THE LEADER IN ENERGY & ENVIRONMENTAL POLICY NEWS

4. CALIFORNIA:

Scientist probes weather risk that's like 'fire hose aimed at the coast'

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Published: Wednesday, April 30, 2014

LA JOLLA, Calif. -- On a 70-degree April day, scientist Marty Ralph looked out his office window here toward a panoramic view of the Pacific Ocean. The sky was clear, the ocean was calm, and paragliders floated toward the water.

It's what most people envision when they think of California weather, said Ralph, who directs the Center for Western Weather and Water Extremes at the Scripps Institution of Oceanography, part of the University of California, San Diego. But the perfect picture belies a truth, he said.

California and the rest of the West Coast can be hit by destructive storms, driven by a phenomenon known as the atmospheric river. A band of wet air about 300 miles wide in the lowest 1 to 2 miles of the atmosphere, it's powered by strong winds and can dump enough rain that the saturated ground gives way. That happened earlier this month when a series of storms set the stage for the deadly mudslide in Washington state.

"It's really a bit like a fire hose aimed at the coast," Ralph said.

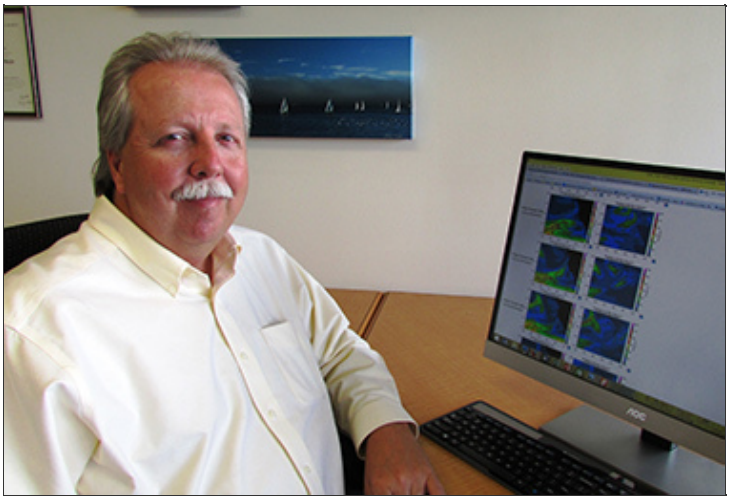
"It is the irony of the weather out here," he added. "It's gorgeous most of the time, but it also can be extremely hazardous."

As the climate changes, the frequency and intensity of atmospheric rivers are likely to morph, Ralph said. It's one reason he pushed to develop the center at Scripps. Now a year old, it's focused on extreme storms in the western United States and trying to better understand, monitor and predict events. It's also working to provide information to city, state and federal experts who prepare for storms.

Events driven by atmospheric rivers are to the West Coast what hurricanes are to the East, Ralph said. But ARs, as they're known, haven't been studied nearly as much. There are major scientific gaps, he said. Current models have tended to underestimate the amount of rain by a factor of two, meaning there can be twice the precipitation that was expected.

Research shows there's reason to be better prepared, Ralph said. A 2011 U.S. Geological Survey model that looked at the impact of an extreme AR storm that hit both Northern and Southern California put potential costs at more than $700 billion, including loss of economic activity. In comparison, models have estimated the destruction from a major earthquake in the Golden State at $100 billion, he said.

"An atmospheric river storm is even more impactful than what people worry about more," Ralph said.



The lack of atmospheric rivers also matters. Their frequency has dwindled in California over the last three years, a reason the state is in the midst of a historic drought, Scripps researchers said. Last winter there were about three AR events, about half of what normally would occur.

"On one hand they're hazardous and they're flood producers, but on the other hand they're an important part of the water supply here," said Dan Cayan, a climate researcher at Scripps and a researcher with USGS. He's working with Ralph on studies examining atmospheric rivers. "When we don't get them, then we're in these dry spells."

Marty Ralph views atmospheric river data at his Scripps Institution Office. Photo by Anne C. Mulkern.

The Scripps research on weather extremes takes place as California leaders and members of Congress debate steps the Golden State should take to deal with drought. Research the center hopes to provide will be important when making decisions about water, Cayan said.

"If you're trying to design a water system, conveyance or storage or what have you, you would like to know about the kinds of storms that you're likely to get over the lifetime of the infrastructure," he said.

"Maybe it's a policy device where you're talking about water rights, or you're talking about water management, you're talking about ecosystem implications," Cayan added. "All of that, in some way that's dependent upon the climate of these extreme events."

Leaders of federal agencies that deal with extreme events have necessarily spent time and financial resources on Hurricane Katrina, Superstorm Sandy and damaging tornadoes in recent years, Ralph said, and haven't focused as much on the West.

"Change can be slow," he said. "But the needs are great enough that I think waiting patiently a lot longer is not the right move. The drought crisis this year has really highlighted that.

"This issue with water in the West -- either too much or too little -- is so important in so many ways that it really needs some specialized attention," Ralph added. "And this is really what's behind the creation of this center."

Opportunity to make a difference

Ralph, 51, a research meteorologist, came to Scripps last year to develop the Center for Western Weather and Water Extremes. He previously worked as chief of the Water Cycle Branch at the National Oceanic and Atmospheric Administration's Earth System Research Laboratory in Colorado.

In taking the job in San Diego he accepted a commuter lifestyle and now travels back and forth to suburban Denver to see his wife and sons.

He's been working on the AR issue about 15 years, although not always using the name "atmospheric river." The term emerged in the late 1990s. A paper by Massachusetts Institute of Technology scientists in 1998 "really clarified the concept in a way that matched what we were seeing with modern data," Ralph said. He started using the term in about 2003.

Ralph's investigations include flying into storms. In February he joined NOAA representatives and guided a G-IV Gulfstream jet into several atmospheric rivers offshore of Northern California. The researchers dropped out sensor packages about the size of soda cans that measured temperature, pressure, wind and moisture and radioed signals back to the aircraft.

It will take more time to crunch data from that trip, Ralph said, but it will be important for quantifying the strength of ARs offshore, as well as their position and structure.

He's planning another research jaunt for January 2015, one that will involve NOAA, NASA, the Department of Energy and other universities. Three research planes will fly into storms over the Pacific Ocean and measure "the heck out of them," he said, including the "size, shape, how much rain is falling out of them, how much ocean moisture is getting into them." The work also will involve a ship.

Those who know Ralph said he has big ambitions, which they see as positive.

"Marty's a very engaging, well-spoken scientist who really knows his stuff and does a really good job of connecting with people and getting people to work together on problems," said Michael Anderson, a climatologist with the California Department of Water Resources. "He brings enthusiasm to it that really helps."

Clad in a yellow button-down shirt and jeans, Ralph was animated as he talked about dams and reservoirs and rainfall. He explained that he's energized by research that could lead to more accurate forecasts of atmospheric river events. That could allow water managers to make better decisions about how much water to keep in reservoirs, he said.

"I'm excited that science and people and technology, there's opportunity for us to really make a difference in how things happen in the future, you know, bring new ideas and people to solve problems for society and the environment," Ralph said. "It's very inspiring to me."

Right now the state typically drains some water from reservoirs in the fall to prevent flooding that could come with winter

storms. The hope is that the reservoirs will refill with rain from those storms. It's a balancing act that affects water deliveries for state residents, farms, fish and the environment.

The planning doesn't always work as well as desired.

Erring on the side of flood prevention

In November and December 2012, the state had heavy rains, with more than double the precipitation it normally gets at that time of year. By Christmas at Lake Mendocino, about 27,000 acre-feet of water -- equal to about 20,250 football fields covered by water a foot deep -- sat above the top of the water supply pool, said Mike Dillabough, chief of operations and readiness for the Army Corps of Engineers' San Francisco District.

Wanting to prevent overflows, managers there released some of the water, timing it so that the Russian River's water level had dropped enough that the release wouldn't trigger flooding of downstream properties.

Forecasts hadn't predicted drought at the time, Dillabough said. The agency was expecting subsequent storms would refill the reservoirs, but there were no more storms that rainy season.

He noted that if the water levels had not been lowered and there were more storms, "we would have been in a world of hurt" in terms of flood prevention.

More accurate prediction tools could help, Dillabough said, which makes Ralph's efforts at the Center for Western Weather and Water Extremes important. But the science to date hasn't advanced enough to change how the Army Corps operates, he said.

"He's got a great concept. It has a great possibility," Dillabough said. "However, data, and modeling done based on that data, is simply not there yet."

Right now, weather forecasts are typically 12 to 24 hours in advance and can change within that window, Dillabough said. In contrast, it takes seven days for the Army Corps to drain the reservoir above the Russian River, the most flood-prone in the state. Dillabough described the process of lowering the water as similar to emptying a bathtub through a straw.

The Army Corps has to err on the side of preventing flooding, he said.

Better warnings

Ralph said he didn't disagree but added that some weather conditions are more predictable than others. There needs to be a thorough effort to identify "exactly what forecasts are needed with what accuracy," he said.

"Gaps in current capabilities become the focus of targeted research to fill them," Ralph said.

He's optimistic that the center could change how water is managed. A goal is to generate tools and products that could inform people "who have to make tough decisions," Ralph said, like water managers, reservoir operators and flood control experts.

"I mean, think of it," he said. "Imagine a day in the future where we've got information on these storms that's good enough that we can keep more water behind the reservoirs, knowing that if we have a storm coming we can drain them lower and be prepared, and not risk the storm not generating enough water to refill the reservoir."

The state, meanwhile, has installed sensors that provide data on wind, water vapor, soil moisture and the freezing elevation at which precipitation falls as snow.

Working with the center at Scripps and with Ralph, state experts are developing tools to better characterize upcoming storms, climatologist Anderson said. They can talk about a storm's physical characteristics, he said, like the magnitude of water vapor, how strong winds are and what direction the event is hitting the watershed.

Ralph is taking that data and producing forecasts the state can use to tell communities that conditions are present that in the past have been a precursor to a damaging event and "heads up, something big is coming your way," Anderson said.

Cayan, meanwhile, is looking at the drought half of the equation by analyzing historical records of rainfall and atmospheric conditions before, during and after atmospheric river events. He's said that he's looking at how the storms fit into the bigger weather and climate picture and "are there large-scale global factors at work that tend to increase or decrease the odds of seeing these extraordinary extreme events?"

He's also looking at climate models to see whether they show signs of atmospheric river conditions changing as the

climate changes.

That will be important, Anderson said, knowing how storms will change in years ahead. There are expectations, he added, that there will be fewer storms but that the ones that hit will be stronger.

"Looking at how some of those physical characteristics are expecting to change will give us a lot more detail to help us understand what's happening," Anderson said, adding that it will mean "getting not only a characterization of what they are presently but what they may evolve into in a warmer climate."

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