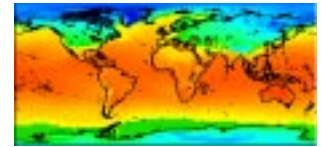




# The SSciVEE Project



## Supportive Scientific Visualization Environments for Education

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**The potential of scientific visualization.** Scientific visualization has had a tremendous impact on the practice of science over the last decade by capitalizing on the power of the human visual perception system to identify patterns in complex data.

The SSciVEE project is exploring the potential of this technology to improve science education in similar ways. The goal of this research is to demonstrate that scientific visualization, incorporated into inquiry-based learning, can enable students of diverse abilities to develop an understanding of complex scientific phenomena such as climate and geography. In traditional settings, this understanding has been out of the reach of all but the brightest and most highly motivated students.

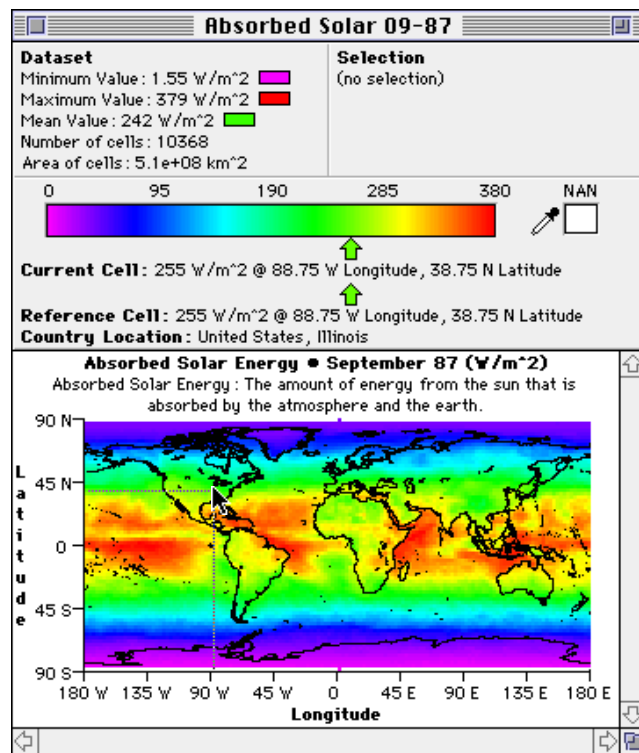
The challenge of this research is to identify the specific software and external supports that are necessary to transform scientific visualization into an effective educational technology.

**Design for learners.** Our previous research has shown that scientific visualization can be a valuable tool for students engaged in inquiry-based learning. However, this research also revealed the need for a software architecture that can provide the specific support required by learners.

The transformation of tools and techniques developed for scientists into environments to support students is a significant challenge. Understanding the requirements of such supportive scientific visualization environments for education is the goal of this research. In the SSciVEE project, we are developing and evaluating scientific visual-

ization environments for the study of climate and global climate change as well as human and physical geography. These supportive environments enable learners to examine data sets created by the scientific community and to create their own data using built-in arithmetic operations and climate models. They allow students to view this data in the form of color maps at a variety of spatial and temporal resolutions. The activities are supported by a multimedia database, or *mediabase*, of background and explanatory materials focusing on science topics and scientific visualization techniques.

**Research on learning.** Using these environments, we are conducting a series of studies designed to examine the prospects for and challenges of scientific visualization as a technology for secondary science education. In these studies, we are examining the ways in which the supportive scientific visualization architecture impacts both students' conceptual understanding and the process by which they conduct scientific inquiry. We are also investigating the process by which students learn to make sense of scientific visualizations and the way that scientific visualization environments are adopted in classrooms.



A visualization window from the WorldWatcher software

## The WorldWatcher Software

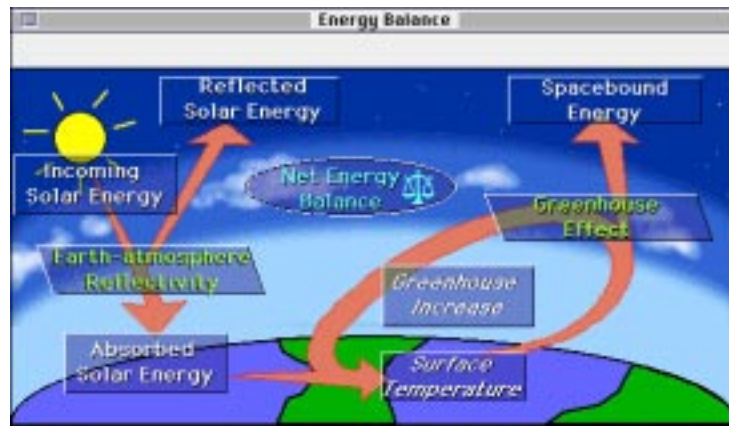
WorldWatcher, a supportive scientific visualization environment for the investigation of scientific data, is an enhanced version of the ClimateWatcher software that has been in use in K-12 and college classrooms since April 1996. Like its predecessor, WorldWatcher provides an accessible and supportive environment for students to explore, create, and analyze scientific data. Its goal is to provide students with access to the same features found in the powerful, general-purpose visualization environments that scientists use while providing them with the support they require to learn through the use of the tools.

**Activities.** WorldWatcher supports three forms of scientific activity that facilitate learning through inquiry:

- **Interpretation.** The examination and manipulation of scientific visualizations in order to construct explanations.
- **Expression.** The creation of visualizations designed to communicate a result or point of view.
- **Modeling.** The use of mathematical operations to explore the relationships between quantities and investigate hypothetical scenarios.

**Data.** WorldWatcher is a visualization environment for two-dimensional, gridded data. Data is distributed with WorldWatcher in data libraries that support educational activities centered around specific topics. In addition, users can import their own data into WorldWatcher using a standard spreadsheet format. The first data library that we have developed was designed to support investigations of global climate and climate change. This climate data includes global data sets showing the transfer of energy through the earth-atmosphere system. This climate-related data is supplemented with human and physical geography data that allow students to examine the causes and implications of climate change. The data sets are drawn from a variety of NASA and other public domain sources. Current data include:

- **Earth Energy Balance:** Insolation, Albedo, Absorbed/reflected solar energy, Surface temperature, Greenhouse effect/increase, Outgoing long-wave radiation, Net energy balance.
- **Additional Climate:** Precipitation, Relative humidity.



*In WorldWatcher, users access data through graphical interfaces such as this one, which illustrates the relationships between the variables that impact the earth's energy balance.*

- **Physical Geography:** Elevation & Bathymetry, Dominant vegetation and ground cover, Plant energy absorption (FPAR), Soil type.
- **Human Geography:** Population magnitude and density, Carbon emissions, Political boundaries.

**Importing Data.** One of the major new features in WorldWatcher is support for importing new data sets and creating new data libraries. This opens WorldWatcher for use in new arenas in the natural and social sciences ranging from human social geography to biodiversity. The SSciVEE Project is actively seeking collaborations with content-area experts to create new data libraries for use in broad educational settings.

**Notes and Annotation.** Users can annotate visualizations with a grease pen feature, record notes in annotation windows, and create dynamic WorldWatcher documents with a notebook feature. The notebook supports text, multimedia, and "hot" links to specific visualizations. Notebooks are simple and easy to use, offering an easily adaptable environment for teachers to design and disseminate activities, and for students to create projects or record their progress.

## Support

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## Inquiries

The WorldWatcher (Macintosh) software and reprints of publications are available upon request.

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*The functions in the WorldWatcher toolbar allow students to focus on specific portions of an image, customize the display of an image, create new data by drawing or performing arithmetic operations, or view alternate visualizations such as histograms or projections.*