Solar storm researchers prepare for the 'big one' with new urgency

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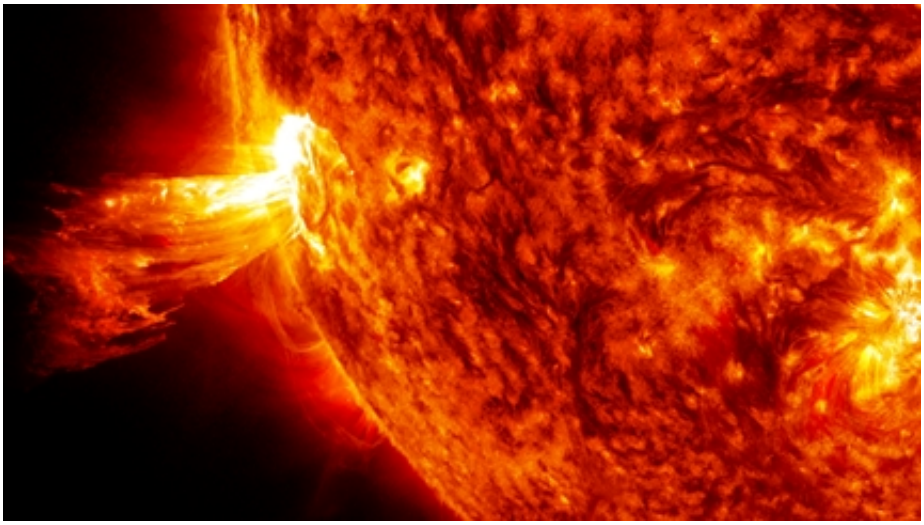

Credit: NASA

The specter of a geomagnetic solar storm with the ferocity to disrupt communications satellites, knock out GPS systems, shut down air travel and quench lights, computers and telephones in millions of homes for days, months or even years has yet to grip the public as a panic-inducing possibility.

But it is a scenario that space scientists, global insurance corporations and government agencies from the Department of Homeland Security (DHS) to NASA to the White House Office of Science and Technology Policy (OSTP) take seriously, calling it a "low probability but high-

impact event" that merits a substantial push on several fronts: research, forecasting and mitigation strategy.

Space Weather Experts Gather

At a recent conference in Washington, D.C. that drew space weather specialists from academia, the federal government, the military and private industry, Louis Lanzerotti, distinguished research professor at NJIT's Center for Solar-Terrestrial Research, summed up the implications of a massive, well-timed solar storm for today's technology-based, hyper-connected global society:

"Since the development of the electrical telegraph in the 1840s, space weather processes have affected the design, implementation and operation of many engineered systems, at first on Earth and now in space," noted Lanzerotti, a panelist at the conference. "As the complexity of such systems increases, as new technologies are invented and deployed, and as humans have ventured beyond Earth's surface, both human-built systems and humans themselves become more susceptible to the effects of Earth's space environment."

In addition to disrupting communications and energy grids, what is broadly known as space weather - powerful bursts of electromagnetic radiation, energetic charged particles and magnetized plasma - has the potential to corrode water and sewer pipelines, to erase historical data stored in computer memory, to undermine military and security operations and to harm astronauts traveling in space.

The symposium, "Space Weather Science and Applications: Research for Today, Training for Tomorrow," sponsored by the Universities Space Research Association (USRA) and the Space Policy Institute at George Washington University, focused on the growing urgency for both basic scientific research and the development of practical applications in the

field.

"Once systems start to fail, (the outages) could cascade in ways we can't even conceive," said Daniel Baker, director of the Laboratory for Atmospheric and Space Physics at the University of Colorado-Boulder and also a panelist, who recommends increasing support for the development of engineering systems and devices capable of protecting Earth's infrastructure.

Trillion Dollar Recovery

In a 2013 report, Lloyd's of London, the insurance market, put the population at risk of a massive storm at "between 20-40 million with durations up to 1-2 years," depending "largely on the availability of spare replacement transformers." The cost of such a recovery would range between $600 billion and $2.6 trillion.

The symposium followed on the heels of a conference late last year, "Space Weather: Understanding Potential Impacts and Building Resilience," convened in Washington, D.C. under the auspices of the Executive Office of the President of the United States and also attended by scientists and engineers from academia and industry, as well as policymakers and elected officials. At that time, the OSTP laid out a multi-part action plan to address, as Lanzerotti put it, "civil societal issues related to all aspects of space weather."

In an op-ed piece that followed, Lanzerotti, who was also panelist at that conference, called the federal plan "impressive for its analyses and coverage of the measurements, data, and models that will be required to ensure security under space weather events of all types—from huge geomagnetic storm-produced telluric currents initiated by coronal mass ejections to solar radio-produced outages of GPS receivers to radiation effects by magnetosphere, solar and galactic radiation to satellite drag

effects from Earth's atmosphere and ionosphere."

These areas are the focus of NJIT's Center for Solar-Terrestrial Research, which has a variety of instruments in space and on the ground for observing and recording space weather, including the world's largest solar optical telescope at Big Bear Solar Observatory, a solar radio telescope array in Owens Valley, instruments across Antarctica and aboard spacecraft in the Van Allen radiation belts.

At the recent symposium, Tamara Dickinson, the principal assistant director for environment and energy at the OSTP, described recent minor storms that had caused disruption: a blackout in Sweden during which NASA also detected anomalies in deep space missions and several years later, the interruption of flight-control systems, again in Sweden, that halted air traffic.

Setting Benchmarks to Assess Risks to Critical Infrastructure

Dickinson said the government is "at a "fundamental turning point" in its approach to space weather planning and prepared to "take decisive action to address this risk."

Ralph Stoffler, the director of weather, deputy chief of staff for operations at U.S. Air Force headquarters in Washington, said the Air Force was currently expanding its network of sensors to monitor space weather, including placing them on all of its satellites.

"We need data to support particular military operations," Stoffler said, adding that the Air Force relies on GPS for missions such as piloting remote aircraft in Afghanistan from the U.S. "If we can predict space weather, we can have other operations in place or delay."

The Federal Emergency Management Agency (FEMA) has recently added space weather to its daily operations briefings. "We know there is a gap in our ability to assess vulnerability and consequences," said Jack Anderson, a senior analyst at DHS's National Protection and Programs Directorate, adding that while there is currently no scale for predicting the magnitude of a storm as exists for hurricanes, for example, "we need to develop that at FEMA."

William Lapenta, director of the National Centers for Environmental Prediction at the National Oceanic and Atmospheric Administration (NOAA) said his agency's goal was to track solar storms "from sun to mud," to predict where conditions following a coronal mass ejection, for example, would be most intense in the ionosphere and on Earth in the form of underground electrical currents, and to calculate impacts on a variety of systems.

One of the near-term challenges for policymakers will be to set benchmarks for assessing the vulnerability of various technology systems and establishing thresholds that would trigger protective or recovery responses, said William Murtagh, the assistant director for the space weather, energy and environment division at the OSTP. There are currently working groups focused on these benchmark amid efforts to reach out to other countries to establish international protocols for aviation conditions, mitigation strategies and data sharing, among other areas.

"We do not fully understand those upper boundaries, but we need to ... once we understand how big these storms are we can develop trigger points," he said, adding that the Nuclear Regulatory Commission was interested in the "10,000-year storm - that's what they need to know."

"The technological and biological impacts of severe space weather events are now firmly in the federal government's sights," noted Andrew

Gerrard, director of NJIT's Center for Solar-Terrestrial Research. "All things being equal, increased research funding from the represented federal agencies will further bolster the incorporation of 'space weather' into our daily lives. Such development will enable the solar-terrestrial community to, for the first time, see a solar storm, track its approach, and prepare accordingly."

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