Researcher sheds light on solar storms

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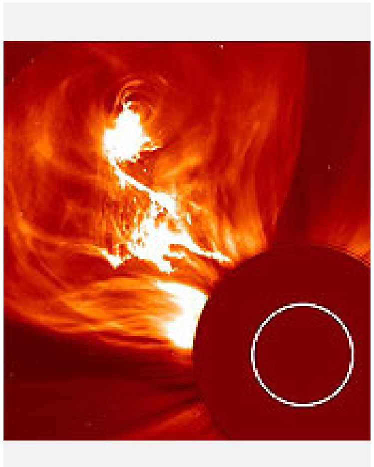

New research from the National Center for Atmospheric Research (NCAR) links a particular magnetic structure on the Sun with the genesis of powerful solar storms that can buffet Earth's atmosphere. The research may enable scientists to create more accurate computer models of the solar storms, known as coronal mass ejections (CMEs), and could eventually point the way to forecasting the storms days before they occur. Sarah Gibson, a scientist at NCAR's High Altitude Observatory (HAO), will present her findings at the American Geophysical Union conference in New Orleans on Thursday, May 26.

Image: Magnetic structures on the Sun are linked to solar storms that can set off disturbances when they reach the upper atmosphere, affecting *satellites, ground-based communications systems and power grids on Earth. Credit: NASA*

Her invited talk is in recognition of winning this year's Karen Harvey Prize. Awarded by the Solar Physics Division of the American Astronomical Society, the prize recognizes an early-career scientist who has produced exceptional solar research. CMEs are a focus of solar research because they suddenly and violently release billions of tons of matter and charged particles that escape from the Sun and speed through space. Ejections pointed toward Earth can set off disturbances when they reach the upper atmosphere, affecting satellites, ground-based communications systems, and power grids.

For her research, Gibson turned to a unique data set: white-light images of the lower reaches of the Sun's enormous halo, called the corona. Taken by NCAR's Mark-IV K-Coronameter on Mauna Loa in Hawaii, the images are sensitive to density alone, avoiding the ambiguity of most other solar images that depend on both temperature and density. The images revealed that lower-density regions in the corona consistent with twisted magnetic field lines can form prior to a CME. The twisted areas, known as magnetic flux ropes, store massive amounts of energy.

"The structures indicate a magnetic system that has enough energy to fuel a CME," Gibson explains. "But their presence is not, by itself, an indication that a CME is about to occur. For that, we need to look at additional characteristics."

The research may put to rest an important debate among solar physicists over whether magnetic flux ropes can form prior to an ejection or are merely present when an ejection takes place. Gibson's findings suggest that, to understand the forces that create CMEs, solar scientists should use magnetic flux ropes as starting points for computer models of the massive storms.

To conduct her study, Gibson used Mark-IV images to observe dark, lower-density areas, known as cavities, that can be formed by the strong, sheared magnetic fields of magnetic flux ropes. She and NCAR colleagues analyzed 13 cavity systems from November 1999 to January 2004. Seven of these systems could be associated with CMEs, and four cavities were directly observed by the coronameter to erupt as CMEs. Gibson used a second technique to identify an additional eight CMEs that erupted from already-formed cavities. She found those cases by gathering images of CMEs and backtracking to see whether cavities existed at those CME sites before each eruption.

One of Gibson's next steps will be to analyze cavities that result in CMEs to determine whether they have identifiable characteristics that may help scientists forecast a CME. Her preliminary findings indicate that a cavity begins to bulge and rise higher in the corona just before erupting. Cavities may also darken and become more sharply defined prior to eruption.

Gibson will also try to determine how widespread cavities are, and if it is possible that most, or even all, CMEs are preceded by the formation of magnetic flux ropes. Beginning next year, she will supplement the Mauna Loa observations with data from a pair of new NASA satellites, known as STEREO (Solar Terrestrial Relations Observatory). Instruments aboard STEREO will provide stereoscopic measurements and 24-hour coverage of the lower solar corona, significantly increasing the chances of directly observing cavities erupting into CMEs.

Source: National Center for Atmospheric Research