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Physics in the news

# Sun unleashes a huge solar flare

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Solar flares have been in the news a lot recently. They can cause huge damage to power infrastructure, but there are ways we can predict them. You can even study them yourself using the equipment in your physics lab.

## Solar storm damage

On 16 February 2011, news media reported that the Sun had unleashed its strongest flare in 4 years.

When a coronal mass ejection (a billion-tonne solar storm cloud from the Sun) hits the Earth's magnetic field, the impact causes the field to shake and quiver. These vibrations induce currents almost everywhere, from the Earth's upper atmosphere to the ground beneath our feet.

High-voltage electric power distribution grids have EMFs (electromagnetic fields) induced in them by such geomagnetic storms. These can overload circuits, trip circuit breakers, and in extreme cases melt the windings of heavy-duty transformers.

The recent coronal mass ejection (February 2011) did not result in widespread damage to electrical systems. However, in Quebec on 13 March 1989 a geomagnetic storm knocked out power across the entire province for more than 9 hours. The storm damaged transformers in Quebec, New Jersey, and Great Britain, and caused problems across the USA. A similar series of events in October 2003 triggered a regional blackout in southern Sweden and caused problems as far away as South Africa.

## Solar Shield

A large-scale blackout due to transformer damage could last a long time. These massive pieces of equipment cannot be repaired in the field, and if damaged in this way would need to be replaced with new units. If they have to be built from scratch they have lead times of over a year.

This is why a forecast of geomagnetic currents is so valuable. Solar Shield is a new and experimental forecasting system for the North American power grid. During extreme geomagnetic storms, engineers could safeguard the most endangered transformers by disconnecting them from the grid. That itself could cause a blackout, but only temporarily. Transformers protected in this way would be available again for normal operations when the storm is over.

Solar Shield springs into action when a coronal mass ejection (CME) is detected billowing away from the sun. Images from SOHO and NASA's twin STEREO spacecraft show the cloud from three points of view, allowing a 3D model of the CME to be made, which in turn allows a prediction of where and when it will arrive at the Earth.

While the CME is crossing the Sun-Earth divide, a trip that typically takes 24–48 hours, the Solar Shield team calculates ground currents. The crucial moment comes about 30 minutes before impact when the cloud sweeps past ACE, a spacecraft stationed 1.5 million km upstream from Earth. Sensors

onboard ACE make in situ measurements of the CME's speed, density, and magnetic field. These data are transmitted to Earth to fine tune the predictions, and give enough time for engineers to act to protect the grid.

## Do it yourself

Your school can detect CMEs if it invests in two simple pieces of equipment:

- a radio antenna and some 21 cm wavelength receiving equipment
- a separate antenna and receiver for detecting 'whistlers' in the ionosphere

A Google search should locate these.

An increase in the latter antenna can be correlated with an increase of the former, taking into account the time of flight from the Sun to the Earth. All in all it makes for an excellent Physics Club project. Many areas of the physics specification are explored in such an activity.

## Find out more

'Space Weather', PHYSICS REVIEW Vol. 19, No. 4, pp. 8–11

Solar Shield: http://ccmc.gsfc.nasa.gov/Solar_Shield/Solar_Shield.html

Explore the Sun's activity: http://jhelioviewer.org/

Solar wind monitoring: http://www.n3kl.org/sun/noaa.html