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# GEO MAGNETIC STORMS MAY 2024: UNDERSTANDING THE THREAT AND EXPLORING SOLUTIONS

## MITIGATING THE IMPACT OF SPACE WEATHER ON OUR TECHNOLOGICAL INFRASTRUCTURE

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Geomagnetic storms are temporary disturbances in the Earth's magnetosphere, caused primarily by solar wind and coronal mass ejections (CMEs) from the Sun. These storms occur when solar particles and magnetic fields interact with Earth's magnetic field, resulting in a variety of effects.

# ORIGIN

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Geomagnetic storms, also known as magnetic storms, are caused by a disturbance in the Earth's magnetosphere due to solar wind.

In May 2024, the storm was associated with a particularly large and complex sunspot group known as Active Region 13664. This region produced several intense X-class solar flares and multiple CMEs that traveled toward Earth. As these CMEs impacted Earth's magnetosphere, they created significant geomagnetic disturbances. The arrival of these solar bursts compressed Earth's magnetosphere, causing a severe geomagnetic storm. This event reached a Dst (Disturbance Storm Time) index of -412 nT, making it the sixth largest storm since records began in 1957( ar5iv )( Annals of Geophysics ).

This event underlined the importance of continuous space weather monitoring and forecasting, as geomagnetic storms can have broad impacts on technology and infrastructure here on Earth.

# SOLARWIND

THE SOLAR WIND IS A CONTINUOUS STREAM OF PARTICLES, MOSTLY PROTONS AND ELECTRONS, THAT FLOW FROM THE SUN.

01

## Arrival Of Solar Wind At Earth

Once the solar wind, carrying the charged particles and magnetic fields, reaches Earth, it interacts with our planet's magnetic field (the magnetosphere). This typically happens 1-4 days after a CME, depending on its speed, or in minutes to hours after a solar flare. Normal Solar Wind Interaction: Under normal conditions, Earth's magnetic field deflects most of the solar wind, keeping it at a safe distance. Disturbed Solar Wind Interaction: However, if a CME or flare is strong enough, the increased speed and density of the solar wind overwhelms the Earth's magnetosphere, causing significant disturbances.

02

## Magnetic Reconnection

One of the key processes that triggers a geomagnetic storm is magnetic reconnection. This occurs when the magnetic field carried by the solar wind connects with the Earth's magnetic field. During reconnection: The solar wind's magnetic field merges with Earth's magnetic field. This process transfers energy from the solar wind into Earth's magnetosphere, increasing its overall energy and causing disturbances. As more energy is pumped into the magnetosphere, it becomes highly disturbed, leading to the formation of geomagnetic storms.

03

## Energy Transfer Into The Magnetosphere

The energy from the solar wind is stored in Earth's magnetic tail (the portion of the magnetosphere that is stretched away from the Sun). Eventually, this energy is released, driving currents in the magnetosphere and ionosphere (the upper layer of Earth's atmosphere, filled with charged particles).

# EFFECTS

AN AURORA ALSO COMMONLY KNOWN AS THE NORTHERN LIGHTS OR SOUTHERN LIGHTS, IS A NATURAL LIGHT DISPLAY IN EARTH'S SKY, PREDOMINANTLY SEEN IN HIGH-LATITUDE REGIONS.

01

## 1. Formation Of Auroras

Auroras during this event were particularly vivid, displaying colors from green to purple and red, depending on altitude and atmospheric composition. These natural light shows were reported from many unusual locations, thanks to citizen scientists contributing photos to platforms like NASA's Aurorasaurus project, helping scientists refine their models for predicting aurora visibility( NASA Earth Observatory ).

02

## 2. Satellite Disruption

Geomagnetic storms can increase atmospheric drag on satellites, particularly those in low Earth orbit, making it difficult to maintain their trajectories. The increased drag requires satellites to perform more frequent adjustments to avoid collisions with space debris( European Space Agency ). Additionally, high-energy particles can damage sensitive satellite electronics and degrade their solar panels( NASA Earth Observatory ).

03

## 3. Power Grid Disturbances

Geomagnetic storms can induce electric currents in long power lines, potentially leading to voltage instability and even large-scale blackouts. For example, a 1989 storm knocked out power in Quebec, Canada. Operators now receive warnings to protect grids by rerouting power or disconnecting vulnerable components( European Space Agency ).

04

## 4. Communication and Navigation Disruptions

Radio communications, especially those using high frequencies, can be severely impacted during geomagnetic storms. The storms can interfere with GPS signals, affecting aviation and shipping that rely on satellite navigation. This disruption occurs because solar flares and CMEs can disturb Earth's ionosphere, where radio waves propagate( European Space Agency ).

## PROBLEMS CAUSED BY GEOMAGNETIC STORMS

- Disruption of critical infrastructure
- Economic losses and productivity impacts
- Risk to human life and safety
- Long-term damage to technological systems

## SOLUTIONS

- Space Weather Forecasting
- Grid Resilience
- International Cooperation
- Satellite Hardening

# THANKS !

Let's work together to develop and implement effective solutions to mitigate the impacts of geomagnetic storms and protect our technological infrastructure.