

In Brief

Earth's climate has changed since the planet's beginning. While earlier climate-change events were related to natural forces, recent warming is distinctly related to human activities. Jeff Dozier, Professor of Environmental Science and Management at the University of California, Santa Barbara, explores the history of climate change in depth each year in his graduate-level Earth System Science class. To help students visualize events through the ages, he is developing a comprehensive history of climate change using ChronoZoom. The timeline includes images, charts, and videos that illustrate major climate changes from the beginning of time through modern day.

Jeff Dozier
Professor of
Environmental Science
and Management
University of California,
Santa Barbara

Websites:
www.chronozoom.com
www.windowsazure.com

Using ChronoZoom to Build a Comprehensive Timeline of Climate Change in the Cloud

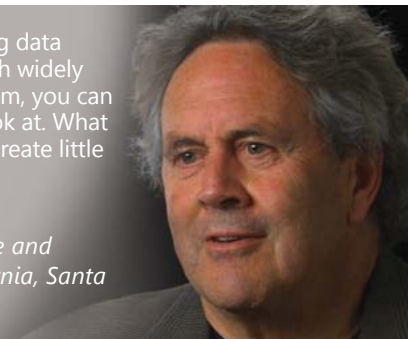
SEEKING A BETTER WAY TO ILLUSTRATE CLIMATE CHANGE THROUGH THE AGES

Earth's climate has changed for as long as the planet has existed. Scientists have uncovered evidence of climate changes dating back millions of years. Early climate change can be traced to naturally occurring events, such as tectonic shifts and orbital variability. More recent changes, however, are caused in part by human activities: burning fossil fuels produces carbon dioxide and atmospheric aerosols; agriculture and coal mining produce methane; and deforestation contributes carbon dioxide along with reductions in evaporation and increases in reflectivity. While some of these actions cool the planet—the aerosols, for example—in total they contribute to a warmer planet, more so than the small changes in solar activity over the last century. This warming trend could lead to rising sea levels, greater occurrences of severe weather, and more frequent heat waves.

Each year, Jeff Dozier, Professor of Environmental Science and Management at the University of California, Santa Barbara, teaches a course in Earth System Science to between 80 and 100 incoming graduate students. Among the issues he teaches: climate record and how the Earth's climate has changed through the ages—and what drivers are behind those changes.

"It's important to understand how the Earth works as a planet," Dozier says. "One of the things we look at is how the climate changes. We know that the Earth goes through periods in which the climate varies. And at different timescales, we understand why the climate changes."

Covering millions of years' worth of warming trends within a class term is a challenge; managing the massive volumes of data, charts, videos, illustrations, and other support materials is even more daunting. "The struggle we have in communicating science is how to



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present information based on data," Dozier says. He needed a way to pull together his materials into an accessible—and manageable—manner. He found the solution in the award-winning ChronoZoom tool.

BUILDING A HISTORICAL VIEW OF CLIMATE CHANGE

ChronoZoom is an open-source community project dedicated to visualizing the history of everything. It was originally developed as a joint effort between the University of California, Berkeley; Moscow State University; the Outercurve Foundation; and Microsoft Research Connections. The goal: to create a massive, illustrated timeline of history. The final product allows users to navigate through "time," beginning with the Big Bang and ending with recent historical events, stopping to study detailed information at any point in the history of the world. Users can zoom in rapidly from one time period to another, moving through history as quickly or slowly as they desire. In 2013, a third-party authoring tool was introduced and built into ChronoZoom. The feature enables the academic community to share information via data, tours, and insights, so it can be easily visualized and navigated through Deep Zoom functionality.

ChronoZoom operates in the cloud and can be accessed from

Microsoft Research Connections



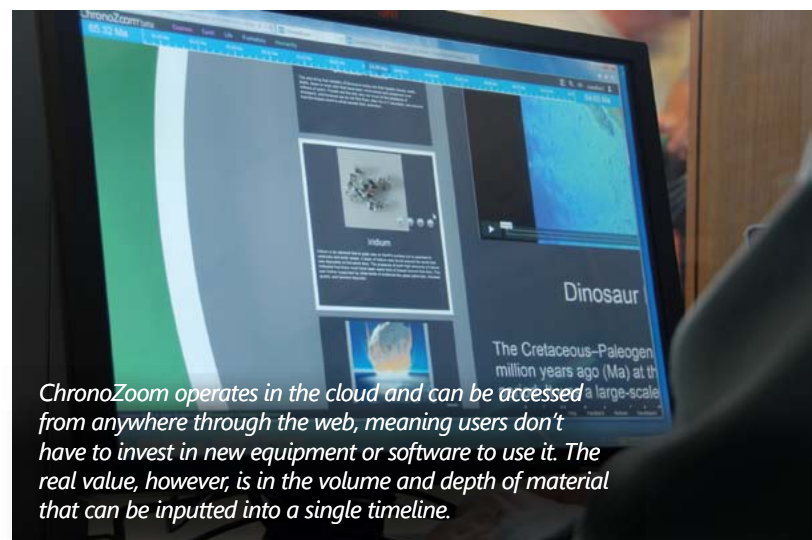
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anywhere through the web, meaning users don't have to invest in new equipment or software to use it. The real value, however, is in the volume and depth of material that can be inputted into a single timeline.

"I've always had difficulty explaining data to students when the data is at such widely different time scales," Dozier says. "In ChronoZoom, you can create tours for other people to look at. What we also can do in ChronoZoom is create little stories that you can drive yourself. You can explore a story I have to tell at any speed you want. You can skip over some details, or you can dive into some of those details."

Visual aids can have a particularly powerful impact when discussing climate change. Dozier is developing a history of the Earth that illustrates changes in climate from the beginning of the planet through modern day. The source materials include images, diagrams, graphs, and time-lapse movies that illustrate changes in the environment. Dozier plans to use the timeline as a teaching aid in his Earth System Science class. "It's really useful to be able to compare things that happened in the distant past with what's going on in the present," he explains. "For example, a thousand years or so ago, there was a medieval warm period when the Vikings settled in North America and Greenland. That was a time when humans weren't affecting the climate at all. What's interesting to show students is that the current period is warmer than the medieval warm period. The temperature rise that has occurred over the past half-century or so is more rapid than anything that we've experienced in the past. Being able to quickly look at climate data from different time periods and compare them is a very powerful tool."

"ChronoZoom has been easy to master and use," Dozier continues. "You don't need any sort of client-side application except a browser. All the data is stored on someone else's machine. The processing is done in the cloud [through Windows Azure], not on your own computer. And the only thing that really shows up on your own computer is the results." Moreover, thanks to the power of Windows Azure, the tool has the flexibility to scale up and down, enabling users



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to zoom in on a particular segment in time or zoom out to review climate change from the beginning of recorded history through today. Plus, content developers can share their presentations or timelines with others by simply sharing a link or posting it to a social media site.

MAKE YOUR MARK ON HISTORY

ChronoZoom has already been used to illustrate the history of the Earth and explore the impact of climate change on the planet through the ages. There are many unexplored possibilities, however. The tool scales up and down, meaning any project can benefit—whether it's the history of the world or just a review of the last few weeks. Dozier is hopeful others will use ChronoZoom to tell their stories by uploading their own data, images, and text to the cloud and using those materials in the classroom.

"I don't know how, but ChronoZoom is going to change the way students learn information," Dozier says. "I'm really looking forward to using ChronoZoom this fall when I teach the course again."