

Data Visualization

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Students can create and explore interactive data visualizations in their web browsers that are both stimulating and informative



In 1998, I asked a Ph.D. student in our department at Maryland to do me a favor in preparation for a public open house event. I wanted him to prepare one or two advanced visualizations of his research data on my new SGI workstation that demonstrated complex relationships between several variables of his research. He agreed.

A week later, he came to me with a sour look, complaining about how much work he had to do to get the visualizations to *show his data correctly*. He then smiled, and told me that he also re-wrote his dissertation draft after discovering that the 3D visualizations he had prepared revealed complex relationships that could not be seen in simple graphs and tables prepared earlier. He was extremely pleased by the learning experience of

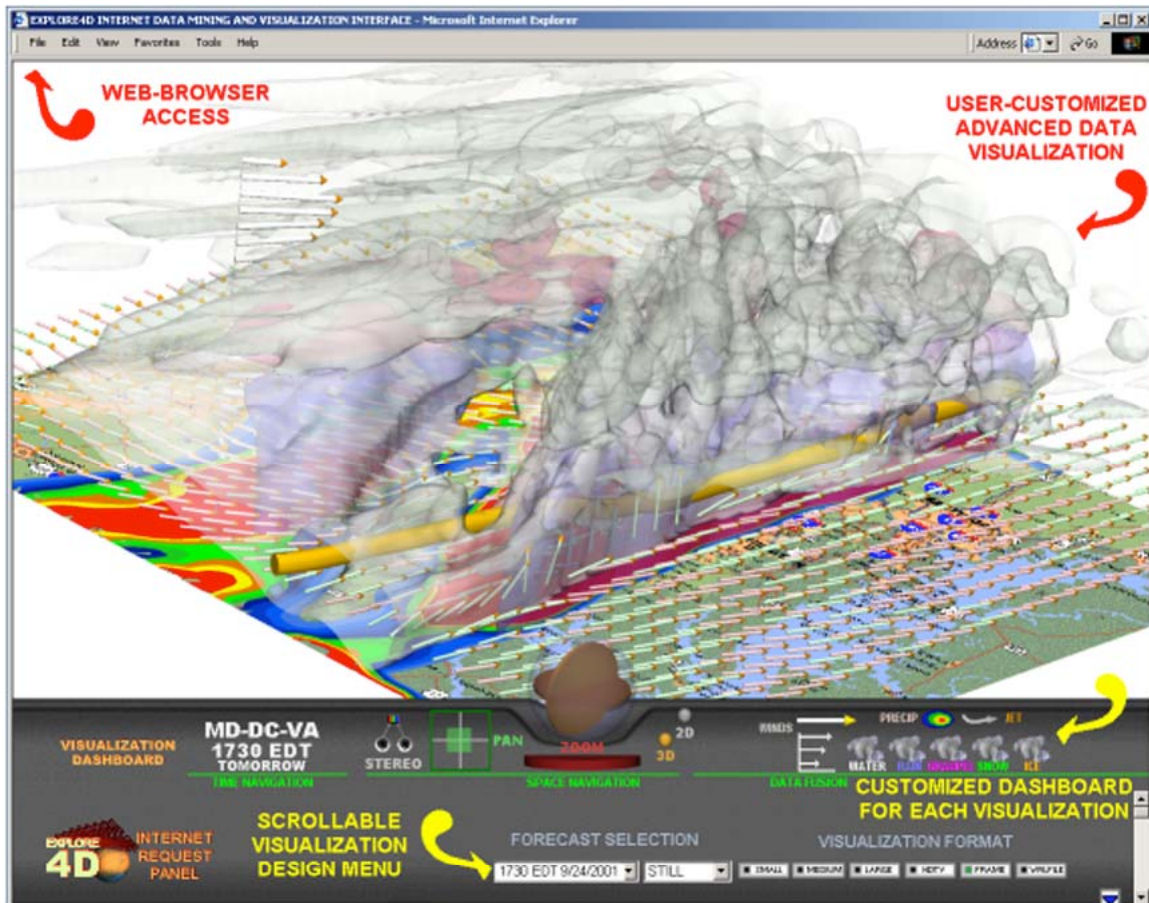
advanced data visualization.

This event occurred at a time when advanced visualization was considered by most researchers as a fancy presentation tool, and not a learning tool. Data and model visualization has come a long way in the last decade or so. Initially, I became curious about it for two reasons: First, the information about a complicated subject that can be gleaned from interactive exploration of multivariate 3D visualization is far greater than that available in a 2D map, graph, or image. Second, I realized that students were coming to university after having been immersed in interactive video games throughout their adolescence. So when I passed out paper maps and graphs of key information, their boredom was evident. My own experience had taught me the value of 3D visualization in learning new things about complex data. But with site licenses running tens of thousands of dollars per seat, this technology was then out of reach for broad educational use.

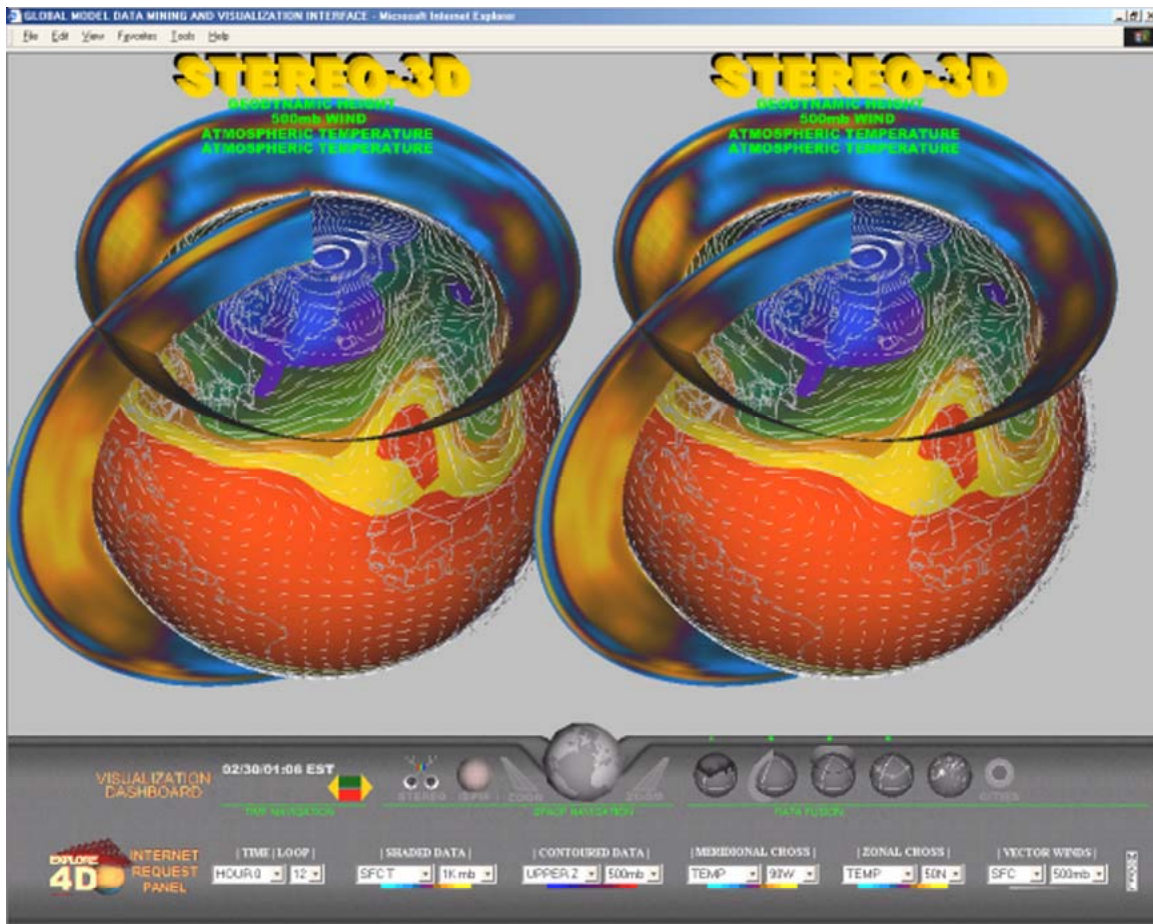
The evolution of the internet proved a boon for visualization. With larger bandwidths and faster computers, it became possible for researchers to share 3D visualizations with anyone, anywhere. Starting about 1997 or so, I focused my summers on building web-based interactive visualization of complex, multivariate, multidimensional data. The first rule was that everything had to work in a web browser with minimal technical requirements of the user.

The second rule was that users could design their own visualizations in a simple, interactive way and get results quickly. The solution was a “client-server” design in which simple visualization design menus were presented to the user, and the user-customized visualizations were sent back to the user’s inexpensive desktops and laptops.

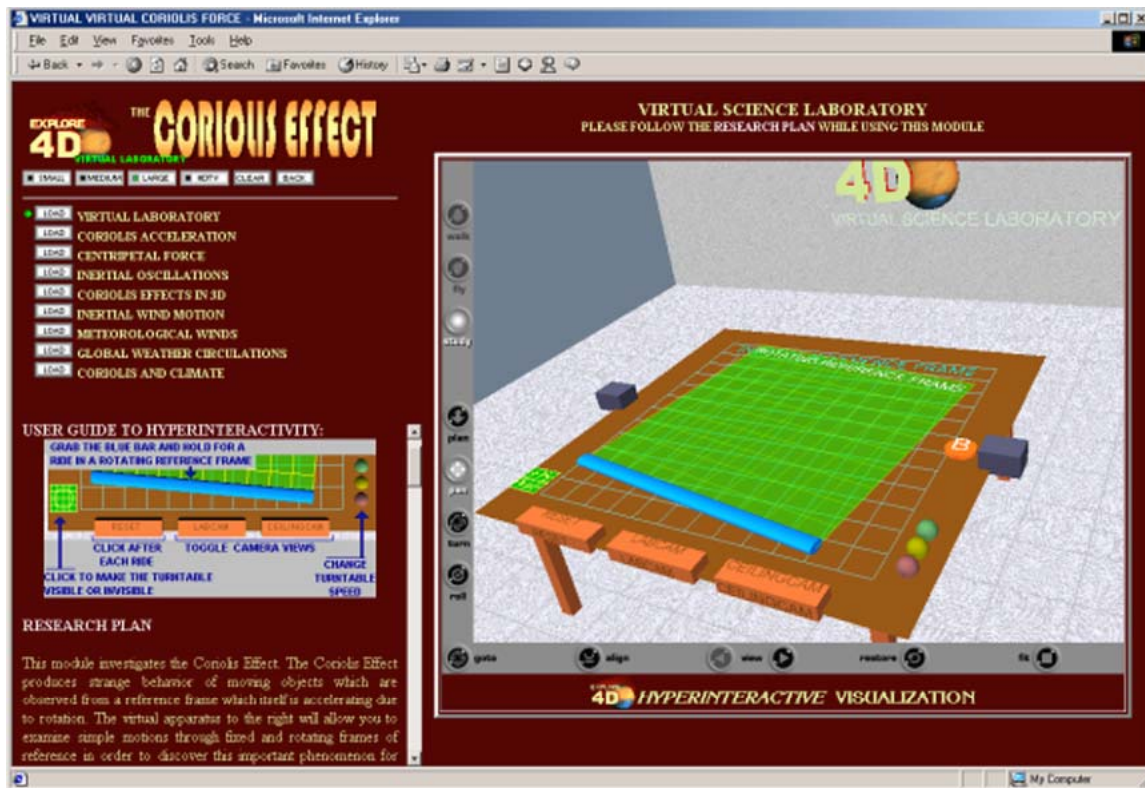
The results proved impressive. Indeed, as you can see from the three screen capture images below, students could create and explore interactive data visualizations in their web browsers that are both stimulating and informative. I look forward to a time when this *hyperinteractive* technology can be shared with all faculty and students exploring Earth system science.



Hyperinteractive web page that allows user design and Internet fetch of an advanced visualization of very high-resolution numerical weather prediction and simulation (MM5) models. (Model data courtesy of Professor Da-Lin Zhang, U. Maryland)



Hyperinteractive web page that allows user design and internet fetch of an advanced visualization of global weather prediction and simulation models. (Model data courtesy of Prof. Emeritus Donald Johnson, U. Wisconsin)



Hyperinteractive educational module exploring the Coriolis effect. Beginning with a simulated lab experiment in which students can watch moving objects from a fixed and rotating coordinate system, the module goes on to include 9 lessons about the Coriolis effect, each with an interactive visualization to elaborate the discussions.