

Solar storms could bring down the global internet system.

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Solar storms, or solar winds, are massive explosions on the surface of the Sun, sending clouds of plasma into space. When they approach Earth, solar storms cause geomagnetic storms and auroras.



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When electromagnetic waves interact with the Earth's magnetic field, they cause electric currents to flow through the Earth's upper atmosphere, heating the air. This causes the atmosphere to expand, creating additional gravitational pull on satellites in low Earth orbit and causing small pieces of space debris to deviate from their path. Electromagnetic waves from large solar storms can also disrupt radio signals and GPS.

Furthermore, strong currents flowing through the upper atmosphere can also generate strong currents flowing through the Earth's crust. These currents have the potential to affect power grids and cause localized power outages. This phenomenon occurred on March 13, 1989, in Quebec, Canada, causing a power outage lasting 12 hours, according to NASA.

However, the probability of solar storms directly impacting Earth is only 1.6%-12% per decade. To date, only two such solar storms have been recorded, in 1859 and 1921.

The Carrington Event of 1859 was also the most powerful solar storm ever witnessed by humankind. At that time, electrical systems were still in their infancy. The storm damaged power systems in Europe and America, some buildings caught fire, and created the aurora borealis near the equator in Colombia.

In February 2022, a solar storm damaged 40 SpaceX Starlink satellites a day after they were launched into low Earth orbit.

Since the development of the global internet system, the impact of a similar geomagnetic storm has remained an unknown. Because fiber optic cables are unaffected by geomagnetic induction, local and regional internet connections would suffer minimal damage. However, with undersea fiber optic cables connecting the internet between continents, the damage would be significant because their signal repeaters are highly susceptible to geomagnetic currents. If a repeater malfunctions, it could render even the entire cable unusable.

Meanwhile, the undersea fiber optic cable system connecting continents to the internet is a different story. The signal repeaters of these cables are highly susceptible to geomagnetic currents. If one malfunctions, the entire cable can become unusable. As a result, undersea fiber optic cable systems can be paralyzed for months due to the time-consuming and costly process of repairing the underwater infrastructure.



Sangeetha Abdu Jyothi, an assistant professor at the University of California, said that entire continents would be cut off from each other if a certain amount of undersea fiber optic cable in one area were affected.

Countries at higher latitudes, such as the US and the UK, are more susceptible to solar weather, and would therefore be the first to be affected if a massive geomagnetic storm were to occur.

A global internet outage would have catastrophic consequences, disrupting everything from supply chains and stock markets to individual work and communication, and even healthcare systems.

It is estimated that a single day of internet outage in the US can cause losses of over \$7 billion. If the network is down for days or months, the damage would be catastrophic.

According to Abdu Jyothi, to avoid an "Internet apocalypse," when expanding global Internet infrastructure, grid operators need to seriously consider the threat from extreme weather. The first step could be to lay more cables at lower latitudes and conduct resilience tests to the effects of large-scale network failures.

The next step is to find better methods for predicting solar storms in the long term. However, this is no easy task. Currently, we can only rely on the activity of sunspots—dark patches on the Sun's surface—to predict solar storms two days before they strike Earth.

Currently, NASA and the European Space Agency (ESA) are researching how to combine historical data and new observations to make predictions about space weather.

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