El Nino's weather extremes gives scientists a chance to study global climate's future

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Scientists understand the basics of how El Nino changes weather around the globe - floods and mudslides in Peru, wildfires and drought in Indonesia, along with heavy rain for the southeastern United States.

But it's harder to answer other questions - how likely or extreme will those problems be? And what broader consequences will they have on the planet? It's valuable information for officials trying to plan for natural disasters and the effects of climate change.

An El Nino that is forecast to be the strongest in nearly two decades could make it easier to answer those questions in the future.

Researchers at the NASA Goddard Space Flight Center are using a fleet of satellites that weren't around for other historic El Ninos to get details on where the climate pattern drops the heaviest rain, how it influences soil moisture and whether it changes the amount of carbon dioxide in the air.

"We can deduce the processes that connect these things together in the world," said Steven Pawson, chief of the Global Modeling and Assimilation Office at Goddard. "We've never had the ability before to observe all these things simultaneously."

El Nino is marked by an area of warmer-than-normal waters along the equator in the central and eastern Pacific Ocean, but it has a broader web of influence around the globe. Those warm seas spawn massive storm

clouds, which send moisture streaming eastward over North and South America, while depriving Oceania and the southwestern Pacific of rainfall.

El Nino's strength is measured by just how warm those waters are - and this time around, the anomaly is dramatic, at as much as 6 degrees in some areas. This El Nino is forecast to rival those of 1997-1998 and 1982-1983, both of which caused disastrous flooding, drought, disease outbreaks and mass deaths of creatures from cormorants to coral.

That makes it a prime opportunity for scientists to gather data that they can analyze for years to come.

"Ultimately, all of those data points allow us to improve our models going forward," said Dalia Kirschbaum, a research scientist in Goddard's Hydrological Sciences Lab.

The National Oceanic and Atmospheric Administration, including the Climate Prediction Center and the National Weather Service, is responsible for weather and climate forecasting. But data from satellites launched and operated by NASA, as well as NOAA and agencies from other countries, are what feed the computer forecasting models with information.

A NOAA spokeswoman said the agency is still putting together its research plans for El Nino.

The key NASA satellite missions include the Global Precipitation Measurement mission, or GPM, a collaboration with Japan to capture detailed observations of rainfall; the Soil Moisture Active Passive mission, or SMAP, which probes the top 2 inches of soil around the globe; and Orbiting Carbon Observatory-2, which monitors changes in carbon dioxide levels in the atmosphere.

The GPM mission builds on the observations of another satellite, the Tropical Rainfall Measuring Mission, or TRMM, which was launched in 1997 amid the last major El Nino. But unlike TRMM, the GPM mission observes rainfall with radar in two distinct frequencies, providing a three-dimensional picture rather than a flat snapshot. And its observations aren't limited to the tropics, extending to the Arctic and Antarctic circles.

Scientists will soon be able to directly compare data gathered by the GPM and TRMM missions, giving a better idea of not only where the heaviest rain falls, but how much falls and how that might vary from one El Nino to the next. While the United States is covered with ground-based radar that can estimate rainfall, most of the planet isn't - including in the middle of the Pacific, ground zero for El Nino.

"As I like to say, the fish are getting really wet," said George Huffman, a research meteorologist at Goddard who is analyzing the precipitation data.

The GPM mission was launched in February 2014, so the scientists will also be able to compare data collected during more "normal" climate patterns in 2014 and early 2015 with the El Nino-influenced rainfall of the second half of this year and early part of next year, Huffman said.

"This is a really great opportunity," he said.

Meanwhile, scientists will use the precipitation data along with the observations of soil moisture to get a better idea of what thresholds there might be for landslides in places like Peru or wildfires in Indonesia. Observations of how the forests of the Amazon respond and how the levels of carbon dioxide in the atmosphere change could have implications for global warming.

What is extreme under El Nino conditions today could be normal in a decade or two, Kirschbaum said.

"We have to understand that because that's what people on the ground that are responding to these events want to know," she said. "Not just that it will get drier or it will get hotter or it will get wetter, but how much? It's trying to bore down to that level."

It's not the first El Nino to be probed by satellites, though. Scientists learned a lot about the fundamentals behind El Nino in the 1997-1998 event, and the tools now in scientists' hands might not significantly improve that knowledge, said Antonio Busalacchi, director of the Earth System Science Interdisciplinary Center at the University of Maryland, College Park.

"Yes, we have better observations of the response, but is that going to lead to a fundamental breakthrough in our ability to predict El Nino?" he said. "I'm not so confident about that."

Still, data will be richer, and could reveal fluctuations and differences scientists don't expect. For example, while this El Nino is expected to reach similar strength as the 1997-1998 event, the waters off the West Coast are warmer this time around, and it's not clear how that could influence weather patterns in the U.S. - particularly in drought-stricken California, where recent rains caused mudslides around Los Angeles.

And observations from this El Nino will also raise new questions for researchers. One planned mission will look at phytoplankton levels across the ocean, important because the microscopic plants help pull carbon dioxide from the oceans.

Busalacchi, recently named co-chairman of a scientific panel to set priorities for future earth-science-focused space missions, said he

expects many more proposals aiming to improve prediction of seasonal climate trends, including El Nino. The panel's report is due in 2017.

"As they say, a problem is an opportunity in disguise," Huffman said.

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