Waves on Sun give NASA new insight into space weather forecasting
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In this north pole view of the sun, the brightpoints can be seen circling counter-clockwise, revealing the magnetized Rossby waves flowing beneath the surface. Credit: NCAR High Altitude Observatory

Our sun is a chaotic place, simmering with magnetic energy and constantly spewing out particles. Sometimes the sun releases solar flares and coronal mass ejections—huge eruptions of charged particles—which contribute to space weather and can interfere with satellites and telecommunications on Earth. While it has long been hard to predict such events, new research has uncovered a mechanism that may help forecasting these explosions.

The research finds a phenomenon similar to a common weather system seen on our own planet. Weather on Earth reacts to the influence of jet streams, which blow air in narrow currents around the globe. These atmospheric currents are a type of Rossby wave, movements driven by the planet's rotation. Using comprehensive imaging of the entire sun with data from the NASA heliophysics Solar Terrestrial Relations Observatory—STEREO—and Solar Dynamics Observatory—SDO—scientists have now found proof of Rossby waves on the sun.

The results, published in a new article in *Nature Astronomy* may allow for long-term space weather forecasting, thus helping better protect satellites and manned missions vulnerable to high-energy particles released from solar activity.

"It's not a huge surprise that these things exist on the sun. The cool part is what they do," said lead author Scott McIntosh, director of the High Altitude Observatory at the National Center for Atmospheric Research in Boulder, Colorado. "Just like the jet stream and the gulf stream on Earth, these guys on the sun drive weather—space weather."

Currently, we can forecast short-term effects after a solar flare erupts, but not the appearance of the flare itself. Understanding the solar Rossby waves and the interior process that drive them, may allow for predictions of when the solar flares might occur—an invaluable tool for future interplanetary manned missions which will fly through regions unprotected from the damaging energetic particles flares can release.

The scientists tracked coronal brightpoints—small, luminous features that can be observed on the sun, directly tied to magnetic activity beneath the surface—using data from 2010 to 2013 with NASA's heliophysics fleet of space observatories.

"The main thing is we were able to observe Rossby waves because of STEREO A and STEREO B, in conjunction with SDO, which allowed us to get a full picture of the entire sun," said co-author William Cramer, a graduate student at Yale University in New Haven, Connecticut.

The STEREO mission used two near-identical observatories in orbit ahead and behind Earth, STEREO A and STEREO B, to get a complete 360-degree view of the sun.

"These missions allowed the researchers to see the entire sun for over three years, something that
would not be possible without the STEREO mission," said Terry Kuchera, STEREO project scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. In October 2014, after eight years in orbit, STEREO B lost contact with ground operations, but the multi-point view STEREO offers remains invaluable. "Having more than one vantage point to look at the sun has a lot of uses, and even with just STEREO A and SDO we can understand how events, like coronal mass ejections, move through the solar system better than we can with just one eye on the sun."

The results clearly show trains of brightpoints slowly circling the sun travelling westwards, revealing the magnetized Rossby waves flowing beneath the surface. The researchers also found the brightpoints shed light on the solar cycle—the sun's 22-year activity cycle, driven by the constant movement of magnetic material inside the sun. The brightpoints may serve as a clue, linking how the solar cycle leads to increased numbers of solar flares every 11 years.

"These waves couple activity happening on instantaneous timescales with things that are happening on decadal and longer timescales," McIntosh said. "What this points to, is that something that might at first glance appear random, like flares and coronal mass ejections, are probably governed at some level by the process that are driving the wave."

When terrestrial satellites were first used to observe the jet stream on Earth, it allowed huge advances in predictive weather forecasting. These results show such forecasting advances may also be possible with observations of the entire sun simultaneously.

**More information:** The detection of Rossby-like waves on the Sun, nature.com/articles/doi:10.1038/s41550-017-0086

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