Predicting El Niño

Mark Cane spent much of his early 20s protesting against the war in Vietnam and volunteering with the civil rights movement in the South. He remains a social activist, but today he does so from his position as one of the world’s top climate modelers. As science-based predictions of the weather a few days in advance became routine, predicting the weather three or four months in advance was left to the likes of The Farmer’s Almanac. All that began to change in 1985 when Mark Cane and his student, Steve Zebiak, published the results of a model they developed to predict the movement of warm water across the tropical Pacific Ocean in a cyclical phenomenon known as the El Niño Southern Oscillation, or ENSO. When it forms, El Niño’s meteorological reach spans the globe, causing a well-known pattern of extreme weather events. The 2009 El Niño, for example, resulted in deep droughts in India and the Philippines and deadly rains in Uganda. Aside from the regular progression of the seasons, no other phenomenon influences Earth’s short-term climate as profoundly as ENSO.

The Zebiak-Cane model showed a moderate El Niño developing in late 1986. People in Peru, Australia, and elsewhere still had vivid memories of the devastating effects of the powerful El Niño that formed in 1982 and 1983, so many scientists opposed publishing forecasts they didn’t yet understand.

“People said, ‘What if you’re wrong?’” said Cane, the G. Unger Vetlesen Professor of Earth and Climate Sciences and a professor in the Department of Applied Physics and Applied Mathematics and the Department of Earth and Environmental Sciences. “I said, ‘What if we’re right and we don’t fail anyone?’”

Cane and Zebiak published their forecast in Nature in June of that year, which gave anyone who cared to listen time to prepare. Despite a delay in its formation early in the forecast window, by the autumn of 1986, the predicted El Niño developed, bringing its associated weather patterns to much of the globe. Most of Cane’s work since that time relates to the impacts of human-induced climate change and natural climate variability on people around the world, such as a seminal paper studying the implications of El Niño-on maize yields in Zimbabwe. He has also created a highly successful master’s degree program in Climate and Societies that prepares students to understand and cope with the impacts of climate variability and climate change on society and the environment.

“Science should be more than just an academic exercise,” said Cane. “We’re not just predicting this thing in the Pacific; we’re trying to predict all these consequences around the world that people care about.”

Modeling Monsoons

Adam Sobel once bought a plane ticket to the city of Darwin in Australia’s tropical north based on a colleague’s weather prediction. That in itself is nothing new, but the prediction he followed was for the start of the monsoon rains three weeks hence, a prediction that was virtually unheard of just a decade earlier for the length of its forecasts. When he got off the plane, no one was happier to see the sky open up and the rain begin right on schedule.

“We had half a meter of rain in ten days,” said Sobel, who holds a dual appointment in the Department of Applied Physics and Applied Mathematics and the Department of Earth and Environmental Sciences. “It was exciting.

For more than one billion people, the seasonal monsoons are both a life-giving annual event and a potential disaster. Although much is known about how the monsoons occur, very little is understood about how they vary. The monsoons are an atmospheric circulation pattern that develops in the tropics at fairly well-defined times of year. The sun warming Earth’s surface draws moisture from ocean waters and forms the iconic, seasonal rains of South and Southeast Asia or sub-tropical Africa and South America. The people who live in these regions, particularly the rural poor, rely on the monsoon rains to water crops and recharge aquifers.

When the monsoons are weak, drought and famine can result; if they come with too much gusto, flooding and disease occur. The fine line between life and death makes monsoon forecasting one of the most important topics within climate modeling these days. Sobel is trying to develop models to predict the variations within a monsoon season, known as “active” and “break” cycles, which have so far been beyond the ability of climate modeling. Recently, he helped demonstrate the central importance of heat stored in the oceans, particularly in the so-called mixed layer that encompasses the top 10 to 50 meters of water, on the formation of active and break cycles.

The atmospheric patterns that drive the monsoon—the Madden Julian Oscillation in particular—are also responsible for spawning tropical storms in distant ocean basins and may influence the formation of El Niño and La Niña cycles in the western Pacific. As a result, Sobel’s work may one day have an impact on people who live well beyond the reach of the monsoon rains.

“We need a central theory that can be stated simply that explains the variations we see,” said Sobel. “Weather prediction can look two weeks in the future, max. Climate models can give us the probability for a strong or weak monsoon a year in advance. This is in between. It’s kind of the Holy Grail right now.”