

# GOES-19 SpWx Product Validation and Its Transition to GOES East

Presented to CGMS-53 JOINT WGI-WGIV-SWCG Working Group  
Agenda 1.2, paper CGMS-53-NOAA-WP-12

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## Executive summary of the WP

The Geostationary Operational Environmental Satellite – 19 (GOES-19) was launched as GOES-U on June 25, 2024 and renamed when it reached orbit. After the Post-Launch Test (PLT) and commissioning, the NASA to NOAA handover took place on January 29, 2025. Product validation started as part of PLT and culminated in two reviews for each instrument.

Reviews for the CCOR-1 coronagraph were held in January and February 2025 immediately after which the public release of imagery products started. First, the Space Weather Prediction Center (SWPC) released the real-time, preliminary products while the National Centers for Environmental Information (NCEI) made the archived versions of these products available provisionally at the NOAA Open Data Dissemination (NODD) until the NESDIS Common Cloud Framework (NCCF) is ready for hosting the data. Second, NCEI has generated retrospective products and will make them available through NCCF as well.

Currently, the satellite is drifting to its operational location. On April 4, it will be declared as GOES East and its products will then be considered operational.

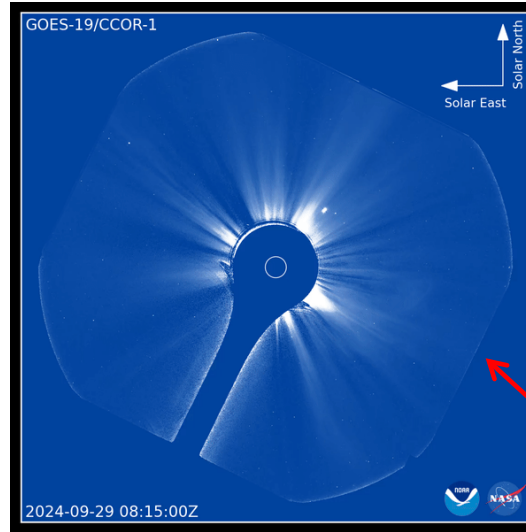
## Satellite and SpWx Instruments

- GOES-U, the fourth satellite in the Geostationary Operational Environmental Satellite (GOES) program, was launched on June 25, 2024 and renamed GOES-19 when it reached orbit.
- It carries several SpWx instruments including the new Compact Coronagraph 1 (CCOR-1).



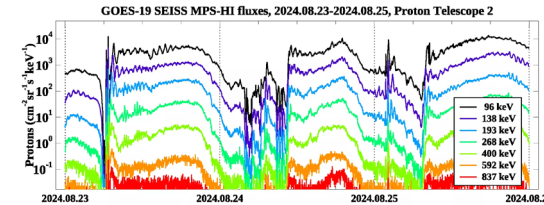
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### CCOR-1

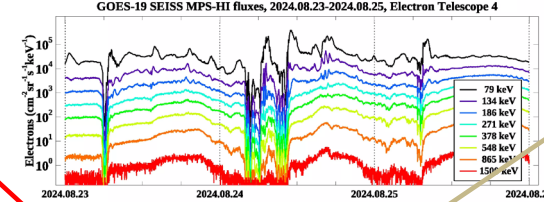


### SEISS

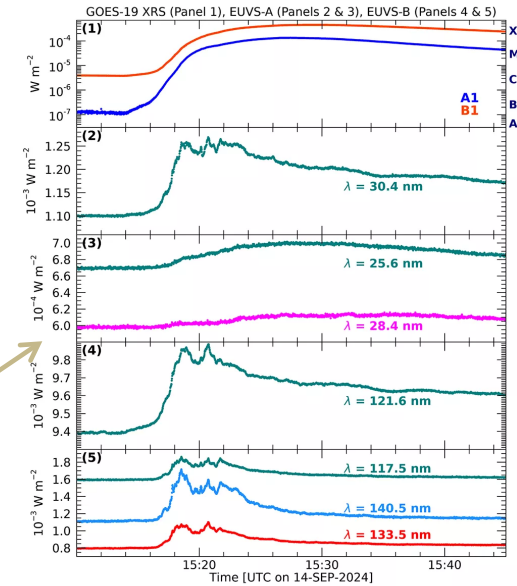
#### MPS-Hi Protons



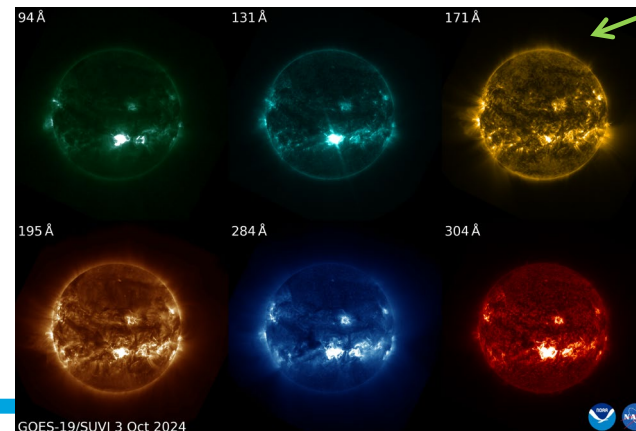
#### MPS-Hi Electrons



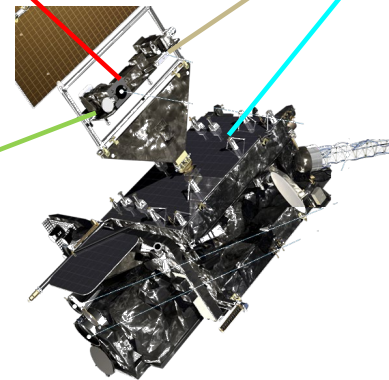
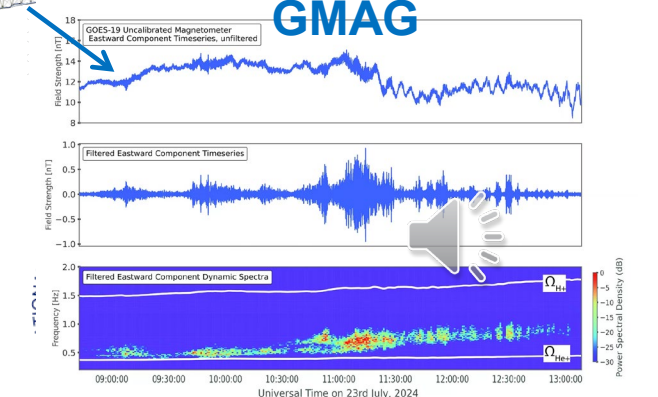
### EXIS



### SUVI



### GMAG



## GOES-19 Product Portfolio

- The GOES-19 portfolio is common to all satellites of the Program, except for CCOR-1 which is hosted on the satellite but the products are developed by the Space Weather Follow On (SWFO) program.

### CCOR in NODD

Coronal White Light Intensity

### ABI L1b in GRB, PDA, CLASS, NODD

Radiances

### GLM L2 in GRB, PDA, CLASS, NODD

Lightning: Events, Groups, Flashes

### SEISS L1b in GRB, PDA, CLASS, NODD

Energetic Heavy Ions

Magnetospheric e<sup>-</sup>/p<sup>+</sup>: Low Energy

Magnetospheric e<sup>-</sup>/p<sup>+</sup>: High Energy

Solar & Galactic Protons

### EXIS L1b in GRB, PDA, CLASS, NODD

Solar Flux: EUV

Solar Flux: X-ray Irradiance

### SUVI L1b in GRB, PDA, CLASS, NODD

Solar EUV Imagery

### GMAG L1b in GRB, PDA, CLASS, NODD

Geomagnetic Field

Legend: \* Enterprise Algorithm

Some products also delivered via HRIT/EMWIN and GNC-A

### ABI L2+ Products in PDA, AWIPS, CLASS, NODD

Cloud and Moisture Imagery (CMI) and Sectorized CMI (KPP)

Aerosol Detection (Smoke & Dust) \*

Aerosol Optical Depth \*

Clear Sky Mask \*

Cloud Cover Layers \*

Cloud Optical Depth \*

Cloud Particle Size Distribution \*

Cloud Top Height \*

Cloud Top Phase \*

Cloud Top Pressure \*

Cloud Top Temperature \*

Derived Motion Winds \*

Derived Stability Indices

Downward S/W Radiation: Surface \*

Fire/Hot Spot Characterization

Ice Age & Thickness \*

Ice Concentration & Extent \*

Ice Motion \*

Land Surface Albedo \*

Land Surface Reflectance \*

Land Surface Temperature \*

Legacy Vertical Moisture Profile

Legacy Vertical Temperature Profile

Rainfall Rate/QPE

Reflected S/W Radiation: TOA \*

Sea Surface Temperature

Snow Cover \*

Total Precipitable Water

### GLM L2+ Products in AWIPS

Gridded Flash Extent Density, Minimum Flash Area, Total Optical Energy



[GOES-R PRO]

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### GOES-19 Commissioning and Product Validation

- Functional, performance, and quality tests were completed during the Post-Launch Test (PLT) stage which was accompanied by product development and validation.
- The Post-Launch Assessment Review (PLAR) was completed on January 21, the Handover Readiness Review (HRR) on January 28, and the handover from NASA to NOAA took place on January 29.
- The PLT stage of GOES-19 ended in Product Validation Reviews (PS-PVRs) for each instrument and its data. Following the second such review (“Provisional”) for an instrument, NOAA has started to publicly release the real-time images.
- An important part is intercalibration with earlier GOES satellites, especially the current GOES East and West.
- Intercalibration is a key process as NOAA prepares to contribute to the GEO ring for space weather observations. Intercalibrations are planned with NASA missions (SDO), international missions (KOMPSAT; in the future: Himawari-10), and others.



## GOES-19 Commissioning and Product Validation

today

Activity	Jun	July					August					September					October					November					December					January					February					March					April					May																							
	6/25	7/2	7/9	7/16	7/23	7/30	8/6	8/13	8/20	8/27	9/3	9/10	9/17	9/24	10/1	10/8	10/15	10/22	10/29	11/5	11/12	11/19	11/26	12/3	12/10	12/17	12/24	12/31	1/7	1/14	1/21	1/28	2/4	2/11	2/18	2/25	3/4	3/11	3/18	3/25	4/1	4/8	4/15	4/22	4/29	5/6	5/13																												
	L+0	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147	154	161	168	175	182	189	196	203	210	217	224	231	238	245	252	259	266	273	280	287	294	301	308	315	322																												
GOES-U Events	▲ Raise to Launch 89.5W		▲ GOES-U = GOES-19																												PLT & PLPT																				▲ Handover to OSPO										Drift to 75.2W					▲ GOES-19 = GOES-East									
GOES-U Maturity			ABI 1st Public Image ♦					▲ ABI L1b/CMI/L2+ Beta															▲ ABI L1b/CMI Provisional					▲ ▲ ▲ ▲					▲ ABI L2+ Groups Provisional																																										
								GLM 1st Public Image ♦																				▲ GLM Beta										▲ GLM Provisional																																					
								EXIS 1st Public Data ♦										▲ EXIS Beta																				▲ EXIS Provisional																																					
			GMAG 1st Public Data ♦															▲ GMAG Beta															▲ GMAG Provisional																																										
			SEISS 1st Public Data ♦															▲ SEISS Beta					▲ SGPS Provisional					MPS-Hi, EHIS ▲					▲ MPS-Lo Provisional																																										
								SUVI 1st Public Image ♦										▲ SUVI Beta										SUVIETC Jan 14-28					▲ SUVI Provisional																																										
							CCOR 1st Public Image ♦																				▲ CCOR Beta					▲ CCOR Provisional																																											

Legend: ♦ 1st Public Image ▲ Beta Maturity ▲ Provisional Maturity GRB data distro commences upon Beta Maturity. PDA & AWIPS data distro commences by subscription status.

<p>Activation includes:</p> <ul style="list-style-type: none"> <li>Initial power-on of instruments</li> <li>Outgassing</li> <li>Final configuration before calibrating and testing</li> </ul>	<p>Observatory testing validates operability and performance is as expected in on-orbit conditions demonstrating continuous, uninterrupted L0 data may be used to generate calibrated L1b products</p>	<p>Post-Launch Product Testing (PLPT)</p> <p>Validation of L1b and L2+ products:</p> <ul style="list-style-type: none"> <li>Execute test plans (RIMPs)</li> <li>Hold maturity reviews for all science products</li> <li>Manage data dissemination</li> </ul>
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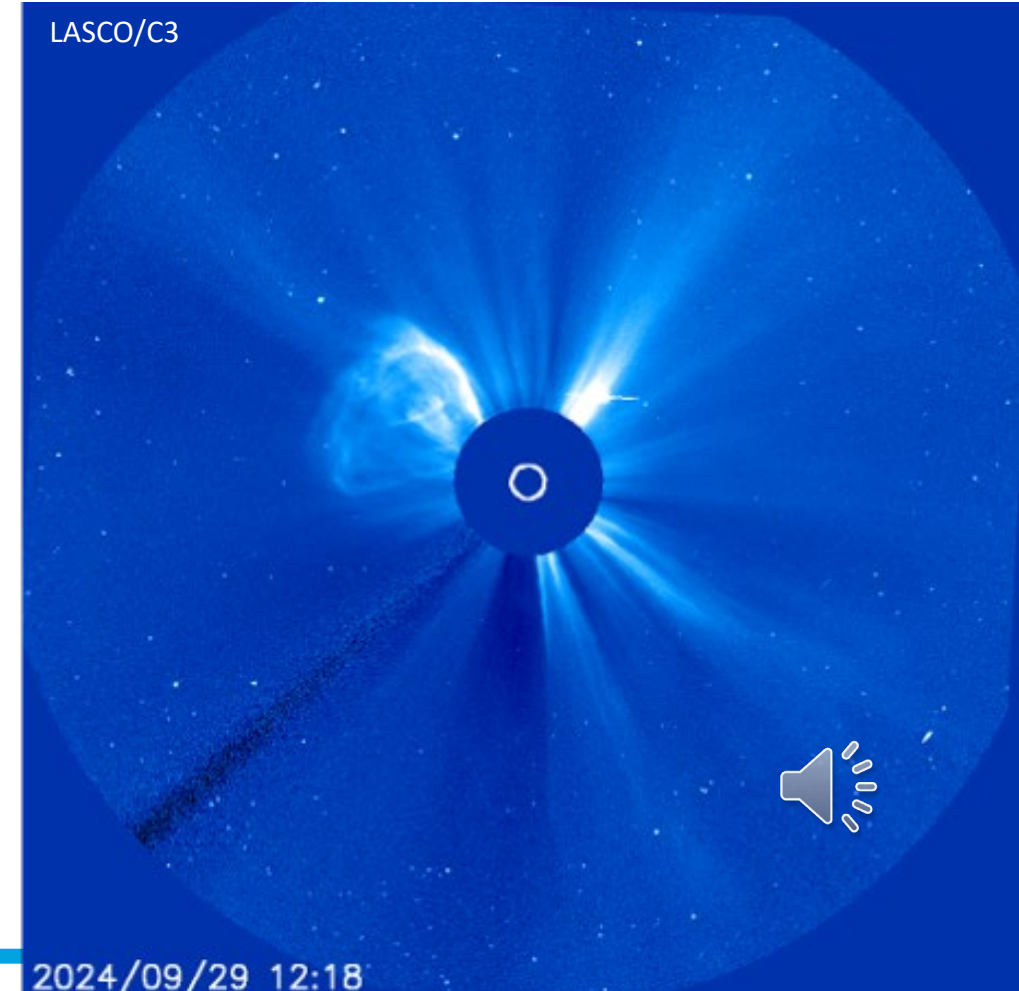
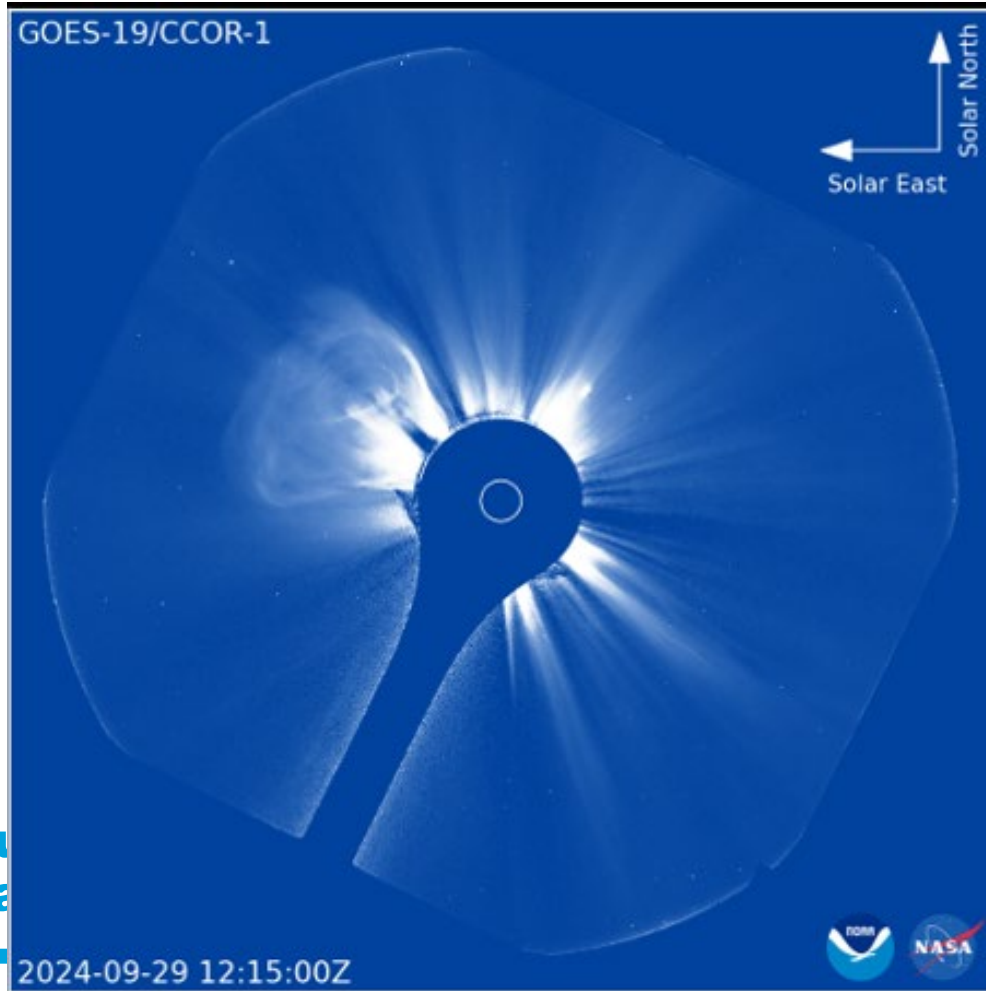
[GOES-R PRO]

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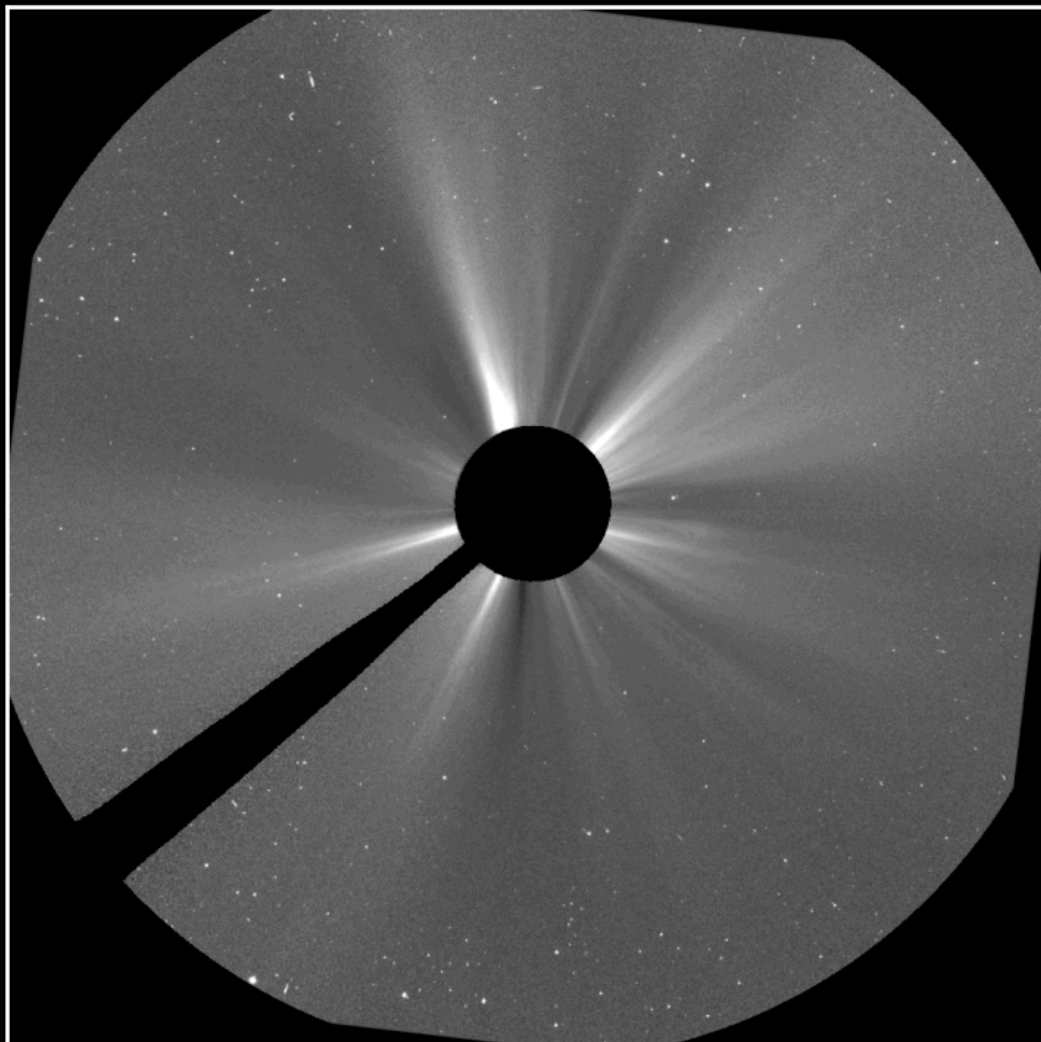
## CCOR-1 Performance

- A new observational capability from GEO is coronal imagery, thanks to the NRL-built CCOR-1 designed to detect coronal mass ejections (CMEs) over a radial range of 3.7-17  $R_{\text{Sun}}$ .
- The operational coronagraph has low latency (30-min req., <25-min perf.) and high availability (96% req.). Its 15-min cadence is highly stable, and is comparable to that of the legacy instrument, LASCO/C3 (12 min).
- Its performance is an improvement to that of LASCO/C3 in several respects:
  - Higher angular resolution (50 arcsec)
  - Wider dynamic range ( $10^{-11}$  -  $10^{-8}$   $B_{\text{Sun}}$ )
  - Quieter background (S/N)

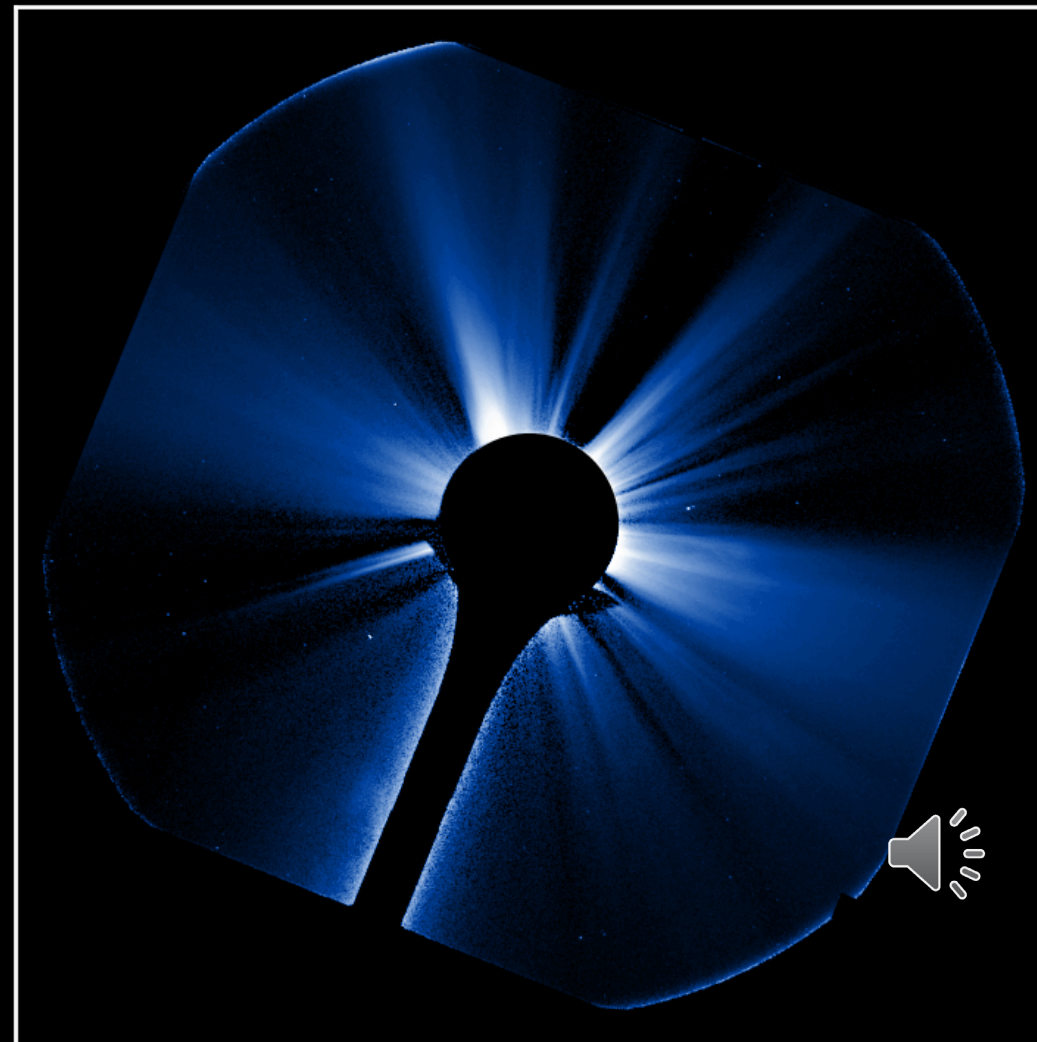


CCOR-1 Performance

LASCO/C3  
2024-11-09 07:06:08



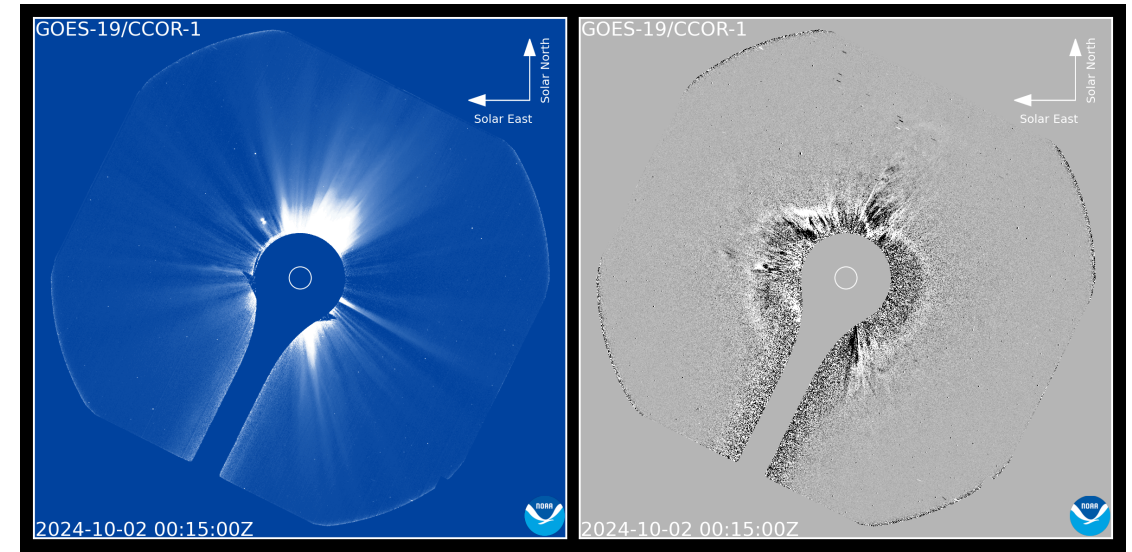
GOES-19/CCOR-1  
2024-11-09 07:00:20



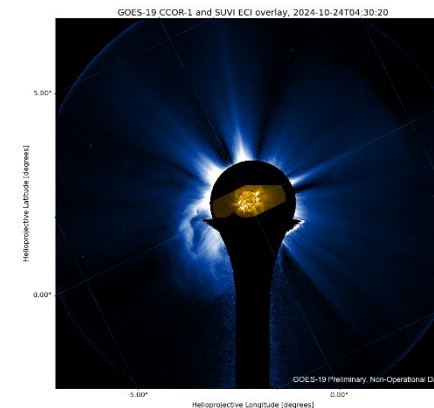


## Selected Observations and Statistics

- CCOR-1 has observed numerous CMEs (halos, limb events), streamers, several shocks, and other structures.
- It has recorded few SEPs thanks to the dynamic Cosmic Ray Scrubbing (CRS) which eliminates bad pixels resulting in higher image quality than LASCO/C2/C3.
- Due to its orbit, CCOR-1 is subject to two eclipse periods per year, lasting approximately 6 weeks and peaking at the two equinoxes. In addition, earthshine (forward scattering of sunlight at the Earth's limb due to ocean/cloud high albedo) produces brief, but intense intensity increases even far from the equinoxes.
  - Mitigation steps have been developed and are being refined for both effects.
- It has also observed celestial objects such as planets, the Moon, and comets ranging from bright (T-Atlas C/2023 A3; C2024 S1) to extremely faint. Using CCOR-1 images, NASA's Sungrazers citizen science project has discovered 12 comets up to this point.



*Regular/differenced images featuring CMEs and other solar and celestial objects*



*CCOR-1 & SUVI superposition*



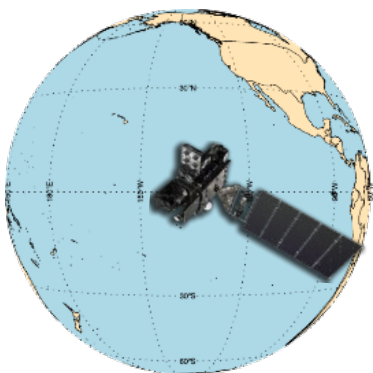
*Comet C2024 S1*



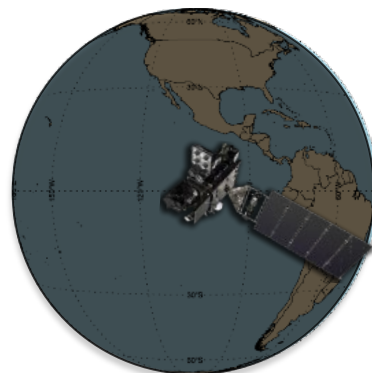
## SpWx Products Through the GEO Ground Segment

- SpWx data flow are delivered by the GEO infrastructure.

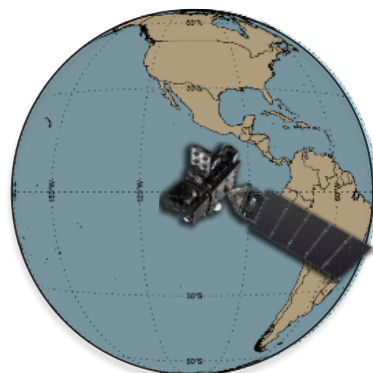
GOES-West  
GOES-18  
137.0°W



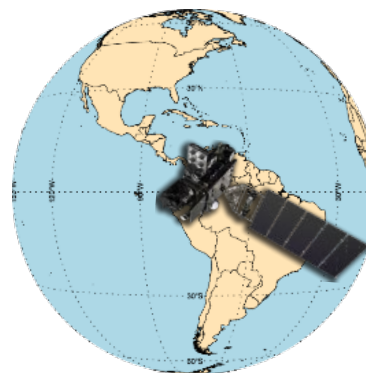
GOES Standby  
GOES-17  
104.7°W



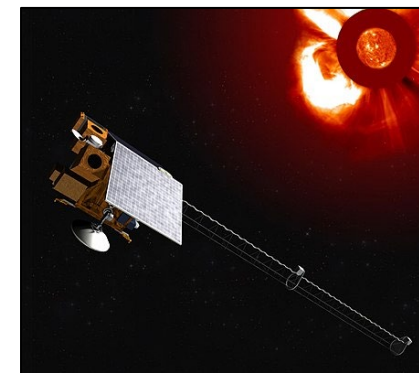
GOES-Test  
GOES-19  
89.5°W DRIFTING EAST



GOES-East  
GOES-16  
75.2°W



SWFO-L1 (9/2025)  
SOL-1  
S-E Lagrange 1



EXIS  
G-Magnetometer  
SEISS  
SUVI

EXIS  
Magnetometer  
SEISS  
SUVI

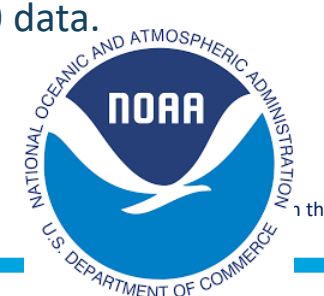
CCOR-1  
EXIS  
G-Magnetometer  
SEISS  
SUVI

EXIS  
Magnetometer  
SEISS  
SUVI

CCOR-2  
-  
Magnetometer  
SWiPS, STIS  
-

- For GOES, L0 and L1b are generated and distributed from GEO Ground Segment except for CCOR-1 L0 data.
- For SWFO-L1, L0 data will be generated by GEO Ground Segment and sent to SWPC.

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## Distribution of GOES-19 SpWx Data Products

- After the PLT activities were largely completed (with the exception of earthshine measurements which will last several more months), data products were evaluated for operational and general use in two reviews per instrument: the beta and provisional-maturity Product Validation Reviews.
- For the four traditional GOES-R SpWx instruments, NOAA will be releasing the operational data at the Space Weather Prediction Center (SWPC) and the archived ones at the National Centers for Environmental Information (NCEI).
- For CCOR-1, SWPC started released the real-time products on an experimental basis <https://www.swpc.noaa.gov/products/ccor-1-coronagraph-experimental> on February 25 after the provisional PS-PVR was completed. FITS, JPEG, MP4, and other products are available at: <https://services.swpc.noaa.gov/experimental/products/swfol1/ccor-1/>

These should be considered preliminary, pre-operational data until April 4.

- On March 5, NCEI started making the archived versions of the same pre-operational CCOR-1 products available at the NOAA Open Data Dissemination (NODD) <https://www.ncei.noaa.gov/products/space-weather/swfo> until the NESDIS Common Cloud Framework (NCCF) is ready for hosting the data on a permanent basis.
- In addition, NCEI has generated retrospective products and is planning to provide access through NCCF.
- Documentation on CCOR-1 and other SWFO products, algorithms, and science is available at <https://www.nesdis.noaa.gov/our-satellites/future-programs/swfo/swfo-data-products-and-science>

## GOES East Transition Plan

- GOES-19 is currently drifting towards the operational longitude of 75.2 W. On April 4, 2025 it will replace GOES-16 to become GOES East.
- GOES-16 will drift to 105 W and enter storage mode.

today →

Date	GOES-16		GOES-19	
	Location	Activity	Location	Activity
6/25/24 – 7/24/24	75.2°W	GOES-East Operations		Launch and Orbit Raising
7/25/24 – 1/25/25			89.5°W	<b>GOES-19 PLT and PLPT</b> <ul style="list-style-type: none"> <li>First public ABI Image (Vis &amp; IR) @ 89.5°W</li> <li>GRB turned on and L1b added upon beta maturity</li> </ul>
1/28/25				GOES-19 Handover Readiness Review (HRR)
1/29/25				GOES-19 Handover to NOAA
1/29/25 – 3/17/25				<b>GOES-19 Pre-Drift Product Checkout</b> <ul style="list-style-type: none"> <li>Planned for future events to avoid G17 Storage Checkout (3/10 – 3/29)</li> </ul>
3/17/25 – 4/1/25		GOES-16 “nudge” to 75.5°W		<b>GOES-19 Drift from 89.5°W to 75.2°W</b> <ul style="list-style-type: none"> <li>~1 deg/day drift</li> <li>GRB Off for drift</li> </ul>
4/1/25	75.5°W	<b>GOES-16 in co-location configuration</b> <ul style="list-style-type: none"> <li>X-Band and S-Band downlink for colocation</li> </ul>	75.2°W	<b>GOES-19 arrives at 75.2°W and instruments resume</b> <ul style="list-style-type: none"> <li>X-Band and L-Band downlink after drift for colocation</li> </ul>
4/1/25 – 4/4/25		<b>GOES-16 in co-location configuration</b> <ul style="list-style-type: none"> <li>X-Band and S-Band downlink</li> </ul>		<b>GOES-19 Post-Drift Product Checkout at new location</b> <ul style="list-style-type: none"> <li>X-Band and L-Band downlink</li> </ul>
4/3/25				GOES-19 Operational Transition Readiness Review (OTRR)
4/4/25		<b>X-band downlink off and instruments shut down</b> <ul style="list-style-type: none"> <li>End GOES-16 GRB Broadcast</li> </ul>		<b>GOES-19 Declared operational GOES-East</b> <ul style="list-style-type: none"> <li>Begin GOES-19 GRB broadcast / nominal distribution</li> <li>SAR/DCS/HRIT/EMWIN services transitioned to GOES-19</li> </ul>
4/4/25		<b>Begin GOES-16 drift to 105°W</b> <ul style="list-style-type: none"> <li>Drift using LTRs</li> <li>~0.5 deg/day max drift rate</li> </ul>		
6/4/25	105°W	<b>GOES-16 arrival at 105°W followed by storage mode</b> <ul style="list-style-type: none"> <li>GOES-17 to relocate to 89.5W (Storage Location) after GOES-16 arrival confirmed successful</li> </ul>		

[GOES-R PRO]

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## Key issues of relevance to CGMS:

- GOES-19 provides a range of solar imagery/irradiance and in situ particle/magnetic-field products. NOAA uses the X-ray irradiance (measured by XRS) and solar energetic particles (SEISS/SGPS) to define two of its SpWx scales. All products have wide and long-term usage.
- The transition to GOES East following the product validation ensures continuity of high-quality data. The use of CCOR-1 expands the product range and usefulness to a wide range of users worldwide.
- Relevance to HLPP 2024-2028:
  - 1.1.6 Ensure continuity of coronagraph observations: CCOR-1 improves on the objective
  - 4.1 Establish a fully consistent calibration of relevant satellite instruments across CGMS agencies: the validation of GOES-19 SpWx products contributes to objective
  - 6.2 Investigate feasibility of a consistent inter-calibration for energetic particle measurements: the validation of GOES-19 SpWx products contributes to objective
  - 6.5 Ensure the timely access to and global exchange of space weather data of CGMS Members, including instruments hosted on third-party satellites: contributes to objective.

## To be considered by CGMS:

- In summary, observations from the GOES-R Program satellites contribute to the CGMS goals for space and terrestrial weather. GOES-19 SpWx product validation has been completed successfully up to the provisional (second) level. The GOES-19 satellite is ready to become the operational GOES East in early April 2025.
- For endorsement: NA
- For actioning: NA