SOLIS observatory gives new insights into space weather

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(Phys.org) —Shifts in the magnetic field just above the surface of the Sun lead to liftoff of interplanetary "space storms," according to new results from the Synoptic Optical Long-Term Investigation of the Sun (SOLIS) instrument. The results were presented by California State University, Northridge, physics and astronomy professor Debi Prasad Choudhary at this week's 44th meeting of the Solar Physics Division of the American Astronomical Society in Bozeman, Mont.

Understanding space weather and the enormous "storms" that cause it, called coronal mass ejections (CMEs), is a major goal of current solar research. SOLIS, built by the National Solar Observatory and operated at Kitt Peak, Ariz., is a special-purpose telescope that can image the magnetic field at the surface of the Sun and, simultaneously, in the layer just above the surface, called the "chromosphere."

CMEs are enormous clouds of material that are far larger than the Sun, can weigh billions of tons, and zoom through space at speeds up to four million miles per hour. When CMEs impact the Earth's outer atmosphere, they cause space weather effects that affect many aspects of life on Earth, including the aviation industry, communication satellites, terrestrial power grids and astronauts. CMEs that are associated with solar flares are the most violent and the most important to predict. Decades of observations of these magnetic explosions on the Sun have produced a wealth of information, yet predicting the exact timing of their occurrence is a challenge for solar astronomers.

"We were trying to find a precursor to solar flares that shoot CMEs into space," said Choudhary. "With magnetic field measurements at multiple locations in the Sun's atmosphere from SOLIS, we were able to show that changes in the vertical structure of the magnetic field lead to flares and CMEs."

Choudhary found that, in the site of a CME-bearing flare over a sunspot, the vertical magnetic field structure would change in an identifiable way: the vertical gradient would steepen, and small scale motions of magnetized regions would become stronger and faster. There would be multiple magnetic clouds with different speeds and magnetic field properties.

Not all flares are associated with the precursor, but in four cases where Choudhary saw the complex material flow and magnetic structure, a CME and flare followed shortly.

SOLIS works by measuring the detailed structure of spectral absorption lines, particular narrow ranges of color that are missing from sunlight. In the presence of a magnetic field, the absorption lines change their structure slightly, and this effect can be used to measure the magnetic field remotely. Because different spectral lines are formed at different altitudes in the solar atmosphere, it is possible to measure at several altitudes simultaneously.

K. D. Leka, senior research scientist with NorthWest Research Associates, said "studying the chromosphere using the diagnostics that are available from the SOLIS facility could hold a wealth of information regarding CME precursors."

Provided by California State University, Northridge