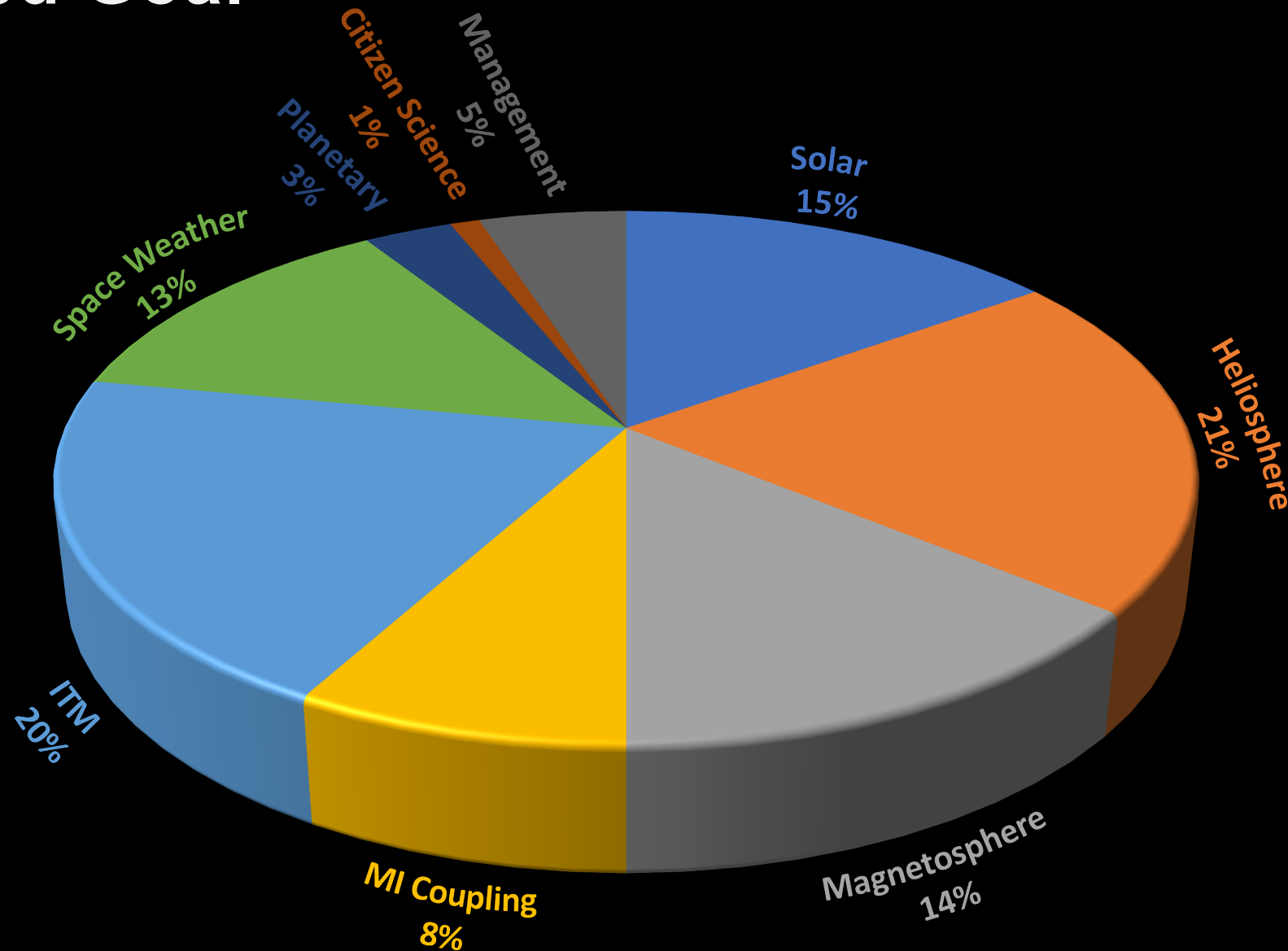


May 2024 Solar & Geospace Superstorm Workshop

Nour E. Rawafi

The Johns Hopkins Applied Physics Laboratory

Objective: Unifying the Community Around a Common Focused Goal





Jinni Meehan

Assistant Director for
Space Policy

**The White House
Office of Science
and Technology
Policy**



Joe Westlake

Director, Heliophysics
Division for the Science
Mission Directorate

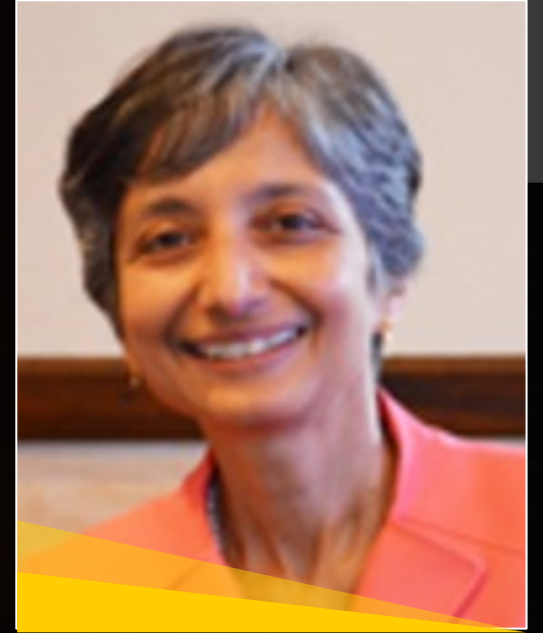
NASA



Elsayed Talaat

Director, Office of
Space Weather
Observations

NESDIS/NOAA



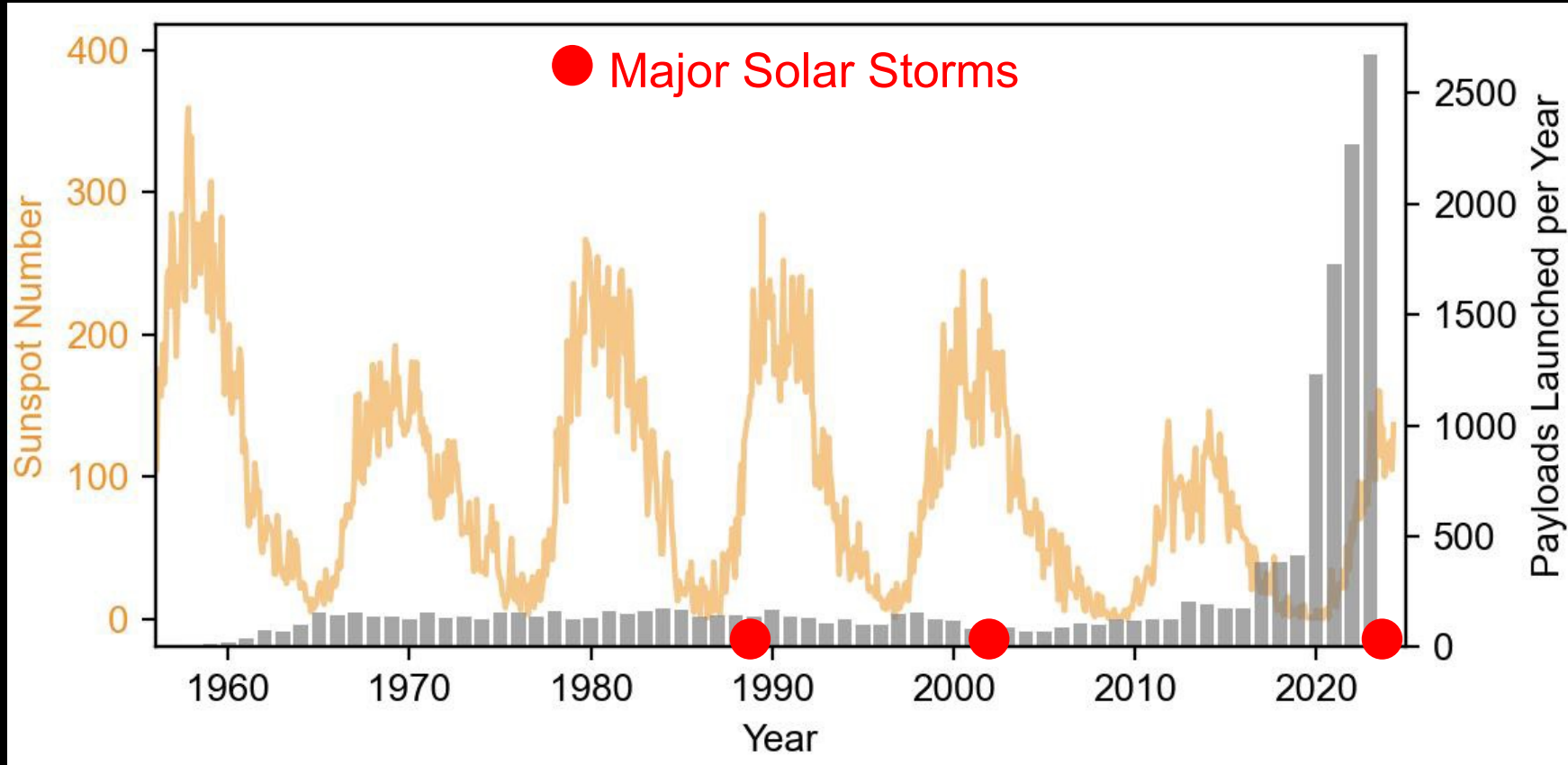
Mangala Sharma

Program Director, Space
Weather Division of
Atmospheric and Geospace
Sciences

NSF

Satellite Operations & Major Storms

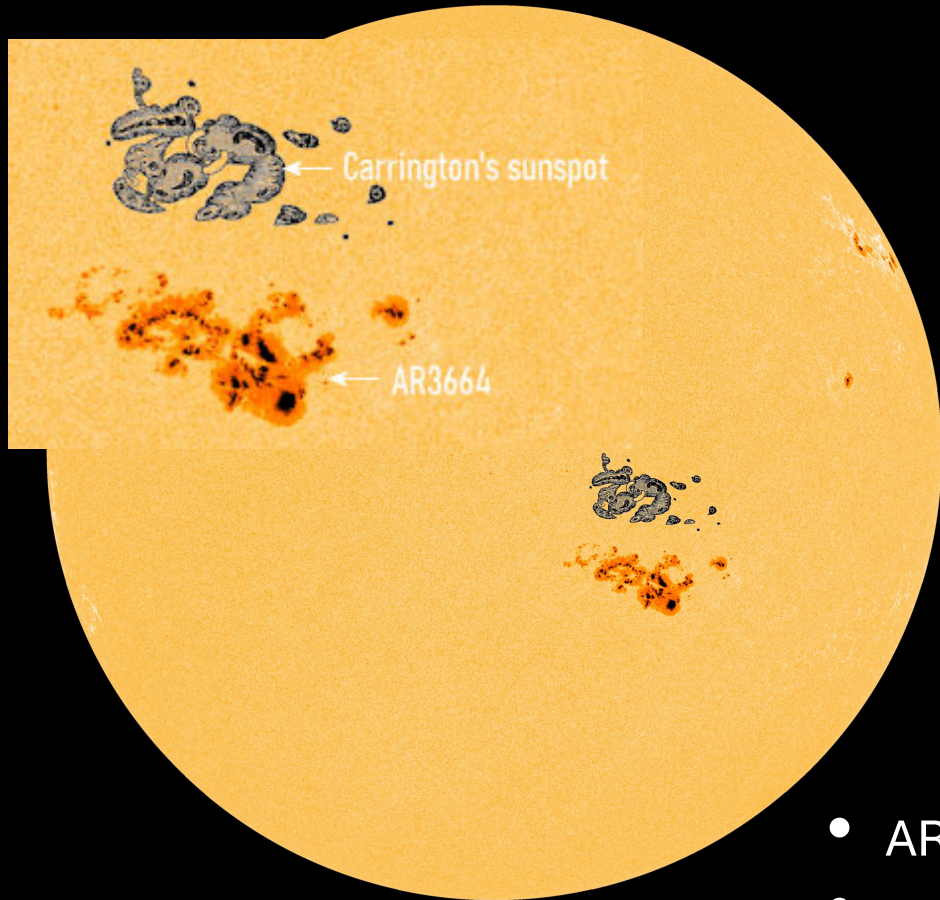
What Changed?



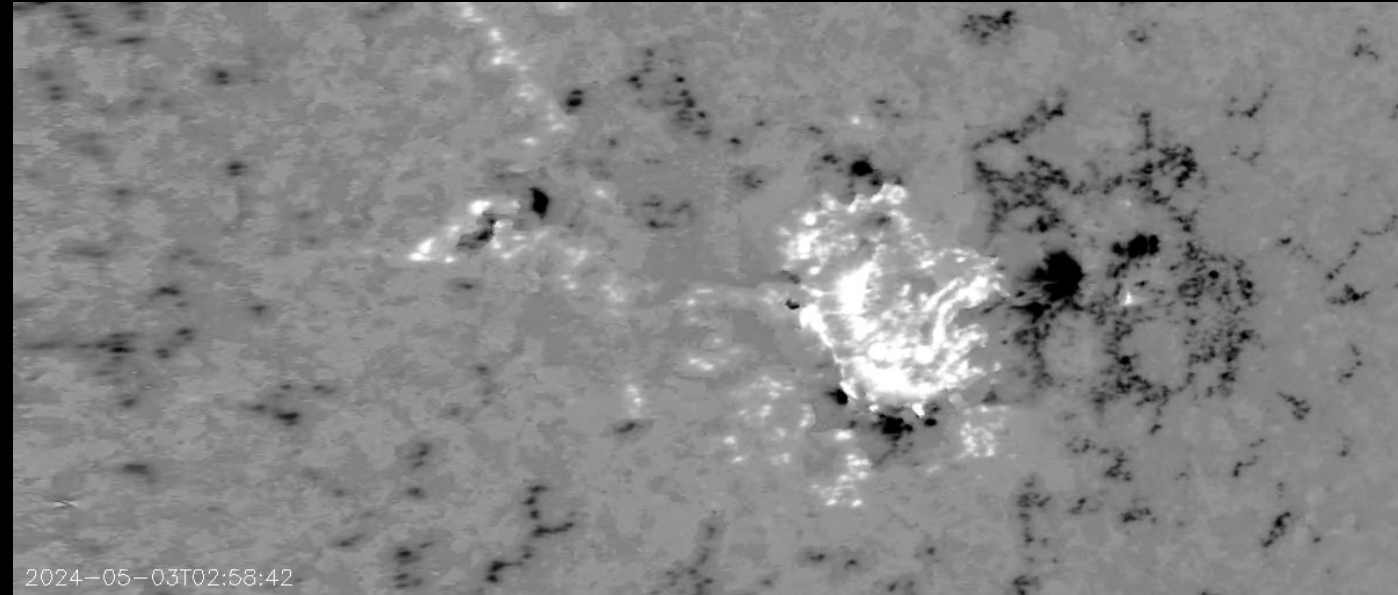
Courtesy of
William Parker (MIT)

- Rapid expansion in low LEO (400-1000 km).
- Satellite operations have changed a lot.
 - Starlink: 50,000 collision avoidance maneuvers in the first half of 2024.

AR3664: A Record Breaker

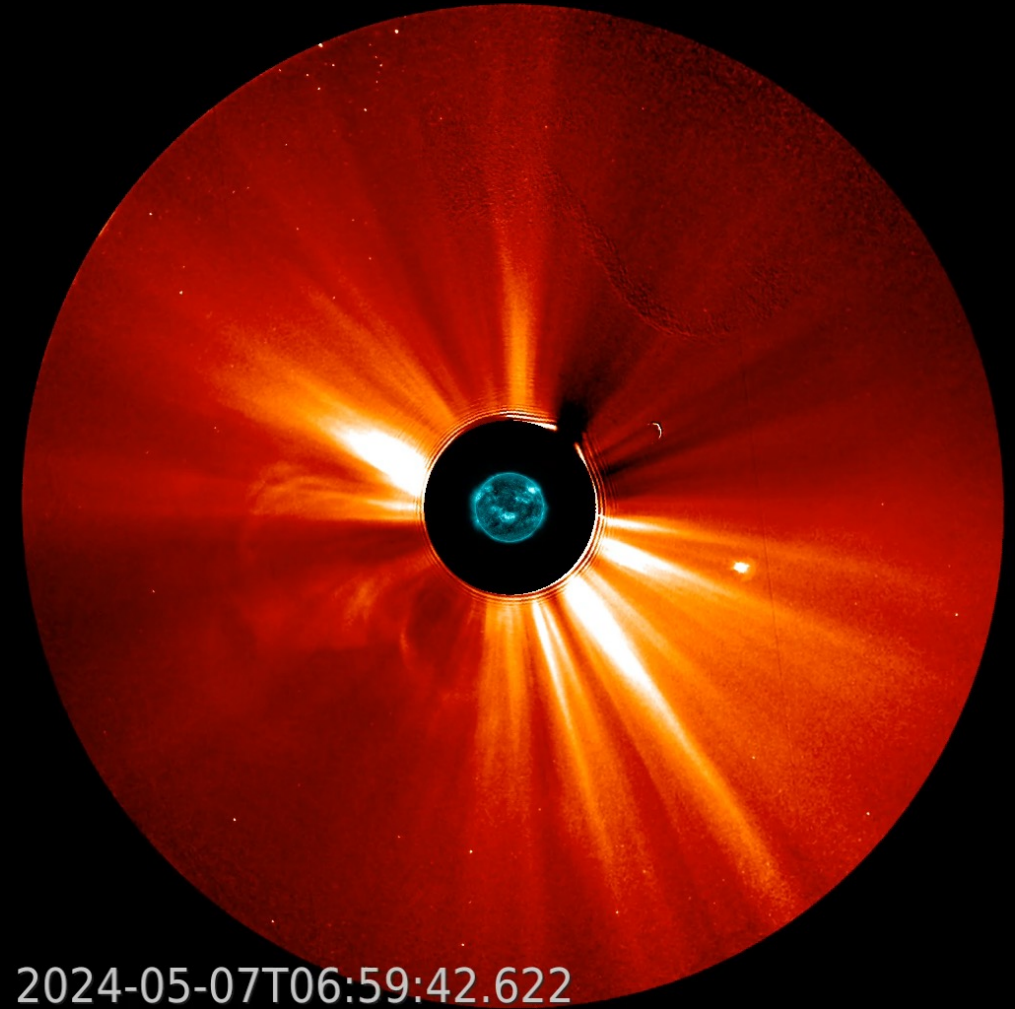
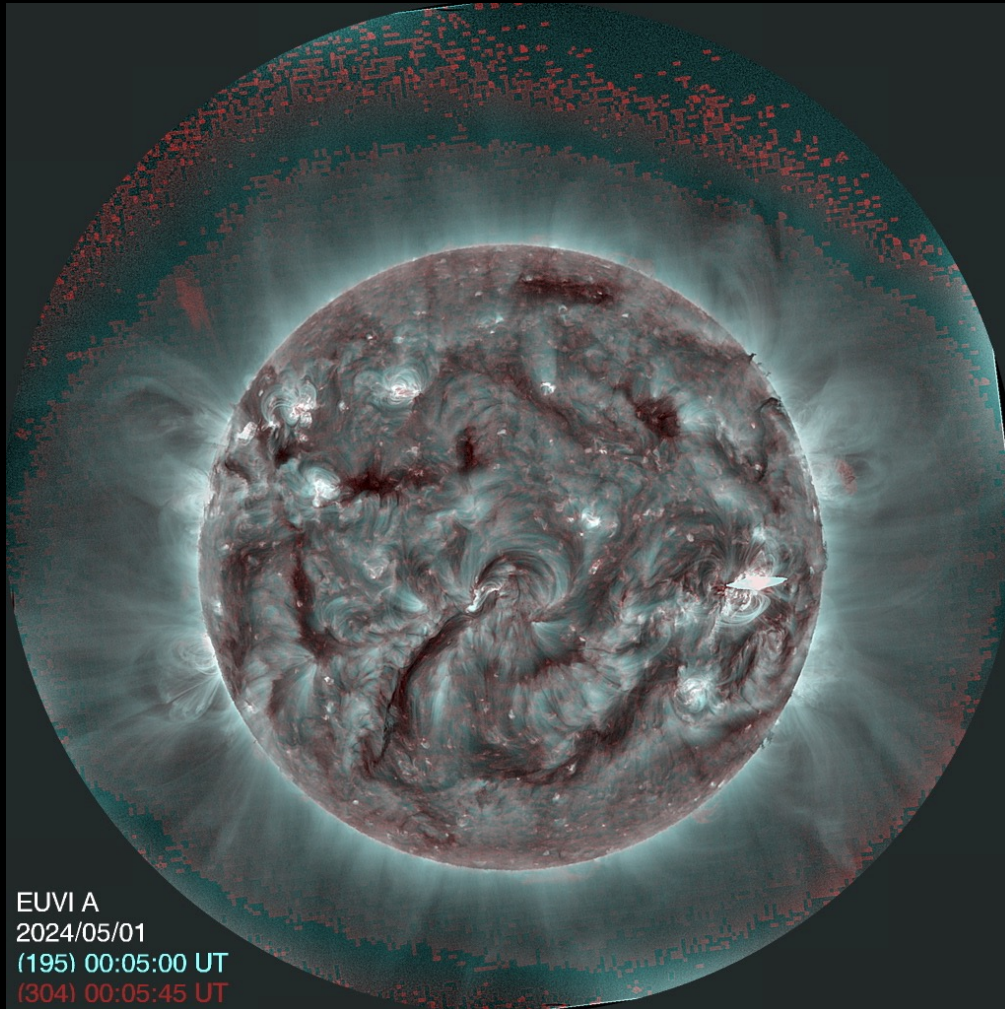


SDO/HMI Quick-Look Continuum: 20240509_010000



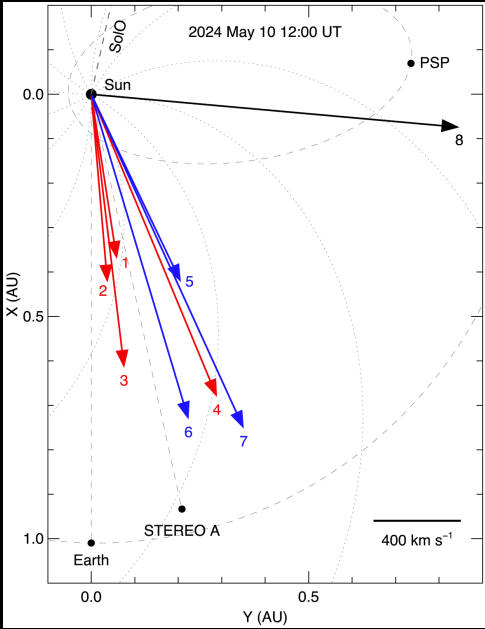
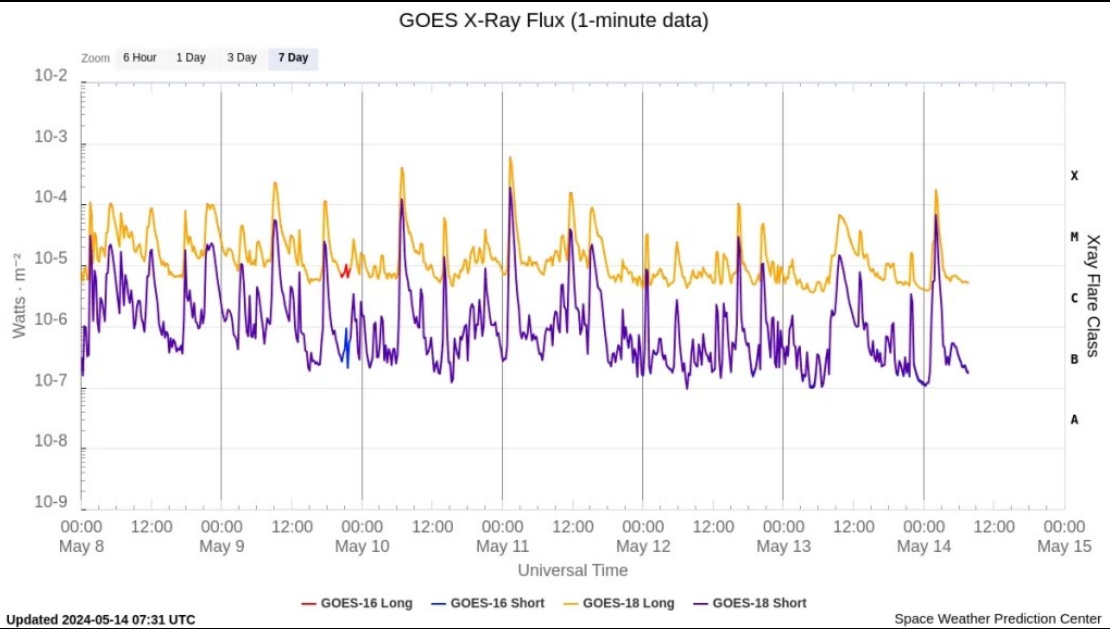
- AR3364 is similar to the active region that led to the Carrington event.
- As new flux emerged, an active region nest formed.
- In terms of free magnetic energy, helicity, net electric currents, etc., AR3364 has the potential to set new records.
- Question: why it did not produce very strong flares and fast CMEs?

AR3664: Prolific Activity



- AR3364 displayed extremely intense flaring activity.
- It also exhibited significant eruptive behavior – 16 CME events recorded.

A Moderate Solar Storm



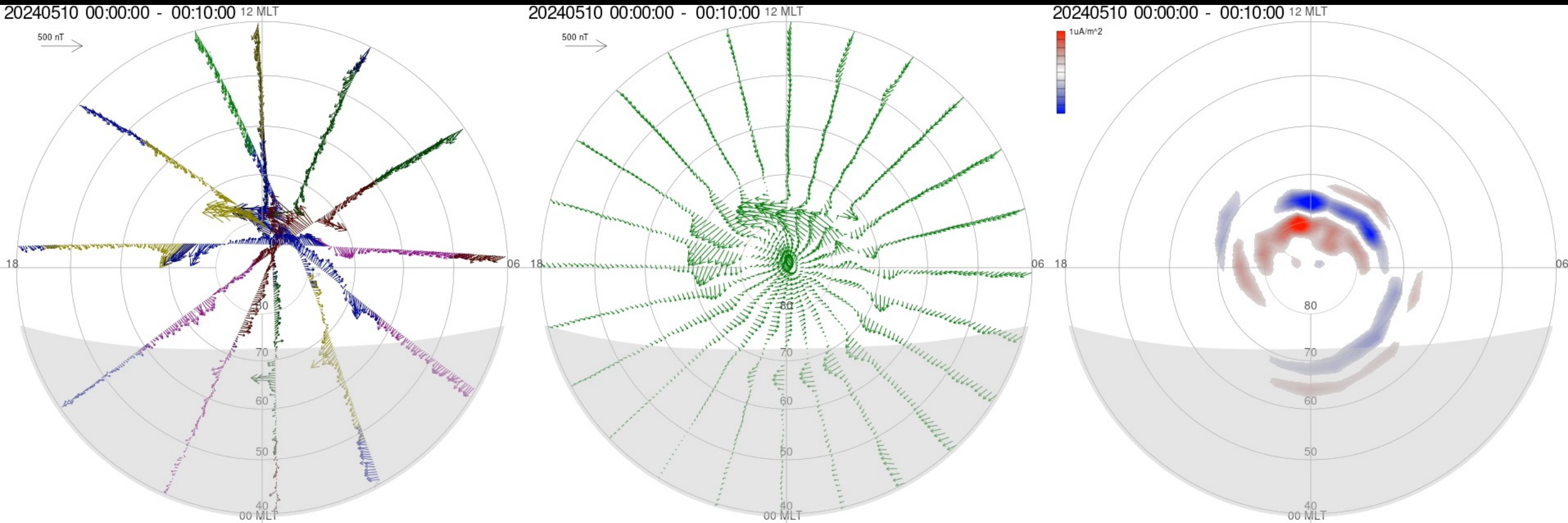
- Flare sizes were relatively moderate, peaking at X5.8 between May 1 and May 14, followed by an X8.7 flare later on May 14.
- CME maximum speed of ~1700 km/s.

No.	Flare Class	Flare Peak Time (UT)	Source Location	CME Direction	CME Velocity (km s ⁻¹)	Tilt Angle	Aspect Ratio	Half Angle
1	X1.0	May 8, 05:09	S17°W09°	S14°W09°	750	-63°	0.96	19°
2	M8.7	May 8, 12:03	S16°W10°	S10°W05°	850	-55°	0.95	15°
3	X1.0	May 8, 21:40	S18°W18°	S16°W07°	1240	-10°	0.72	9°
4	X2.2	May 9, 09:13	S18°W23°	S12°W23°	1480	-25°	0.84	8°
5	X1.1	May 9, 17:44	S15°W28°	S06°W26°	940	-3°	0.92	10°
6	X3.9	May 10, 06:54	S14°W34°	S10°W17°	1530	52°	0.62	6°
7	X5.8	May 11, 01:23	S15°W44°	S05°W25°	1660	58°	0.92	36°
8	M6.6	May 13, 09:44	S23°W80°	S36°W85°	1700	90°	0.70	25°

Liu et al. (2024)

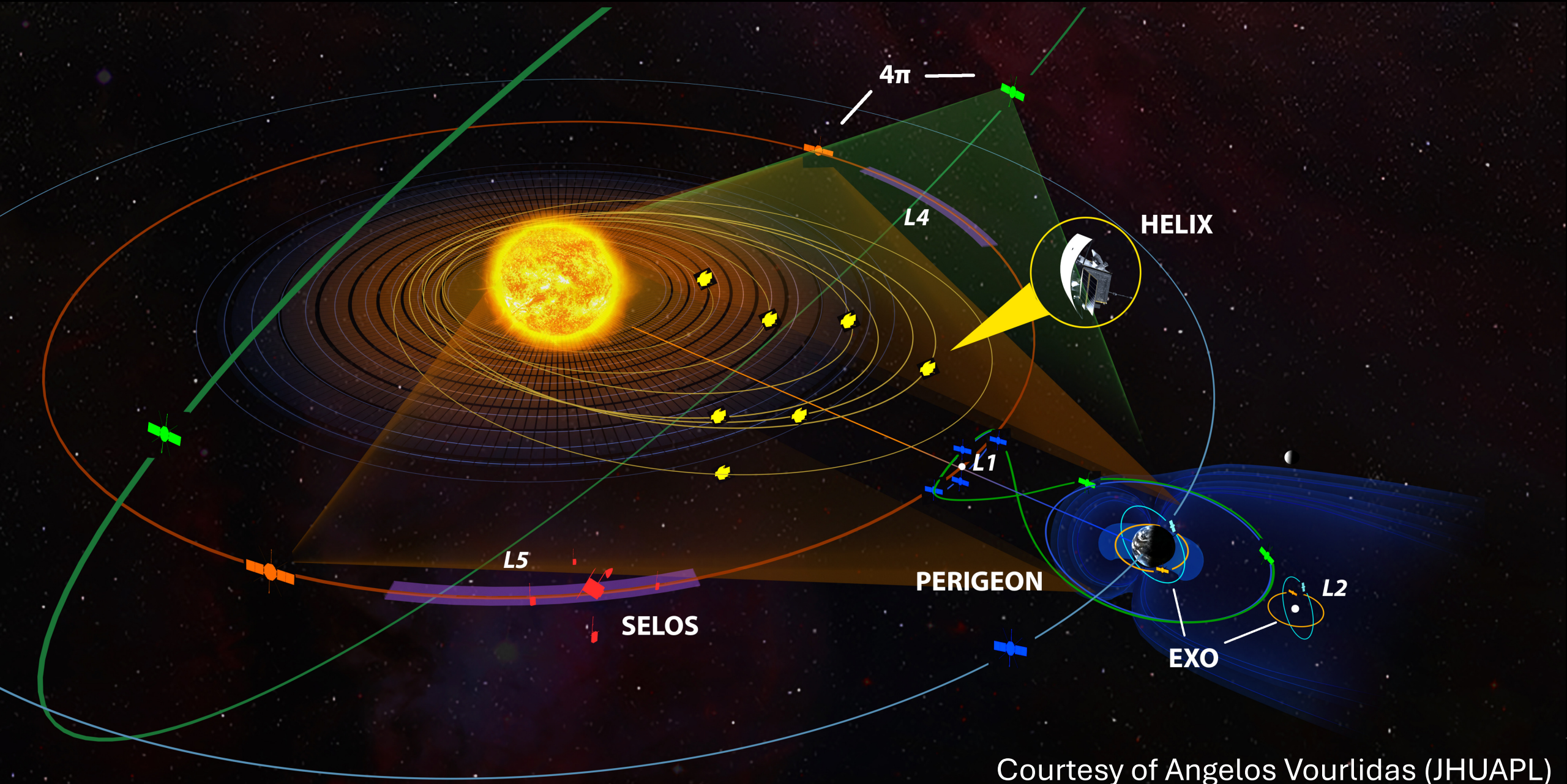
Strong Geospace Response

Courtesy of Brian Anderson (JHUAPL)



- Although solar activity was as strong as expected from AR3664, the combined effect of the two slower CMEs with other two faster ones led to the G5 storm.
- What would be the impact if the solar events were much stronger?

Charting the Path Ahead: What's Next?



Courtesy of Angelos Vourlidas (JHUAPL)