

By Bobby Oerzen

Hurricane Katrina caused an estimated \$90 billion in damage when it blew through New Orleans four years ago. Imagine a storm whose total damage to the nation would be more than 20 times that—\$2 trillion. It could happen.

First, your cell phone would lose service. Then, the electricity would go out for days, maybe even weeks. Satellites would malfunction and might fall out of orbit, crashing to Earth. Ground fires and explosions would cause chaos everywhere.

The only silver lining to such a storm would be a sky glowing with *auroras*. Auroras are vivid ribbons of light that are normally visible over the polar regions as the *aurora borealis* (the northern lights) and the *aurora australis* (the southern lights).

That type of storm is called a geomagnetic storm. The biggest known one struck in 1859. The impact of another one of that size would be calamitous to our heavily electrified world. The federal government recently released a 132-page report warning of such an event. “Big space storms are a definite worry,” says Bruce Tsurutani, a physicist at the California Institute of Technology who works with NASA, the U.S. space agency.

CARRINGTON EVENT

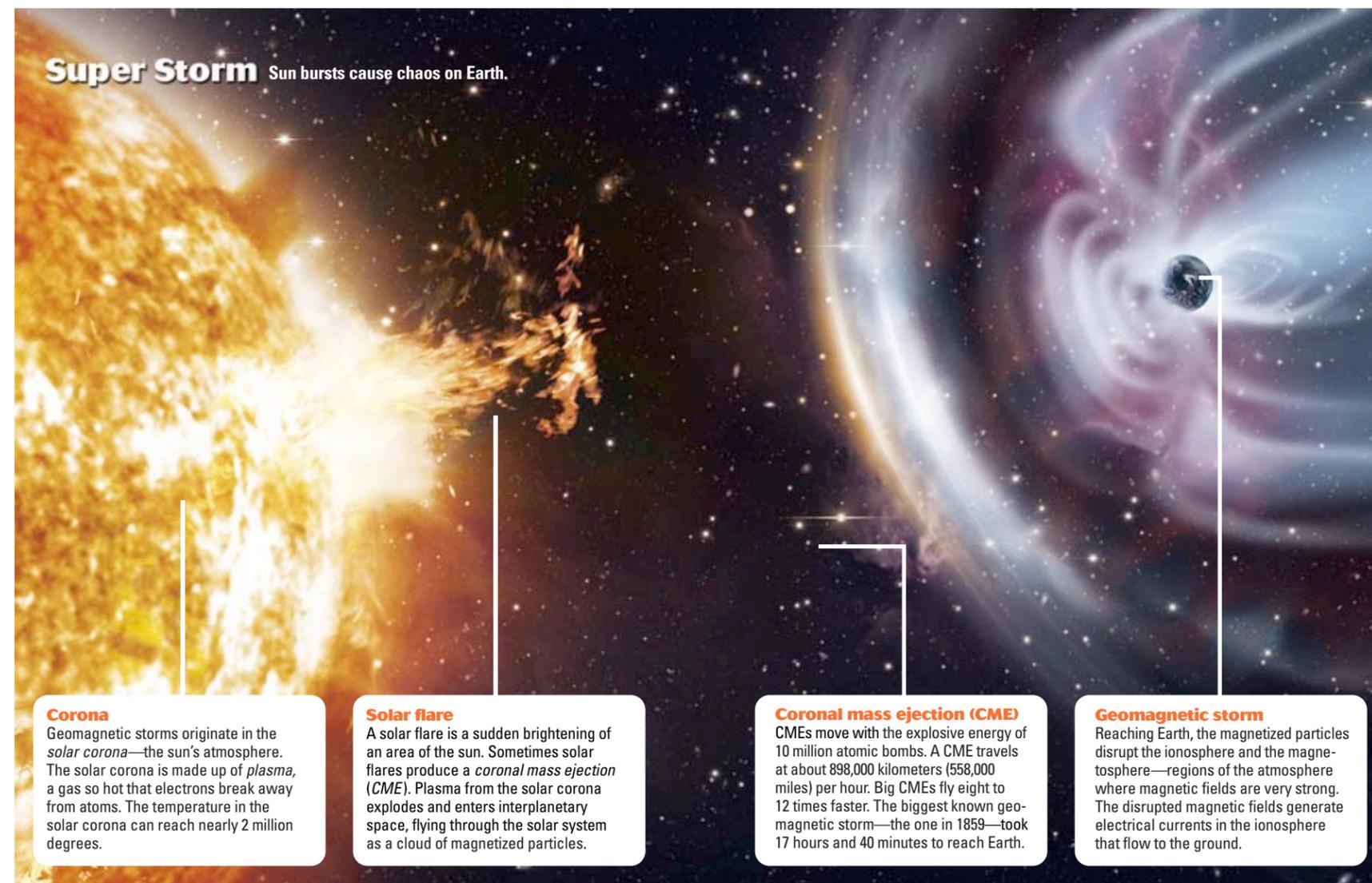
On Sept. 1, 1859, a young British astronomer, Richard Carrington, observed two extra-bright spots of light radiating from the sun. The bright spots occurred in a group of *sunspots*—dark areas on the sun that have intense magnetic fields.

Not long after Carrington’s sighting, night skies around the world lit up with auroras. People saw the northern lights as far south as Hawaii. The sky was so bright that campers in the Rocky Mountains mistook night for day.

SOLAR POWER

Is Earth ready for what might be the

most destructive storm of all time?



Super Storm Sun bursts cause chaos on Earth.

Corona

Geomagnetic storms originate in the *solar corona*—the sun’s atmosphere. The solar corona is made up of *plasma*, a gas so hot that electrons break away from atoms. The temperature in the solar corona can reach nearly 2 million degrees.

Solar flare

A solar flare is a sudden brightening of an area of the sun. Sometimes solar flares produce a *coronal mass ejection (CME)*. Plasma from the solar corona explodes and enters interplanetary space, flying through the solar system as a cloud of magnetized particles.

Coronal mass ejection (CME)

CMEs move with the explosive energy of 10 million atomic bombs. A CME travels at about 898,000 kilometers (558,000 miles) per hour. Big CMEs fly eight to 12 times faster. The biggest known geomagnetic storm—the one in 1859—took 17 hours and 40 minutes to reach Earth.

Geomagnetic storm

Reaching Earth, the magnetized particles disrupt the ionosphere and the magnetosphere—regions of the atmosphere where magnetic fields are very strong. The disrupted magnetic fields generate electrical currents in the ionosphere that flow to the ground.

An early wake-up was the least of anyone’s concerns, however. Many fires broke out. *Telegraph systems*, which carried coded signals via electrical wires over long distances, went haywire. Telegraph operators found that their machines worked better unplugged, powered solely by the electrical current induced by the geomagnetic storm.

Scientists rushed to explain what was causing the bizarre events, but

only Carrington knew the truth. He had been observing bright spots on the sun for days and knew that the ones he saw on September 1 were exceptional. Modern scientists have honored Carrington’s keen eye by naming the 1859 geomagnetic storm the Carrington Event.

Louis Lanzerotti, a professor of engineering at the New Jersey Institute of Technology, was one of the first scientists to realize the

importance of Carrington’s observation. “I was very taken by what Carrington did,” he says.

What led Lanzerotti back to Carrington’s work? It happened in 1972. He and a team of researchers were analyzing the outage of a Bell Telephone telecommunications cable. A phone line running from Chicago to San Francisco had mysteriously blacked out. Lanzerotti identified a geomagnetic storm as

the culprit and helped Bell redesign its systems to endure future storms.

BRIGHT STAR

Not all technology is as storm-resistant as the Bell system. How, then, might a big geomagnetic storm affect the modern world? The first impact would come from the solar flares—bright spots on the sun (see diagram). Solar flares emit particles, some in the form of

X-rays, that take about an hour to reach Earth. The X-ray particles would disrupt the *ionosphere*, an outer region of the atmosphere that contains a high concentration of free electrons. Radio waves and satellite signals travel through the ionosphere, so such a disruption would severely weaken cell-phone reception, among other things.

The brunt of the storm would be felt anywhere from 20 hours to a few days later. Magnetized particles from the sun would heat and lift the upper atmosphere, throwing satellites out of orbit.

Then, electrical currents in the ionosphere would flow to the ground, looking for connections. Any grounded object capable of carrying an electrical current—that is, any metallic object—would receive a jolt of energy. Many *electrical grids* (interconnected power lines), phone lines, and other grounded current carriers are not prepared for an *electrical overload* (too much current). They would explode, melt, or catch fire.

EYES ON THE STORM

Scientists are trying to prepare today’s technologies for tomorrow’s geomagnetic storms. “There are hundreds, if not thousands, of researchers around the world studying different facets of geomagnetic storms,” notes Tsurutani.

He would know. Since 1995, NASA has been monitoring geomagnetic storms and solar flares with its SOHO satellite. Government agencies depend on solar updates to give pilots sufficient warning if their navigation instruments might malfunction.

If SOHO sensed a big oncoming storm, Earth would have only half a day to prepare—if that. Satellites could be shifted into safety mode and power companies warned to shut down service. “Unfortunately,” Tsurutani says, “our present-day technology is much more vulnerable to magnetic storms compared to what existed in 1859.” **CS**