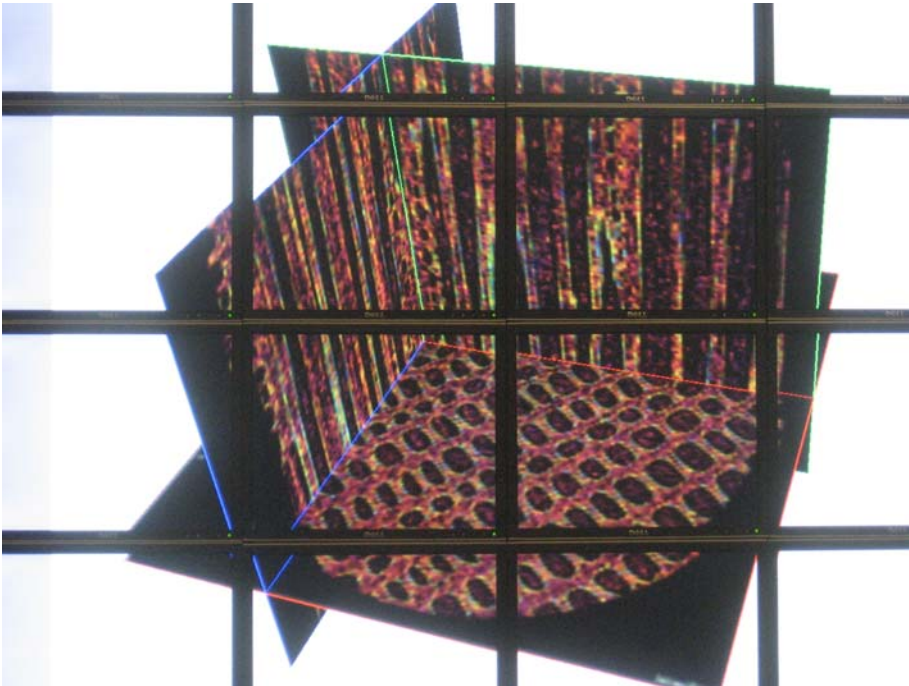


Figure 4: Sample imagery of cross sections of a wood fiber shown on a 16 tile visualization wall.

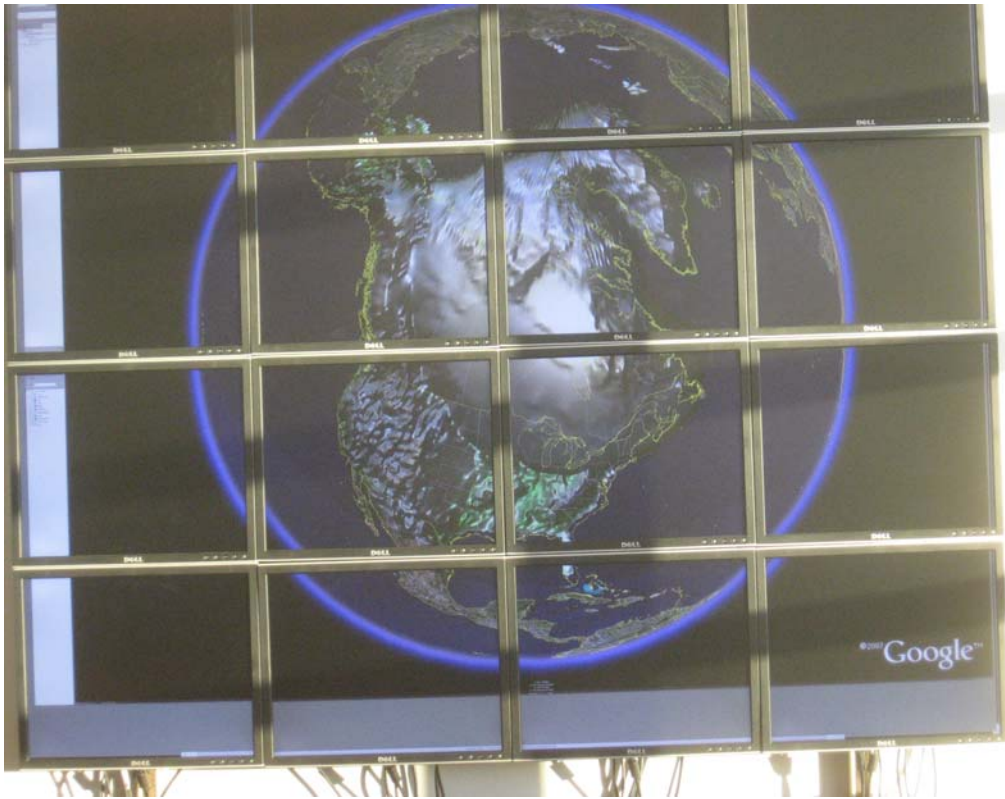


Figure 5: Ice sheet computer model data superimposed on Google Earth and displayed on a 16 tile wall.



Figure 6: NSF REU students interacting with a visualization wall.

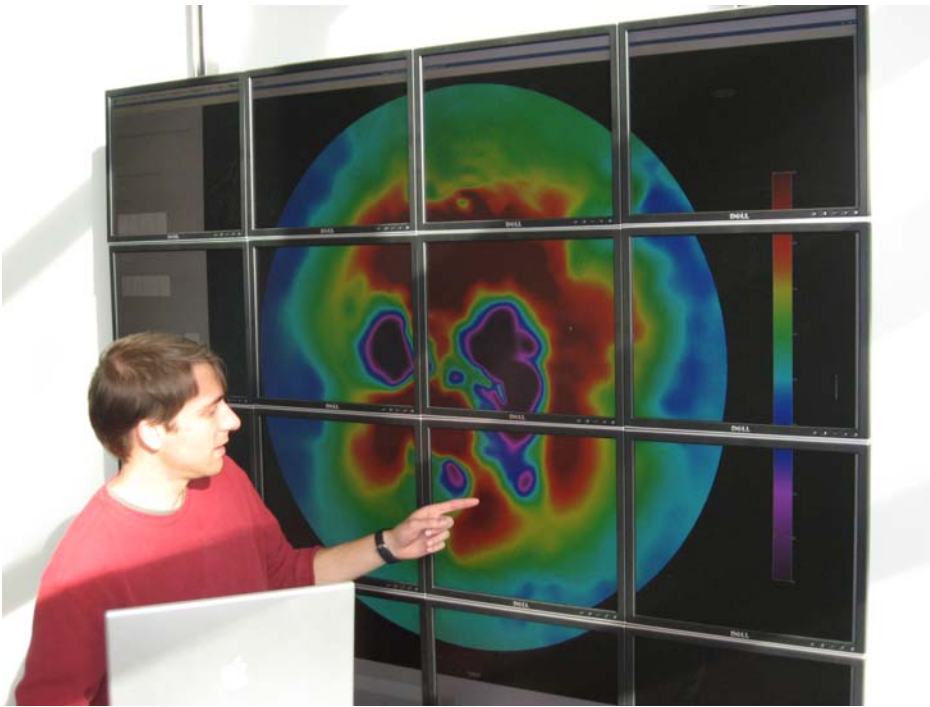


Figure 7: Graduate student interacting with a Matlab program on the 16 tile wall.

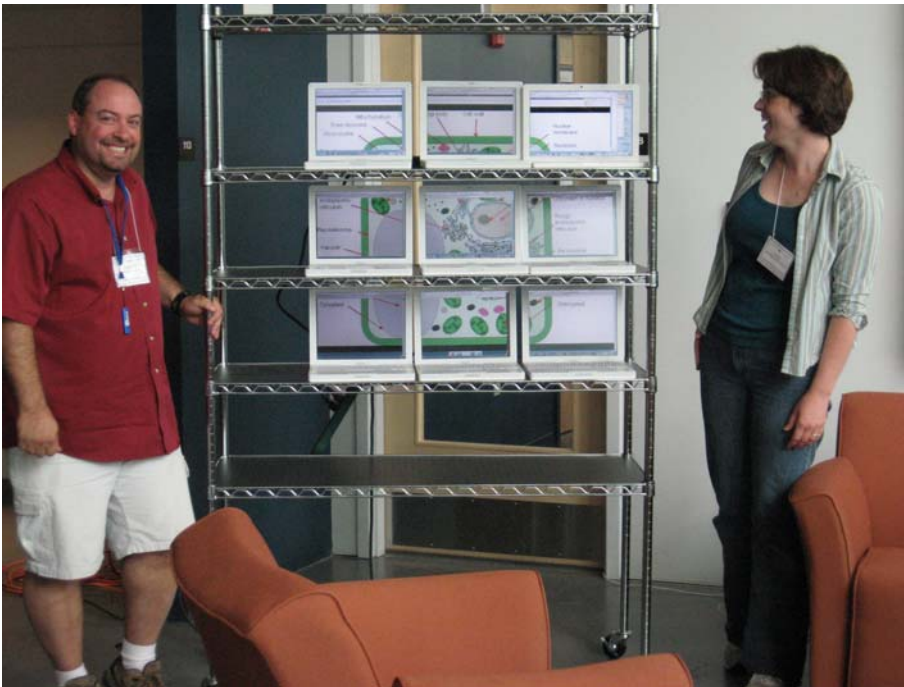


Figure 8: Teachers participating in an NSF ITEST project, demonstrating a 3x3 wall of laptops with imagery detailing the inside of a cell.

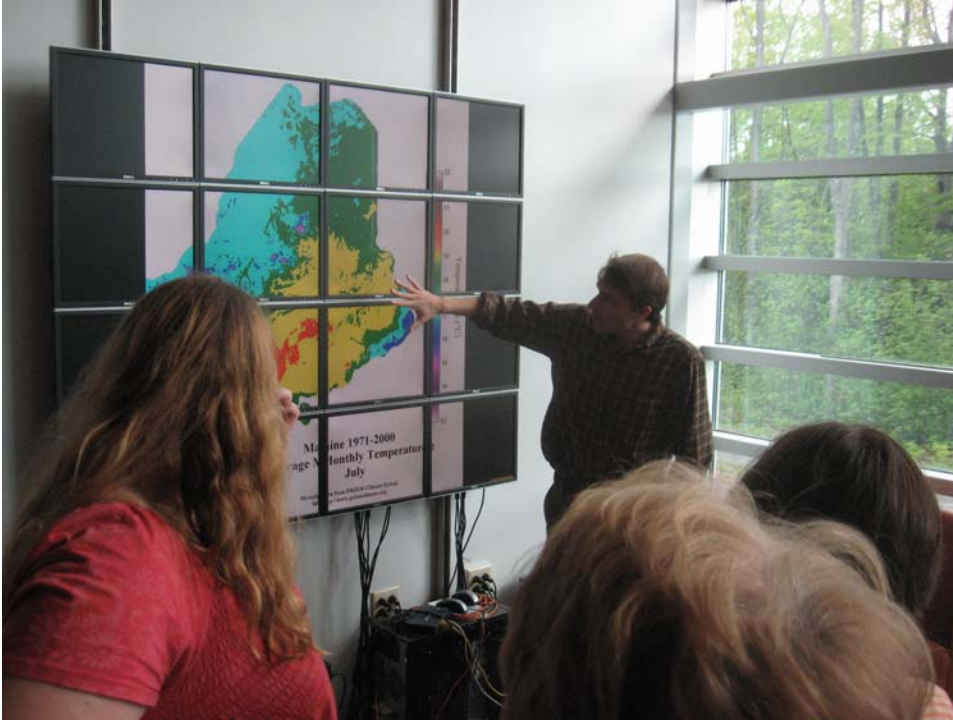


Figure 9: ITEST teachers interacting with a display showing temperature for Maine in July.



Figure 10: Updated monitors increase the size to 6 ft by 9 ft and resolution to 36 Mpixels.

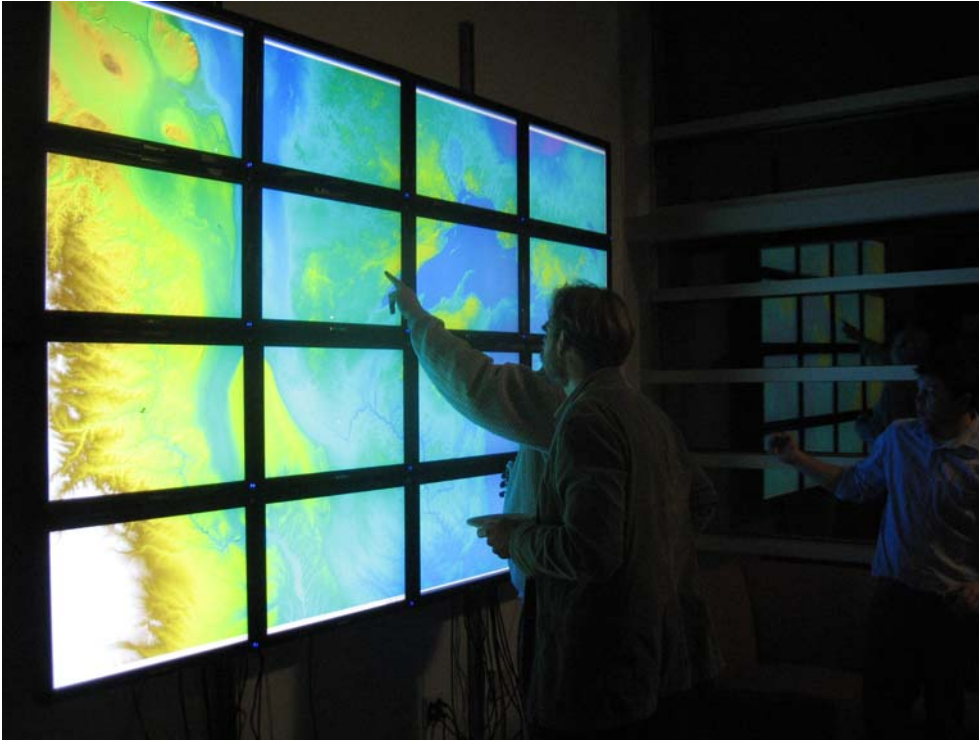


Figure 11: Climate researchers interacting with a high resolution elevation map showing North America during the last ice age. The body of water that became Lake Superior is visible in the upper right. Researchers are observing that the moraines caused by the advance and retreat of the ice can be clearly seen.

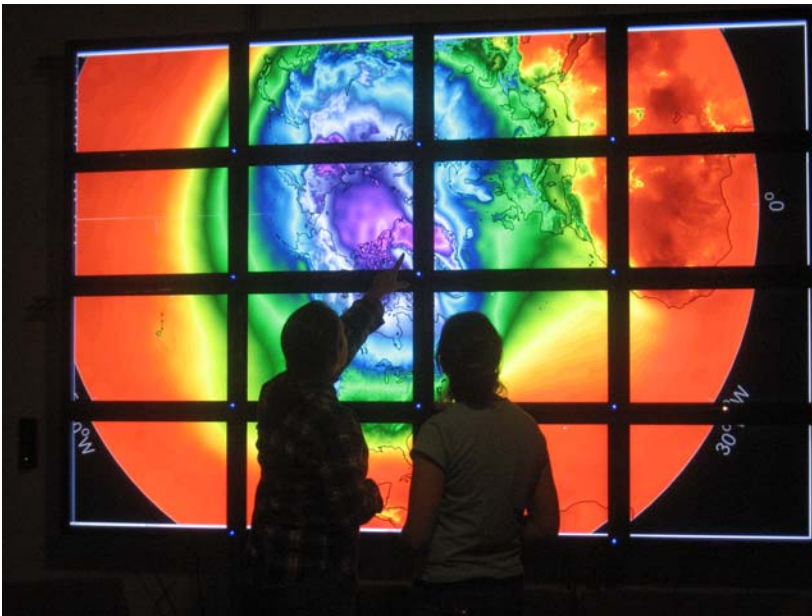


Figure 12: Researchers interacting with a combined atmospheric, land, ocean, and ice model. View is looking down on the North Pole. The researcher is pointing the edges of the Greenland ice sheet.