

Joint Functional Component Command for Space

JSpOC Weather Flight Operations and Conjunction Assessment



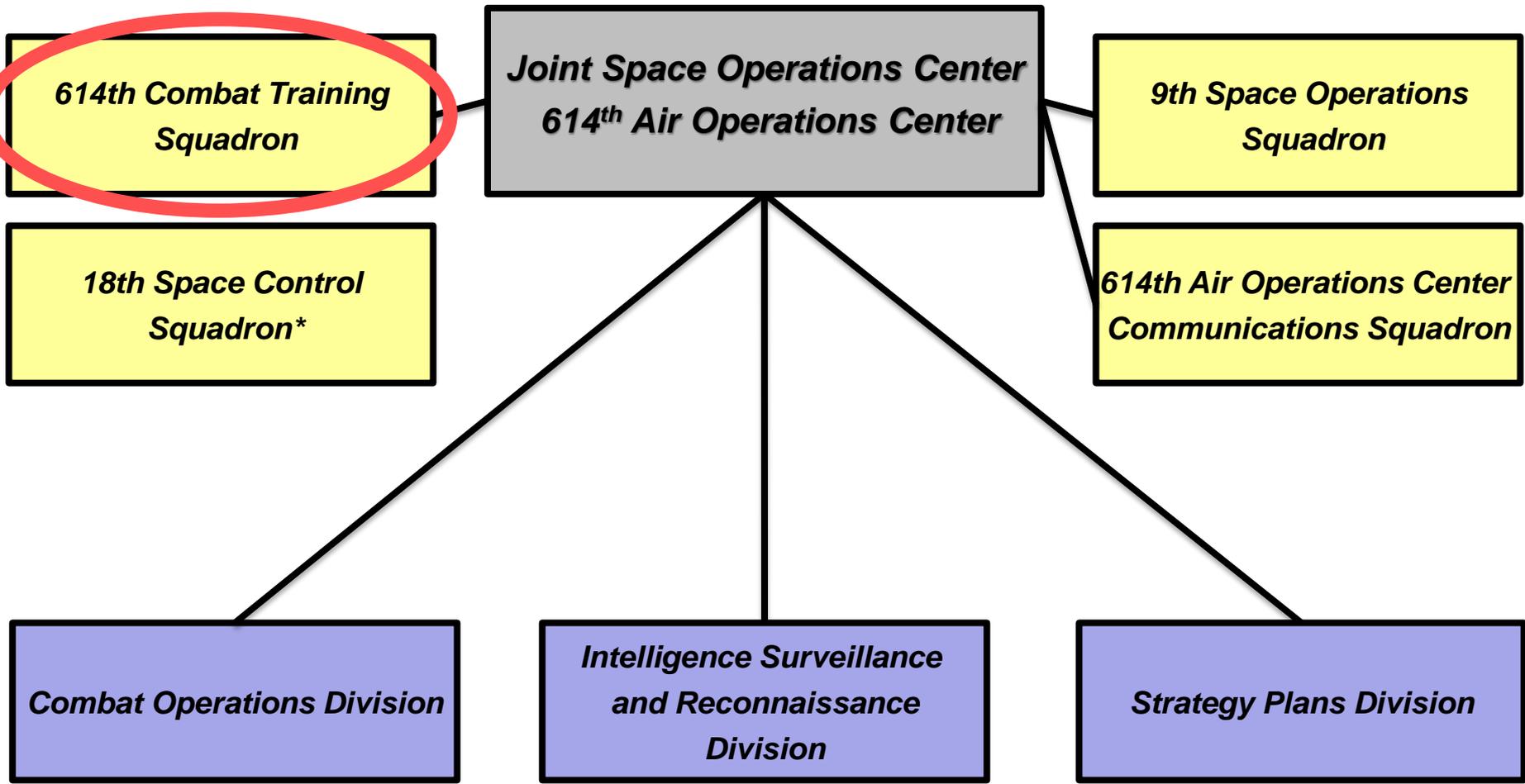
Frederick Schmidt
Captain, USAF
Flight Commander, 614 CTS/DOW



- **JSpOC Overview**
 - **614 CTS**
 - **614 CTS/DOW**
 - **Support Structure**
- **DoD in the Space Environment**
- **Severe Space Weather**
- **18 Space Control Squadron (18 SPCS)**
- **Geomagnetic Storming and Conjunction Assessment**



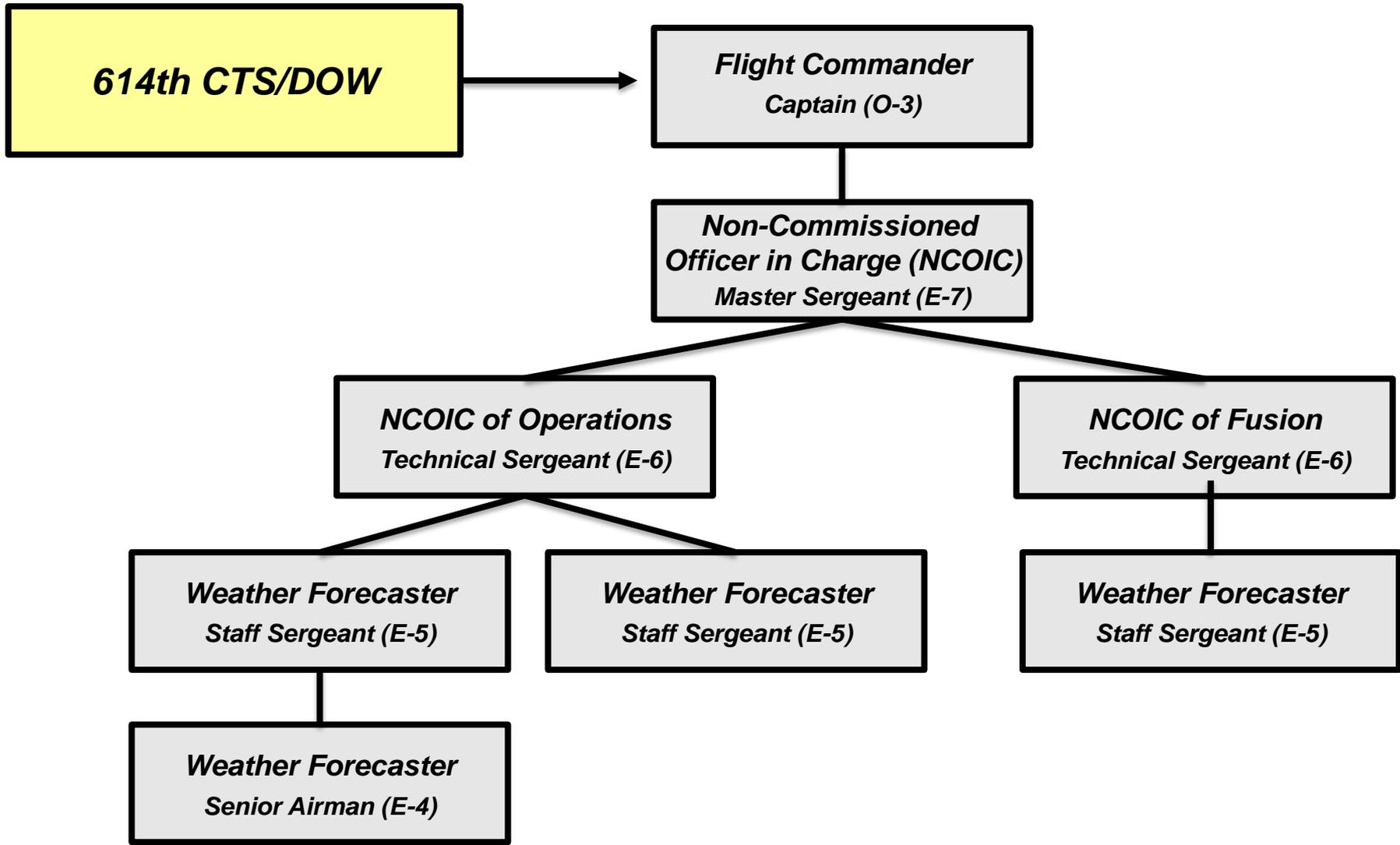
JSpOC Overview



**Under 21st Space Wing*



JSpOC Weather Flight Overview





614 CTS Weather Flight Support Structure

Combat Operations Division

- Anomaly Assessments (as needed)
- 3x Daily update brief (7 days/wk)
- Terrestrial/Space Weather support for JFCC Space Assets
- Exercise Participation

Strategic Planning Division (SPD)

- Briefing Support

Combat Training Squadron (CTS)

- Continuation Training for Crew Force (JFUNDS)

614 CTS/DOW Support

18 SPCS

- Real-time Notification of Space Weather Events
- Space Weather Forecast Products for Radar Sites

Vault

- 7-Day Terrestrial Weather Forecast

Intelligence, Surveillance and Reconnaissance Division (ISRD)

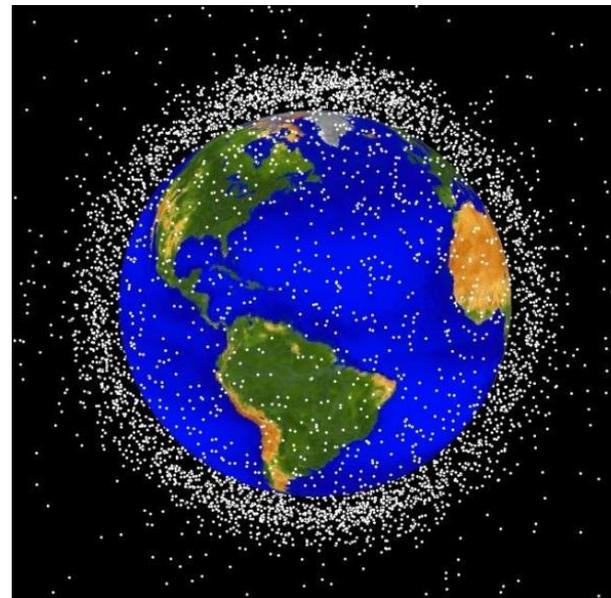
- Terrestrial/Space Weather Launch forecasts (M-F)
- 'Anomaly Assessments' misnomers and shortfalls



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DoD in the Space Environment

- The space domain is becoming increasingly more crowded
- More nations are putting satellites in space (military and commercial)



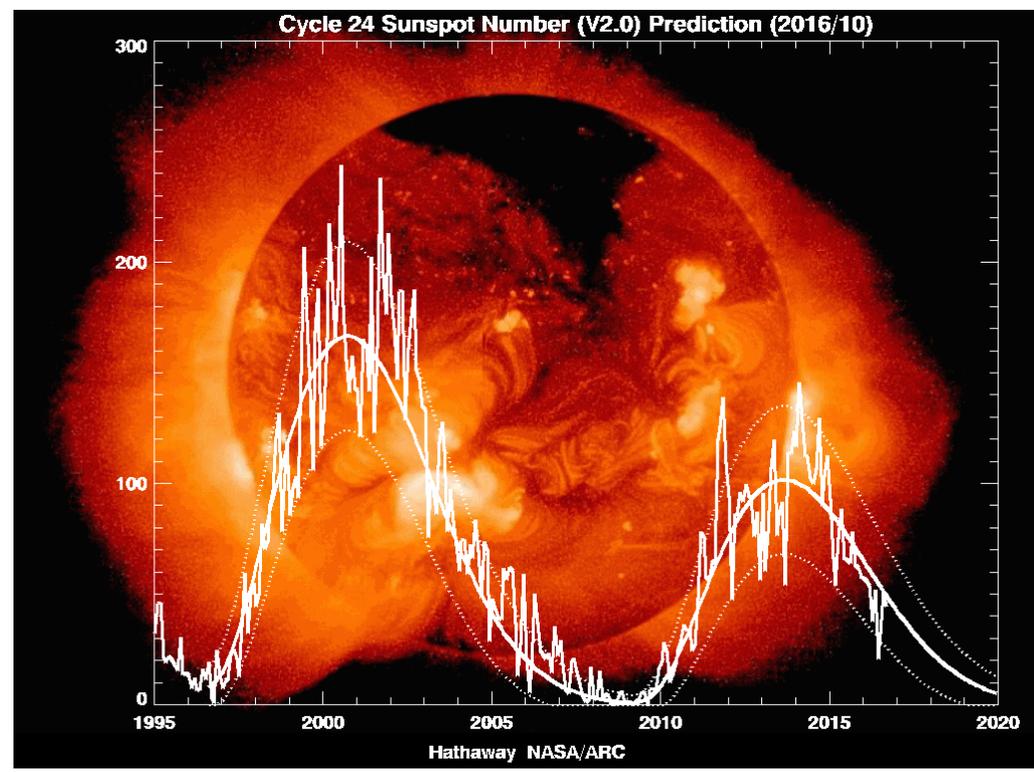
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DoD in the Space Environment

- Operators and decision makers must deal with inconvenient but inevitable space weather events
- The 614 CTS/DOW is charged with providing situational awareness to the Commander, Joint Functional Component Command for SPACE



- Communication is key. The current state of the solar cycle, solar minimum, can lead to complacency.

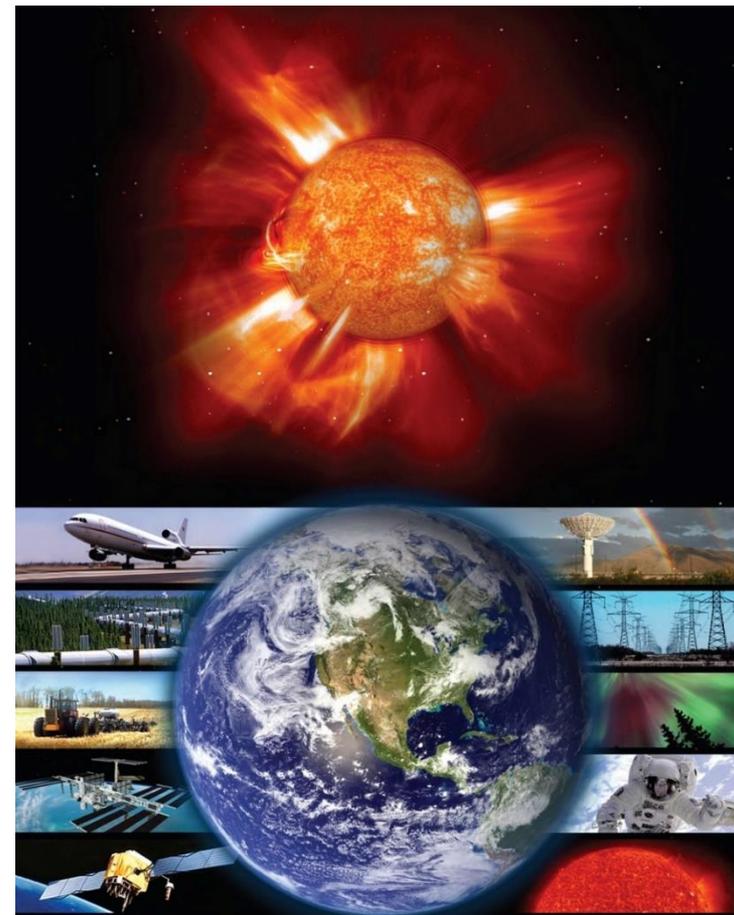
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Severe Space Weather

- JSpOC Requested Information
 - M5 – X class solar flares
 - Radio Bursts
 - Proton Events
 - Spacecraft Charging
 - Geomagnetic Storming
- All warnings/bulletins are received from the 557th Weather Wing's (557 WW) 2 Weather Squadron (2 WS)
- JSpOC issues a Space Advisory Warning Message (SAWM)

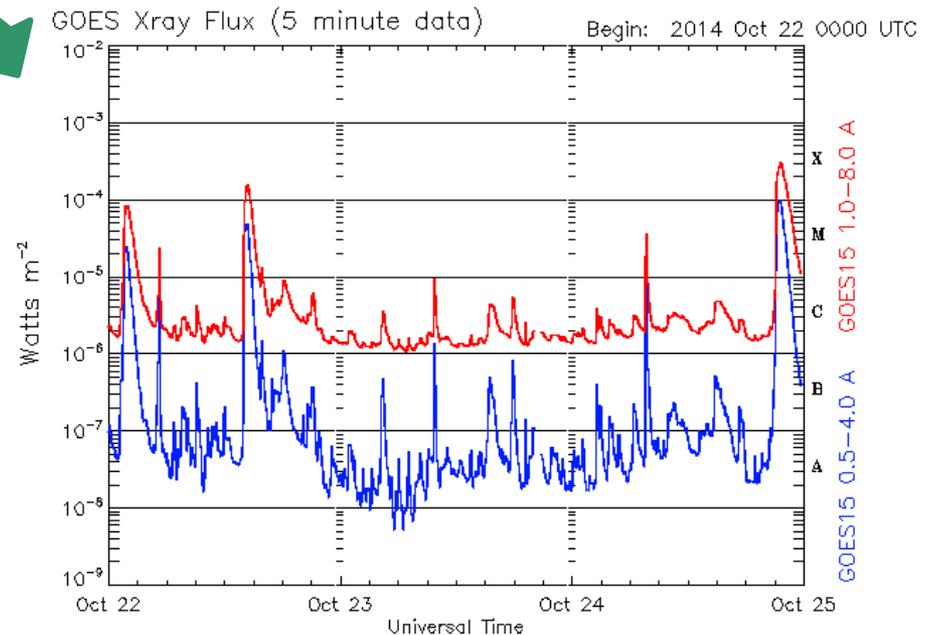
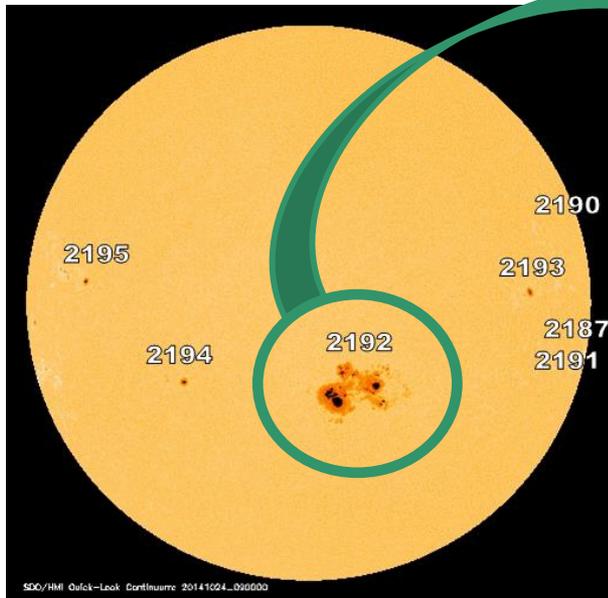


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Solar Flares

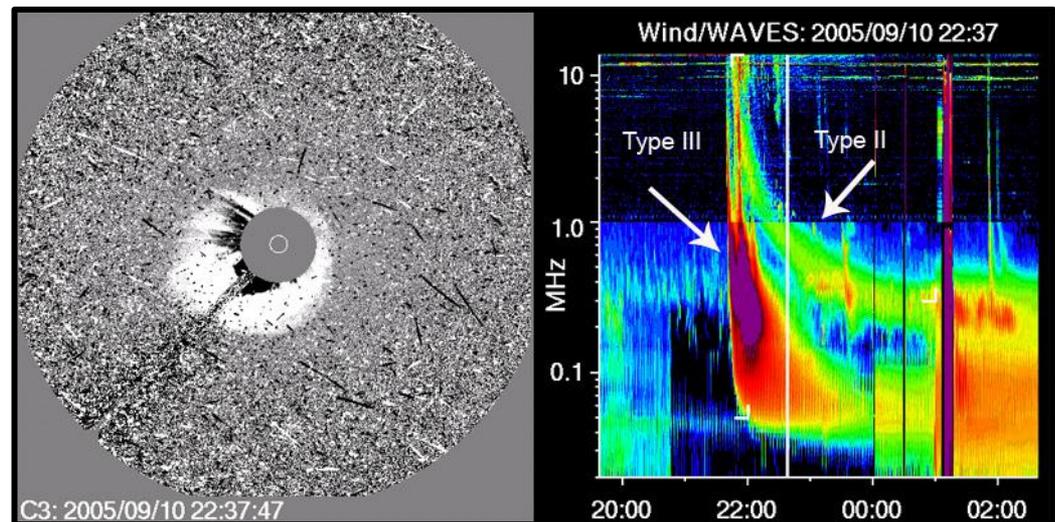
- Weather Duty Techs are constantly monitoring the X-ray Flux data.
- Bulletins are sent by the 2 WS when M5, X, and peak X-ray values are reached
- 15 min warning time notification after onset is required to the theater
- Source of several anomalies to space/terrestrial DoD assets





Radio Bursts

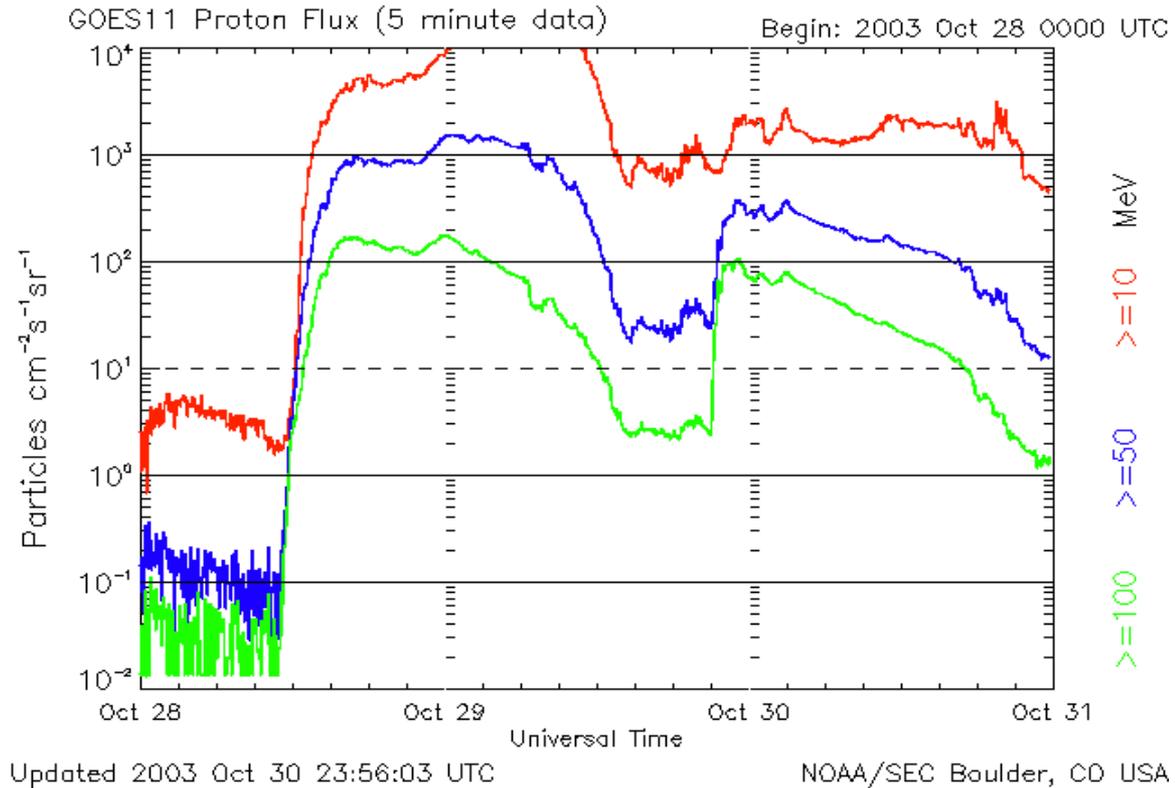
- Radio frequencies that become unusable from an influx of radiation and can severely hinder military communications
- The 2 WS issues bulletins of affected frequency(ies) which are relayed by the JSpOC Weather Duty Technicians to the theater
- 15 minute warning time notification after onset is required to the theater





Energetic Particle Events

- Warnings based upon measurements from GOES satellite
- Impacts Include:
 - Internal/external charging on satellites
 - Sensor degradation
 - Threats to high-altitude fliers/astronauts
 - Degradation to communications
- 15 minute warning time notification after onset is required to the theater

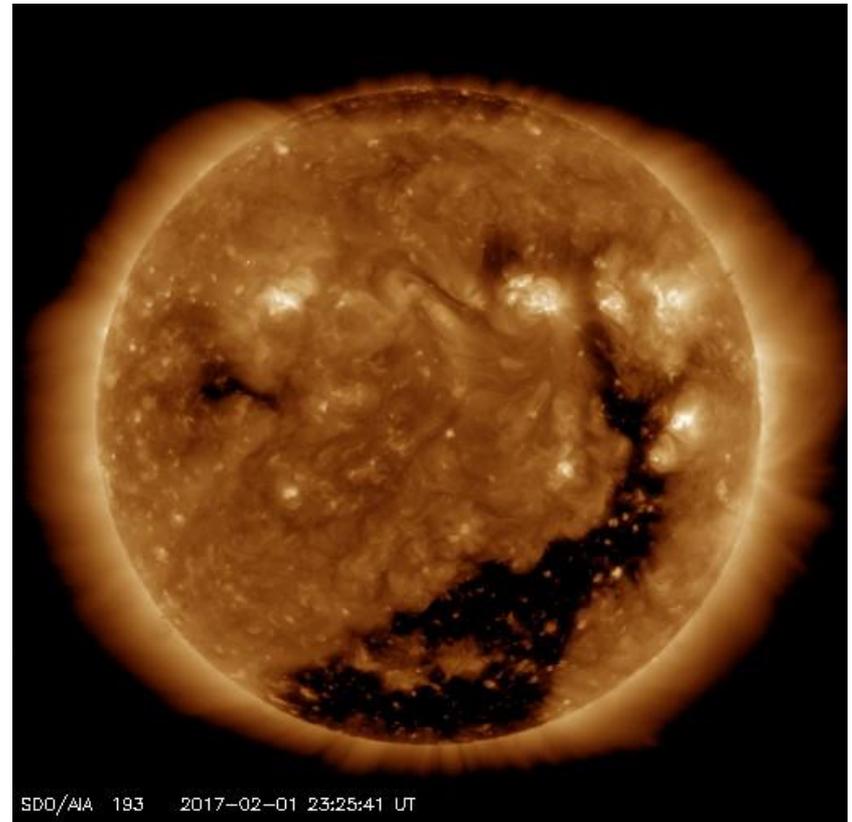




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Spacecraft Charging

- Follows extended periods of fast solar winds
- Build-up of high energy electrons on the inside & outside of satellites
 - Geosynchronous and highly elliptical orbits are more vulnerable
- Common anomalies are single event upsets (SEUs)
- 30 minute warning time notification after onset is required to the theater

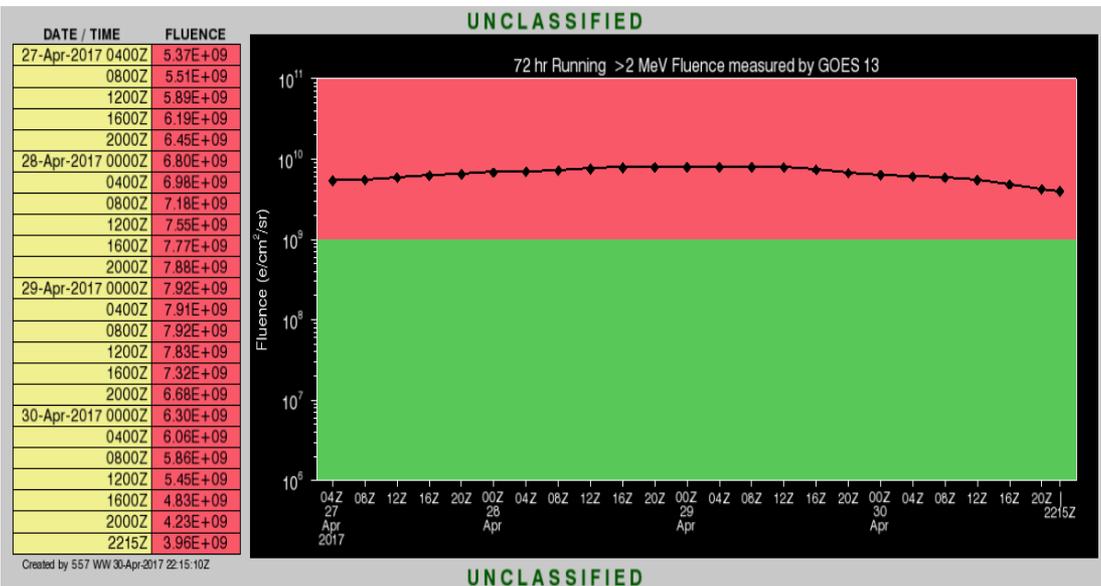
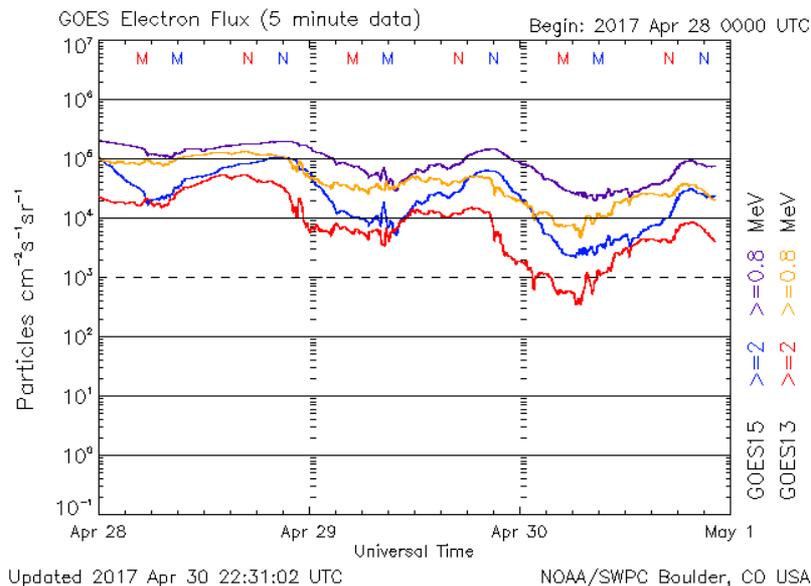


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Spacecraft Charging Cont.

- Determined from the GOES electron ≥ 2 MeV sensor
- Flux values are converted to a 3-day fluence
- This accounts for extended exposure to high flux values

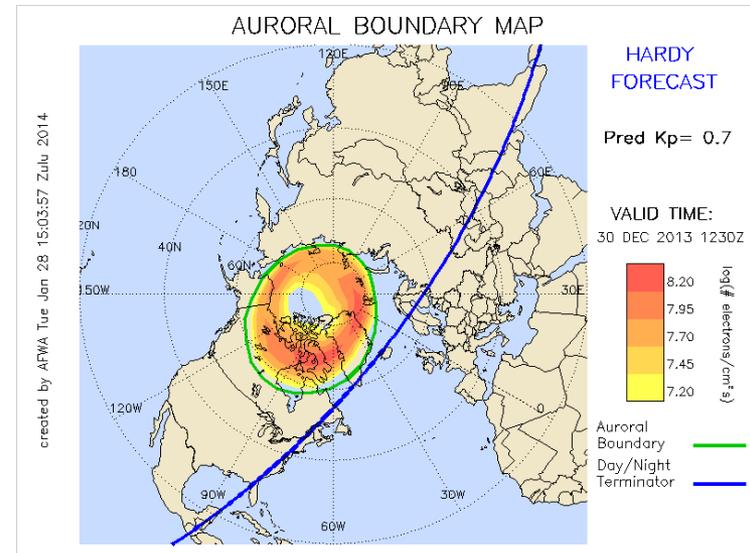
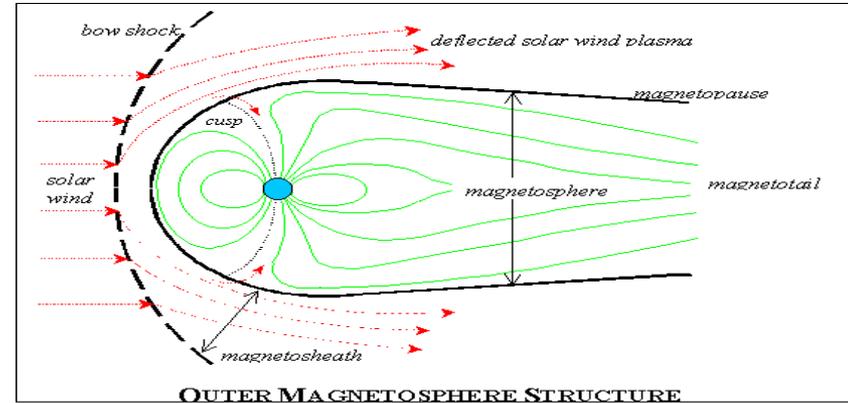


DATE / TIME	FLUENCE
27-Apr-2017 0400Z	5.37E+09
0800Z	5.51E+09
1200Z	5.89E+09
1600Z	6.19E+09
2000Z	6.45E+09
28-Apr-2017 0000Z	6.80E+09
0400Z	6.98E+09
0800Z	7.18E+09
1200Z	7.55E+09
1600Z	7.77E+09
2000Z	7.88E+09
29-Apr-2017 0000Z	7.92E+09
0400Z	7.91E+09
0800Z	7.92E+09
1200Z	7.83E+09
1600Z	7.32E+09
2000Z	6.68E+09
30-Apr-2017 0000Z	6.30E+09
0400Z	6.06E+09
0800Z	5.86E+09
1200Z	5.45E+09
1600Z	4.83E+09
2000Z	4.23E+09
2215Z	3.96E+09

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Geomagnetic Storming

- The Earth's magnetosphere is often disrupted by the solar environment
 - Elevated solar winds
 - Coronal Mass Ejections
 - Southward oriented Interplanetary Magnetic Field
- Impacts include:
 - Limitations to HF/UHF communications
 - Surface charging while passing through the aurora boundary
 - Increased atmospheric drag on LEO satellites





USAF Magnetometer Values

- The JSpOC weather flight uses an hourly report of the 3-hour a_p value produced by the 2 WS
- The 3-hour a_p value is a quasi-linear conversion of the commonly used K_p value
- The values are broken down into named criteria
 1. Quiet: 0-7
 2. Unsettled: 8-15
 3. Active: 16-29
 4. Minor Storming: 30-49
 5. Major Storming: 50-99
 6. Severe Storming: ≥ 100

MAGNETOMETER ANALYSIS FOR 12 JUL 16
24 HOUR SUMMARY OF 3-HOURLY MAX GAMMA DEFLECTIONS/K INDICES

	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-00
MEANOOK	69/3	304/5	724/6	1500/7	101/3	35/2	51/3	68/2
SITKA	67/3	105/4	142/3	208/4	80/3	30/1	32/2	47/3
OTTAWA	59/3	116/4	88/4	79/4	26/2	20/1	32/2	46/3
SAINT JOHNS	51/3	65/4	74/4	69/4	33/3	29/3	28/2	33/3
NEWPORT	53/3	100/4	119/4	120/4	25/2	29/2	29/2	46/3
FREDERICKSBU	37/3	60/5	58/4	45/3	20/2	18/1	23/2	28/3
BOULDER	39/3	72/4	95/5	48/3	15/1	23/1	30/3	33/3
HARTLAND	31/3	52/4	46/4	37/4	13/0	25/2	21/2	33/3
FRESNO	25/3	49/4	65/4	54/4	16/2	22/2	26/3	28/3
3-HOUR a_p	22	39	39	32	9	7	12	18
3-HOUR K_p	4M	5M	5M	4P	2P	2P	3M	3P
24-HOUR a_p	12	16	20	23	23	23	23	22
99999								

Minor Storming

Quiet



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Geomagnetic Storming Actions

- The hourly a_p values are sent out 15 minutes after the hour
- When Minor – Severe Storming thresholds are met, we notify the Crew Chief and supported units within 30 minutes
- Severe Geomagnetic Storming warrants a SAWM and caused action to be taken by the 18th Space Control Squadron (18 SPCS)

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Space Environment Analysis

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	Observed				Today				Forecast								
	4/18/2017	4/19/2017	4/20/2017	4/21/2017		4/22/2017		4/23/2017		4/24/2017		4/25/2017	4/26/2017				
Space Weather Threat																	
Flare Activity/ Radio Burst																	
Charged Particles (Protons)																	
Spacecraft Charging (Electrons)																	
Geomagnetic Activity																	
	Reported Impacts				Today				Forecast								
	4/18/2017	4/19/2017	4/20/2017	4/21/2017		4/22/2017		4/23/2017		4/24/2017		4/25/2017	4/26/2017				
Space Weather Impacts																	
Spacecraft Operations																	
Space Object Tracking																	
Radar Operations																	
Communications (HF/UHF/GPS)																	

Space Weather Features:
Solar activity is currently at low levels. Low levels are forecast for the remainder of the period with a slight chance for M class flares.

Space Weather Phenomena:
Geomagnetic activity is currently at Active levels. Extremely fast solar wind speeds are expected to vary between Active and Major levels through 23-24 Apr.

Charged Particles
Proton levels are at low levels. Low levels are forecast for the remainder of the period. Energetic Electrons are expected to reach spacecraft charging levels on 24 Apr.

Acronyms

CH: Coronal Hole
HSS: High Speed Stream
CME: Coronal Mass Ejection

Legend

Low
Medium
High
No Report

VT: 23 Apr 17 / 0230Z

CAO: 23/1400Z Apr 17

Contact Info: JSpOC Weather Flight
DSN: 276-4234 COMM: (805) 606-4234 EMAIL: 614aocodw@us.af.mil

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- Squadron primarily responsible for space situational awareness (SSA)
- Life cycle Includes:
 - Tracking objects
 - Space Surveillance Network (SSN)
 - >30,000 tasking's per day
 - 18 Sensor Sites
 - Identify
 - Catalogue
 - Reentry Assessment
 - Break-up Process
 - Conjunction Assessment
 - Detect
 - Launch Support
 - Launch Conjunction Assessment

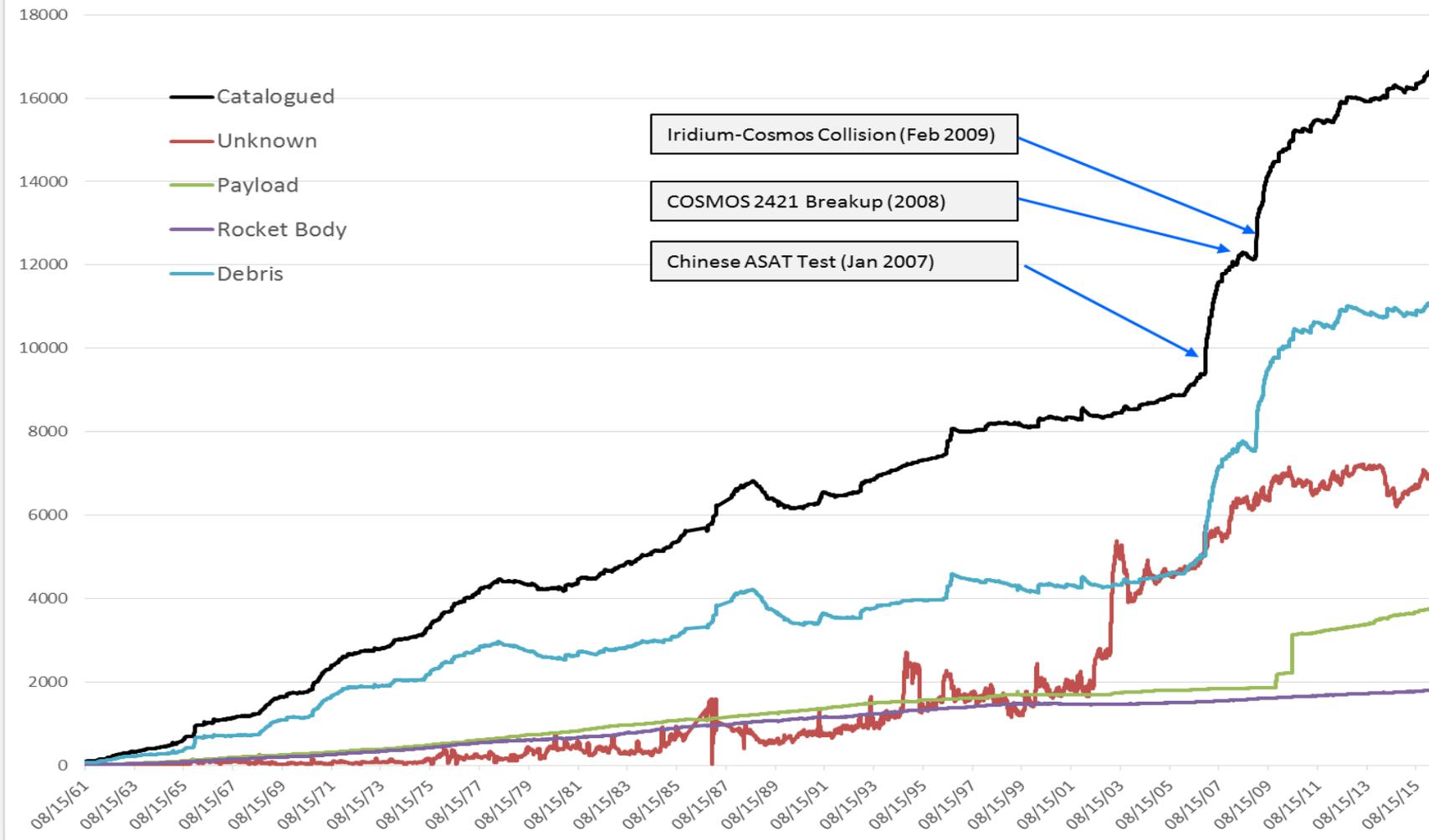




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Satellite Catalog Growth

Objects in Orbit from Aug 1961 to Present



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Geomagnetic Storming and Conjunction Assessment

- 18 SPCS needs hourly a_p values to account for changes to the thermosphere
- Heating of the thermosphere increases neutral density and leads to increased atmospheric drag on satellites
- Severe geomagnetic storming thresholds ($a_p > 100$, $K_p \sim 7$) cause the model to account for increased atmospheric drag
- The Astrodynamics Support Workstation (ASW) is a system run by the 18 SPCS technicians. It initiates a timer for 72 hours during and after severe geomagnetic storming ends to account for the potential errors in tracking
- The JSpOC Weather Flight provides radar tracking forecasts and geomagnetic storming forecast durations. These are received from the 2 WS and tailored for the 18 SPCS
- Accurate forecasts are key to successful conjunction assessment

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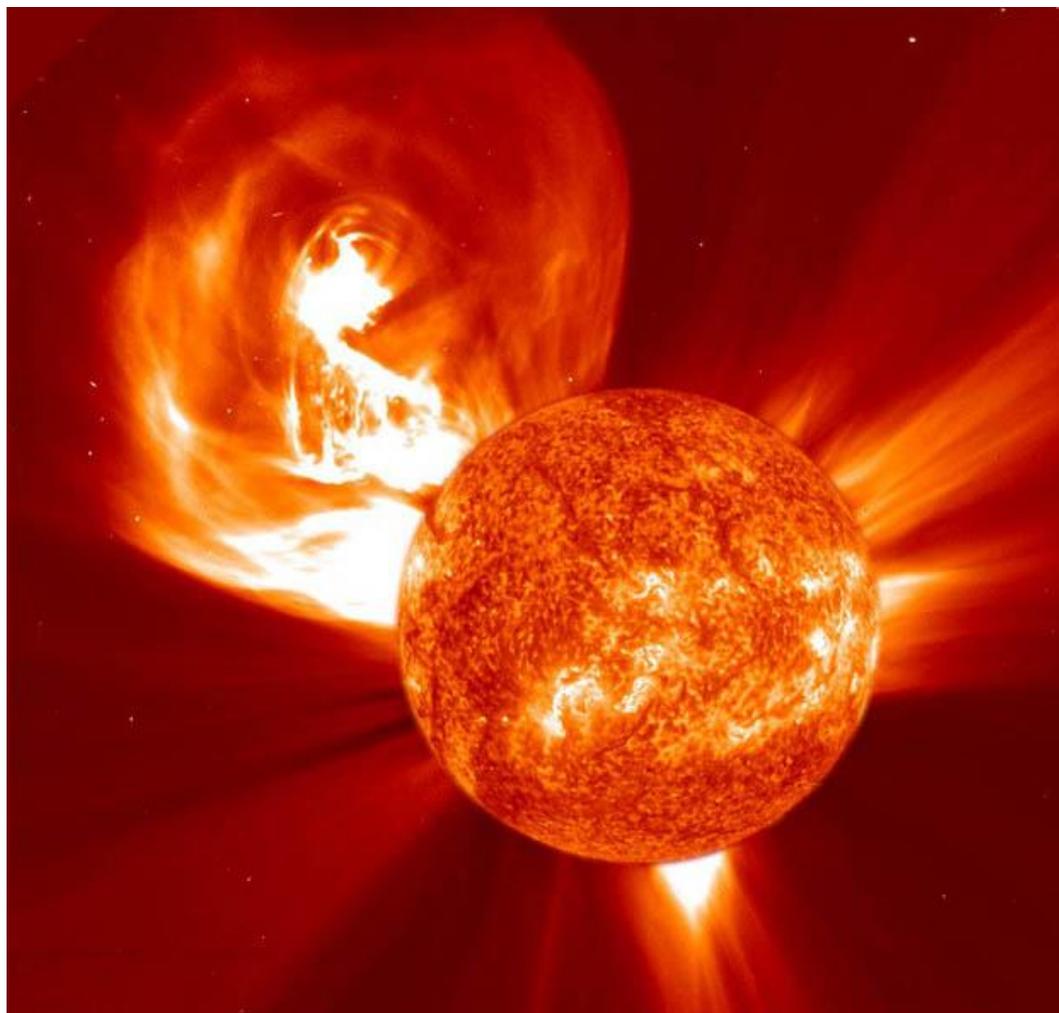
Summary

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Questions?



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