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By ROBERT LEE HOTZ

Digital Age Means We Must Care More About Space Weather

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A moody, middle-age star, our sun has an explosive temperament. Power surges that flare from its roiling magnetic fields send outbursts of charged particles, radio static and X-rays across the 93 million miles to Earth. With little warning, these cosmic tsunamis of energy periodically have disabled commercial satellites, overloaded power grid transformers, blacked out radio communications and sent space-station astronauts scrambling for radiation shelter.

Space weather forecasters are bracing for a new season of intense sunspot activity that could begin by March and peak in 2012 -- and they worry that outages and damage could be even greater this time because the world has become increasingly dependent on wireless and cellular electronic networks. We are, therefore, even more susceptible to these sudden gales of solar wind.

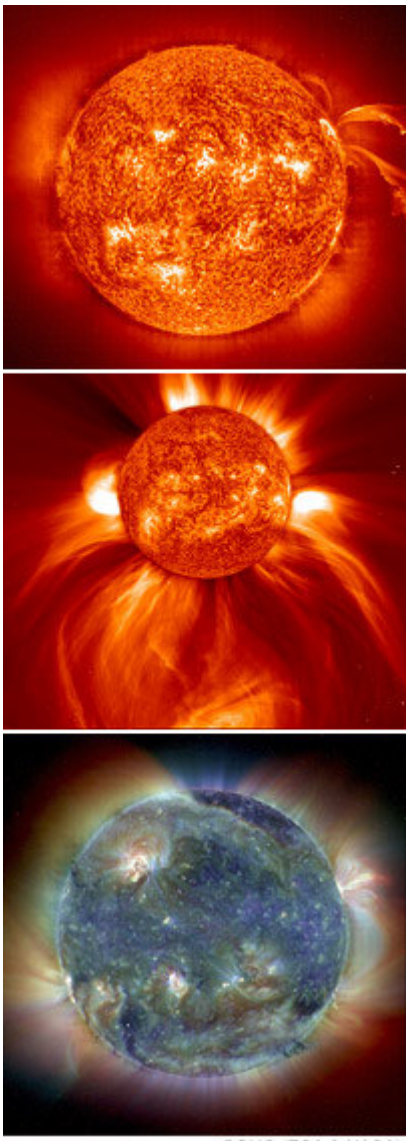
"We are set up for a nasty surprise," said Thomas Bogdan, director of the federal Space Environment Center in Boulder, Colo., the largest of 13 international space weather warning centers. "There are going to be impacts on all these services in the next few years."

Worries about solar storms are as old as the telegraph. When 19th-century entrepreneurs first started stringing long-distance wires across the U.S., they discovered that the lines attracted so much electricity during peak solar activity that the system could run without batteries and telegraph operators risked electrocution.

FORUM

1 Solar flares can disable satellites and overload power grids, but our ability to predict them is primitive. Should solar research be a higher priority?[2]

In a world in which even temporary service outages can pose problems, commercial satellite operators are often reluctant to discuss the impact of solar storms on



SOHO (ESA & NASA)

At top, the eruption of a solar prominence, or a cloud of plasma suspended in the sun's corona. The hottest areas appear almost white, while redder areas are cooler. Middle, a widely-spreading solar mass ejection blasts more than a billion tons of matter into space. At bottom, a composite image reveals solar features unique to different wavelengths.

their global networks, but technical reports prepared for the U.S. Commerce Department after severe solar storms in 2003 reveal just how widespread such problems can become.

A barrage of 17 major solar flares -- each an interplanetary shotgun blast of charged electrons and protons -- briefly scrambled computer circuits on more than half of NASA's satellites and space probes. The charged particles disabled navigation systems, inserted spurious commands and disrupted computer memories. A few sensors were knocked completely out of commission, while others took days to recover.

The Defense Department lost control of three surveillance satellites over "high-interest areas" for 29 hours, while Japan permanently lost contact with a $640 million Earth observation satellite.

The geomagnetic storms also caused power outages in Northern Europe and a blackout in Sweden. They forced 13 U.S. nuclear power plants to take control-room precautions, so that the electrical surges wouldn't affect reactor operations.

Forecasters at the Boulder facility -- to be renamed the Space Weather Prediction Center next week -- can offer at best a few hours' or minutes' warning of solar disturbances to their 5,700 customers, often not enough time to protect vulnerable systems.

RECOMMENDED READING

-- by Robert Lee Hotz

For the daily solar weather forecast, check the NOAA Space Environment Center[3], which offers free solar forecasts, warnings and alerts to 5,700 customers. It is the largest of 13 international solar weather warning centers.

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The Space Weather Journal[4], published online by the American Geophysical Union, is a new journal devoted to the emerging field of space weather and its impact on technical systems, including telecommunications, electric power and satellite navigation.

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NASA's Solar and Heliospheric Observatory[5] is one of a growing number of satellites and observatories that keep a weather eye on the sun. The SOHO home page features images and movies of sunspots and solar activity, as well as animations of interactions between the sun and Earth.

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Hinode[6] (Sunrise) is a project to study the sun, led by the Japanese Aerospace Exploration Agency in collaboration with NASA, the Particle Physics and Astronomy Research Council, and the European Space Agency. Hinode's three-year mission is to explore the magnetic fields of the sun and improve our understanding of the mechanisms that power

Consequences can be as minor as a sudden shower of dropped cellphone calls or as serious as the loss of an expensive satellite, said University of Colorado physicist Daniel Baker, chairman of a National Research Council panel evaluating space weather's economic impact. With more than 860 satellites in orbit, the losses during the most extreme solar storm could run up to $30 billion,

the solar atmosphere and drive solar eruptions.

* * *

Space Weather Resources[7] is an online clearinghouse of sites and background information maintained by Rice University.

NASA researchers reported this spring in the journal Space Weather.

Changing travel patterns also add risk.

To save time and fuel on flights between North America and Asia, 11 commercial airlines today routinely route planes over the high Arctic, where the aircraft are especially vulnerable to radio blackouts and radiation bursts. In 2005, 3,731 commercial flights took the shortcut over the North Pole -- 10 times the number at the height of the last sunspot season in 2000. As the next solar cycle reaches its peak in 2012, polar airline traffic is expected to grow to 1.7 million passengers a year.

At the height of the 2003 solar storms, polar flights had almost daily communications blackouts, which required that planes be rerouted. The Federal Aviation Administration for the first time also warned pilots on polar routes to stay at lower altitudes to avoid slightly higher radiation levels.

Every flight rerouted due to solar radiation or radio blackouts costs airlines up to $100,000 and, without sufficient warning, airlines must scramble at the last minute to take the necessary precautions. Passengers may be delayed or miss connections. The slightly increased radiation may also pose a health hazard to pregnant women and, over the long run, to flight crews who regular fly the Arctic.

"An airline passenger going over the Pole has to worry," said physicist Douglas Biesecker, chairman of the federal solar-cycle forecasting panel.

Until next spring, the sun is in a periodic lull. Even so, it can catch forecasters off-guard.

Last December, Cornell University researchers reported, the sun unleashed a burst of high-frequency radio waves 10 times as powerful as any previously measured -- strong enough to interfere with Global Positioning System signals world-wide.

Email me *at sciencejournal@wsj.com[8]. For a discussion on today's column, go to the Science Journal forum[9].*

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