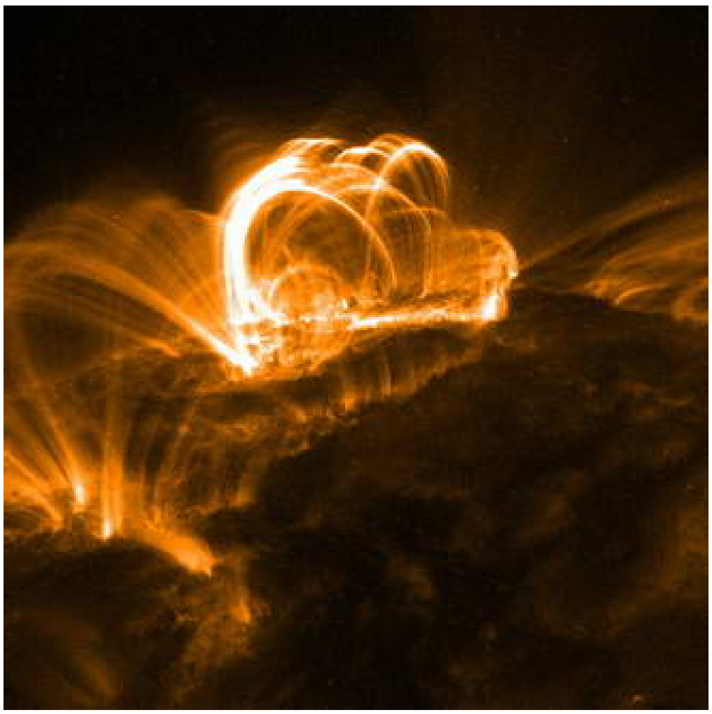
Stanford pair helping predict solar storms

February 19 2015, by James Urton, San Jose Mercury News



Life as a forecaster is not easy. Just ask National Weather Service forecasters who misjudged how a recent winter storm would impact the Big Apple. Now imagine trying to predict weather activity on a burning sphere 1.3 million times larger than Earth and 93 million miles away. That is the task of space weather forecasters, who watch the sun carefully for solar flare activity, knowing it can garble radio communications, cook satellites and shut off the lights for millions.

Solar flares are difficult to predict. But two Stanford University researchers are combining an artificial intelligence program with NASA's largest-ever collection of solar observations in an approach that may prove to be the fastest, most reliable means yet of tipping off forecasters to solar storms.

"Forecasting the sun can be difficult," said Stanford researcher Monica Bobra. "It's like predicting the weather on Earth: You can be moderately successful, but then you might miss a major storm."

Bobra and colleague Sebastien Couvidat have studied the sun for years as researchers in Stanford's solar observatories group. Artificial intelligence was new to them, but that wasn't a deterrent.

"We realized we could use this really cool technique ... to look at active regions of the sun," Bobra said.

Bobra and Couvidat studied solar flares using machine learning, a type of artificial intelligence that uses computer algorithms to analyze data and make predictions. Though other solar researchers have taken a similar approach, Bobra and Couvidat had an advantage: a NASA spacecraft in orbit called the Solar Dynamics Observatory.

"It's basically videotaping the sun," Bobra said. "The Solar Dynamics Observatory takes an image once every several seconds 98 percent of the time since it launched."

No other NASA satellite has collected as much data as the observatory. Since its launch in 2010, it has delivered up to 1.5 terabytes of data - the equivalent of about 750,000 iPhone photos - each day about the sun's surface, magnetic field and atmosphere. This includes information on the sun's burps, bulges and flares as well as its more quiet periods.

To "teach" their machine-learning algorithm about solar flares, Bobra and Couvidat fed it data on more than 1,000 regions of the sun's surface, including whether those regions eventually flared.

"The 'learning' took a couple of minutes," Couvidat said. "It's basically instantaneous."

To see if their algorithm really had "learned" anything about solar flares, they showed it other active regions on the sun and asked it to predict whether those regions would flare.

Bobra and Couvidat's algorithm was fast and accurate at predicting the most severe solar flares. When their algorithm predicted a region would stay quiet, it was right 87 percent of the time. Before that, the most recent artificial intelligence approach had delivered correct predictions only 67 percent of the time.

Bobra and Couvidat's more accurate approach is welcome news to Robert Rutledge, who heads the forecasting office at the Space Weather Prediction Center in Boulder, Colo.

"These guys are spot on," he said. "They're doing what we think are the next most likely steps for predicting solar flares."

Rutledge and his colleagues watch the sun 24 hours a day, 365 days a year. When a solar flare occurs, they measure its size and strength - and ascertain whether it will affect Earth. Solar flares emanate volleys of charged particles, and occasionally bits of the sun's atmosphere, into outer space. If Earth is in the path, they can also predict damage and issue warnings.

"Sometimes when we get an eruption, we don't get much lead time," Rutledge said. Some particles reach Earth within minutes, while others take days.

Strong solar flares often disrupt certain radio signals, including the types used by transoceanic flights, though they have backup communications. The strongest solar flares also emit radiation that can put astronauts at risk and damage satellite memory and control systems. For those of us on the ground, solar flares can disrupt Earth's own natural magnetic field and overwhelm electricity grids.

Scientists first made this connection in 1859, when particles from a particularly mighty solar flare struck Earth and knocked out telegraph systems across Europe and North America. A similar flare in 2012 missed Earth, but about a half dozen solar flares in the 20th century disrupted electricity and communications, including a 1989 blackout across Quebec that lasted more than 11 hours.

"The sun is full of surprises," Rutledge said.

Bobra and Couvidat credit the glut of data from the Solar Dynamics Observatory for their algorithm's accuracy in predicting solar flares. They plan to incorporate even more satellite observations in the future, including data on the sun's turbulent atmosphere.

With our lives dictated more and more by satellite connections and proximity to an electrical outlet, these solar forecasters have billions counting on them.

"We want to protect our astronauts," Bobra said. "We want to protect our satellites. We want to protect Earth."