

MSN'26 | ACM SIGMETRICS 26'

A Comprehensive Study of Satellite Network Performance During Severe or Extreme Geomagnetic Storms over 1.5 Years (May 2024 – Oct 2025)

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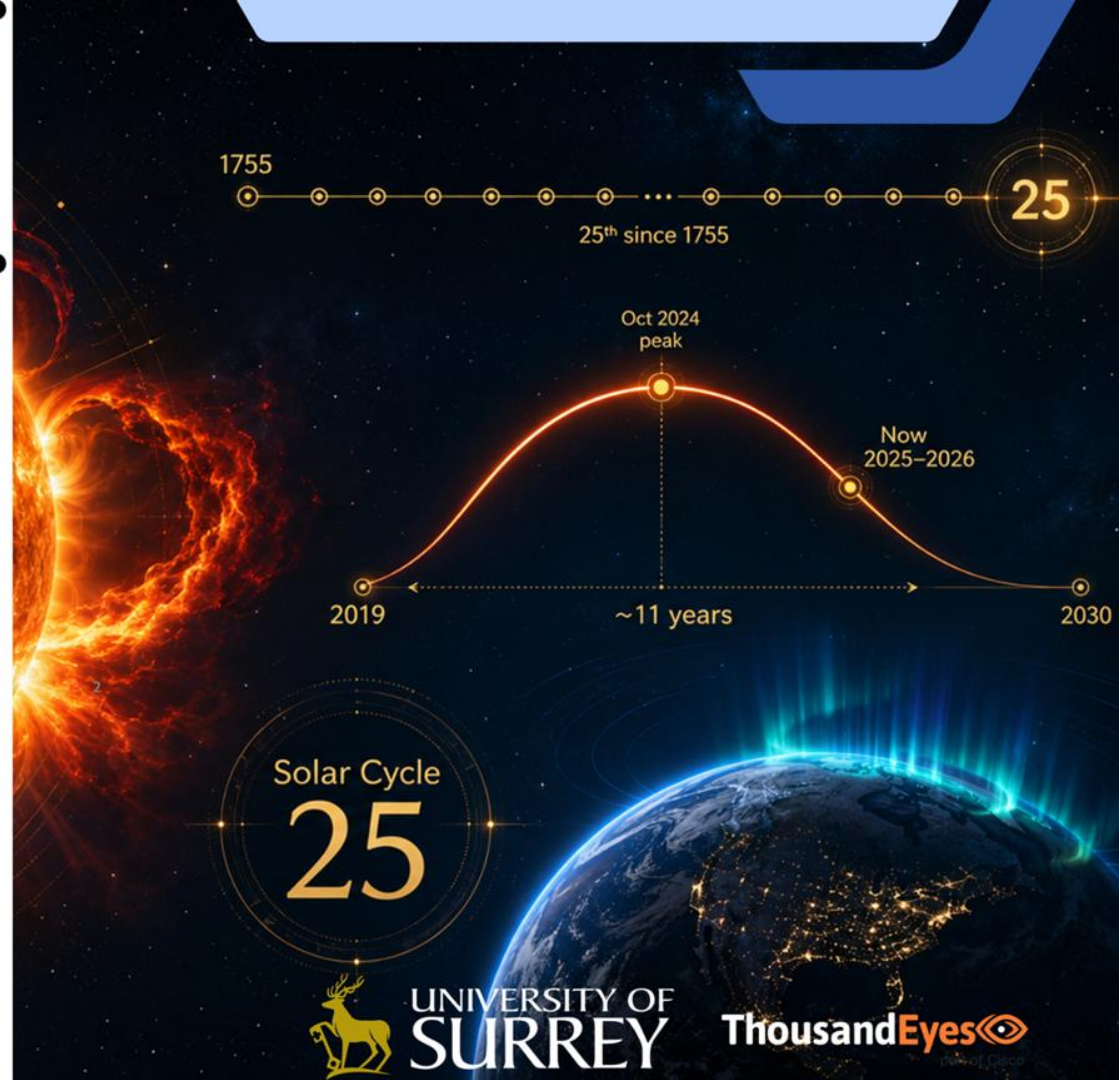
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Solar Storms Are Not Just Beautiful Auroras



1859 – Carrington Event

Telegraph disruption;
sparks and fires
reported.



1989 – Québec Blackout

Power-grid failure;
~6M people without
electricity for
~9 hours.



2003 – Halloween Storms

Polar-route aviation
communication issues;
GPS also affected.

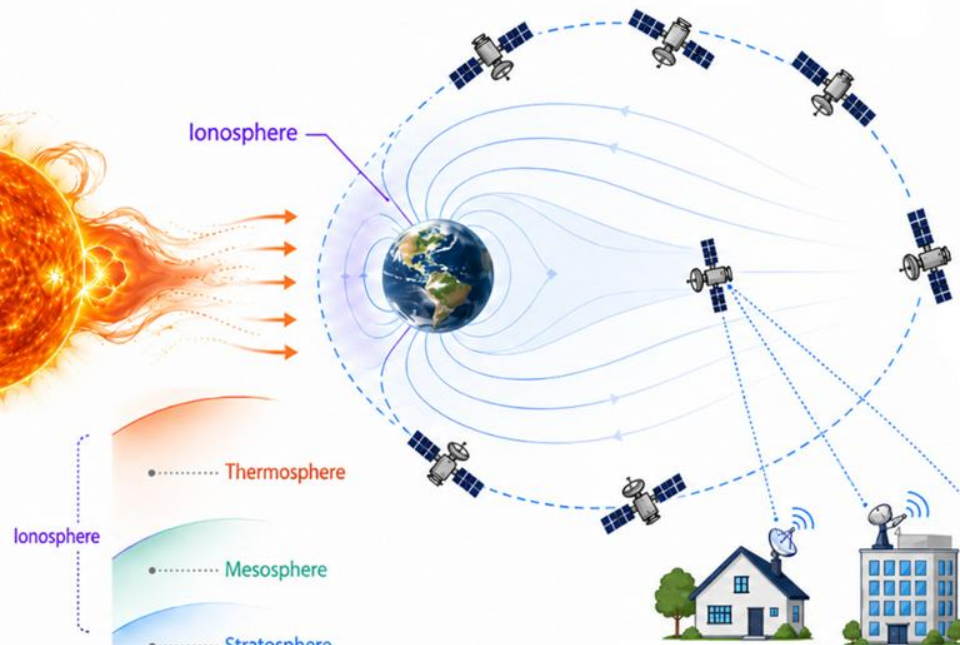


2022 – Starlink Loss

Increased drag
contributed to loss of
38/49 newly launched
satellites.

But what happens to real satellite Internet performance during severe storms?

When Space Weather Hits Satellite Internet



G5

Extreme
Kp = 9



Average frequency:
4 per cycle
(4 days per cycle)

G4

Severe
Kp = 8



Average frequency:
100 per cycle
(60 days per cycle)

G3

Strong
Kp = 7



Average frequency:
200 per cycle
(130 days per cycle)

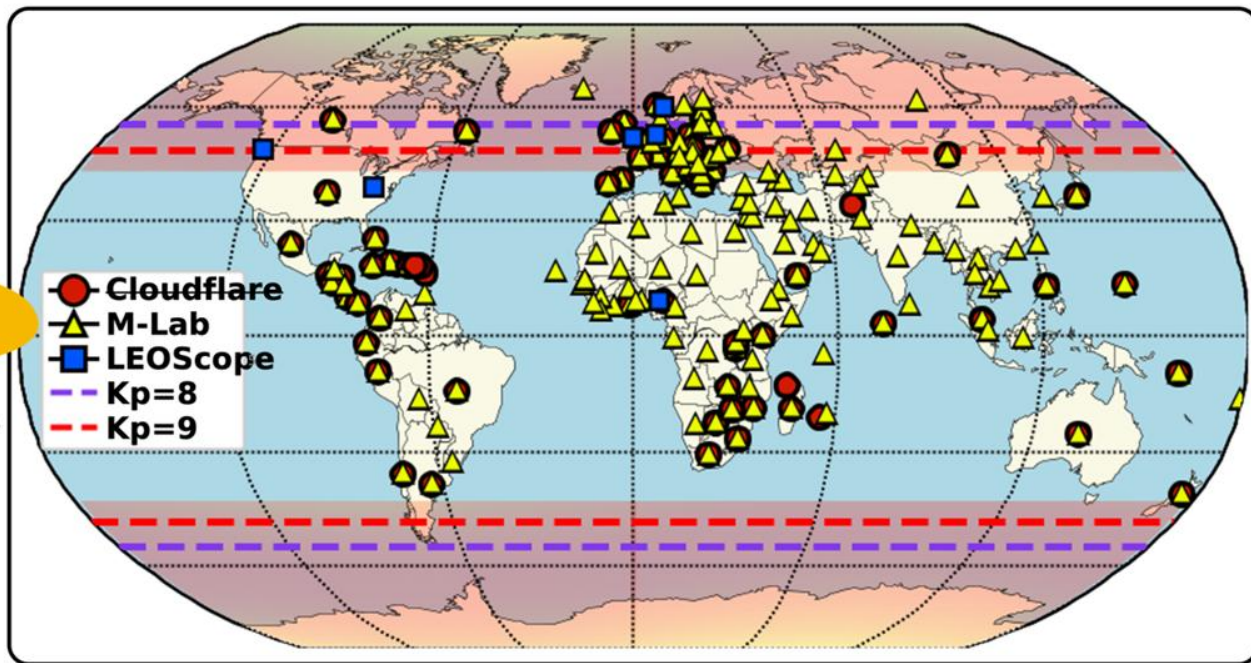
Core Narrative

Can the Sun measurably degrade satellite Internet, and can we prove it from the network layer up to user experience and operator response?

- **LEOScope**: For time and precision.
- **M-Lab NDT7**: For geographic diversity and scale.

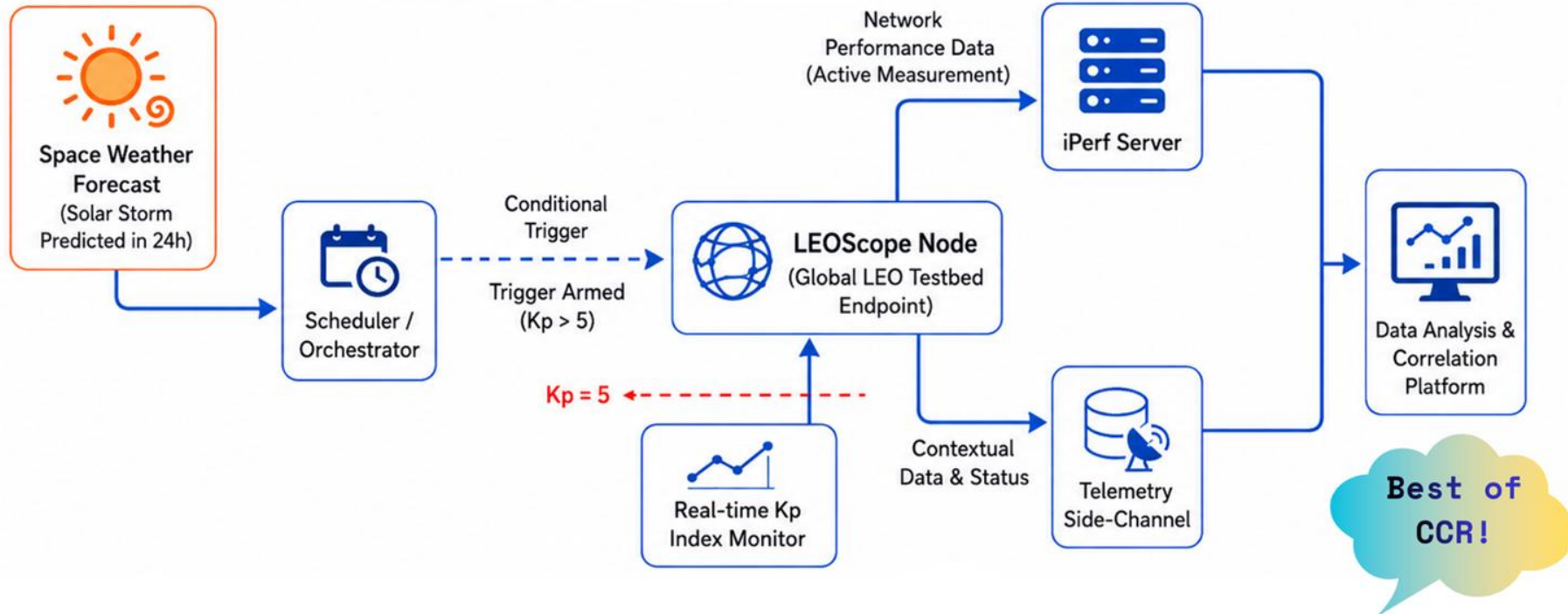
For the sake
of time!

- ~~Cloudflare AIM: For end user experience.~~
- Celestrak TLE data: Fleet Manoeuvres.



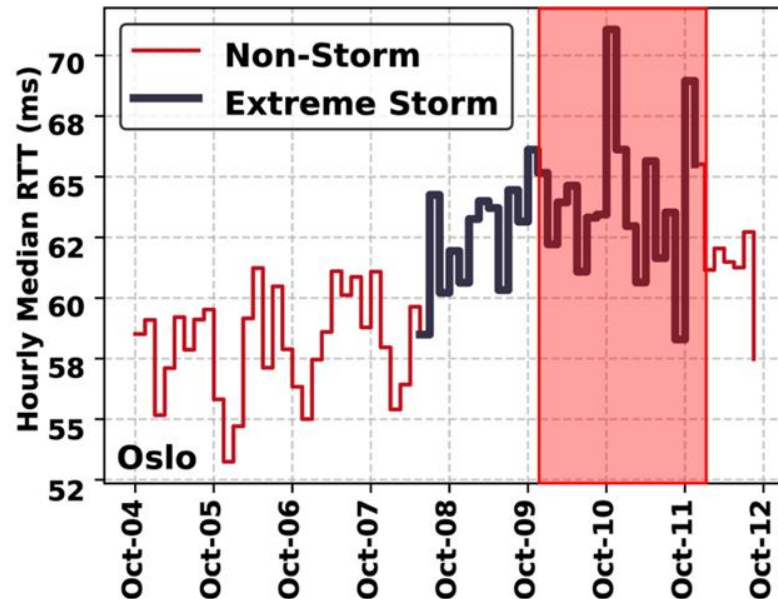
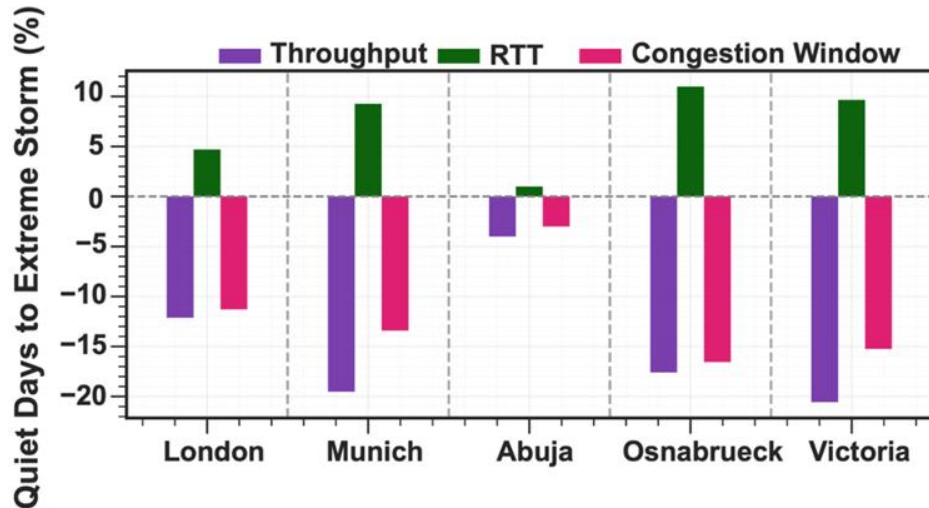
First: a controlled view from LEOScope

Scene 1. Why?



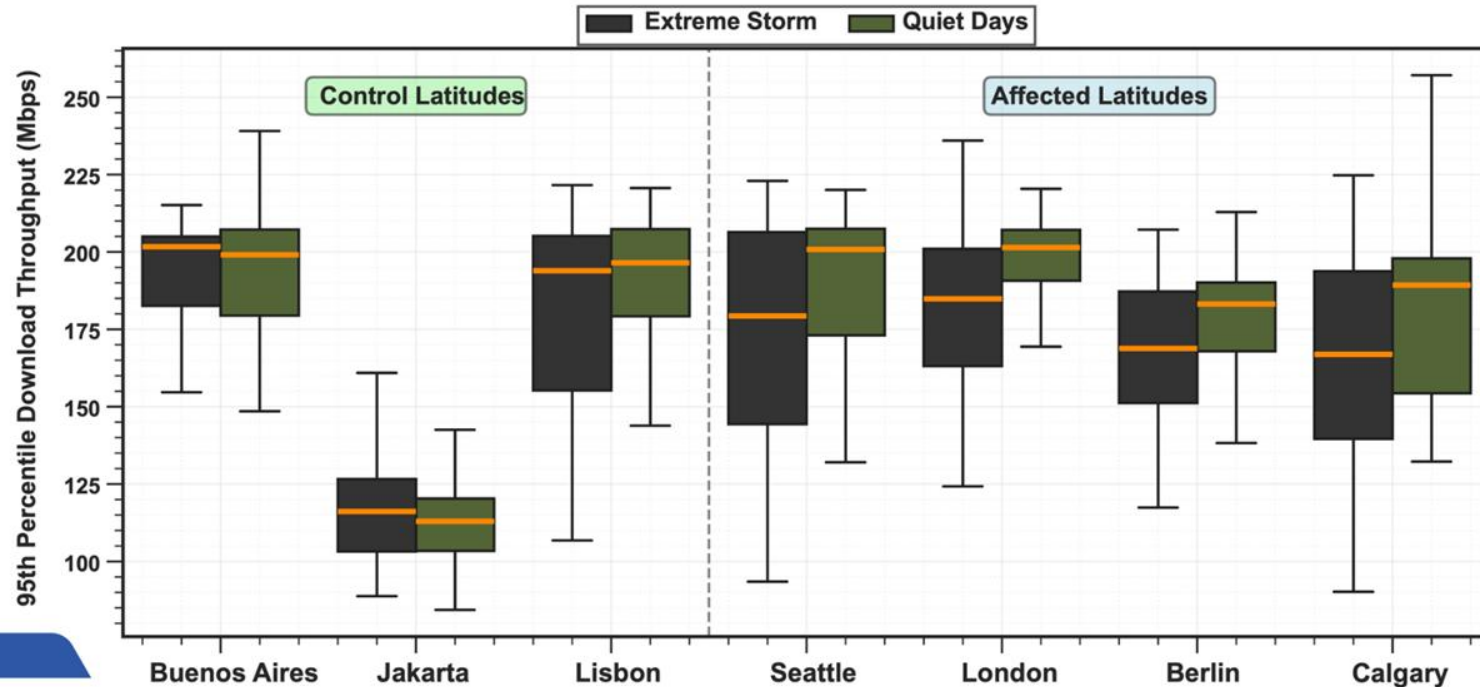
Fadaei et al. "LEOScope: Building a Global Testbed for Low-Earth Orbit Satellite Networks." SIGCOMM CCR, 2025.

LEOScope - Scene 2. iPerf3 & Speed-Test

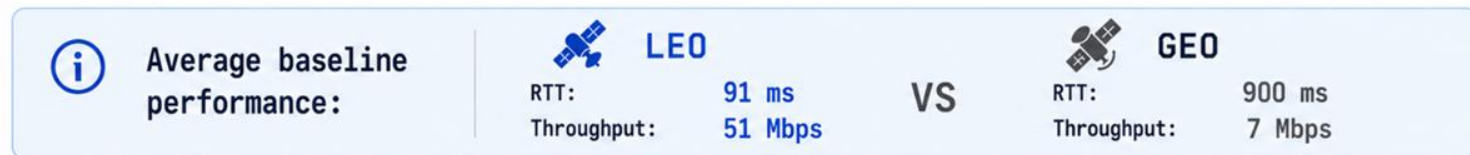
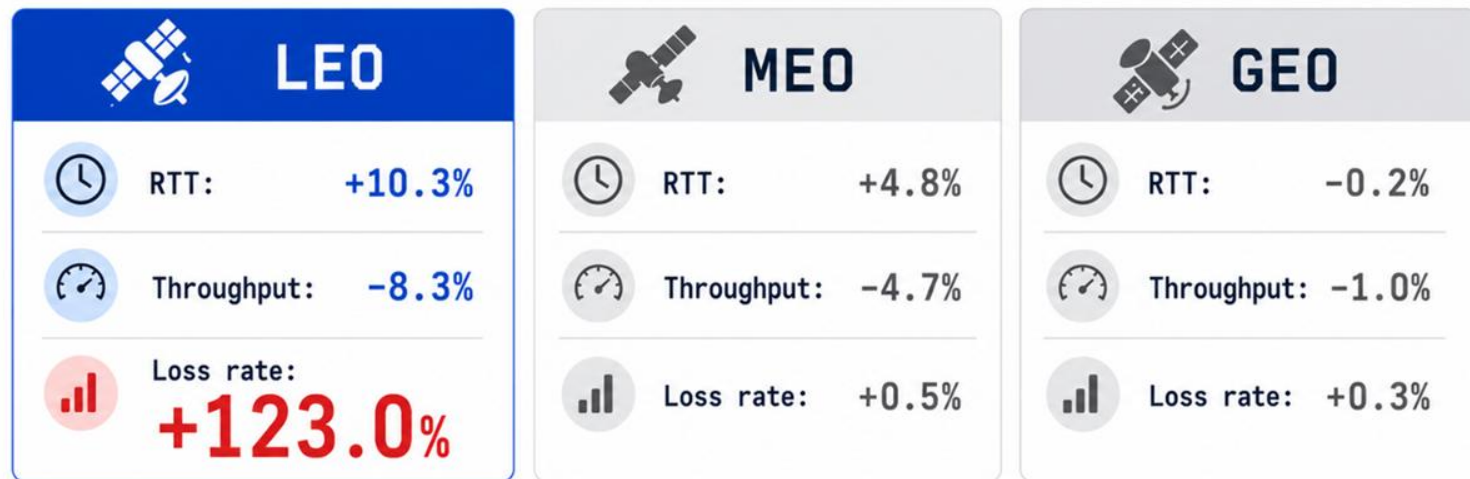


Global signals in M-Lab: Throughput Distribution Shifts

Affected latitudes shift downward.



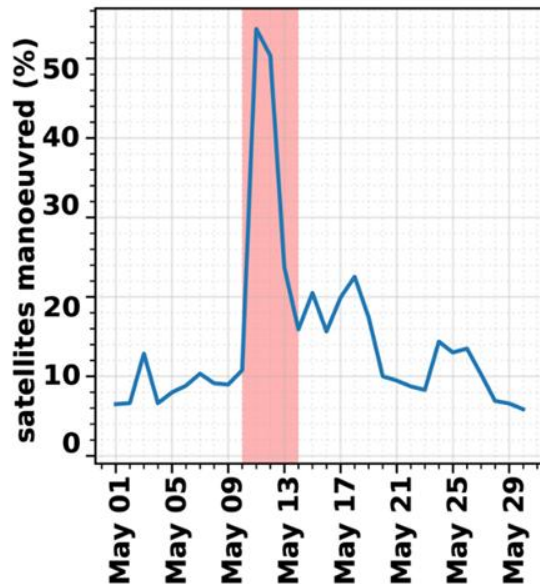
LEO vs MEO vs GEO



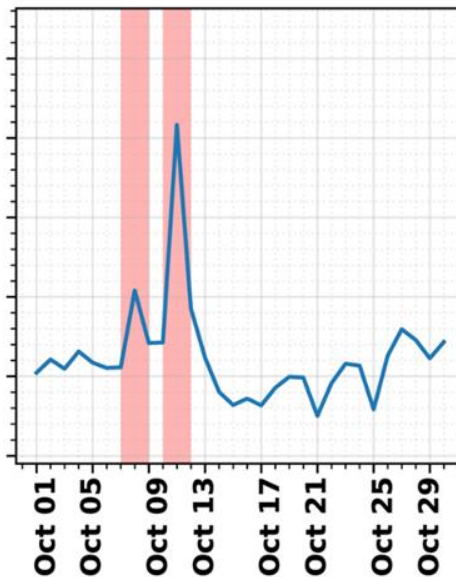
Storm impact on **loss** is dramatically larger in **LEO** than in MEO/GEO.

The network story is coupled to orbital operations: Fleet Manoeuvres

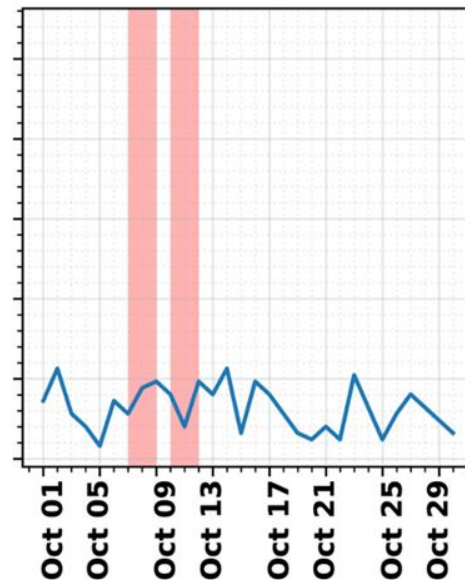
Storms also trigger orbital-scale responses



**STARLINK (LEO)
MAY STORM**



**STARLINK (LEO)
OCTOBER STORM**



GEO



Space weather is now an Internet measurement problem.

- Storms degrade controlled LEO measurements.
- Effects generalize globally and concentrate in affected latitudes.
- The impact is visible in QoE and orbital operations.

Fadaei et al. "A Comprehensive Study of Satellite Network Performance During Severe or Extreme Geomagnetic Storms over 1.5 Years." **ACM SIGMETRICS**, 2026.

Thank You