Researchers identify driver for near-Earth space weather

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New findings indicate that the aurora and other near-Earth space weather are driven by the rate at which the Earth's and sun's magnetic fields connect, or merge, and not by the solar wind's electric field as was previously assumed.

The merging occurs at a spot between the Earth and Sun, roughly 40,000 miles above the planet's surface, and appears fundamental to the circulation of particles and magnetic fields throughout near-Earth space.

Researchers at the Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Md., and the Air Force Research Laboratory at Hanscom Air Force Base (Massachusetts) will announce the results of their study at the Fall American Geophysical Union Meeting in San Francisco on Dec. 11. The researchers, led by Patrick Newell of APL, have developed a formula that describes the merging rate of the magnetic field lines and predicts 10 different types of near-Earth space weather activity, such as the aurora and magnetic disturbances.

"Having this formula is a big step forward for understanding how the sun and Earth interact," says Newell. And that understanding could help predict the space weather that affects communications, navigation, and the health of humans in space.

The space between the Earth and Sun is not empty, but filled with energetic particles, most of which are generated in the solar atmosphere.

Temperatures of a few million degrees accelerate a stream of these particles, called the solar wind, to roughly 1 million miles per hour. Space weather scientists had long assumed that near-Earth space weather phenomena could best be predicted by the behavior of the solar wind electric field. However, Newell and his colleagues were the first to put this theory to a rigorous test with many data sets from a number of years.

The team of researchers studied NASA satellite observations of global auroral activity, NOAA satellite observations of the stretching of the Earth's magnetic field lines on the Earth's nightside, and Air Force satellite observations of the access of solar wind particles to the Earth's upper atmosphere. They questioned whether the electric field activity was really the best predictor, or if each phenomenon would require its own formula, and were surprised to learn that a single formula—for the merging rate—gave the best clues to the behavior of these 10 aspects of space weather.

Professors George Siscoe of Boston University and Stanley Cowley of Leicester University had previously suggested that the merging rate would better explain near-Earth convection, but Newell and his colleagues were surprised at how well the single new formula works.

For a space scientist, the work is interesting also because it provides the first strong empirical estimate of the global merging rate. Boston University's Siscoe says of the study, "It clearly represents a massive amount of work, and it is undoubtedly an important contribution to the subject of solar wind-magnetosphere coupling. People will probably be discovering further implications of the formula for years."

Source: Johns Hopkins University