

# ***Using Web-based Java Applets to Simulate Weather and Climate***

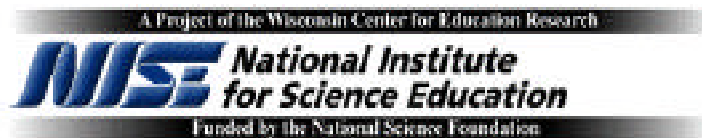
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## Using Web-based Java Applets to Simulate Weather and Climate



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### **Why use technology?**

About three years ago I began thinking of using technology in my class because my students were having difficulty understanding a fundamental concept – contour analysis. I just didn't have the time to spend with the students as they struggled with the material; they needed *a lot* of feedback as they practiced drawing contours. My NASA grant required some outreach funding, so I decided to use some of those funds to create some java applets that would enable my students to practice drawing contour maps on their own with very basic data sets and then with actual data. They could draw a map and then get immediate feedback on their success by looking at a correct contour map.

This was so successful, that my colleague, Tom Whittaker, and I began to develop other interactive simulation applets and integrate them into almost every topic covered in my "Introduction to Weather and Climate" course. These simulations sometimes use very simple data, and other times use actual weather data. The java applets help students to develop skill in reading station models of weather variables, identifying cold and warm airmasses, finding fronts, and reading satellite images.

These simulations have been successful for a number of reasons. First, these simulations are visual, and my tests of students' learning styles reveal that I have a lot of visual learners in my class. By doing these interactive models, they can change one thing -- like temperature -- and can see in a picture how that affects the wind, or how that affects the satellite image. Second, these simulations present the concept without the complex mathematics behind them. This is important because 85% of my students dislike math. Third, these simulations help my students to begin to think like scientists, since scientists use models similar to these applets to better explore and understand climate.

### **The strategy**

I started using technology to help students understand a particular concept. And this holds true for the other applets Tom and I have developed. I only do an applet when there's something students don't understand and I'm not getting to them. Then I say, "Well this isn't working. I need to get them doing something."

Once I decide to create an applet, then I talk with about it with Tom, who works in the Interactive Systems Development Group at the UW-Madison Space Science and Engineering Center (SSEC). He then takes a stab at programming it and we go back and forth tweaking it to fit our needs. When we feel fairly confident that the applet works, we ask our colleagues here at the SSEC for feedback. We'll make changes as necessary, and if no major changes are required, I'll use it in class. If I still have doubts about its usefulness, I'll assign it as extra credit and ask students to give me feedback.

Sometimes, the program just doesn't work as intended. For instance, my colleagues will use a program in ways I didn't even expect, which means that students definitely will also. For example, we developed an applet in which the user could modify the temperature and humidity profiles of the atmosphere and -- with the correct parameters -- grow a thunderstorm. When we first designed that applet, I wanted to give it to the students as a homework assignment. But, when I gave it to my colleague to test, and watched over his shoulder as he played with it, I realized, "Oh, this isn't going to work." I could see what he was doing, and he was trying to grow a thunderstorm in the classic sense and it just wasn't going to work. So, I immediately thought, "Oh, no this isn't going to work because he's doing things with it that I wouldn't have done." However, with a little instruction, students now use the program effectively: they just need to know how to use the parameters appropriately.

I introduce one of these simulation applets in class after I have outlined the theory that underlies their use. Then I explain how the simulations work (the different sliders and what they do) and then I ask the students to play with them. I have found that if I don't spend time explaining the features, students will just start playing with them and quickly get lost. Students need guidance in how to use the different parameters appropriately.

Through this process, I have learned a great deal about how to use technology effectively in my classroom. First, I've learned to start small, creating small programs and then use a variety of them to illustrate a range of concepts. Second, I've learned that the technology should only be used when needed: if you don't need it, don't use it. And third, I've learned the value of having somebody to work with – it's a lot more fun and you make a lot fewer mistakes.

### **The course**

The course I teach using this technology is Atmospheric and Oceanic Sciences 101: Introduction to Weather and Climate Class. This introductory course attracts students who are generally non-science majors hoping to fulfill their natural science breadth requirement. The course is taught in the fall and spring semester and serves about 400 students each semester. Two teaching assistants provide help with grading of homework and exams.

All of these simulations are available on my class web page, as are the syllabus and weekly exercises. I also do pre-tests prior to my lectures that assess students' understanding of topics to be covered during the week. This pre-test helps me to determine what material I should focus on during my lecture.

### **The learning technology**

All of the interaction simulations mentioned here are **free** and are web-based. The applets can be run from the website without a download, or can be downloaded as well. We've tested them and they work almost everywhere. Last year and this year as well, I assigned a homework that used one of these applets and out of a 400-student class, only one person had a problem.

### **The project support**

As I explained, my colleague, Tom Whittaker, and I developed these technologies, with Tom doing the programming. Our original funding came from the outreach portion of a NASA grant. Later, I received some money from a division on campus that supports the use of technology in the classroom, and from another campus program for major achievements in teaching,

research, and services.

In addition, I received funding from the NSF to create the "Suomi Virtual Museum" that honors Dr. Verner Suomi, father of the geostationary satellite and a pioneer in the field of geosciences. It is at this museum that you can access these applets.

### The results

I have found the applets to be very helpful to my teaching and others have as well: we have had a lot of requests for the applets from other instructors.

The students like the applets too. 107 out of 400 students completed our survey on the applets, which as based upon field-tested questions from "The Flashlight Project." The results are:

- 82% "believed" or "somewhat believed" that the applets helped them to master skills and concepts more quickly than with traditional methods
- 75% "believed" or "somewhat believed" that the applets helped to develop their skills and understanding better than through traditional reading and pencil-and-paper exercises.
- 71% "believed" or "somewhat believed" that the applets allowed them to learn more on their own, with less assistance from the TA.

Students appreciated having an additional resource help them understand the material and break up the "monotony of homework" (as one student said). Their major complaint was regarding access: it was sometimes difficult to get to a computer if they did not already own one.

If you have any questions about our project, you can contact me at: [stevea@ssec.wisc.edu](mailto:stevea@ssec.wisc.edu)

LINKS
<i>Atmospheric and Oceanic Sciences 101:</i> <a href="http://mapmaker.meteor.wisc.edu/%7Ejbrunner/ackerman/web101.html">http://mapmaker.meteor.wisc.edu/%7Ejbrunner/ackerman/web101.html</a>
<i>Cloud formation applet:</i> <a href="http://profhorn.meteor.wisc.edu/wxwise/museum/a8/a8tstm.html">http://profhorn.meteor.wisc.edu/wxwise/museum/a8/a8tstm.html</a>
<i>Contouring applets: Isotherms:</i> <a href="http://mapmaker.meteor.wisc.edu/%7Ejbrunner/ackerman/contourI/isotherm0.html">http://mapmaker.meteor.wisc.edu/%7Ejbrunner/ackerman/contourI/isotherm0.html</a>
<i>Contouring applets: Isobars:</i> <a href="http://mapmaker.meteor.wisc.edu/%7Ejbrunner/ackerman/contourII/isobar0.html">http://mapmaker.meteor.wisc.edu/%7Ejbrunner/ackerman/contourII/isobar0.html</a>
<i>Tom Whittaker's home page (links to other applets):</i> <a href="http://www.ssec.wisc.edu/~tomw/homepage1.html">http://www.ssec.wisc.edu/~tomw/homepage1.html</a>
<i>Verner E. Suomi Virtual Museum:</i> <a href="http://profhorn.meteor.wisc.edu/wxwise/museum/a0main.html">http://profhorn.meteor.wisc.edu/wxwise/museum/a0main.html</a>
<i>Suomi Virtual Museum gift shop (links to other applets):</i> <a href="http://profhorn.meteor.wisc.edu/wxwise/museum/a99main.html">http://profhorn.meteor.wisc.edu/wxwise/museum/a99main.html</a>
<i>Space Science and Engineering Center (SSEC):</i> <a href="http://www.ssec.wisc.edu/">http://www.ssec.wisc.edu/</a>
<i>Space Science and Engineering Center (SSEC) (links to weather data):</i> <a href="http://www.ssec.wisc.edu/data/">http://www.ssec.wisc.edu/data/</a>
<i>Flashlight Project:</i> <a href="http://www.tltgroup.org/programs/flashlight.html">http://www.tltgroup.org/programs/flashlight.html</a>