Stray satellite signals help measure snowfall in arid West

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In this Jan. 8, 2015 photo, Kristine Larson, a professor of aerospace engineering at the University of Colorado, pictured at work on the campus of CU in Boulder, Colo. Larson is using stray GPS signals that interfere with earthquake research as a tool to measure snow depth and soil moisture, providing valuable information to climatologists. (AP Photo/Brennan Linsley)

Climate scientists are gleaning valuable information about snowfall and droughts from errant satellite signals once considered a nuisance.

The data comes from GPS receivers, mostly ones used by earthquake researchers to detect motion in the Earth's surface.

The receivers use signals from GPS satellites to measure movement. But there's a problem: In addition to picking up signals directly from the satellites, the receivers also pick up satellite signals that bounce off the ground first, providing false readings.

"First I tried to get rid of them because they were making the earthquake data bad," said Kristine Larson, a professor of aerospace engineering at the University of Colorado.

But about four years ago, Larson and other Colorado scientists discovered those nuisance signals have some value. In winter, researchers can determine the depth of nearby snow by how long it takes the reflected signals to reach the receiver. If the ground is bare, they can tell how much moisture is in the soil by the strength of the reflected signal.

That can be valuable information, particularly in the arid West, where snow depth in remote mountain ranges determines how much water will be available to cities, farms and wildlife when the spring melt begins.

Larson and a team of researchers now monitor about 500 GPS receivers, mostly in the western United States, for snow and moisture data.

The National Drought Mitigation Center at the University of Nebraska-Lincoln uses the information from Larson's team to supplement data from a nationwide snow-measuring network of about 3,000 human observers and more than 730 automated stations called SNOTEL, for Snowpack Telemetry.

Operated by the U.S. Agriculture Department, the stations have a pressure-sensing pad, precipitation gauge and thermometer and use radio signals to relay information about snow depth and moisture content.

The stations are widely spaced and can be difficult to reach if they break, said Brian Fuchs, a climatologist with the National Drought Mitigation Center. Data from other sources, including Larson's team, helps fill in the gaps.

"It gives us a better idea of what's going on between data points and in data-poor areas," Fuchs said.

Larson said the soil moisture data could also help farmers know whether to expect floods. Heavily saturated ground can't absorb much more rain and snow, making flooding more likely.

With an annual budget of about $250,000, the project is relatively inexpensive because it uses data from GPS receivers installed and paid for by other projects, Larson said. And GPS receivers are plentiful and well-maintained, because the system is so integral to society, she said.

The satellites provide precise timing and location information used in weapons, navigation, banking and other applications.

Many of the GPS receivers Larson's team monitors were installed for earthquake research. Others are used by public and private surveyors or state highway departments. The operators have been happy to share the data, Larson said.

She hopes the project can grow to about 5,000 receivers worldwide.

"I have not met an environmental scientist who wants less soil moisture and snow data," she said.

Earthquake researchers have found ways to work around the reflected signals, Larson said. Data can be averaged over longer periods—a full day instead of a few minutes, for example—to minimize any errors caused by the stray signals.

"We've all learned to live with them," she said.