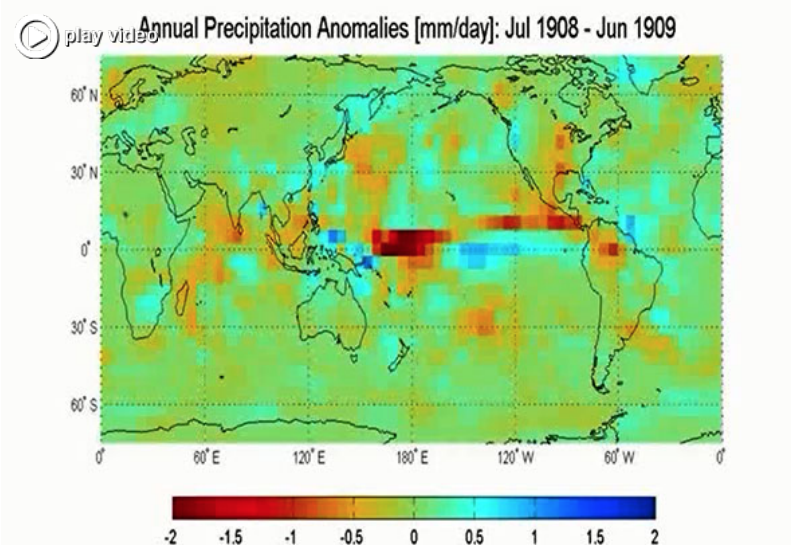
Research Story

Wednesday, October 15, 2014

Weather History Time Machine

A program allows researchers to look back in time to see how precipitation across the globe contributed to major weather events.



Shen and colleagues created a video showcasing their historical precipitation data. At 00:31 (July 1933 - June 1934), you can see the extreme dryness in the Pacific Ocean preceding the Dust Bowl.

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***By* Michael Price**

During the 1930s, North America endured the Dust Bowl, a prolonged era of dryness that withered crops and dramatically altered where the population settled. Land-based precipitation records from the years leading up to the Dust Bowl are consistent with the telltale drying-out period associated with a persistent dry weather pattern, but they can't explain why the drought was so pronounced and long-lasting.

The mystery lies in the fact that land-based precipitation tells only part of the climate story. Building accurate computer reconstructions of historical global precipitation is tricky business. The statistical models are very complicated, the historical data is often full of holes, and researchers invariably have to make educated guesses at correcting for sampling errors.

Hard science

The high degree of difficulty and expertise required means that relatively few climate scientists have been able to base their research on accurate models of

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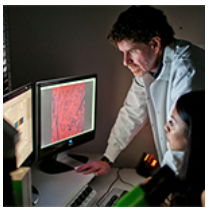

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historical precipitation. Now, a new software program developed by a research team including San Diego State University Distinguished Professor of Mathematics and Statistics Samuel Shen will democratize this ability, allowing far more researchers access to these models.

"In the past, only a couple dozen scientists could do these reconstructions," Shen said. "Now, anybody can play with this user-friendly software, use it to inform their research, and develop new models and hypotheses. This new tool brings historical precipitation reconstruction from a 'rocket science' to a 'toy science.'"

The National Science Foundation–funded project is a collaboration between Shen, University of Maryland atmospheric scientist Phillip A. Arkin and National Oceanic and Atmospheric Administration climatologist Thomas M. Smith.

Predicting past patterns

Prescribed oceanic patterns are useful for predicting large weather anomalies. Prolonged dry or wet spells over certain regions can reliably tell you whether, for instance, North America will undergo an oceanic weather pattern such as the El Nino or La Nina patterns. The problem for historical models is that reliable data exists from only a small percentage of the earth's surface. About eighty-four percent of all rain falls in the middle of the ocean with no one to record it. Satellite weather tracking is only a few decades old, so for historical models, researchers must fill in the gaps based on the data that does exist.

Shen, who co-directs SDSU's Center for Climate and Sustainability Studies Area of Excellence, is an expert in minimizing error size inside model simulations. In the case of climate science, that means making the historical fill-in-the-gap guesses as accurate as possible. Shen and his SDSU graduate students Nancy Tafolla and Barbara Sperberg produced a user-friendly, technologically advanced piece of software that does the statistical heavy lifting for researchers. The program, known as SOGP 1.0, is based on research published last month in the *Journal of Atmospheric Sciences*. The group released SOGP 1.0 to the public last week, available by request.

SOGP 1.0, which stands for a statistical technique known as spectral optimal gridding of precipitation, is based on the MATLAB programming language, commonly used in science and engineering. It reconstructs precipitation records for the entire globe (excluding the Polar Regions) between the years 1900 and 2011 and allows researchers to zoom in on particular regions and timeframes.

New tool for climate change models

For example, Shen referenced a region in the middle of the Pacific Ocean that sometimes glows bright red on the computer model, indicating extreme dryness, and sometimes dark blue, indicating an unusually wet year. When either of these climate events occur, he said, it's almost certain that North American weather will respond to these patterns, sometimes in a way that lasts several years.

"The tropical Pacific is the engine of climate," Shen explained.

In the Dust Bowl example, the SOGP program shows extreme dryness in the tropical Pacific in the late 1920s and early 1930s — a harbinger of a prolonged dry weather event in North America. Combining this data with land-record data, the model can retroactively demonstrate the Dust Bowl's especially brutal dry spell.

"If you include the ocean's precipitation signal, the drought signal is amplified," Shen said. "We can understand the 1930s Dust Bowl better by knowing the oceanic conditions."

The program isn't a tool meant to look exclusively at the past, though. Shen hopes that its ease of use will encourage climate scientists to incorporate this historical data into their own models, improving our future predictions of climate change.

Researchers interested in using SOGP 1.0 can request the software package as well as the digital datasets used by the program by e-mailing sogp.precip@gmail.com with the subject line, “SOGP precipitation product request,” followed by your name, affiliation, position, and the purpose for which you intend to use the program.

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5500 Campanile Drive
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