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Gaining New Insights from Old Storms

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Blasts from the Past: New Insights from Old Space Storms

This large solar prominence was imaged in August 2012 by NASA's Solar Dynamics Observatory. Powerful bursts of energy and particles from the Sun can trigger space storms on Earth. Credit: NASA/SDO/AIA/Goddard Space Flight Center

On 4 August 1972, a burst of solar plasma rocked Earth's magnetic field after hurtling through space for about 14.6 hours—the fastest Sun-to-Earth plasma journey ever recorded. The resulting space storm, one of several that occurred from 2 to 11 August, triggered widespread disturbances to electrical and communication grids and likely caused accidental detonations of U.S. undersea naval mines in North Vietnam.

Nearly 2 decades later, from 6 to 19 March 1989, another series of space storms took place. The largest, on 13 March, damaged North American electrical grids and caused a 9-hour blackout across Quebec, Canada.

In a new review, *Tsurutani et al.* take a closer look at the 1972 and 1989 events, comparing them with each other and with other historical space storms. Their study underscores the potential for modern space storms to rival or even surpass the power of the most extreme geomagnetic disturbance in recorded history, the Carrington event of 1859.

Like most space storms, the 1972 and 1989 events involved coronal mass ejections (CMEs)—strong bursts of highly energetic plasma particles and magnetic field structures ejected from the Sun as part of a solar flare.

However, each storm had distinct qualities. The 1989 storm featured two CMEs, both of which moved more slowly than the one in the record-breaking 1972 storm, taking about 54.5 and 31.5 hours to reach Earth. The solar flares behind the 1989 event were also at least 10 times less intense than the flares in the 1972 storm. However, at more than 23 hours, the main phase of the 13 March storm in the 1989 event was the longest in recorded history. Typical magnetic storms studied by scientists last an average of about 12 hours.

Having revisited data from both events, the researchers propose that under slightly different, but realistically possible, conditions, the 1972 CME could have produced a storm even bigger than the destructive Carrington event. They also suggest that the largest 1989 storm actually did surpass the Carrington event by one measure: the amount of energy carried by particles in the ring current, a stream of charged particles that surrounds Earth, whose current intensifies during a space storm.

The 1859 Carrington event triggered aurorae that reached the tropics and destroyed telegraph equipment. Should a similar storm occur today, its destructive effects could cost trillions of dollars and leave millions of people without electricity for 2 years.

By looking at these historical storms, the researchers gained new insights into the complex mechanisms that drive extreme space weather. Their findings could help guide future space weather research and prediction, the authors say. (*Journal of Geophysical Research: Space Physics*, https://doi.org/10.1029/2024JA032622, 2024) **—Sarah Stanley,** *Science Writer*