Tracking California's Rivers of Rain

New instruments are helping forecasters get ahead of the "pineapple express."

Richard A. Lovett, National Geographic News, 12-5-12

As northern California dries out after its latest series of intense rains, new weather stations are helping forecasters there more accurately predict flooding from the state's most damaging type of winter storms.

Sometimes referred to as the "pineapple express," these events occur when winds sweep tropical moisture into narrow filaments.

The filaments, which scientists call atmospheric rivers, hit land as a series of intense storms, one after another. In 2010 one particularly strong atmospheric river doused parts of California with up to 26 inches (660 millimeters) of rain and dumped up to 17 feet (5.2 meters) of snow in the mountains.

The latest one struck last week, dropping 15 inches (450 millimeters) of rain in parts of northern California—just as scientists were preparing to report on the new forecasting system in San Francisco, at the annual meeting of the American Geophysical Union (AGU).

Atmospheric rivers are concentrated bands of water vapor that form about a mile (1.6 kilometers) above the ocean, typically ahead of a cold front, then migrate east.

Satellite images have long been able to show them heading for the coast. But it's only now that forecasters are able to zero in on just how much precipitation and flooding they might cause when they arrive.

Tracking Rivers in the Sky

To do this, the National Oceanic and Atmospheric Administration (NOAA) and other scientists are in the process of installing an $11 million array of automated weather stations, which will be scattered throughout the state.

The backbone of the new system consists of four "atmospheric river observatories" spaced along the coast. These will train Doppler radar on the heart of approaching storms.

"That tells us a lot about the winds aloft," Martin Ralph, a meteorologist at NOAA's Earth System Research Laboratory in Boulder, Colorado, said at the AGU meeting. Knowledge of the winds helps predict how far inland the storms will travel and how fast.

Backing up these observatories is a grid of soil-moisture monitors and snow-level radars. The former help determine how much rain the soils can absorb without flooding.

The latter instruments beam radar pulses into the sky to determine the altitude at which falling snowflakes are changing to raindrops. That information will allow forecasters to estimate how much precipitation will fall as snow, and how much as rain, when the storms plow into the Sierra Nevadas.

Snow collects in the mountains and doesn't run into rivers until the spring melt. Rain runs off immediately. So the difference between snowflakes and raindrops is crucial—and forecasters have had great trouble calling the outcome in advance.

"Out over the Pacific we have very little data," said Kevin Baker, meteorologist-in-charge at the National Weather Service's San Francisco Bay office. "We're relying on satellites. The integration of this kind of information is critical to improving the forecast."

The Pacific Northwest isn't the only place where coastlines can be hit by atmospheric rivers. At any given time several of the filaments can be spotted around the globe.

"They're the engines of the water cycle in the mid-latitudes," Ralph said—the main pathway by which water vapor from the warm, wet tropics is shunted toward the cold, dry poles. On average, the atmospheric rivers striking the U.S. West Coast carry ten times as much water as the Mississippi River.

Global Warming Impact Unclear

How will California's weather change as a result of global warming? The state seems fairly certain to get more of its precipitation in the future as rain and less as snow. That by itself will increase the risk of flooding—and also of water shortages, because the Sierra Nevada snowpack functions as a natural reservoir.

It's less clear how global warming will affect atmospheric rivers and the storms they bring. The warmer air of the future will be able to hold more moisture, but weather models indicate that the speed at which the storms move may slow down.

The first change will tend to increase, the second to reduce the rate at which moisture hits land. Global climate models suggest that by the end of this century, "on average, the changes are relatively small," said Michael Dettinger, a research hydrologist for the U.S. Geological Survey in La Jolla, California.

But that's the average. The models also suggest that global warming will increase the extremes, Dettinger said—delivering "a few megastorms of a scale that we may not have encountered, historically."