KYUSHU UNIVERSITY

Public Relations Office, Kyushu University
744 Motooka Nishi-ku Fukuoka, 819-0395
TEL: +81-92-802-2443 FAX: +81-92-802-2139
E-MAIL: koho@jimu.kyushu-u.ac.jp
URL: https://www.kyushu-u.ac.jp

PRESS RELEASE (2025/05/13)

Enhanced activity in the upper atmosphere of Sporadic E layers during the 2024 Mother's Day super geomagnetic storm

New study reveals the impact of the Mother's Day geomagnetic storm on the Sporadic E layers that could disrupt radio communications and navigation systems

Fukuoka, Japan—In a paper published in *Geophysical Research Letters*, researchers from Kyushu University report on the activity of sporadic E layers—about 90-120 km above sea level—during the Mother's Day geomagnetic storm. The team found that the E layers were significantly enhanced during the recovery phase of the geomagnetic storm. Sporadic E layer, as the name suggests, is a phenomenon in which thin—about 1-5 km thick—but dense patches of ionized metals suddenly appear in the E layer of the ionosphere.

Moreover, the team found that these series of sporadic E layers occurred mainly over Southeast Asia, Australia, the South Pacific, and the East Pacific. They also observed a propagation characteristic of the phenomenon wherein the clouds were first detected around high latitude areas of the poles and then detected successively in lower latitude areas over time.

"When studying the Mother's Day geomagnetic storm, many researchers looked at what happened in the F layer of the ionosphere. It is about 150-500 km above sea level and is where the most ionization occurs," explains Professor Huixin Liu of Kyushu University's Faculty of Science, who led the study. "The sporadic E layer hasn't been studied very much during the storm because it appeared unaffected by solar storms. But we wanted to see if something as powerful as the Mother's Day geomagnetic storm did anything to the E layer. What we found was very interesting."

To track sporadic Es across the globe the team collected data both from the ground, using 37 ground-based radars called ionosodes, and from space, using the COSMiC-2 satellite network. This vast amount of data gave the researchers an unprecedented global map of sporadic Es activity during and after the solar storm.

"This large amount of data was critical for both detecting the presence of sporadic Es and tracking where they formed as time went by," continues Liu. "In our analysis, we found that sporadic Es formed after the main phase of the solar storm, during what we call the recovery phase. Sporadic Es were also detected first in the higher latitude regions, around the Earth's poles. They were then detected gradually in lower latitudes over time. This propagation characteristic from high to low latitudes suggests that sporadic E layers are most likely caused by the disturbed neutral winds in the E region."

Understanding the activity of the E layer is vital due to its potential to disrupt radio communications in the HF and VHF bands. The research team hopes that their new findings will lead to better insights on Es layer activity and how such unique phenomena are created in the ionosphere.

"We now know that sporadic Es enhance during the recovery phase of a solar storm, so perhaps we can forecast more accurately sporadic Es using the propagation characteristics

found in our study and mitigate potential communication disruptions," concludes Liu. "We also plan to re-examine the data from other solar storms to see if we can better understand these phenomena."

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For more information about this research, see "Sporadic-E Layer Responses to Super Geomagnetic Storm 10–12 May 2024," Lihui Qiu, Huixin Liu, Geophysical Research Letters https://doi.org/10.1029/2025GL115154

About Kyushu University

Founded in 1911, Kyushu University is one of Japan's leading research-oriented institutes of higher education, consistently ranking as one of the top ten Japanese universities in the Times Higher Education World University Rankings and the QS World Rankings. The university is one of the seven national universities in Japan, located in Fukuoka, on the island of Kyushu—the most southwestern of Japan's four main islands with a population and land size slightly larger than Belgium. Kyushu U's multiple campuses—home to around 19,000 students and 8000 faculty and staff—are located around Fukuoka City, a coastal metropolis that is frequently ranked among the world's most livable cities and historically known as Japan's gateway to Asia. Through its VISION 2030, Kyushu U will "drive social change with integrative knowledge." By fusing the spectrum of knowledge, from the humanities and arts to engineering and medical sciences, Kyushu U will strengthen its research in the key areas of decarbonization, medicine and health, and environment and food, to tackle society's most pressing issues.

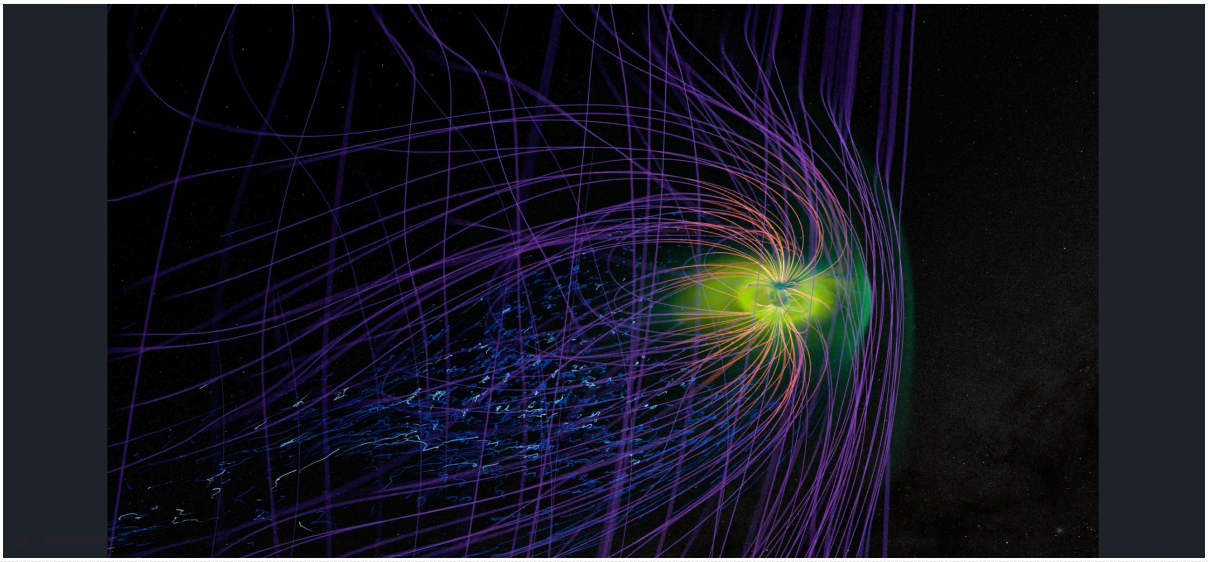

Fig. 1. Visualization of Earth's magnetosphere being hit by the Mother's Day geomagnetic storm. A screen shot from NASA's Scientific Visualization Studio that visualizes the Earth's magnetosphere being hit by a geomagnetic storm that happened throughout May 10-11, 2024. The powerful geomagnetic storm resulted in auroras being viewed in relatively low latitude areas around the globe. Kyushu University researchers found that sporadic Es were also enhanced during these storms. (NASA's Scientific Visualization Studio and NASA DRIVE Science Center for Geospace Storms https://svs.gsfc.nasa.gov/5435)

[Contact]
Liu Huixin, Professor
Faculty of Science Department of Earth and Planetary Sciences
Tel: +81 92-802-4234
E-mail: liu.huixin.295@m.kyushu-u.ac.jp