Imagine taking snow measurements and recording cloud observations for NASA researchers. Imagine a scientist using your data in an important scientific study related to global climate change. Sound like a difficult job? How about for a sixth grader?

Given the chance, most children would jump at the prospect of becoming scientists for a day. This opportunity came to over 1,750 students in the Upper Midwest (U.S.) through a program led by Dr. Kevin Czajkowski, professor of geography at the University of Toledo. Czajkowski and a team of researchers developed an educational outreach program, funded by the NASA New Investigator Program, that enabled teachers and students to collect data for a global change study.

Beginning in summer 2000, the University of Toledo hosted a "Global Change and Remote Sensing Seminar" for elementary and secondary teachers in Ohio, Michigan, and Pennsylvania. During the seminar, Czajkowski introduced the teachers to climate-related topics, such as solar radiation, weather observing techniques, satellite imagery, and global climate change issues.

Janet Struble, a science educator and visiting faculty member at the University of Toledo who managed the seminar, helped the teachers develop classroom lesson plans based on Czajkowski's scientific discussions. These lesson plans introduced students to principles of remote sensing and global climate change through hands-on data collection.

According to Struble, many children don't understand the meaning of global climate change. "A common misconception is that everything is heating up, but Dr. Czajkowski pointed out that in some parts of the world the temperature is actually decreasing," she said.

In the first year of the program, Czajkowski, Struble, and Terri Benko, a researcher with the University of Toledo, accompanied a local television meteorologist to schools to discuss the students' role in collecting data for the project. "Our ultimate goal is to collect surface temperature data and compare those data with measurements from local meteorological stations and satellites, which will help us better understand local temperature patterns. To build the foundation for that future study, we needed to first validate the data retrieved from satellites, so we introduced the students to Earth science data — namely, clouds and snow," said Benko.

Czajkowski stressed the important role that ground-based cloud and snow data play in making sure the satellite data are valid. "Some satellite sensors can't detect surface features on the Earth, because of their inability to penetrate cloud cover. Since the Upper Midwest is mostly cloudy in the winter months, we

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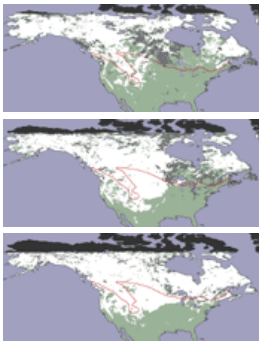


In the early winter of 2000-01, MODIS recorded above-average snow cover. These images show snow cover for the weeks of November 1-7 (top), November 8-15 (middle), and November 16-23 (bottom). The red line indicates the 35-year average, and the black areas show where no data were collected. Click here for more information.

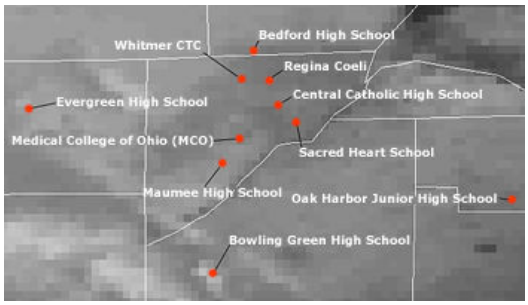
The Electromagnetic Spectrum

The electromagnetic spectrum is a categorization of solar radiation that includes the entire range of radiant energies or wave frequencies. Arranged from the longest to the shortest wavelengths, the spectrum is usually divided into seven sections: radio, microwave, infrared, visible, ultraviolet, X-ray, and gamma-ray radiation.

Remote sensing satellites detect the amount of electromagnetic radiation emitted and reflected from objects and features on the Earth's surface. Although microwave radiation is easily transmitted through clouds to space, visible and infrared radiation cannot penetrate clouds. Therefore, satellites that measure wavelengths in the microwave range, such as the Defense Meteorological Satellite Program's Special Sensor

needed snow cover measurements and cloud coverage observations from the students," he said.

Although Czajkowski only needed the percentage of cloud coverage, he asked students to record the types of clouds and their relative height (low, medium, or high) to teach them more about weather-related phenomena.



University of Toledo researcher Kevin Czajkowski mapped schools in the Toledo area that participated in the study. The map is shown here against a backdrop of AVHRR imagery.

Students were given a "Data Collection Manual" with detailed instructions for recording their observations. The first set of observations took place from December 4 - 12, 2000, and the most recent from January 28 to February 8, 2002. Teachers helped the students identify cloud patterns, 24-hour snow depth, and how much water results from melting snow (snow water equivalent). Czajkowski, Struble, and Benko often accompanied the students outside to show them proper data collection techniques. "When there was no snow on the ground, we demonstrated how to measure snow depth using popcorn instead of snow," said Benko.

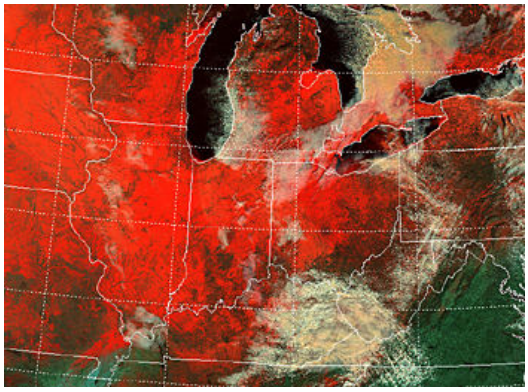
The program became so popular that the number of participating students increased with each new data collection phase. "Originally we had 25 schools involved, but then it became too many schools to visit after the second year," he said. Now, Czajkowski communicates topics in remote sensing and global climate change to students through a Web-based presentation, and he answers questions via an Internet discussion board.

Students submitted their observations online through a simple Web interface so others could see their results. "When Dr. Czajkowski and I looked at the first batch of student data, we discovered mathematical errors and some excess data. So we created a Web interface that performed calculations from students' data and only allowed them to enter valid data. It was a much more efficient means of compiling data compared to the original paper spreadsheets the students used in 2000," said Benko.

Using latitude and longitude values that students recorded for their school location, Czajkowski compared the students' snow data with satellite-derived snow cover data for the same location. He used Moderate Resolution Imaging Spectroradiometer (MODIS) snow cover data, available from the National Snow and Ice Data Center (NSIDC) in Boulder, Colorado, to create satellite pictures of snow cover over the Midwest U.S. Czajkowski also posted satellite pictures from the Advanced Very High Resolution Radiometer (AVHRR) sensor, also available from NSIDC, on the project's Web site. "We needed to make it visually appealing for the students, so in addition to displaying the snow product, we also showed a visible band of AVHRR data," he said.

Microwave/Imagers (SSM/I), can "see" snow cover at the surface. However, satellites that measure visible radiation, such as MODIS and AVHRR, cannot detect snow cover or other surface features that are beneath cloud cover.

The National Snow and Ice Data Center DAAC archives both MODIS and AVHRR snow and ice data sets.



This false-color MODIS image, captured on January 2, 2001, shows the extent of snow cover over the north-central United States. Land surfaces appear as green, water surfaces as black, snow cover as red, and clouds as white. Click here for more information (in a new window).

Czajkowski unveiled the results of comparing student observations with MODIS satellite pictures in a Webcast to all participating schools on the last day of Earth Week, April 26, 2002. Students will later learn how to measure surface temperature at their schools, and how their observations compare with satellite-derived temperatures. “Data are only collected for two-week periods, so students and teachers won’t be able to see if average temperatures in their neighborhoods are changing over time,” said Benko. “But they will be able to use their data to study local temperature patterns.”

“Having the satellite pictures online with students’ observations showed teachers and parents how exciting the science really is, and more importantly, how satellite data contribute to global climate change studies. The students asked us a lot of good questions about snow, clouds, and global climate change — I was astounded by their interest in science,” said Benko.

According to Struble, the program appealed to teachers partly because it required only a short time commitment. “Many projects ask teachers to devote more time than they have available, but we only asked for four weeks of manageable data collection,” she said. “The teachers also appreciated the interaction. Czajkowski was very accessible, and the students were excited when he visited their school or sent them e-mail messages.”

Czajkowski, Struble, and Benko plan to continue the Global Change and Remote Sensing Seminars for at least five more years. “We want to recruit more teachers for next winter’s program and continue the snow and cloud observations. Our goal is to link an educational outreach opportunity to a viable scientific question such as, ‘Will global warming affect where I live?’ This project teaches the concepts of global climate change to students and teachers by having them collect data and observe weather patterns in their own communities,” said Czajkowski.

Observing Earth Systems from Space. Accessed April 1, 2002.

Czajkowski, K., T. Benko, and J. Struble. 2002. Global change and remote sensing summer teacher workshop and observation program. Proceedings from the 11th Annual Education Symposium, American Meteorological Society, Jan. 13-17, 2002, pp. 87-89.