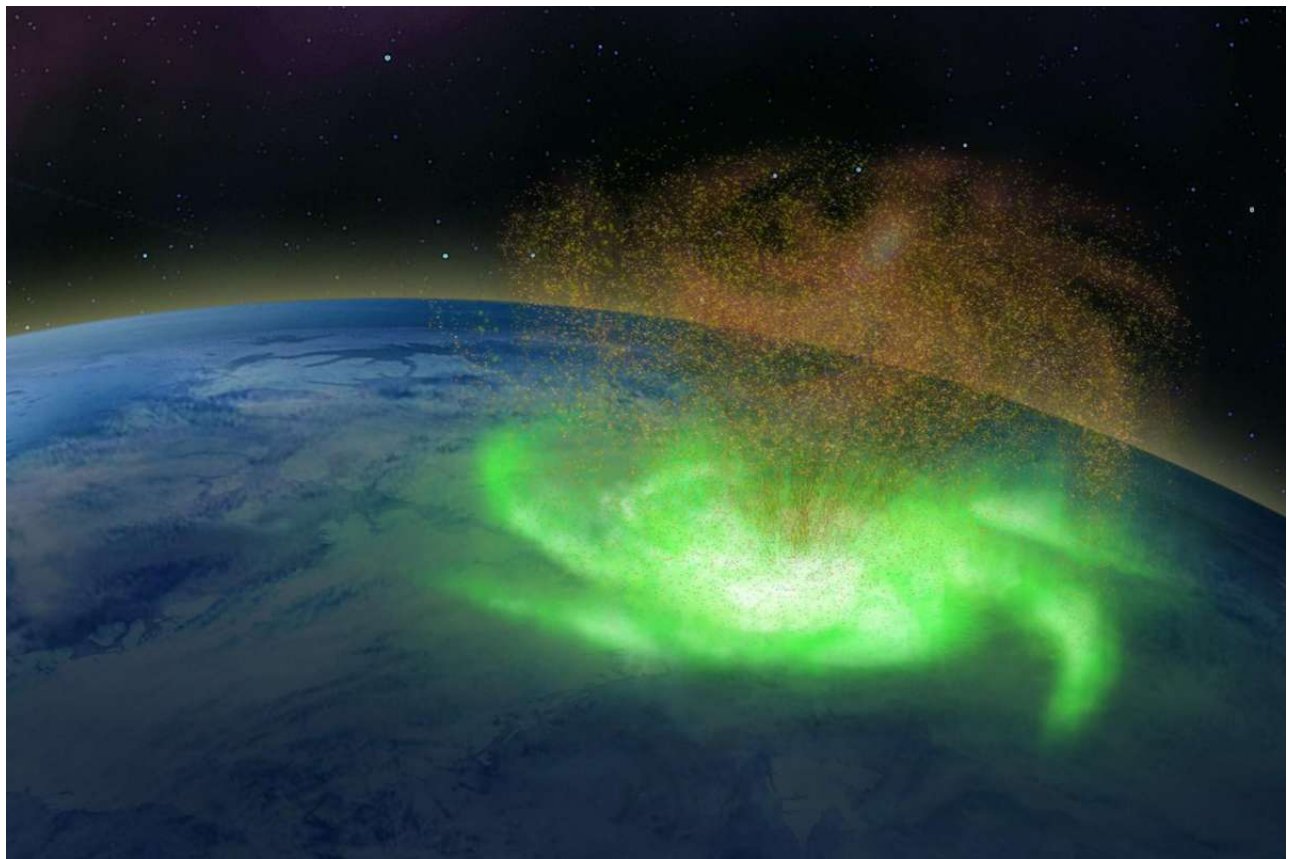


Gigantic space hurricane with 4,000 mph winds stalled above Earth, new research shows

Andrea Leinfelder , Staff writer March 18, 2021
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Pictured is an artist's drawing of the space hurricane.

Ya-Fei Ning

It sounds like a cheesy end-of-the-world movie: a gigantic space hurricane, packing 4,000 mph winds, is stalled above the Earth raining down high-

energy electrons instead of water.

Except this isn't a movie. It happened. And it's the topic of research published in a scientific journal.

Space hurricanes are a newly discovered type of storm that could be occurring every year. More than 10 have been documented in the upper atmosphere.

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“On the ground, we are safe from it because it's far away,” said Yongliang Zhang, co-author of the paper in [Nature Communications](#) and a space physicist with Johns Hopkins University Applied Physics Laboratory.

For traditional hurricanes: [NASA researchers use machine learning to better predict if a hurricane will rapidly intensify](#)

But such space storms aren't harmless. The weather above Earth is an increasingly urgent topic as it could disrupt our technology-dependent world.

Legislators are worried about these storms overloading electrical grids and causing power outages. They could also affect satellites used for cell phones, weather predictions, TV, search and rescue missions, navigation, military surveillance, and credit card and ATM transactions.

To address this, former President Donald Trump signed the Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow Act in October. Its mandates include better coordination between federal agencies and the private sector to assess the effects of space weather and identify ways to improve forecasting and mitigate potential damage.

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“There’s no politics in this issue,” said Bill Murtagh, program coordinator for the Space Weather Prediction Center at the National Oceanic and Atmospheric Administration. “Both sides of the aisle fully support it.”

Aurora: A window into space weather

Zhang and his co-authors found a space hurricane while studying the physical process behind the aurora (the Northern and Southern lights), a byproduct of space weather.

“Aurora, actually, it’s really my favorite,” Zhang said, “because that’s the window to the universe.”

It turns out a vibrant aurora is a sign of more active space weather.

Space weather is caused by the sun. Solar wind carries particles (mainly protons and electrons in a state known as plasma) from the sun’s outer atmosphere.

The Earth’s magnetic field will generally stop these particles from entering our atmosphere, but it’s not foolproof. And when electrons interact with oxygen and nitrogen in the Earth’s atmosphere they emit lights seen as the aurora.

Green and red aurora are caused by electrons colliding with oxygen. Blue occurs when electrons collide with nitrogen.

Zhang and his colleagues, led by Qing-He Zhang with Shandong University in

China, were studying a quiet period when the aurora was weak. The researchers were sorting through data collected from satellites in 2014 when they noticed the hurricane-like storm.

The storm began 40,000 miles above the Earth's surface and continued down to about 100 miles above the surface. Around 520 miles, where the satellites observed the storm, the hurricane's diameter was more than 600 miles. Plasma wind moved around the storm's center at speeds of 2,200 to 4,500 miles per hour.

But unlike a hurricane found in the Gulf of Mexico, where the eye is calm, the electrons rained down through the storm's center.

The 2014 space hurricane occurred when the polar region was sunlit. The researchers are looking at other space hurricanes to see if any occurred when the polar region was dark. If they occur when it's dark, Zhang expects the aurora from a space hurricane would look like a huge bright green patch — the eye of the storm — connected to a few curved auroral sheets.

How space weather affects Earth

Patricia Reiff, a professor of physics and astronomy at Rice University, said the geometry of space hurricanes is what makes the finding unique. Space storms, in general, have been observed for quite some time.

These storms are influenced by a variety of factors, with the main contributor being the sun's 11-year cycle. The most recent cycle, Solar Cycle 25, began in December 2019 and will reach its peak intensity around 2025.

More on Solar Cycle 25: [Every 11 years the sun enters a new cycle. The latest has begun.](#)

Solar flares and coronal mass ejections are more likely to occur during peak intensity. Coronal mass ejections, massive explosions from the sun that hurl plasma and magnetic fields into space, cause most of the violent space

weather, Reiff said.

On Earth, coronal mass ejections can cause strong electrical currents in power lines, exceeding the capacity of the system and possibly damaging transformers. On March 13, 1989, an hours-long blackout engulfed the entire province of Quebec, Canada. Across the U.S., there were more than 200 power grid problems within minutes of the storm's start, [NASA reported](#).

This 1989 storm was so powerful that the aurora was seen in Houston. More severe storms (which are very rare) could cause power outages for days or even one to two years, depending on the availability of spare replacement transformers, according to a [2013 report from insurer Lloyd's of London](#). If a massive storm caused extended U.S. power outages, Lloyd's said the total economic cost could be up to \$2.6 trillion.

The 1989 storm spurred regulation requiring power system utilities to assess their space weather vulnerability, said Bob Arritt, a technical executive who specializes in space weather for the Electric Power Research Institute, a nonprofit that conducts research and development relating to the generation, delivery and use of electricity.

He said grid operators monitor space weather and use their vulnerability assessments to prepare for storms. Preparations can include postponing maintenance so all power lines and transformers are operating during the storm. This helps the system handle the increased current and reduces the risk that the system will become overloaded and shut down.

Grid operators might also reduce the current on their power transmission lines ahead of a storm, he said.

This 1989 storm also caused some satellites to tumble out of control for several hours.

Space storms can push high-energy particles into satellite electronics and give

phantom commands, Reiff said. To prevent this, satellite operators can tell their spacecraft to ignore commands when a storm is approaching.

Coronal mass ejections can also cause turbulence in the ionosphere, which is part of the Earth's upper atmosphere, that's used to bounce high-frequency radio waves from one part of the planet to another. Commercial aircraft use high-frequency radio and can lose communications for a period of time. A turbulent ionosphere can also disrupt GPS signals being beamed down from satellites.

Space dependency

Space weather monitoring and forecasting grows more important as society becomes intertwined with space.

GPS is ubiquitous. More and more satellites are orbiting the Earth as SpaceX and other companies seek to create satellite clusters that provide high-speed broadband internet. Space tourism is on the cusp of becoming an industry, and NASA is working to return astronauts to the moon.

“Space weather, in this way, is becoming more and more relevant to our daily life,” said Liying Qian, a scientist who studies the thermosphere and ionosphere at the National Center for Atmospheric Research.

NASA has recently launched spacecraft that are studying causes of space weather, including the Magnetospheric Multiscale Mission launched in 2015 and the Parker Solar Probe launched in 2018, and other missions are in the works. A NOAA satellite set to launch in 2024 will put a new coronagraph into space. This instrument blocks out the sun, allowing its outer atmosphere to be observed for solar eruptions.

Looking at the sun: [NASA close-up pictures show 'little campfires' on the sun](#)

Presidents Barack Obama and Donald Trump both signed executive orders

related to space weather. And in 2019, the Federal Emergency Management Agency [identified space weather among threats](#) that could affect the entire nation (pandemic was also identified as a nationwide threat).

As such, Murtagh said the legislation signed into law last year is just one example of the increased interest in space weather.

As federal agencies, companies and academics identify ways to improve space weather observation and resiliency, Congress will have to appropriate money.

“We must ensure that we have the tools and resources to research and predict these events, and protect our nation’s infrastructure so we can avoid an economic catastrophe in the event of severe space weather,” the office of U.S. Sen. Gary Peters, D-Michigan, one of the senators who introduced the space weather legislation passed last year, said in an email. “Senator Peters — who serves on the Commerce, Science and Transportation Committee — will be working to ensure that Congress provides the appropriations and support necessary to fully implement this legislation.”

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