New tool could predict large solar storms more than 24 hours in advance

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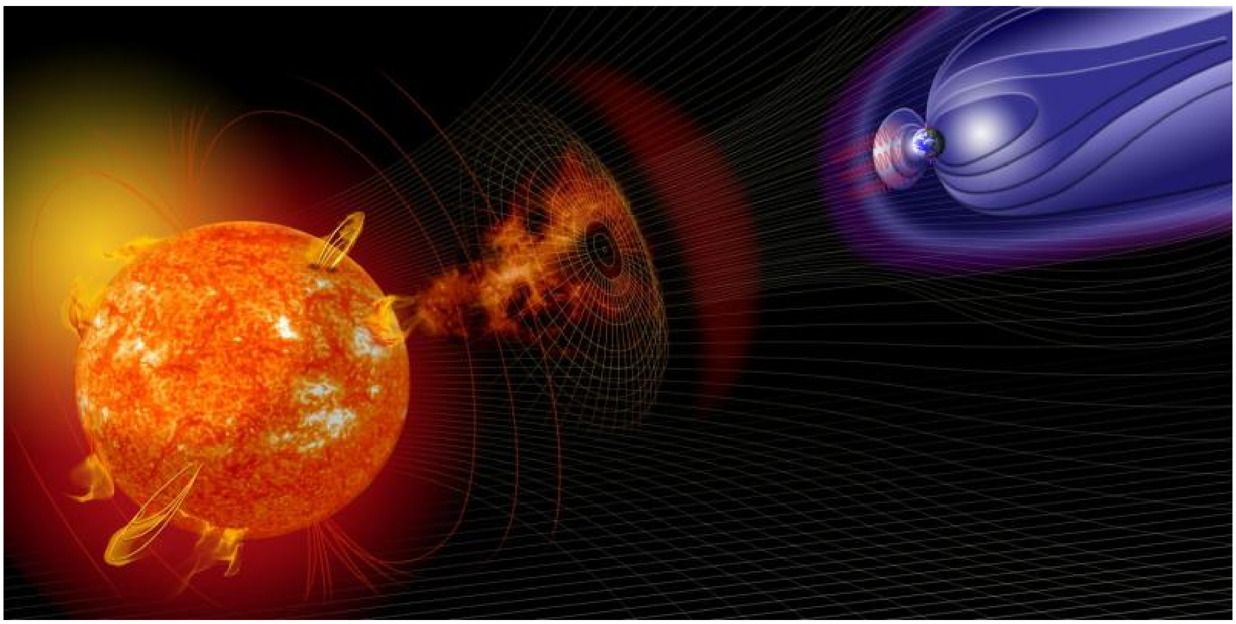

On Jan. 7, 2014, the Sun's surface erupted with an unusually large explosion, called coronal mass ejection (CME), with NOAA releasing a significant false alarm geomagnetic storm at Earth. Credit: NASA

Large magnetic storms from the Sun, which affect technologies such as GPS and utility grids, could soon be predicted more than 24 hours in advance.

Coronal mass ejections (CMEs) are eruptions of gas and magnetised material from the Sun that have the potential to wreak havoc on satellites and Earth-bound technologies, disrupting radio transmissions and causing transformer blowouts and blackouts.

These mass ejections can cause problems with GPS technology - used by all kinds of vehicles, from cars to oil tankers to tractors. For example, they can affect the ability of aircraft systems to judge precisely a plane's distance from the ground for landing, leading to planes being unable to land for up to an hour.

However, not every mass ejection from the Sun that travels past the Earth causes this much disturbance; the power depends on the orientation of magnetic fields within the mass ejection. Currently, satellites can only tell the orientation of a mass ejection's magnetic field with any certainty when it is relatively close to the Earth, giving just 30-60 minutes' notice. This is not enough time to mitigate the impacts on utility grids and systems operating on GPS.

Now, a new measurement and modelling tool could give more than 24 hours' notice of mass ejections that could be harmful to systems on Earth. Details of the technique, developed by a team led by Dr Neel Savani, an alumnus and Visiting Researcher at Imperial College London and a space scientist at NASA's Goddard Space Flight Center, were published today in a paper in *Space Weather*.

"As we become more entwined with technology, disruption from large space weather events affects our daily lives more and more," said Dr Savani. "Breaking through that 24 hour barrier to prediction is crucial for dealing efficiently with any potential problems before they arise."

The orientations of magnetic fields within coronal mass ejections depend on two things: their initial form as they are erupted from the Sun, and their evolution as they travel towards Earth. Mass ejections originate from two points on the Sun's surface, forming a croissant-shaped cloud in between that discharges into space.

This cloud is full of twisted magnetic fields that shift as they travel. If one of these magnetic fields meets the Earth's magnetic field at a certain orientation, the two will connect, 'opening a door' that allows material to enter and cause a geomagnetic storm.

Previously, predictions had relied on measuring the initial CME eruption, but were not efficient modelling what happened between this and the cloud's arrival at Earth. The new technique takes a closer look at where mass ejections originate from on the Sun and makes use of a range of observatories to track and model the evolution of the cloud.

Dr Savani and colleagues have tested the model on eight previous mass ejections, with the results showing great promise at improving the current forecasting system for large Earth-directed Solar storms. If further testing at NASA supports these initial results, the system could soon be used by NOAA in the US and the Met Office in the UK for geomagnetic storm predictions.

More information: Savani, NP (2015) "Predicting the magnetic vectors within coronal mass ejections arriving at Earth: 1. Initial architecture" is published by Space Weather, an American Geophysical Union journal. A pre-publication version is online via Wiley Online Library, DOI: 10.1002/2015SW001171

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