# Solar storms accelerate SpaceX Starlink satellite re-entries, raising safety concerns



The rapid expansion of the satellite industry presents a formidable challenge as thousands of spacecraft orbit the Earth under the influence of the sun's unpredictable behaviour. Recent developments highlight a pressing dilemma: how can these satellites, including SpaceX's prolific Starlink constellation, safely coexist amidst escalating solar activity? The consequences of this interplay not only impact space commerce but also raise safety concerns for our atmosphere and the environment below.

In August 2024, a 2.5-kilogram fragment identified as part of a SpaceX Starlink satellite was discovered on a Saskatchewan farm, an incident underscoring the unanticipated risks associated with the soaring number of satellites in low Earth orbit. As the sun approaches the peak of its 11-year solar cycle, dubbed solar maximum, its powerful eruptions instigate geomagnetic storms. These storms generate significant atmospheric changes that can substantially increase drag on satellites, thereby reducing their operational lifespans. Denny Oliveira of NASA's Goddard Space Flight Center noted that during geomagnetic events, satellites fall back to Earth faster than normal, with lifetimes reduced by as much as ten days in some cases.

In a world transformed by mega-constellations, SpaceX has already launched over 7,000 Starlink satellites, with an ambition to deploy tens of thousands more. This surge has turned low Earth orbit into a bustling channel, where the frequency of satellite launches and their subsequent deorbits reaches unprecedented levels. Each week, satellites are entering the atmosphere, with Oliveira emphasizing that “it’s the first time in history we have so many satellites re-entering at the same time.” Data reveals that between 2020 and 2024, 523 Starlink satellites were tracked during their re-entry, a phenomenon likely to become a daily occurrence in the near future.

The implications of these rapid re-entries extend beyond simple orbital logistics. Research indicates that debris from burning satellites could have far-reaching effects on Earth's magnetic field, potentially compromising the protective magnetosphere and allowing harmful cosmic radiation to penetrate deeper into the atmosphere. This concern is compounded by the lower altitude of many satellites, as geomagnetic storms can result in increased atmospheric drag, causing them to spiral back to earth unexpectedly. During recent geomagnetic events, satellites orbiting below 300 kilometres re-entered in as little as five days, a stark contrast to the 15 days they would typically require under stable conditions.

Experts like Samantha Lawler from the University of Regina point out that we are navigating uncharted territory in the context of satellite technology. “This is the first solar maximum that we’ve had in the mega constellation era,” she stated, emphasising the need for diligent measurements to assess the impact on satellite longevity and safety. Sean Elvidge from the University of Birmingham also notes that quicker satellite re-entries may inadvertently benefit operators by reducing the time derelict satellites remain in orbit, thus lessening the risk they pose to active spacecraft.

However, the increased rate of re-entries raises a troubling question: will satellites always burn up upon atmospheric re-entry? As Oliveira cautioned, there exists a possibility that some fragments might reach the surface, posing risks to populated areas. The situation is precarious, especially considering that Saskatchewan's flat landscape facilitates recovery of fallen debris, raising concerns about how often such incidents may occur elsewhere, unnoticed.

With the satellite landscape evolving rapidly and the sun's volatility seemingly on the rise, satellite operators and researchers are increasingly aware of the urgent need for monitoring and mitigating space weather effects. Agencies like NOAA play a critical role in forecasting space weather events, allowing operators to take proactive measures to safeguard their assets. Such vigilance is essential not just for maintaining the success of satellite missions, but for ensuring the safety of our atmospheric environment amid the burgeoning satellite revolution. As this dynamic field continues to evolve, the balance between advancing technology and safeguarding our skies remains a paramount concern.

## Reference Map:

* Paragraph 1 – [[1]](https://www.techspot.com/news/108090-sun-unpredictable-outbursts-forcing-satellites-back-earth-sooner.html), [[4]](https://en.wikipedia.org/wiki/Geomagnetic_storm)
* Paragraph 2 – [[1]](https://www.techspot.com/news/108090-sun-unpredictable-outbursts-forcing-satellites-back-earth-sooner.html), [[2]](https://www.space.com/satellites-re-entering-magnetosphere-effects-study), [[5]](https://www.cvskiran.com/post/low-earth-orbit-with-solar-flares-a-ticking-time-bomb)
* Paragraph 3 – [[3]](https://theconversation.com/solar-storms-can-destroy-satellites-with-ease-a-space-weather-expert-explains-the-science-177510/), [[6]](https://www.nesdis.noaa.gov/news/safeguarding-satellites-how-noaa-monitors-space-weather-prevent-disruptions)
* Paragraph 4 – [[1]](https://www.techspot.com/news/108090-sun-unpredictable-outbursts-forcing-satellites-back-earth-sooner.html), [[3]](https://theconversation.com/solar-storms-can-destroy-satellites-with-ease-a-space-weather-expert-explains-the-science-177510/)
* Paragraph 5 – [[6]](https://www.nesdis.noaa.gov/news/safeguarding-satellites-how-noaa-monitors-space-weather-prevent-disruptions), [[7]](https://hesperia.gsfc.nasa.gov/sftheory/spaceweather.htm)

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## Bibliography

1. <https://www.techspot.com/news/108090-sun-unpredictable-outbursts-forcing-satellites-back-earth-sooner.html> - Please view link - unable to able to access data
2. <https://www.space.com/satellites-re-entering-magnetosphere-effects-study> - A study suggests that debris from burning satellites could affect Earth's magnetic field. The conductive shell of re-entering satellites may create holes in the magnetosphere, potentially allowing more harmful cosmic radiation to reach Earth's surface. Additionally, aluminum oxides produced during satellite combustion are known to deplete the ozone layer, raising concerns about atmospheric impacts. While these effects are not immediate threats, they highlight the need for further research into the environmental consequences of satellite re-entries.
3. <https://theconversation.com/solar-storms-can-destroy-satellites-with-ease-a-space-weather-expert-explains-the-science-177510/> - Solar storms pose significant risks to satellites, including increased atmospheric drag and potential electronic damage. During strong geomagnetic storms, the upper atmosphere expands, increasing drag on low Earth orbit satellites, leading to faster orbital decay and re-entry. Additionally, high-energy electrons from solar storms can penetrate satellite shielding, causing electronic malfunctions. These effects underscore the importance of monitoring space weather to protect satellite infrastructure.
4. <https://en.wikipedia.org/wiki/Geomagnetic_storm> - Geomagnetic storms, often triggered by solar activity, can lead to increased atmospheric drag on satellites in low Earth orbit. The expansion of Earth's upper atmosphere during such storms increases drag, causing satellites to slow and eventually re-enter Earth's atmosphere. Historical instances, like the premature re-entry of Skylab in 1979, highlight the impact of solar activity on satellite lifespans and the importance of considering space weather in satellite mission planning.
5. <https://www.cvskiran.com/post/low-earth-orbit-with-solar-flares-a-ticking-time-bomb> - Solar flares release high-energy radiation and particles that can damage satellite electronics, disrupt communication systems, and increase atmospheric drag. The heating and expansion of Earth's upper atmosphere during solar flares lead to higher drag on low Earth orbit satellites, causing them to lose altitude unpredictably. This phenomenon poses challenges for satellite operators, especially for large constellations, as it can lead to rapid orbital decay and potential collisions.
6. <https://www.nesdis.noaa.gov/news/safeguarding-satellites-how-noaa-monitors-space-weather-prevent-disruptions> - NOAA monitors space weather to protect satellites and critical infrastructure. Geomagnetic storms can disrupt satellite operations, damage electronics, and induce currents in power grids, leading to blackouts. NOAA's forecasts enable satellite operators to take proactive measures, such as switching spacecraft to safe mode, to mitigate risks. This proactive approach is essential for maintaining satellite functionality and ensuring the resilience of space-based services.
7. <https://hesperia.gsfc.nasa.gov/sftheory/spaceweather.htm> - Solar flares produce high-energy particles and radiation that can damage satellite electronics and increase atmospheric drag. The X-rays from flares heat and expand Earth's upper atmosphere, leading to increased drag on low Earth orbit satellites. This effect can shorten satellite lifespans and cause premature re-entry. Understanding these interactions is crucial for satellite mission planning and for developing strategies to mitigate the impacts of space weather.