

An Online Hybrid Multimedia Environment for K-12 Education in the Atmospheric Sciences

Steven E. Hall, Mythili Sridhar, Mohan K. Ramamurthy, Robert B. Wilhelmson,
Joel Plutchak, and David Wojtowicz

Department of Atmospheric Sciences
University of Illinois at Urbana-Champaign
105 S. Gregory St.
Urbana, IL 61801
hall@uiatma.atmos.uiuc.edu

Phone: 217-333-8132

Fax: 217-244-4393

1. INTRODUCTION

Though many questions about the Internet remain unanswered, one thing is certain; there's no going back now. The Internet has added a whole new dimension to science education. The ease of the World Wide Web (WWW) narrows the gap between classroom exercises and the practices of the broader community. Today, students access information and materials as scientists do: without leaving the classroom. However, despite the Internet's exploding popularity, a number of obstacles must be overcome before the WWW can play an integral role in classroom science education. This paper focuses on two of them; 1) the inability of most web sites to allow users to interact with the information they browse (for example, dynamic generation and/or user-customized products) and 2) the dramatic increase in network traffic during the past couple of years, resulting in slower access to and downloading of Internet materials. This second point is especially important since the reality of most schools consists of slow Internet connectivity at best and coupling this with increased network traffic would effectively render many online resources useless for classroom instruction, especially given the time constraints experienced by most teachers.

The CoVis-Horizon group in the Department of Atmospheric Sciences (DAS) at the University of Illinois Urbana-Champaign (UIUC) has taken up the challenge to address these issues. In this paper, we introduce an online hybrid multimedia environment for K-12 education in the atmospheric sciences. This learning environment is hybrid in the sense that it makes effective use of existing and "cutting-edge" technologies to help students take an active role in the learning process. This is accomplished through increased interaction with the computer, and with solutions that simultaneously decrease one's dependency on network resources.

2. CONTRIBUTIONS TO THE COVIS AND HORIZON PROJECTS

Several faculty and staff members from UIUC are participating in an NSF-funded project known as "Collaborative Visualization", or *CoVis*¹. In CoVis we have worked with teachers in the development of activities to transform their classrooms from traditional teacher-centered classes to project-enhanced classes in which students learn about science through personal and group inquiries. An important UIUC contribution to the CoVis project has been the development of the *Online Guide to Meteorology*², a collection of web-based instructional modules that effectively uses multimedia technology to introduce and discuss essential concepts in atmospheric sciences as they arise in project science inquiry. These resources are Internet accessible through our weather and environmental web server, *The Daily Planet*TM (TDP)³, thus their usage is not limited to the CoVis project, and, in fact, they are being accessed daily by a variety of Internet users (Hall *et al.*, 1996a).

¹ <http://www.covis.nwu.edu/>

² <http://covis.atmos.uiuc.edu/guide/>

³ <http://www.atmos.uiuc.edu/>

UIUC faculty and staff members are also involved in a NASA-funded project called *HORIZON*⁴ which seeks to enable greater public access to earth and space science data through enhancements of and innovations in WWW technology. A valuable contribution to both projects has been *The Weather Visualizer*⁵: an Internet-based visualization tool that allows public access to real-time and archived weather data. Users generate customized weather images through a point-and-click interface, increasing the interactivity with the computer by giving the user complete control over which features appear on the final product. An additional feature of The Weather Visualizer is the generous use of Helper sections whose purpose is to equip the user with the knowledge and skills required for valuable and correct interpretation of the images (Hall *et al.*, 1996b).

To deal with increasing demand for Weather Visualizer resources, we used the *Java*TM Programming Language in the development of the next generation Weather Visualizer⁶. Through the execution of Java programs (called “Applets”), students can customize weather images with nearly instantaneous results, promoting a significant increase in student-computer interactivity while at the same time reducing dependency on network resources. More details provided in a companion paper (Plutchak *et al.*, 1997).

The CoVis community (which includes more than 50 schools) has proven to be a valuable testbed for these resources. *CoVis Interschool Activities* (CIA) provide teachers with meaningful curriculum built around the Guide to Meteorology and The Weather Visualizer, covering a variety of topics from clouds to winter storms. For example, students investigating cold fronts would access necessary background information from the *Guide to Fronts* instructional module, then would use The Weather Visualizer to access selected sets of archived weather data for tracking cold fronts on weather maps. Students generate a variety of surface images, analyze them, and extract the information necessary for completing the project. These and other CIA's are found on the *CoVis Geosciences Web Server*⁷, which contains a collection of project-based activities that provide teachers with practical applications for data, student mentoring, and other Internet resources (Ramamurthy *et al.*, 1996).

3. AN ONLINE HYBRID MULTIMEDIA ENVIRONMENT

The CoVis-Horizon group at UIUC has begun the development of an online hybrid multimedia environment in the atmospheric sciences supporting increased student interaction with a variety of online resources while reducing network dependencies. This environment draws on a diverse spectrum of technologies, beginning with local access capabilities of CD-ROMs, to the overnight distribution of prepackaged materials via webcasting, to the fast Internet connectivity often required for obtaining dynamic resources like real-time weather data.

This implementation of this structure is perhaps best visualized through examples, in this case, focusing on hurricanes. The definition of a hurricane, how hurricanes develop and the various components of a hurricane are pieces of factual information and unlikely to change over time. Such facts are considered to be *static* information, which would be ideal for storage on CD-ROMs in multimedia format. In turn, these educational CD-ROMs could be distributed to schools, thus providing local access to these materials without need for Internet connectivity. Similar materials suited for CD-ROM storage include archived weather data, instructional modules, plus multimedia resources like extended animations and audio explanations, otherwise too voluminous for normal Internet access. Since these materials are accessible in a web environment, the interface is no different than using a live network connection, however, access from the disc is noticeably faster.

The material on CD-ROM would be constructed to work hand-in-hand with dynamic resources on the Internet. For example, suppose a student had just learned about the components of a hurricane (in the *Hurricane* instructional module), he/she could then follow strategically embedded links to Internet resources like The Weather Visualizer and access the latest hurricane advisories, tracking information, or relevant image products useful in hurricane detection. Students could also access a sequence of images and construct an animation using the Java image viewer which has been incorporated into our renovated

⁴ <http://horizon.atmos.uiuc.edu/>

⁵ <http://covis.atmos.uiuc.edu/covis/visualizer/>

⁶ <http://covis.atmos.uiuc.edu/java/>

⁷ <http://www.covis.nwu.edu/>

weather web server *Weather World 2010TM* (WW2010)⁸. More details provided in a companion paper (Wojtowitz *et al.*, 1997). From such animations, students could track the speed and direction of a hurricane, and like the forecaster from the National Hurricane Center, could use that information to predict if, when and where the storm would make landfall. Thus the students take an active role in applying their knowledge to real data through predicting a future state. The accuracy of the predictions would be revealed as the hurricane evolves over time. So from the CD-ROM, students are able to thoroughly investigate atmospheric phenomena explained in the local instructional pages by accessing real-time weather data. Through the integration of these different technologies, students can really assert themselves in the learning of hurricanes, and this capability can be applied to related atmospheric science topics and other fields too.

Another option soon to be made available to teachers is called *webcasting*. Webcasting can be thought of in a similar light as broadcasting over television and radio, only in this case, the transmission of data and multimedia products is specially processed and made available over the web. This technology is currently being used for the transmission of music concerts and speeches by political officials. In addition, users have the capability to tune in for live updates on special events. We intend to expand this new and exciting technology into science education.

Through the implementation of webcasting, teachers can request the overnight downloading of pre-selected bulk images and materials. These products would be available on the teacher's computer the next day for use during class. Continuing with the hurricane example, suppose a teacher was interested in presenting weather images or information about a current hurricane, but doesn't have the network capability to do so during class time. That teacher could "tune" in to our webcasting transmission and receive a package of valuable data and image products for usage in class the next day. Such a transmission would take place during times of reduced network traffic and the resources would be downloaded directly on to the teacher's computer. A webcasting package about hurricanes might consist of the next day's tracking information, statistics, hurricane advisories and satellite and tracking images carefully selected by DAS members. The focus and content of webcasting parcels would be determined by the important weather events of the day. Webcasting would be especially useful to those teachers who either lack rapid network connectivity or simply don't have the time to browse around the numerous weather sites looking for images and data that would be useful for classroom instruction.

These varying degrees of technology provide teachers with a variety of approaches and solutions for bringing valuable Internet resources into the classroom for instruction in the atmospheric sciences. The challenge of providing these services will be formidable and there are a number of issues that need to be dealt with before this project will be successful. For example, deciding exactly which resources should be placed on the CD-ROM, or when and where these materials should link to *live* Internet tools and resources. To implement a webcasting system, we'll need to determine solutions for encoding, storing, broadcasting and decoding the materials sent in a transmission. Finally, we would like to develop a point-to-point webcasting environment, where specific parcels can be delivered per requests of individual teachers. While these are just a few of the issues that need to be dealt with during the completion of this project, they are not impossible to overcome.

4. CONCLUSION

With Internet expanding at an incredible rate, more educational resources are available to teachers on the WWW than ever before. However, many web servers lack the ability for users to interact with the information they browse and longer access times are required to download an increasing number of Internet resources. These obstacles hinder the effective integration of web resources into classroom instruction. In response to this need, members of the CoVis-Horizon group at UIUC have constructed an online hybrid multimedia environment for the teaching K-12 atmospheric sciences. By incorporating a variety of technologies, content materials and data and image products, Internet resources are brought together to help students to become more active in the learning of atmospheric sciences through increased interaction with the computer while simultaneously reducing dependency upon network resources. These capabilities effectively make these resources more useful for classroom instruction. Static materials and products like instructional modules and archived data will be made available to schools through the distribution of

⁸ <http://ww2010.atmos.uiuc.edu/>

educational CD-ROMs, providing students with quick, local access to these resources and bypassing the delay times often a result of heavy network traffic. From materials on the CD-ROM, students have access to selected dynamic Internet resources related to the content instructional materials. Not only can students learn the characteristics of weather processes, but can also investigate these processes through the analysis of real-time weather data. Teachers can also take advantage of webcasting as another means for bringing valuable Internet resources into the classroom. The completion of this project will be challenging, yet rewarding. The benefits of such an environment will not only give students more ability to interact with web-based materials than previously experienced, but will also allow more schools to take advantage of these materials through decreased demand on network resources.

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