GOES-18 EXIS EUVS

L1b Full Maturity Peer Stakeholder-Product Validation Review (PS-PVR)

November 17, 2023

Presenter

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Contributors

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Summary

- GOES-18 behavior is similar to GOES-16 & GOES-17 analyzing L1b & L2 science-quality data
- GPA: Many ADRs have been submitted and most have been resolved. Some ADRs remain open.
- Instrument: Some issues remain but overall the instrument performance is within requirements
- All PLPTs: PASSED
- Full Validation Product Maturity Assessment: PASSED

PLPT = Post-Launch Product Test

GPA = Ground Processing Algorithm

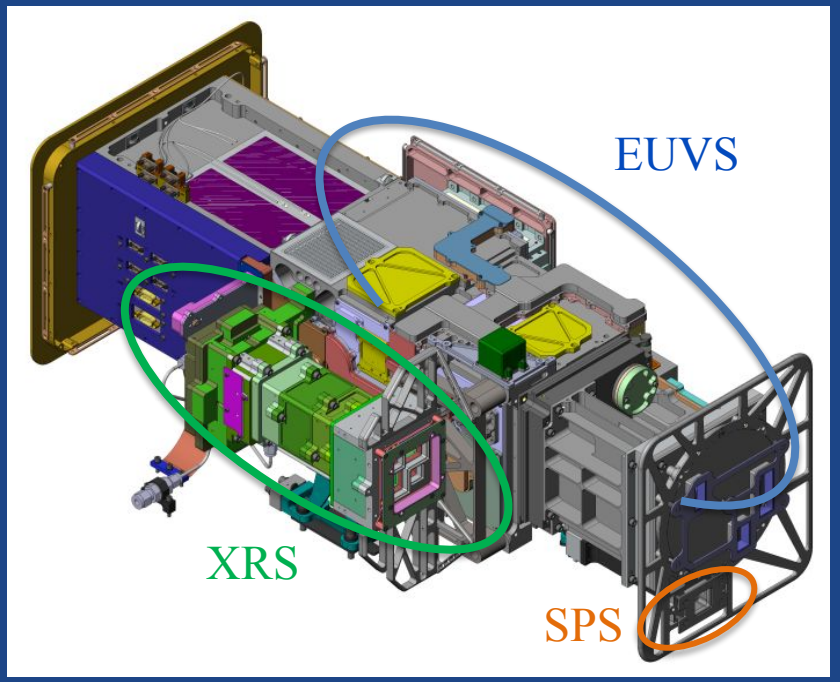
ADR = Algorithm Discrepancy Result

LUT = Look-Up Table

EXIS Overview

EUV and X-Ray Irradiance Sensors (EXIS)

- X-Ray Sensor (XRS)
  - Monitor solar flares
    - Impacts communications and navigation
    - Warns of potential SEP events



- Extreme Ultraviolet Sensor (EUVS)
  - Measures ultraviolet irradiance which impacts upper atmosphere

- Sun Pointing Sensor (SPS)
  - Used for alignment (quad diode, 3.5° FOV)

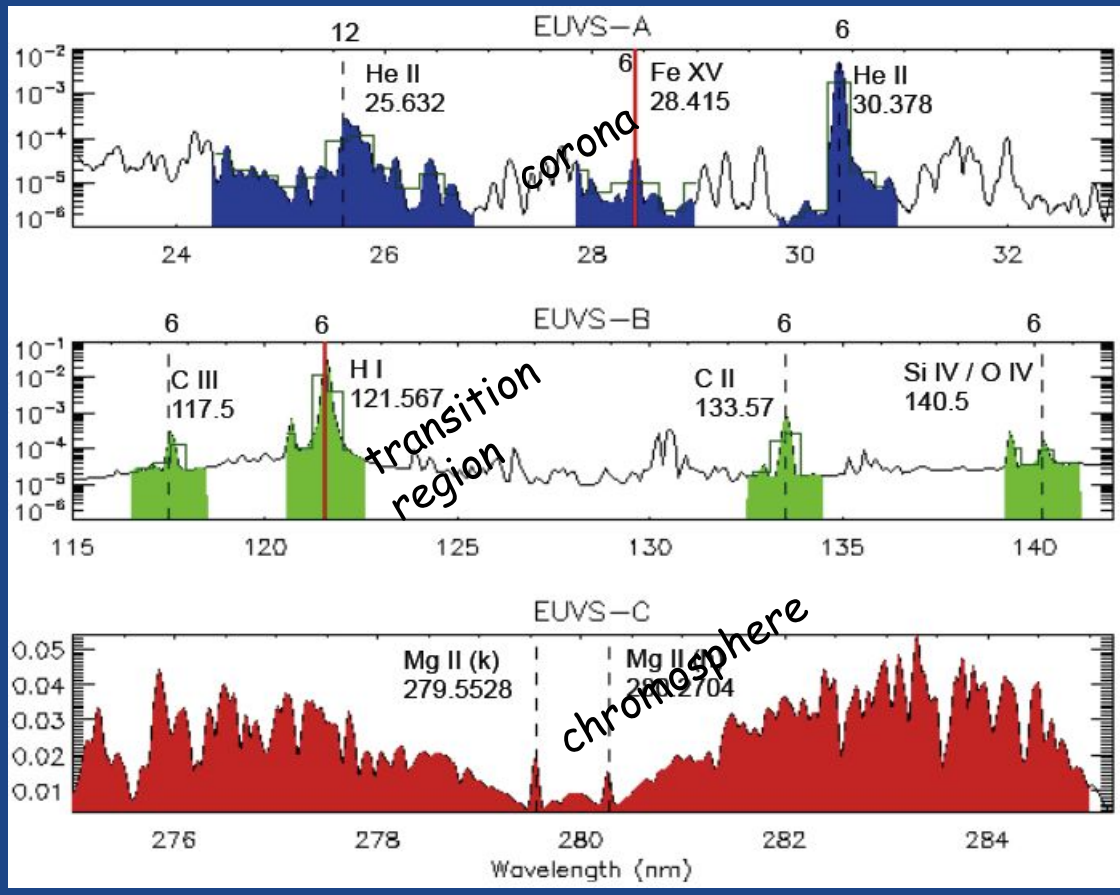
EXIS was designed, built and tested by the Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado

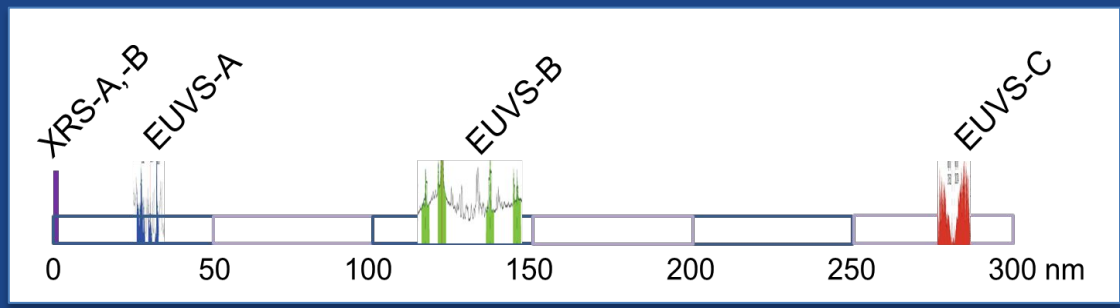
Extreme Ultraviolet Sensor (EUVS)

- Requirements
  - ≤ 30 s cadence
  - ≤ 20% accuracy
  - Spectral model (5-127 nm)

- 3 Grating Spectrographs
  - EUVS-A: 24 diode array, filter wheel
  - EUVS-B: 24 diode array
  - EUVS-C: 512 diode array

- L1b Products
  - 7 solar lines
  - Mg II index
  - Spectral model (5-127 nm)
  - High-resolution data (L2)



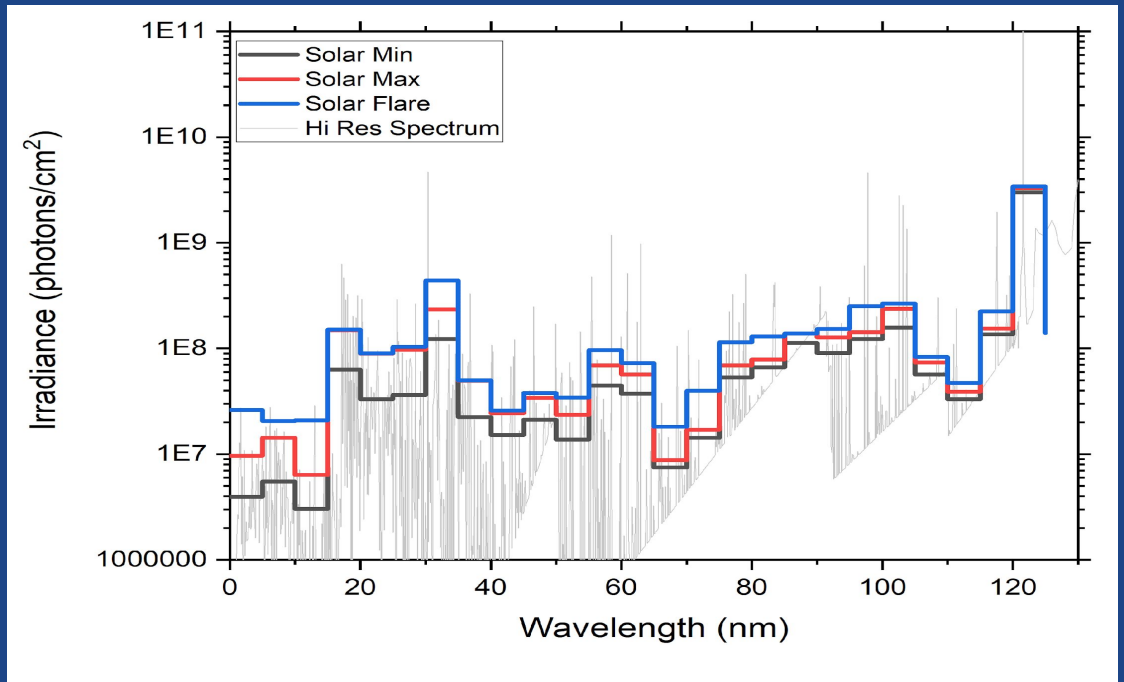


EUVS Sensor

- Primary Measurements Used in Spectral Model:
  - Chromospheric:
    - MgII C/W (EUVS-C)
    - CIII 117.5 nm (EUVS-B)
    - CII 133.5 nm (EUVS-B)
  - Transition Region:
    - Ly-alpha 121.6 nm (EUVS-B)
    - SiIV/OIV 140.5 nm (EUVS-B)
    - HeII 30.4 nm (EUVS-A)
    - HeII 25.6 nm (EUVS-A)
  - Corona:
    - FeXV 28.4 nm (EUVS-A)
  - Hot Coronal:
    - 0.1-0.8 nm (XRS)
    - 0.05-0.4 nm (XRS)

EUVS Science

- EUV (10-120 nm) and soft X-ray irradiance create the ionosphere and heat the thermosphere
- Solar EUV irradiances change by factors of 2 to 50 on times scales of minutes to years
- The thermosphere (neutral density) and ionosphere (electron density) change by similar amounts across all time scales
- EUV / X-ray irradiances have the highest variability
- < 0.01% of total solar irradiance (TSI)
- Total solar irradiance (TSI) varies by 0.1% while EUV varies by <2, X-rays by $<10^5$



Why Measure EUV Variability?

- Air Force High Accuracy Satellite Drag Model (HASDM)
  - Calculates and predicts neutral density and satellite position for collision avoidance
  - Users: DOD, NASA, NOAA, Every satellite operator in the US

- Variations in solar EUV by up to a factor of 10 increase have major impacts for satellites in low Earth orbit (LEO)
  - More EUV irradiance causes more heating in the thermosphere, which causes the atmosphere to expand
  - Satellite drag can increase by a factor of 10 and operators must correct orbit calculations

- More EUV irradiance modifies the ionosphere, which impacts radio communications and GPS navigation

Why Measure EUV Variability?

- NOAA Whole Atmosphere Model – Ionosphere Plasmasphere with Electrodynamics (WAM-IPE based on the GFS weather model)
  - Specify and predict ionosphere conditions for radio communication and satellite navigation.
  - Specify and predict neutral density for satellite orbit predictions and collision avoidance.
  - Customers: DOD, DHS/FEMA, FAA, ICAO, Satellites, Construction, Agriculture, Mineral Exploration, etc.
  - Status: Currently developing the appropriate interface between the GOES EUVS data and the operational WAM-IPE model

- The recently formed DOC **Office of Space Commerce** will eventually include civil **Space Traffic Management** and **Space Situational Awareness.** This office will likely manage satellite drag models which will require solar EUV input from GOES to improve model performance.

L1B PRODUCT QUALITY ASSESSMENT

Post-Launch Product Tests

PLPT	Test Title	Operator	Status	Criteria
14	XRS/EUVS/Mg II Inter-Satellite Comparisons (L2)	NCEI	Pass	None
15	Degradation Trending for EUVS-A (L1b)	NCEI	Pass	[1]
16	Degradation Trending for EUVS-B (L1b)	NCEI	Pass	[1]
17	Degradation Trending for EUVS-C (L1b)	NCEI	Pass	[1]

- Test Plans and Procedures are from the RIMP*
- Ground System OE L1b and L2 data used for considerable ADR testing
- Ground System OE L1b data is used for degradation trending (PLPTs #15-17)
- Science-Quality L1b and L2 data is used for PLPT #14
- [1] RIMP Full Success Criteria: "EUVS L1b product data are available and analysis is completed."

* Appendix A.3, pp 29, EXIS Readiness, Implementation, and Management Plan (RIMP v2.0; 410-R-RIMP-0316)

Data Types

- Reasons to use L2 data instead of L1b data
  - Averaged aggregations are easier to use for mission-length cross-analysis

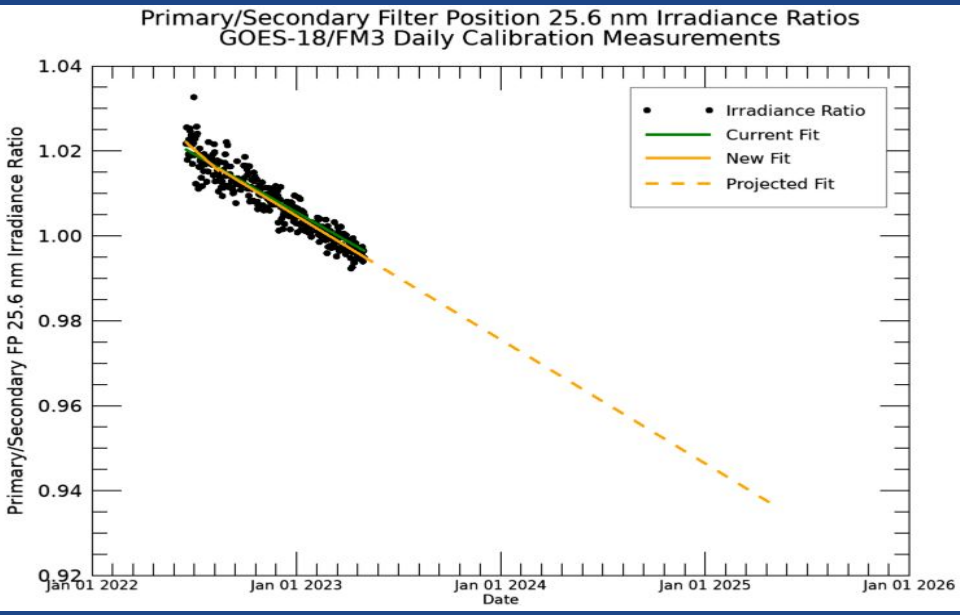
Data	L0 → L1b processing	L1b	L2
SWPC	GS	30-s granules	Low latency, subset of variables to public
NCEI Ops	GS	Daily aggregations	Daily and mission aggregations
NCEI Science	NCEI	Daily aggregations	Daily and mission aggregations
LASP	LASP	Internal only	N/A

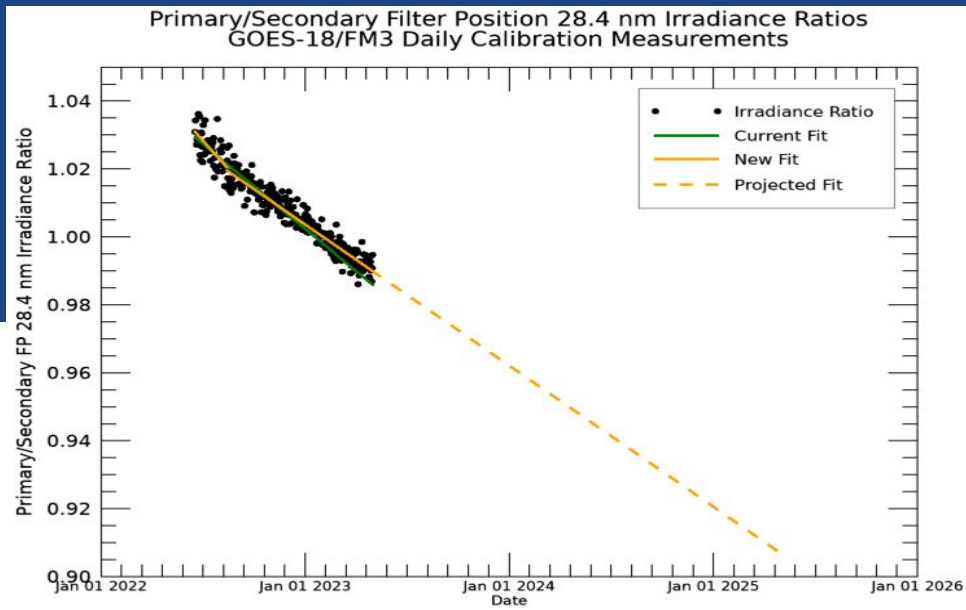
Ops = Operational
GS = Ground System

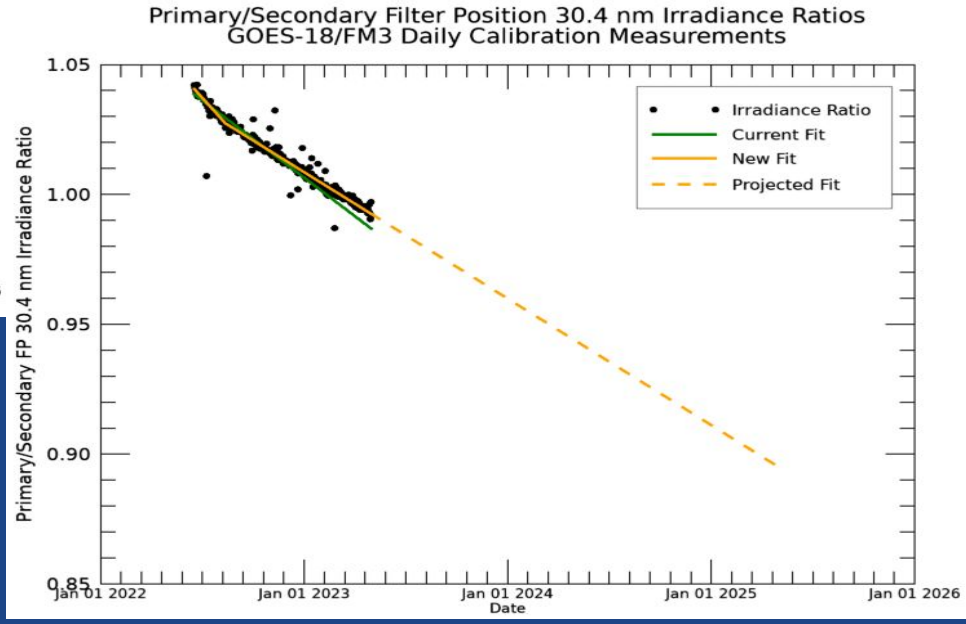
PLPT #15: EUVS-A Degradation Trending

- EUVS-A wavelengths are 25.6 nm, 28.4 nm and 30.4 nm
- Filters were calibrated at SURF (Synchrotron Ultraviolet Radiation Facility; NIST calibration laboratory)
- On-orbit degradation is tracked with daily primary/secondary filter comparisons
- Periodic sounding rocket flights (led by LASP) provide an absolute calibration
- EUV degradation rates tend to start high and decrease in time
  - Degradation trending usually starts as a linear fit, then changes to a decaying exponential fit as the mission continues
  - Degradation rate changes with solar variability and operational changes

PLPT #15: EUVS-A Degradation Trending







PLPT #15: EUVS-A Degradation Trending

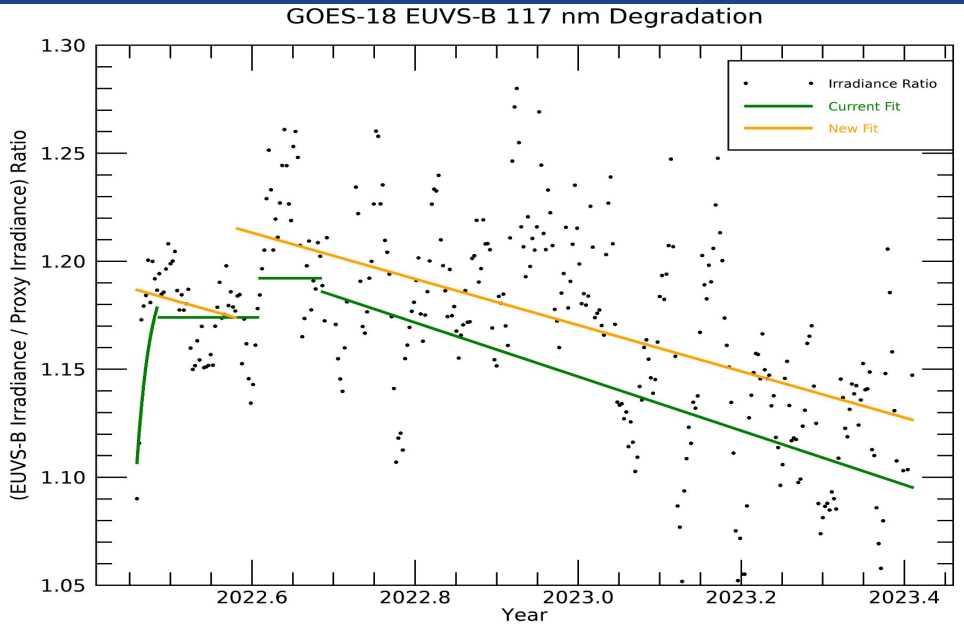
GOES-18 Degradation (Primary to Secondary Filter Ratios)	Years Since Launch (Launch Date = 2022060)	25.6 nm	28.4 nm	30.4 nm
2023060	**1**	1.000	0.997	1.001
2024060	**2**	0.971	0.955	0.952
2025060	**3**	0.942	0.914	0.903
2027060	**5**	0.883	0.831	0.806
2032060	**10**	0.738	0.623	0.563
2042060	**20**	0.446	0.208	0.076

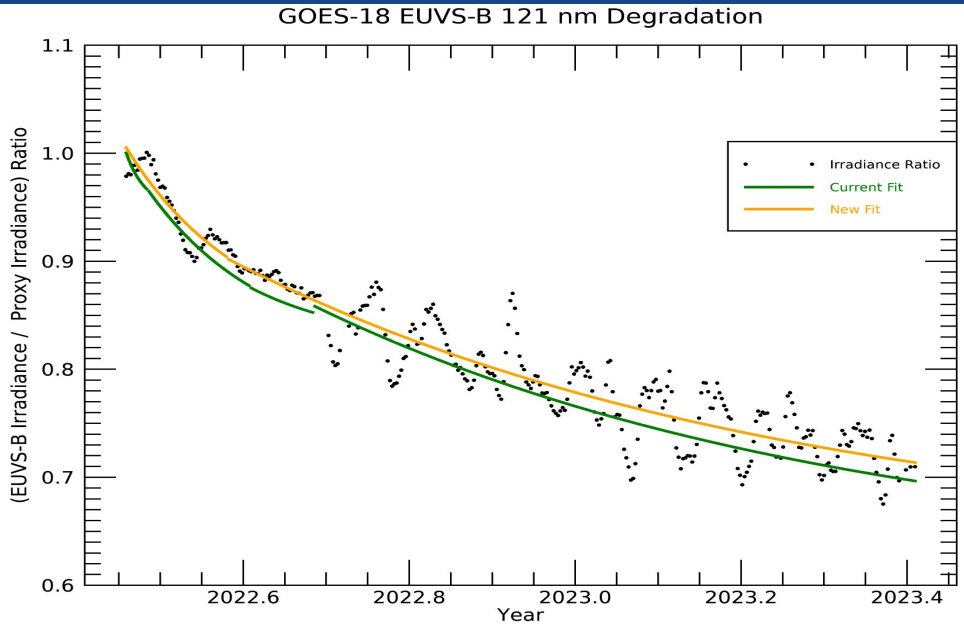
- Degradation at 2, 3, 5, 10 & 20 years post-launch are projected values based on current fit
- 25.6 nm: Linear fit from 2022168 to present
- 28.4 nm: Linear fit from 2022168 to present
- 30.4 nm: Linear fit from 2022168 to present
- **Orange** values should be considered as lower bounds; this is the linear extrapolation, before the degradation has switched to an exponential fit

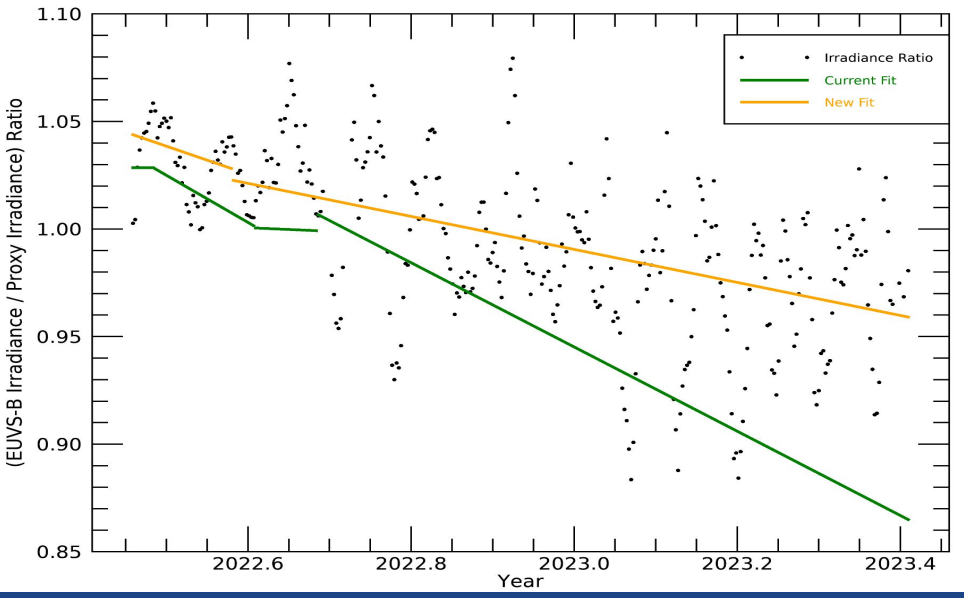
PLPT #16: EUVS-B Degradation Trending

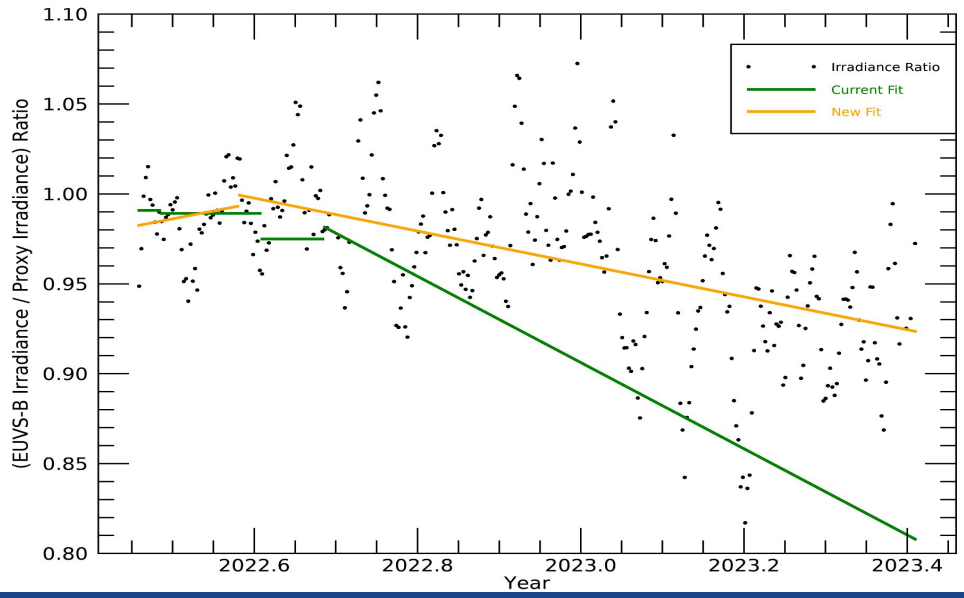
- EUVS-B wavelengths are 117.5 nm, 121.6 nm, 133.5 nm and 140.5 nm
- Degradation determined by comparing GOES-18 EUVS-B irradiance to GOES-18 proxy irradiance (described in detail on slide 20)
- EUV degradation rates tend to start high and decrease in time
  - Degradation trending usually starts as a linear fit, then changes to a decaying exponential fit as the mission continues
  - Degradation rate changes with solar variability and operational changes

PLPT #16: EUVS-B Degradation Trending









PLPT #16: EUVS-B Degradation Trending

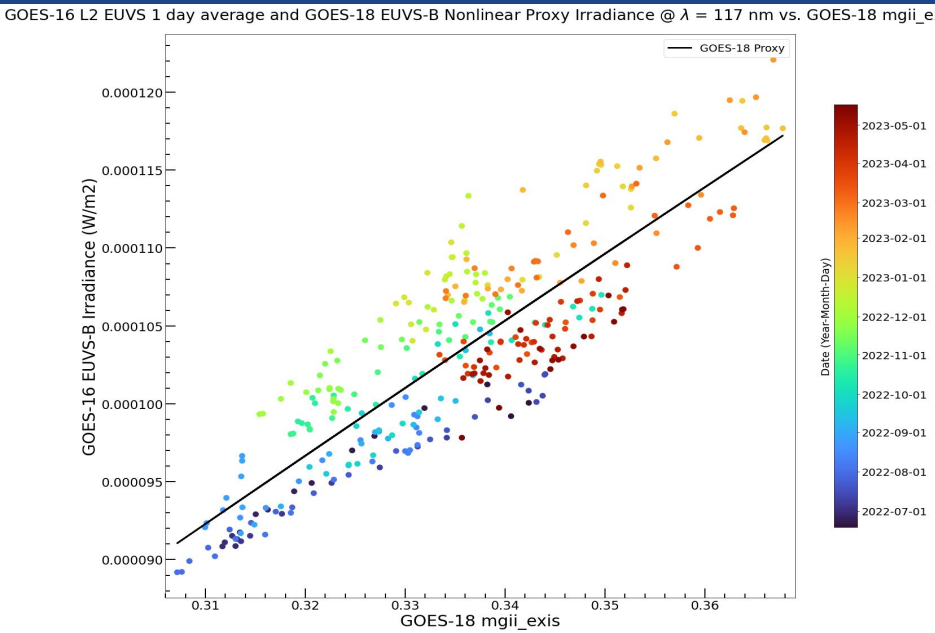
GOES-18 Degradation	Years Since Launch (Launch Date = 2022060)	117 nm	121 nm	133 nm	140 nm
2023060	**1**	1.153	0.748	0.978	0.946
2024060	**2**	1.046	0.662	0.901	0.855
2025060	**3**	0.939	0.642	0.824	0.763
2027060	**5**	0.725	0.637	0.671	0.580
2032060	**10**	0.190	0.637	0.287	0.122
2042060	**20**	-0.881	0.637	-0.481	-0.793

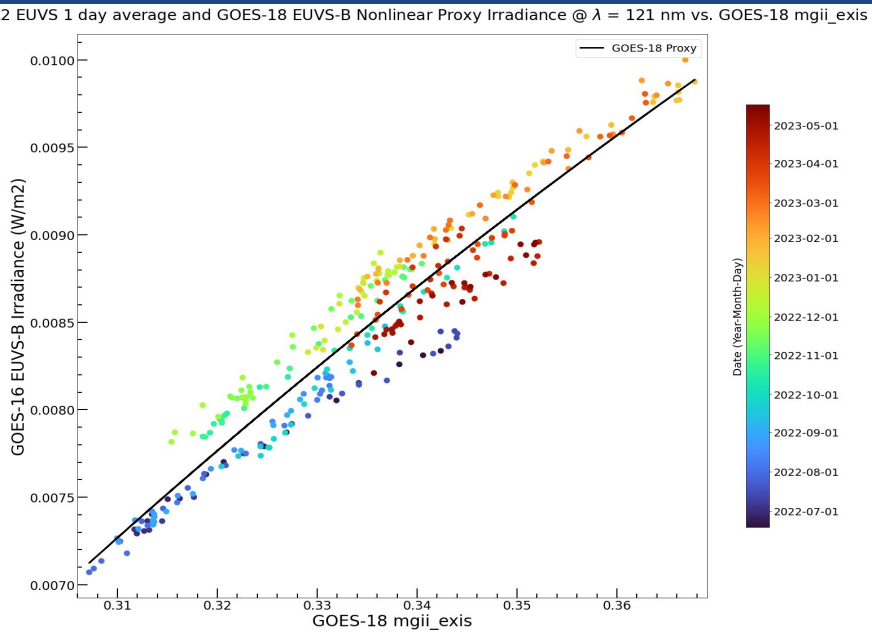
- Degradation at 10 & 20 years post-launch are projected values based on current fits
- 117 nm: Linear fit for entire mission
- 121 nm: Nonlinear fit for entire mission
- 133 nm: Linear fit for entire mission
- 140 nm: Linear fit for entire mission
- **Orange** values should be considered as lower bounds; this is the linear extrapolation, before the degradation has switched to an exponential fit

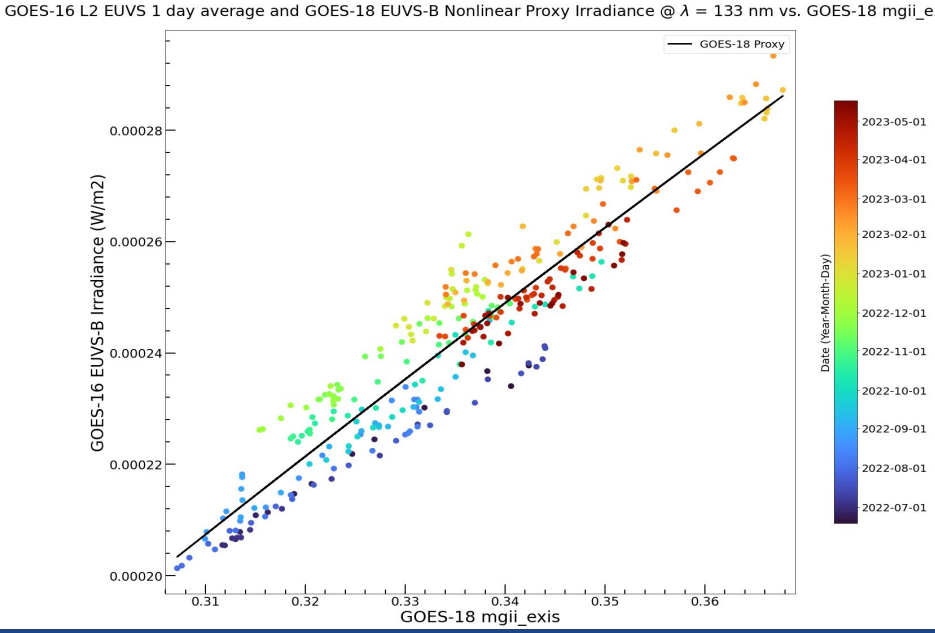
EUVS-B Proxy Irradiance

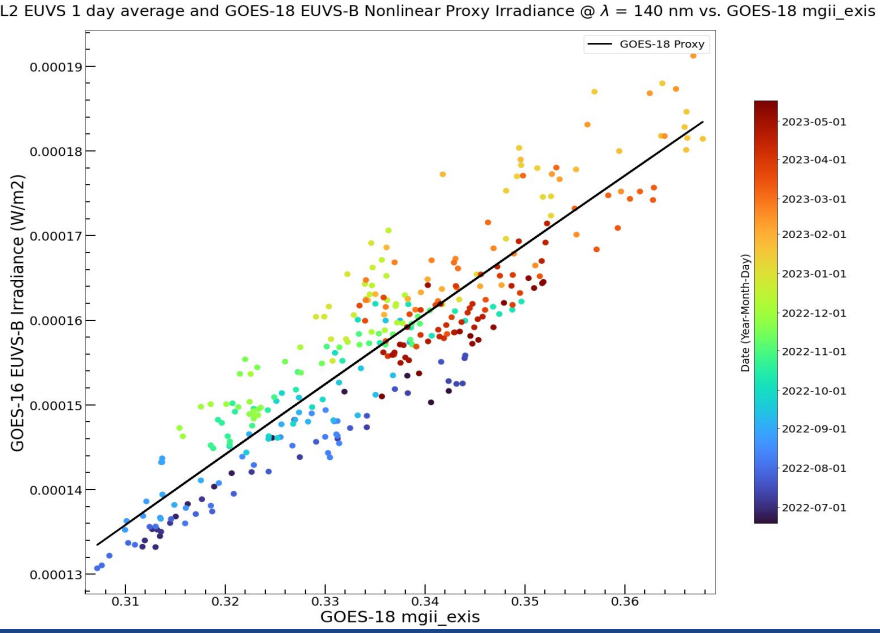
- Proxy irradiance is determined by fitting GOES-16 EUVS-B irradiance vs. GOES-18 Mg II data
  - Mg II replaces SORCE SOLSTICE (SORCE mission ended February 2020)
- The coefficients of the GOES-16 EUVS-B vs. GOES-18 Mg II fit are updated every time the GOES-18 EUVS-B degradation is updated
- This ensures the proxy irradiance is determined with as much data, and the most recent data, as possible
- A limitation of this method is that the GOES-18 EUVS-B degradation correction now depends on the GOES-16 EUVS-B irradiance, which itself depends on degradation corrections determined by using a different irradiance proxy

EUVS-B Proxy Irradiance







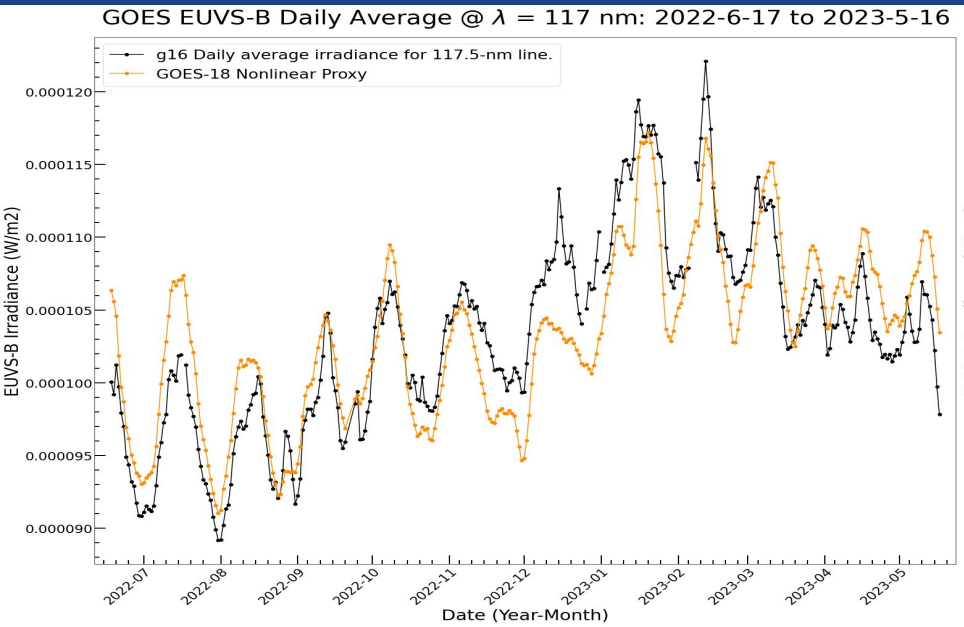


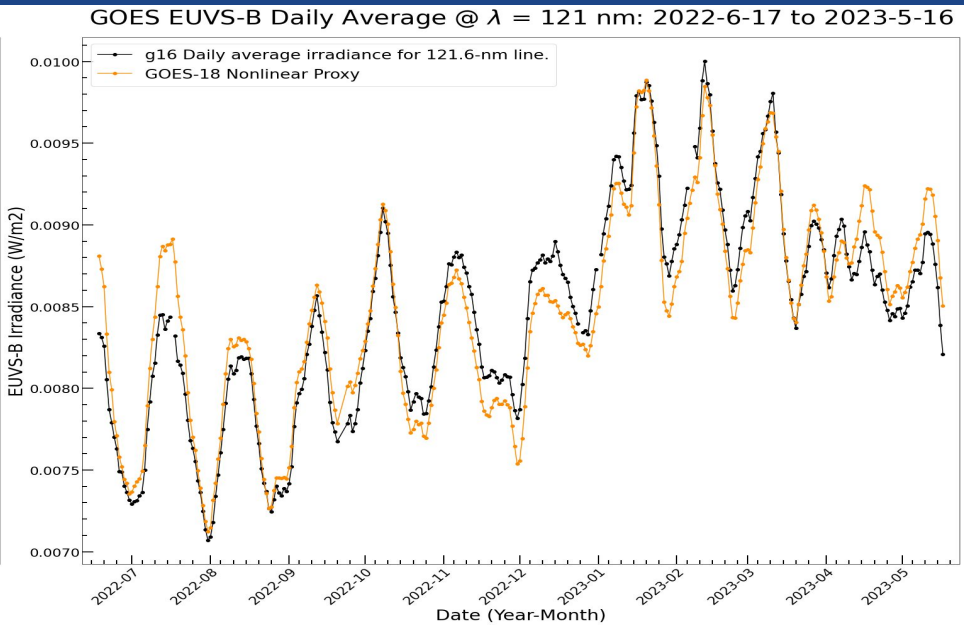
EUVS-B Proxy Irradiance

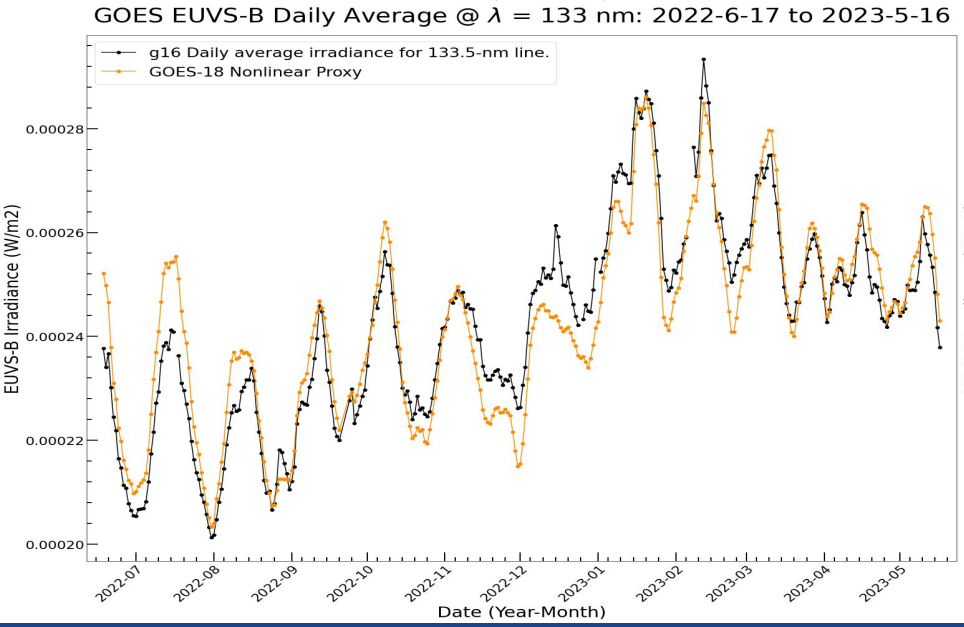
Nonlinear Fit	117 nm	121 nm	133 nm	140 nm
Standard Deviation	3.131	2.142	2.616	3.130
Average Error (%)	-0.099	-0.046	-0.069	-0.099
Average Absolute Error (%)	2.731	1.827	2.175	2.599
Linear Fit				
Standard Deviation	3.139	2.169	2.624	3.124
Average Error (%)	0.548	0.397	0.345	0.172
Average Absolute Error (%)	2.672	1.787	2.136	2.585

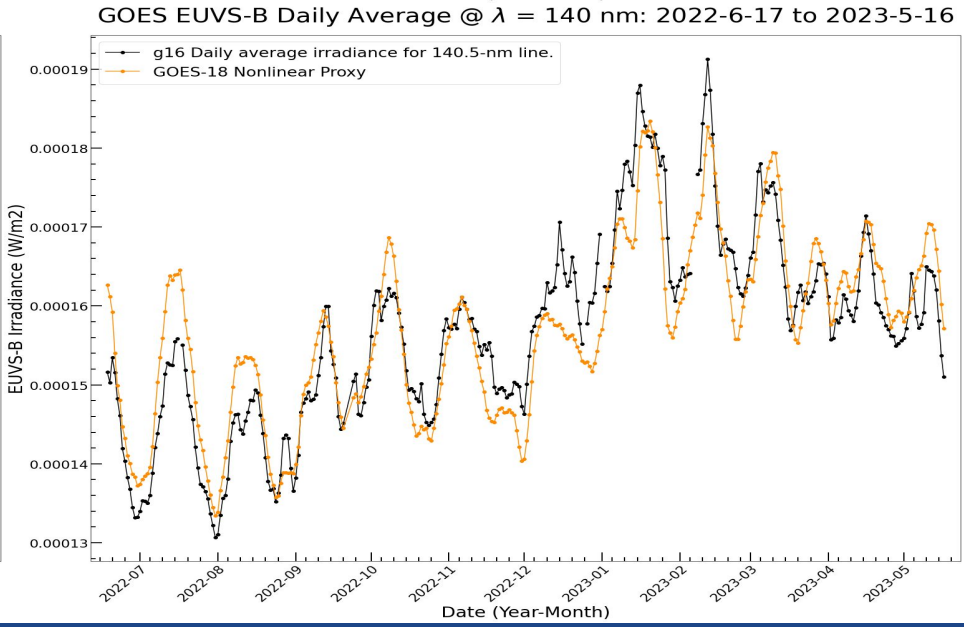
- The nonlinear fit of GOES 16 EUVS-B vs. GOES-18 Mg II was used to generate the proxy irradiance because it has a smaller standard deviation and smaller average error than the linear fit.

EUVS-B Proxy Irradiance



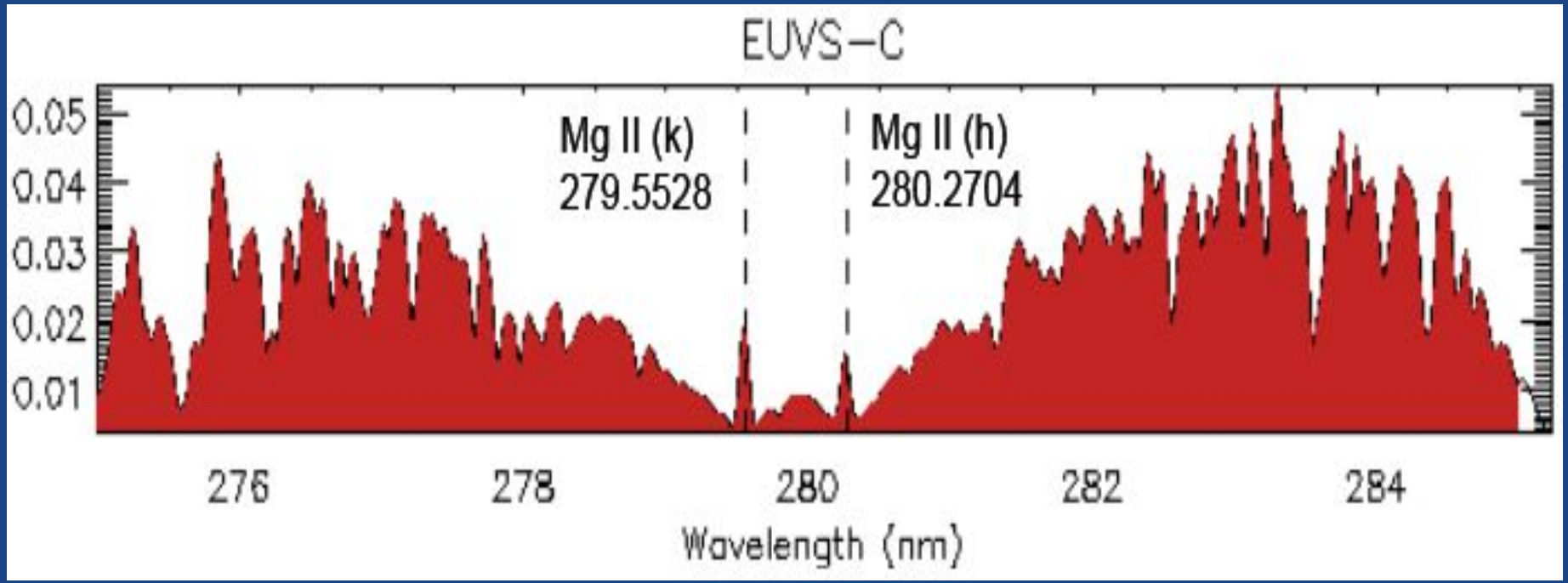




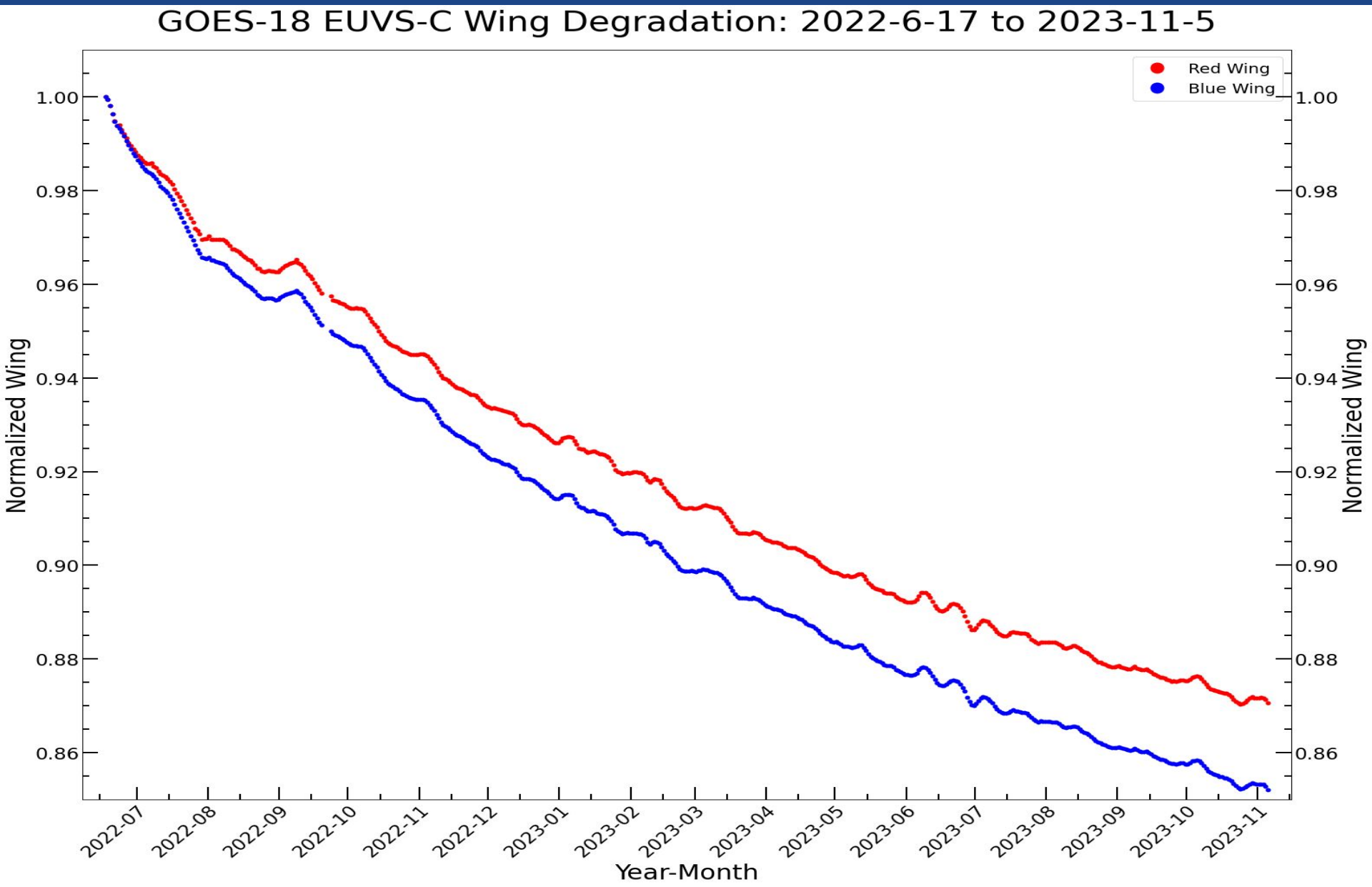


PLPT #17: EUVS-C Degradation Trending

- EUVS-C measures the spectrum near 280 nm
- The Mg II index is a unitless value of EUV solar energy
- Red wing is > 280 nm, blue wing is < 280 nm
- Mg II index = $(I_h + I_k) / (I_{red\_wing} + I_{blue\_wing})$
- Data is normalized to the first data point. Degraded data is then measured from this initial normalization.
- If the degradation is nonlinear across the EUVS-C spectrum, the Mg II index calculation is compromised, which also affects EUVS-B degradation
- The core line degradation shows more variation, correlated with solar activity



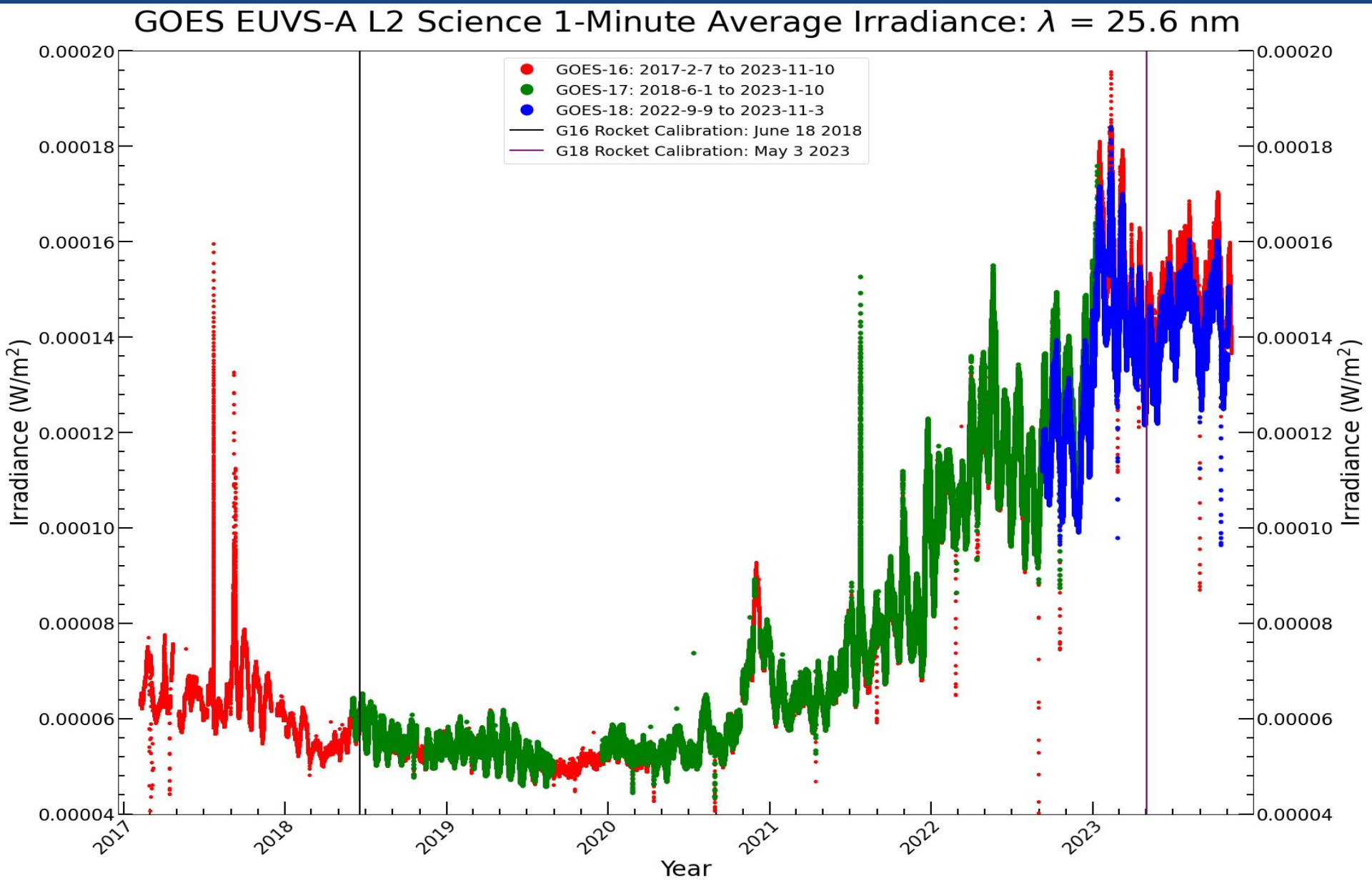
PLPT #17: EUVS-C Degradation Trending



PLPT #14: EUVS/Mg II Inter-Satellite Comparisons

- EUVS-A, EUVS-B and EUVS-C: Comparisons of G16, G17 and G18
- EUV model spectrum: Comparisons of G16 and G18
- G17 and G16 have slightly different bandpasses and so do not exactly agree for the dimmer lines
- Plots show L2 1-minute average science data
- Plots show the following:
  - Line irradiances (EUVS-A and EUVS-B)
  - Line irradiance ratios: G18/G16, G18/G17, G17/G16 (EUVS-A and EUVS-B)
  - G18 and G17 vs. G16 line irradiances and linear fits (EUVS-A and EUVS-B)
  - Mg II, red & blue wing and h & k line data (EUVS-C)
  - Mg II, red & blue wing and h & k line ratios: G18/G16, G18/G17, G17/G16 (EUVS-C)
  - Model spectrum irradiance: G18 and G16 (EUV model spectrum)

PLPT #14: EUVS-A



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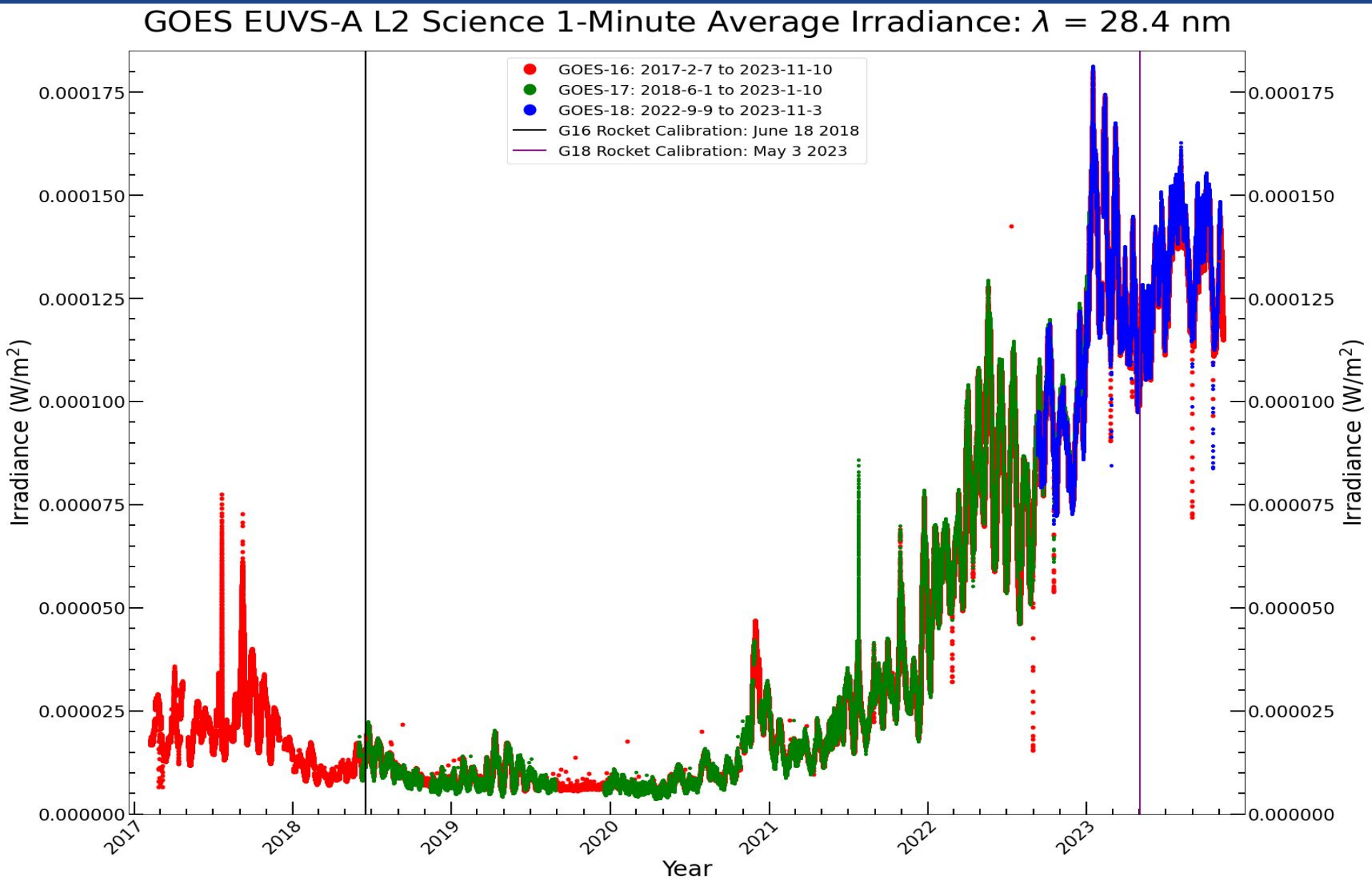

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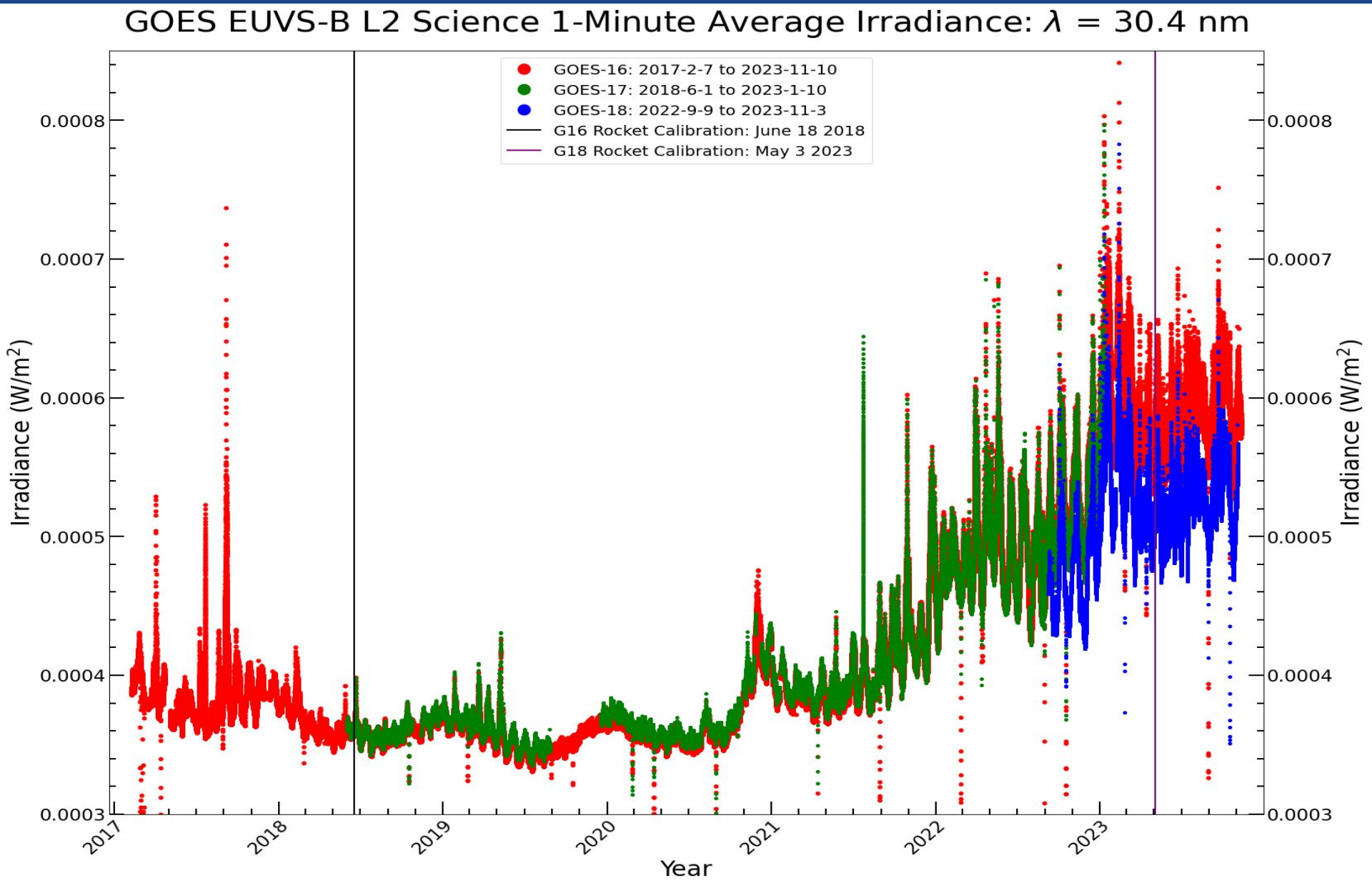
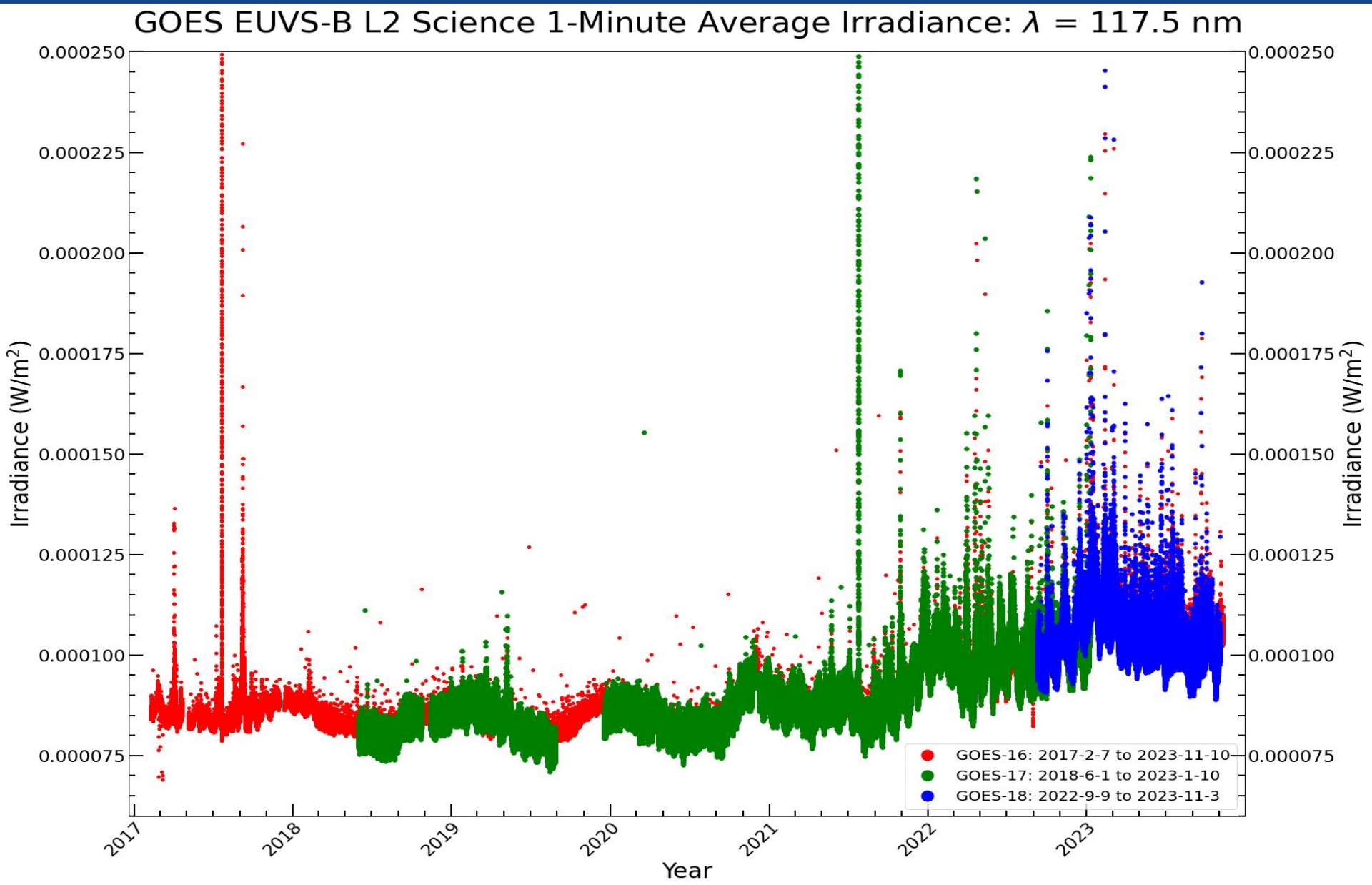


PLPT #14: EUVS-B



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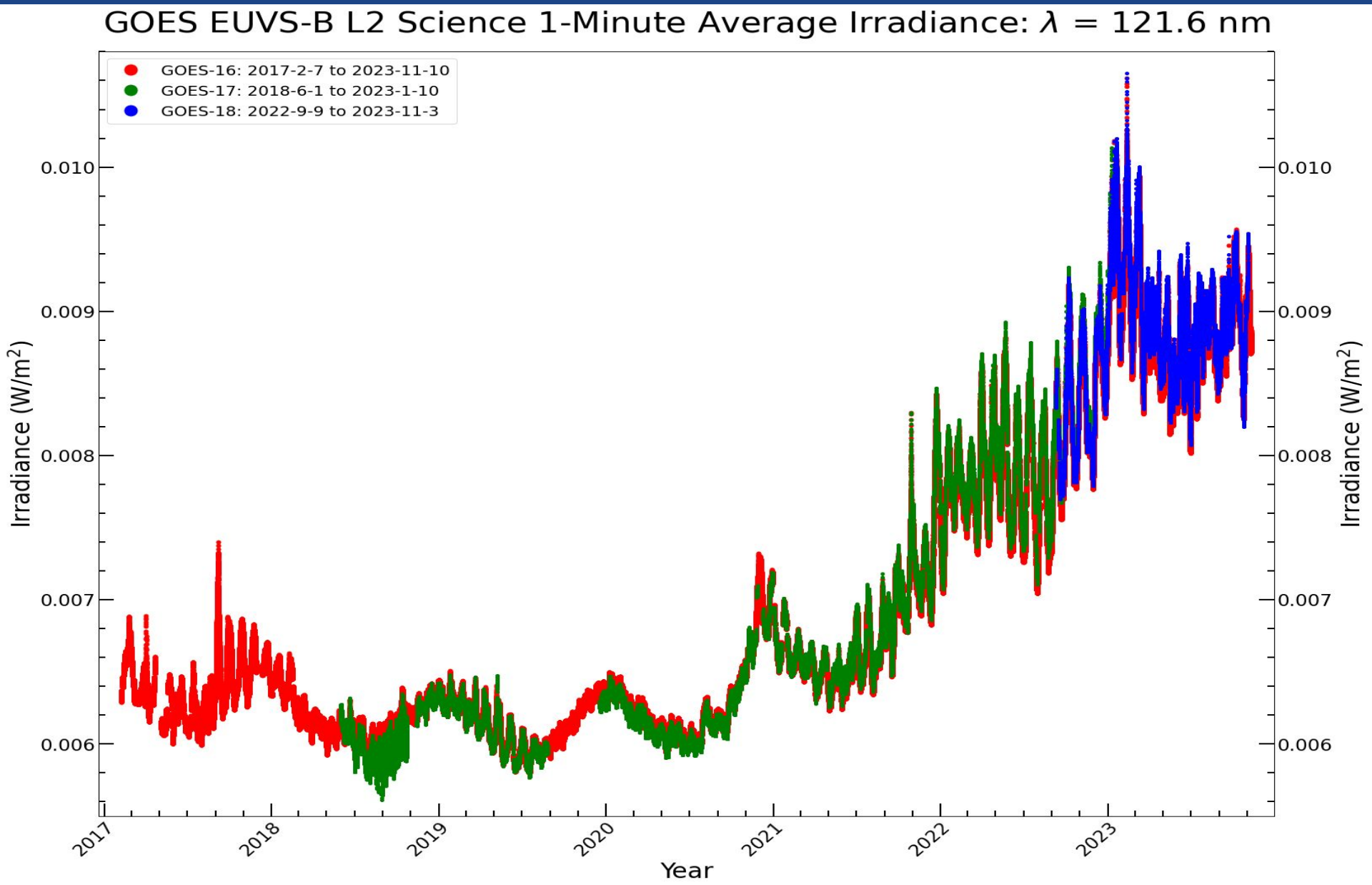

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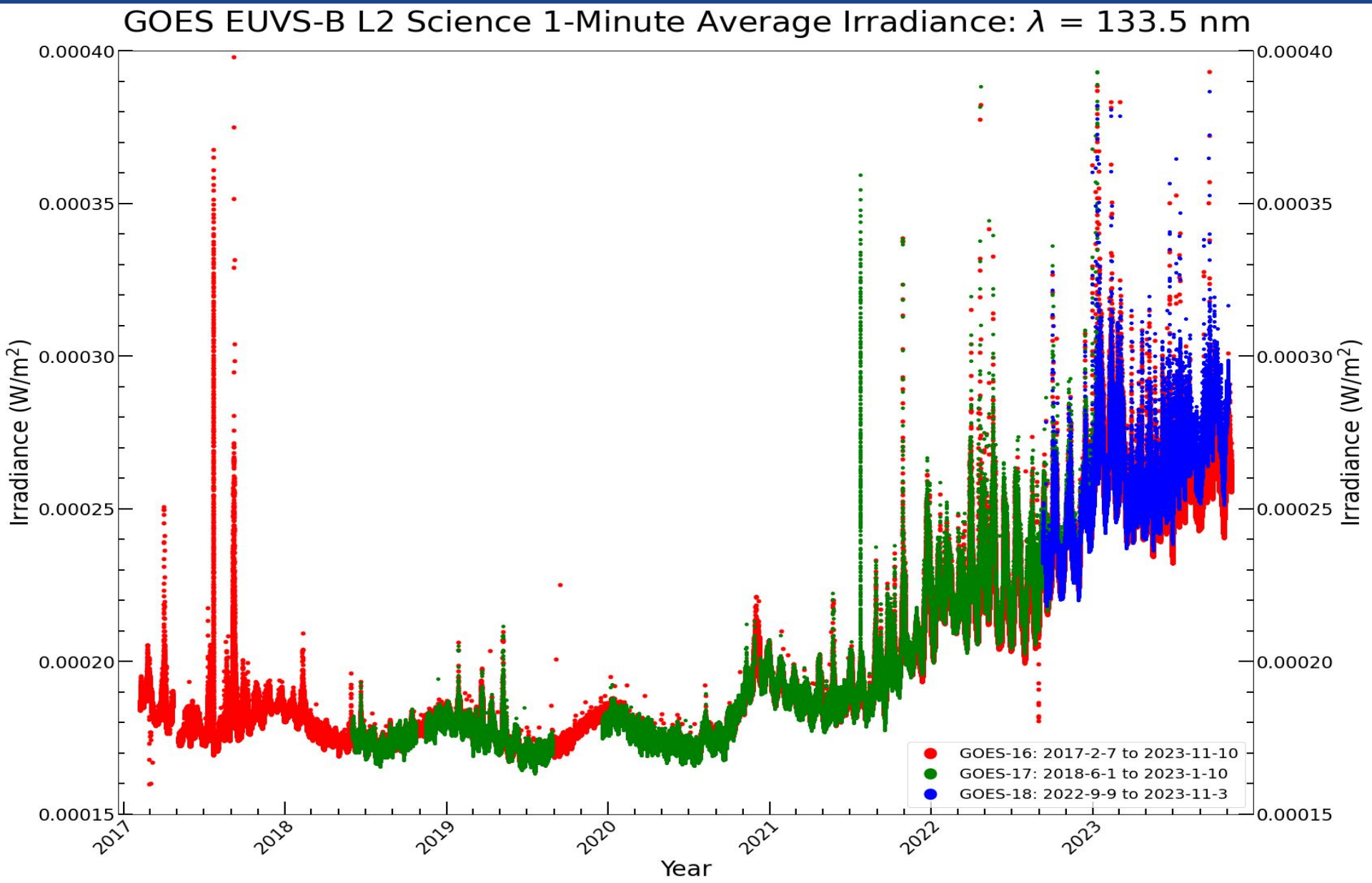

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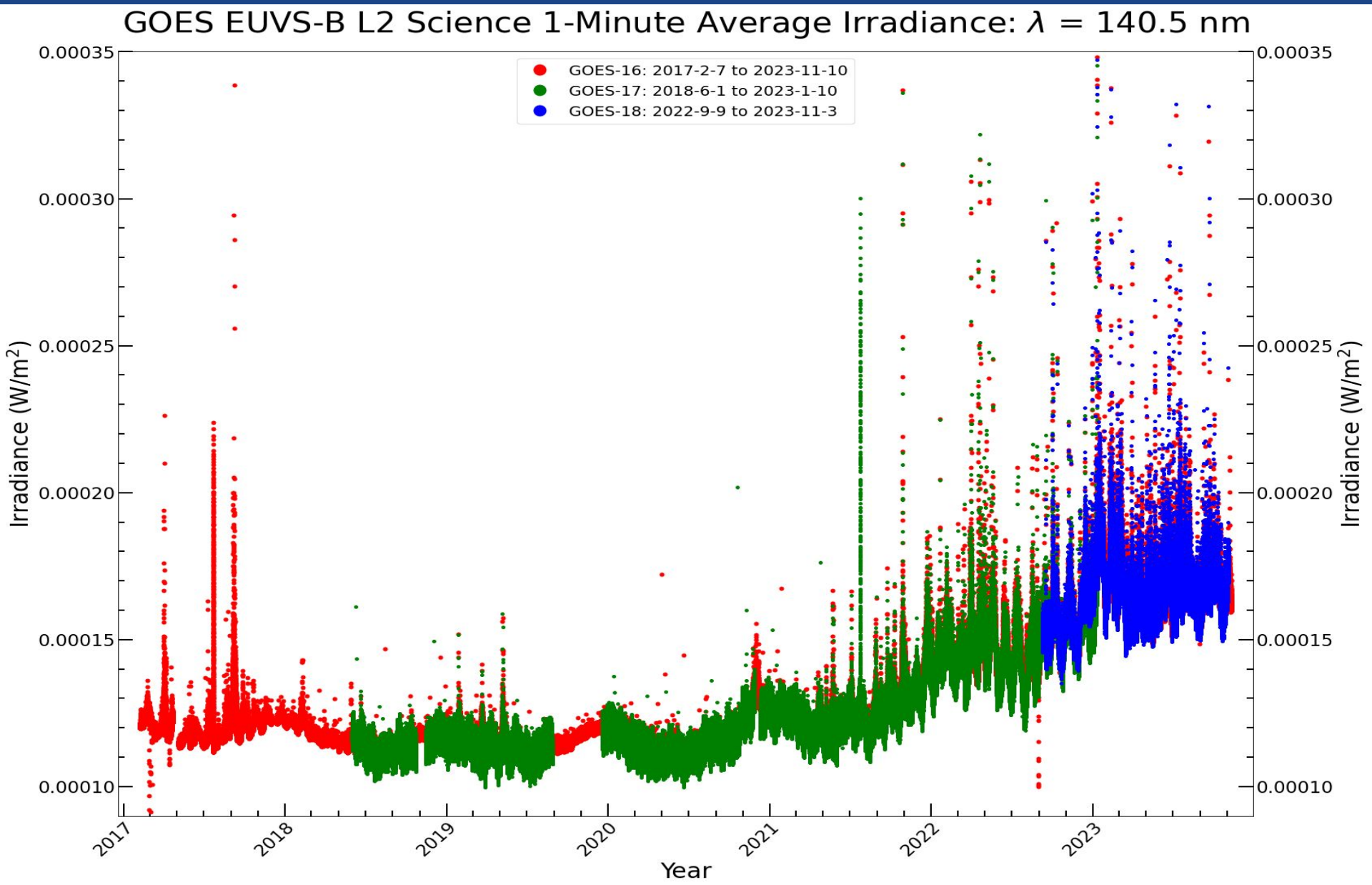

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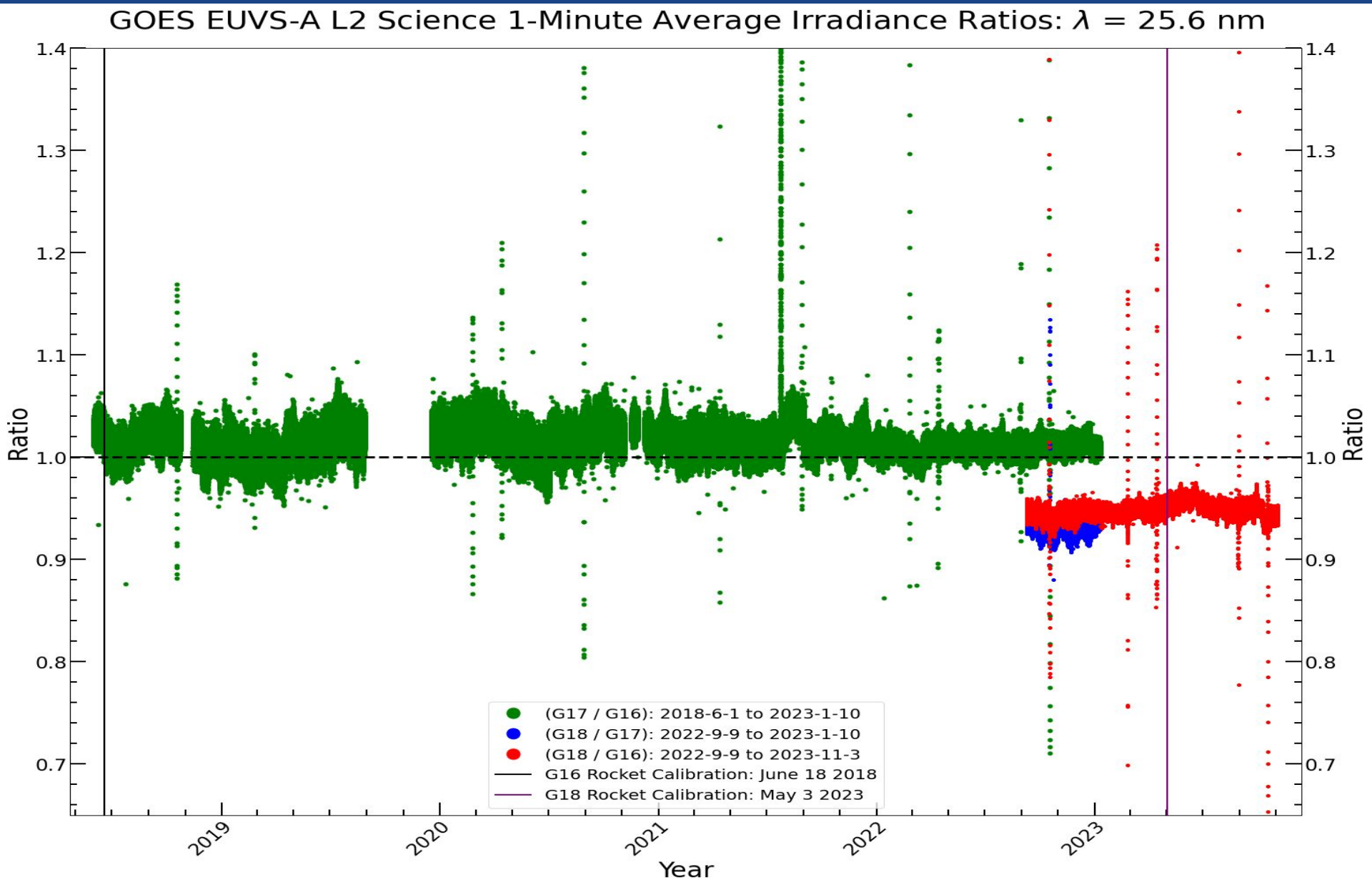

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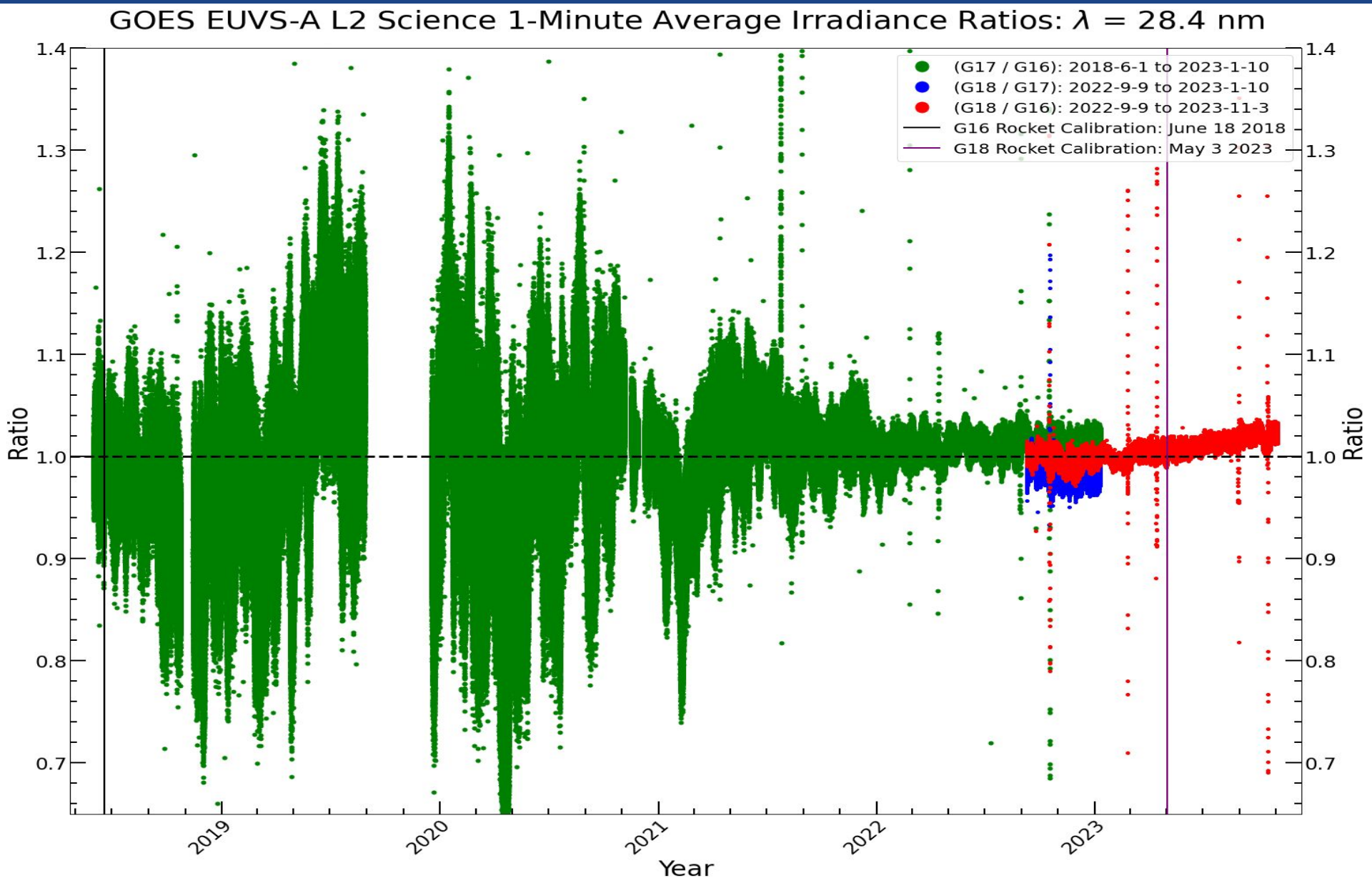

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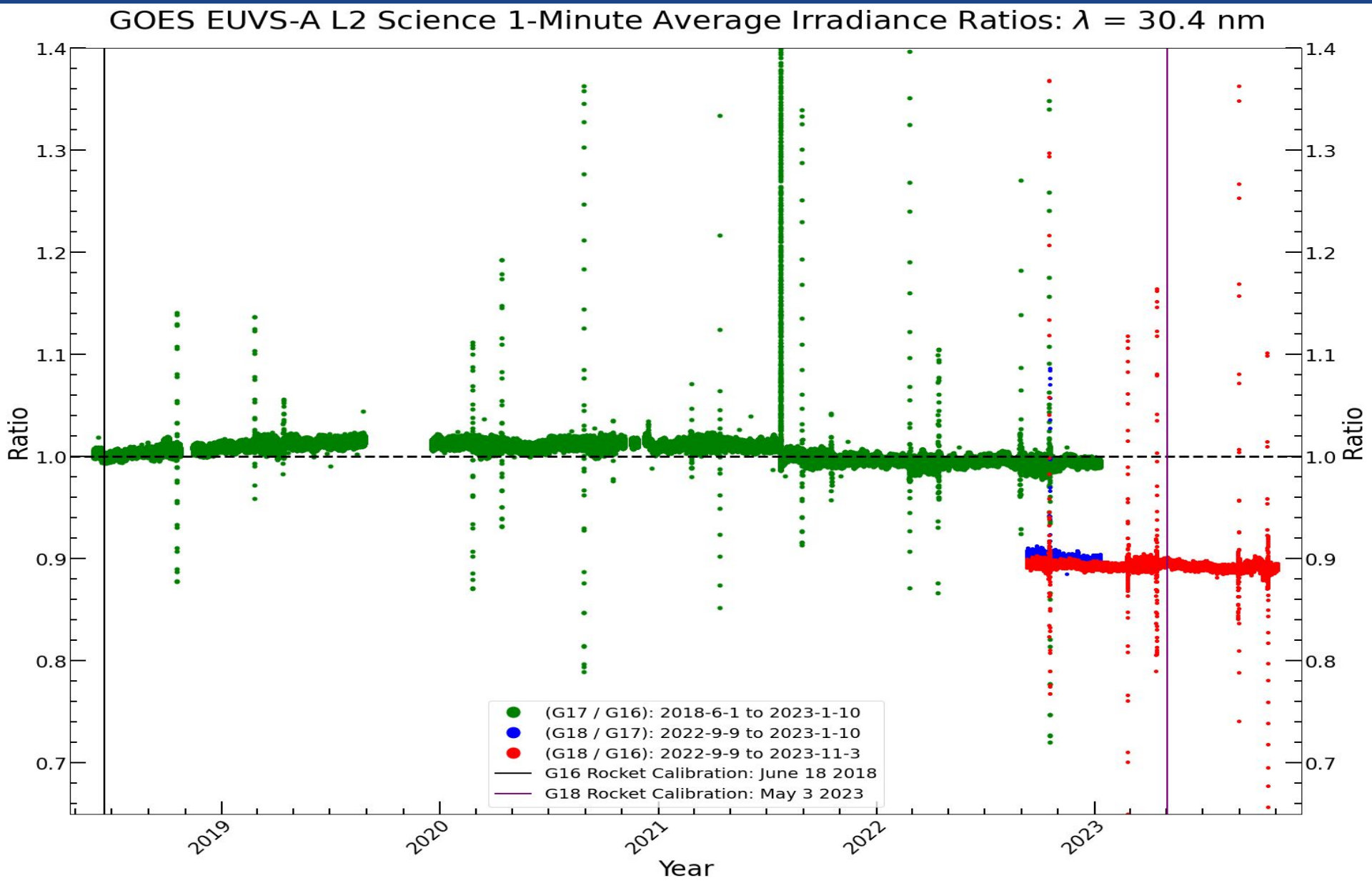

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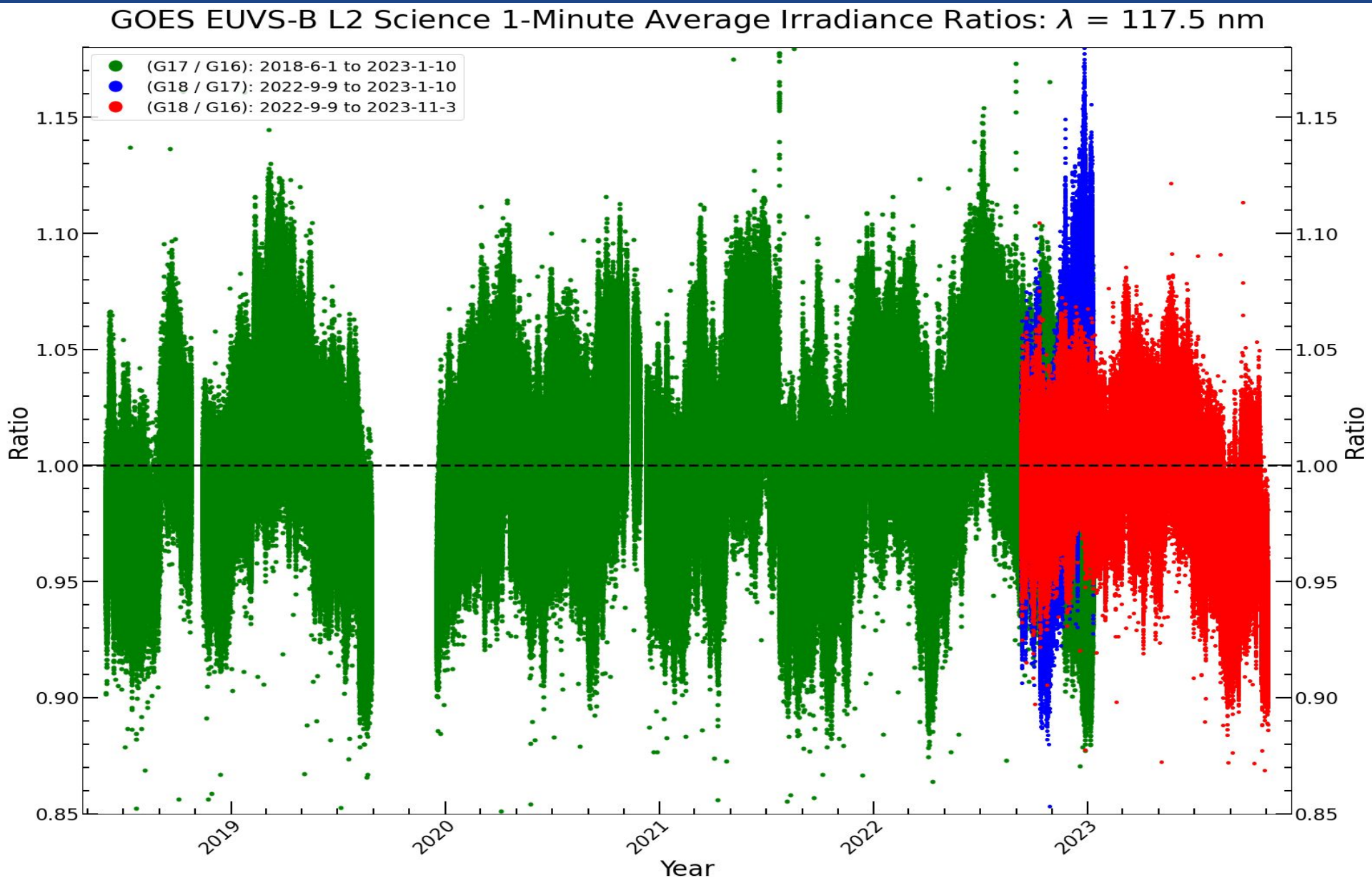

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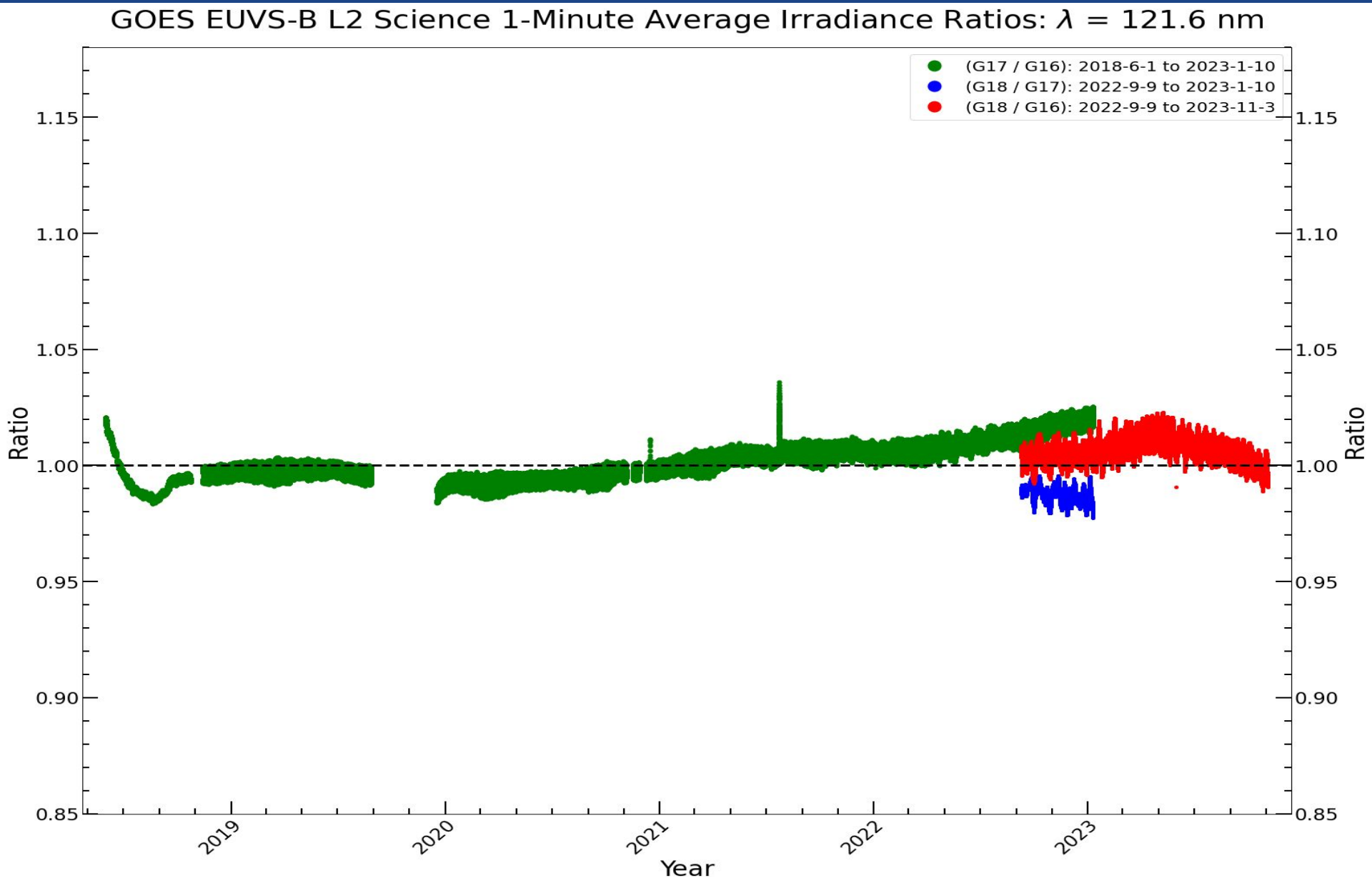

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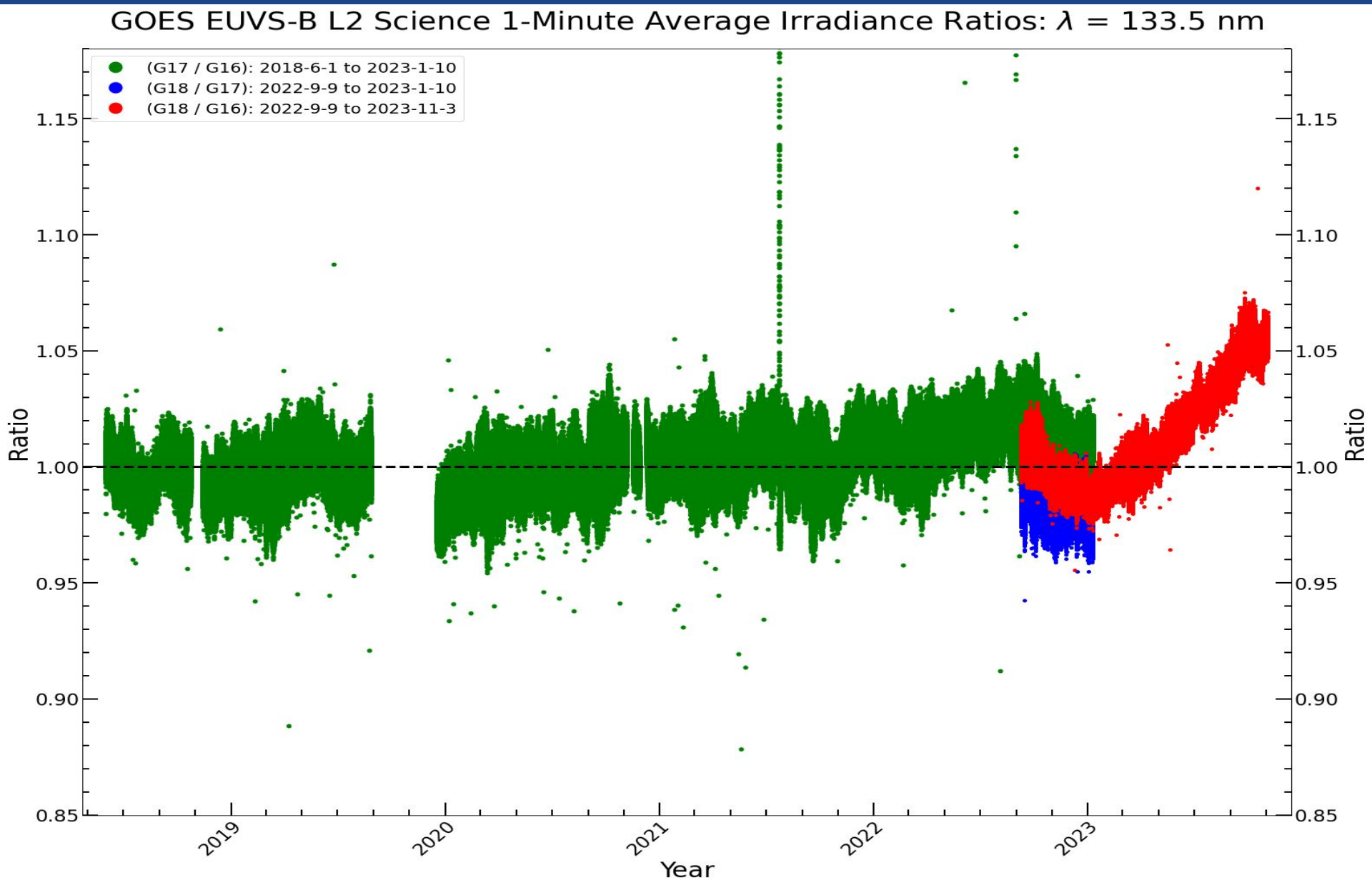
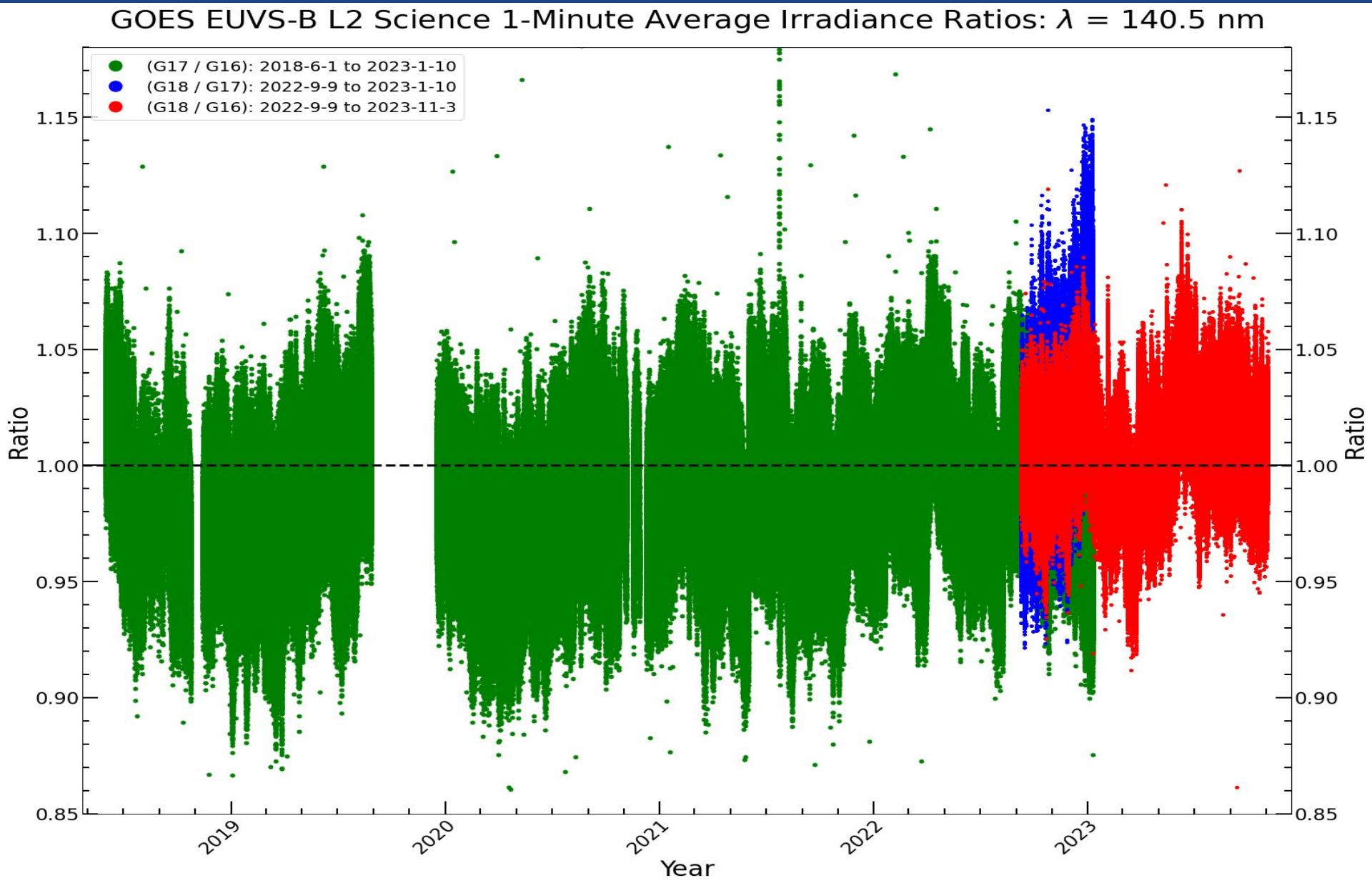


PLPT #14: EUVS-B

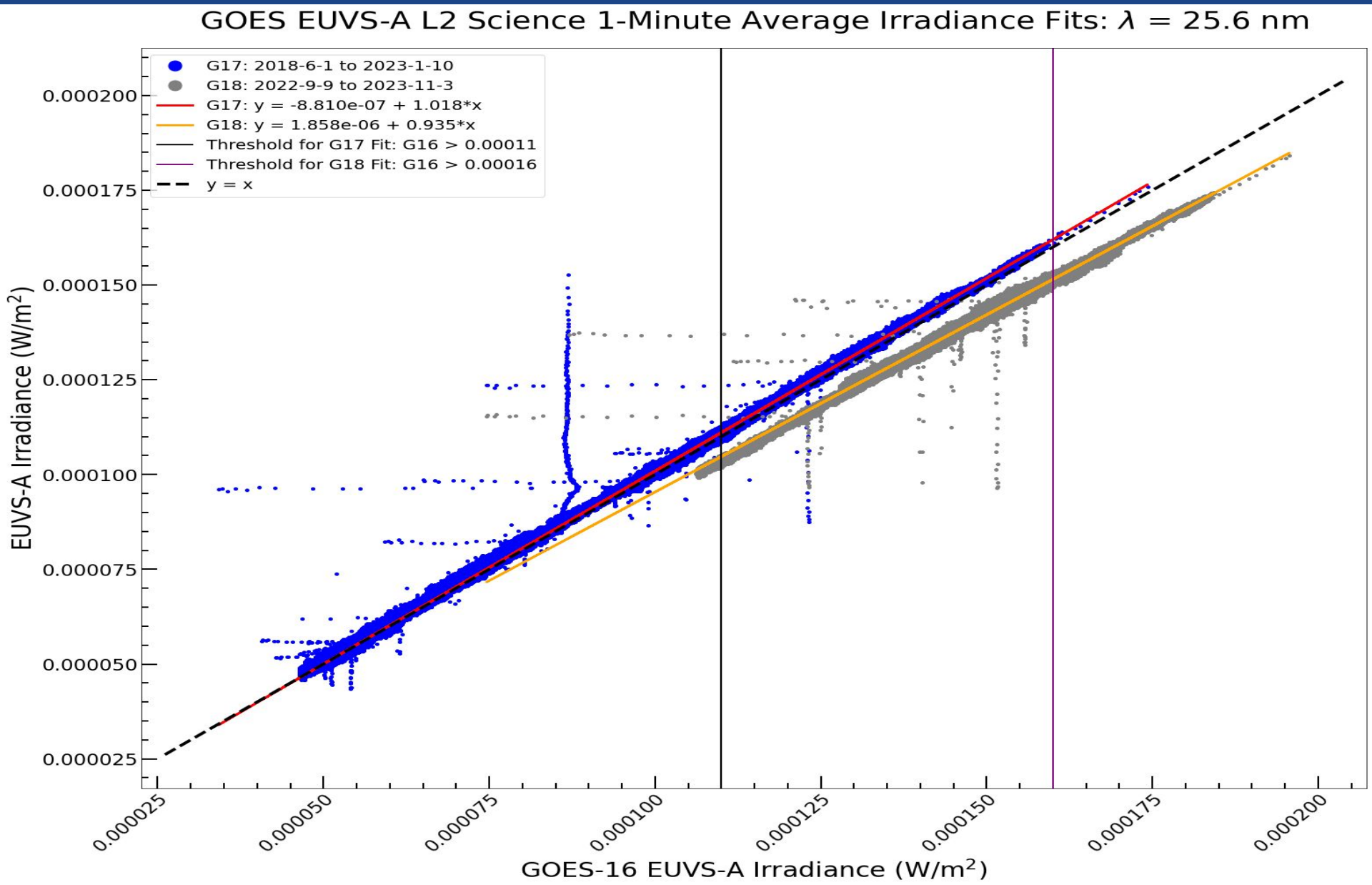


PLPT #14: EUVS-A & EUVS-B Intersatellite Comparisons

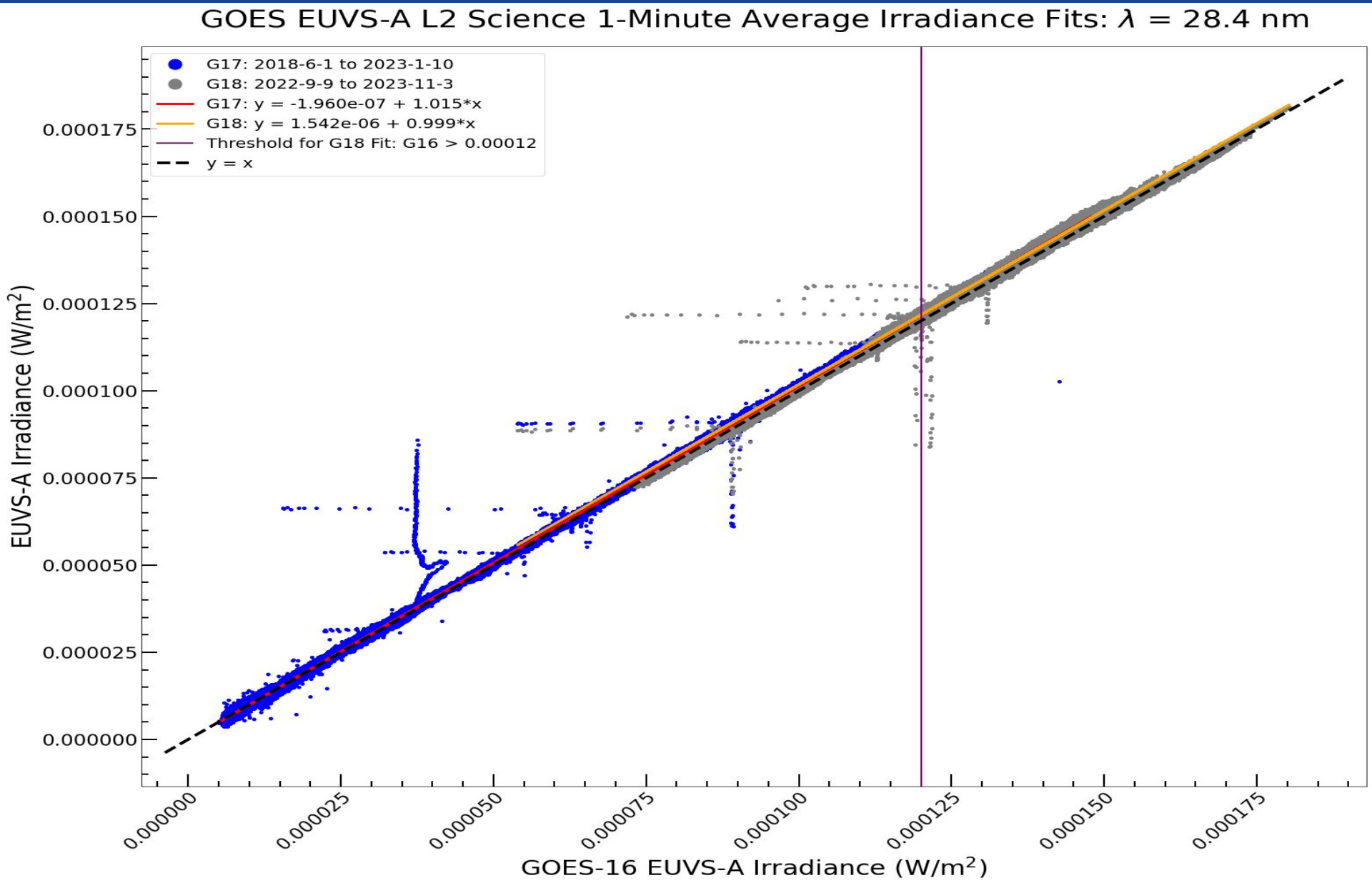
- If the satellites matched exactly, the x-coefficient for the irradiance vs. irradiance fits would be 1
- Most wavelengths show offsets **<5%** (within the stability required by MRD 577 and 2032); all are within the **20%** accuracy required by MRD 2028
  - Routine updates to temperature, dark drift and degradation corrections will ensure irradiance agrees with the other satellites

X-coefficient of Linear Fit to GOES-16	25.6 nm	28.4 nm	30.4 nm	117.5 nm	121.6 nm	133.5 nm	140.5 nm
GOES-17	1.018	1.015	0.986	1.04	1.077	1.022	1.037
GOES-18	0.935	0.999	0.886	1.067	1.014	1.01	1.025

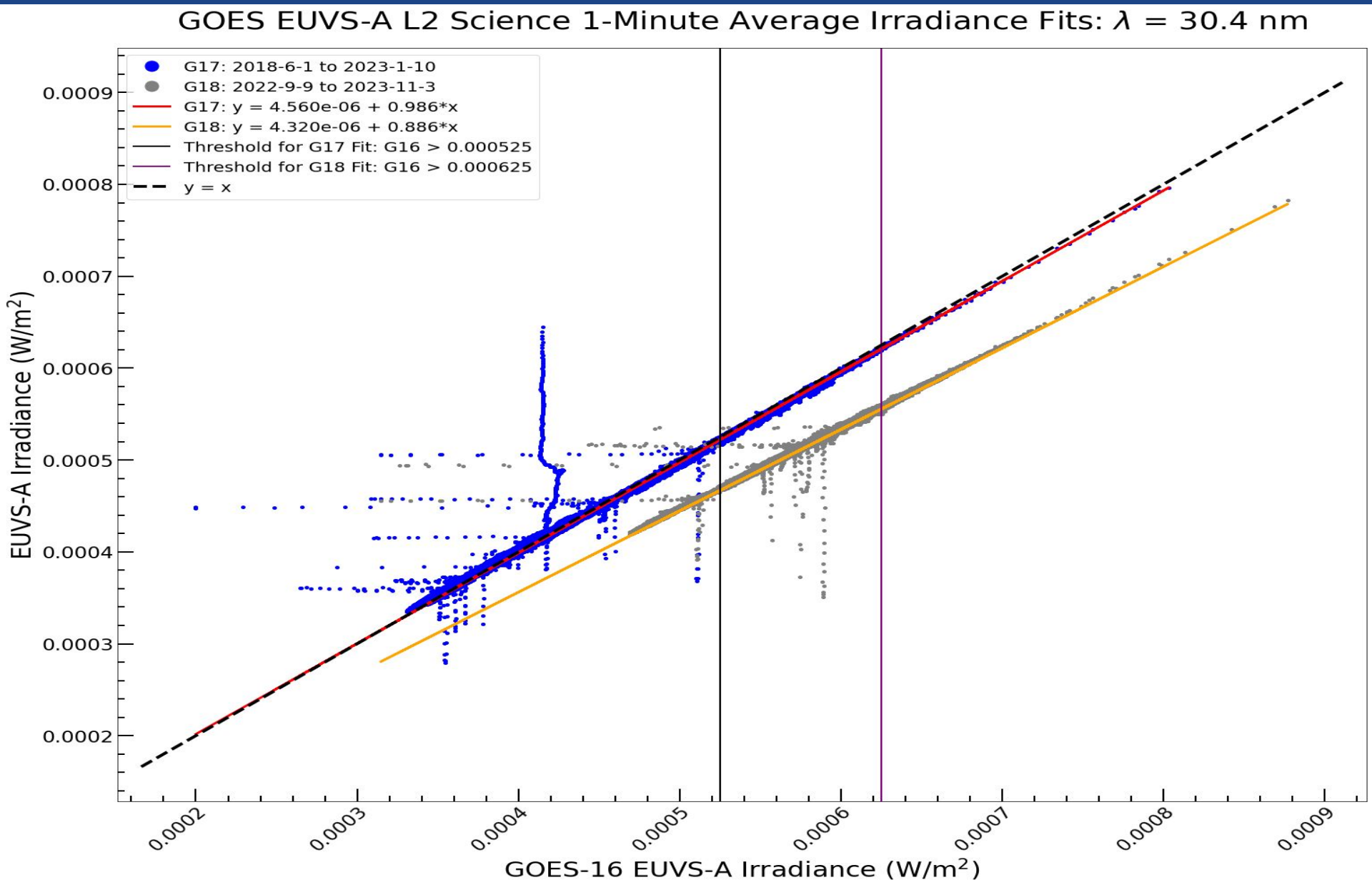
PLPT #14: EUVS-A



PLPT #14: EUVS-A



PLPT #14: EUVS-A



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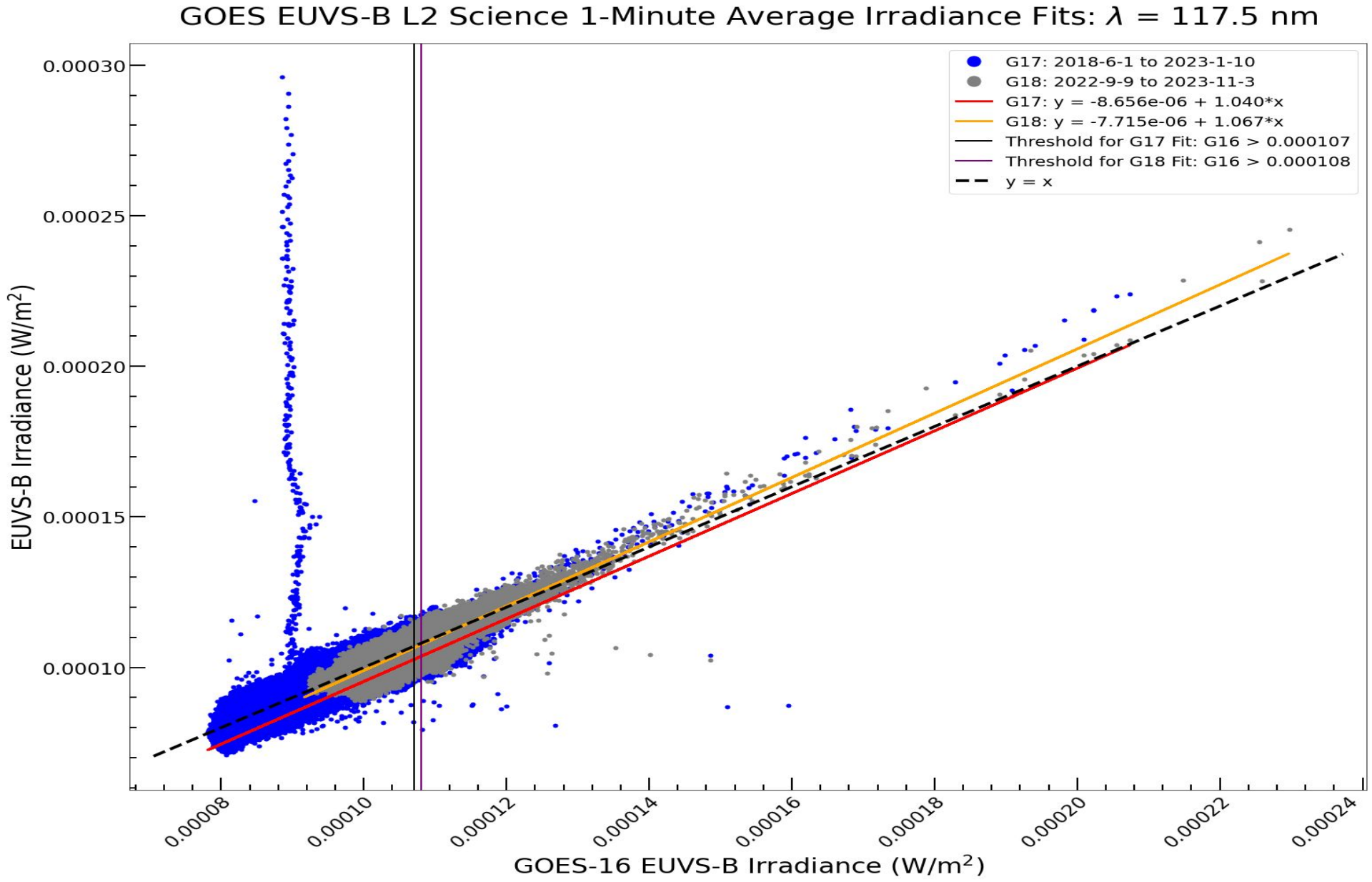
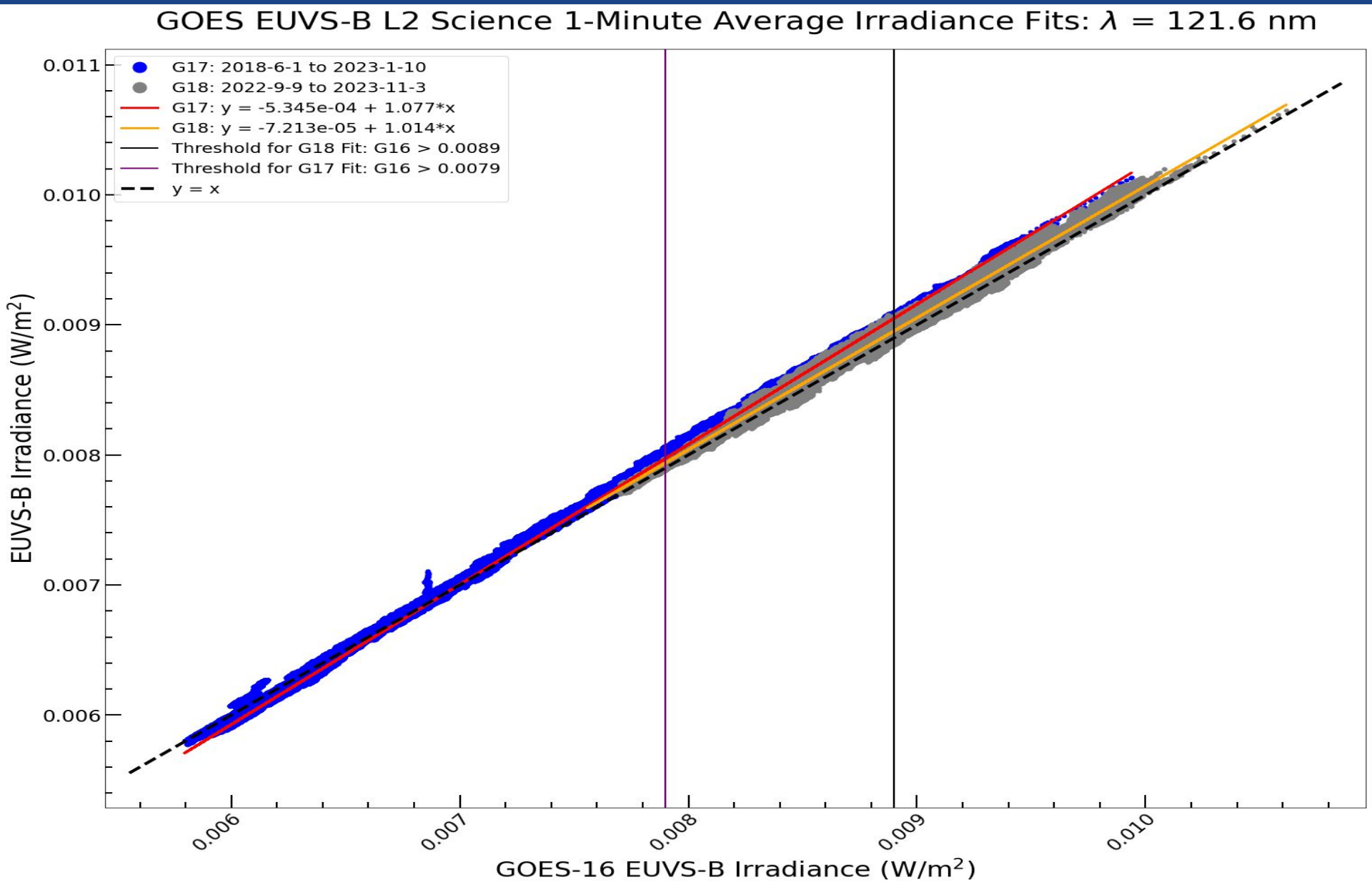


PLPT #14: EUVS-B



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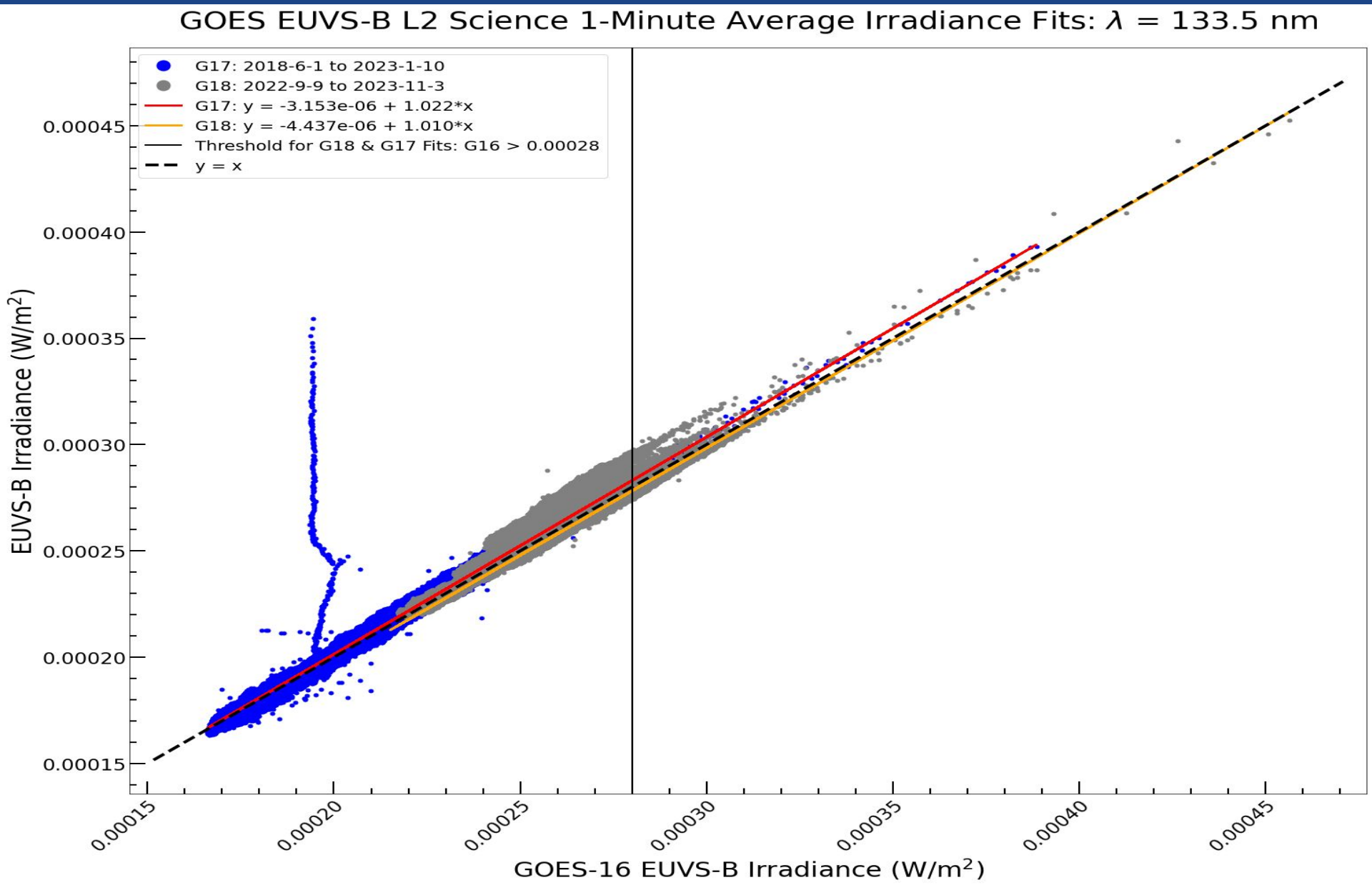
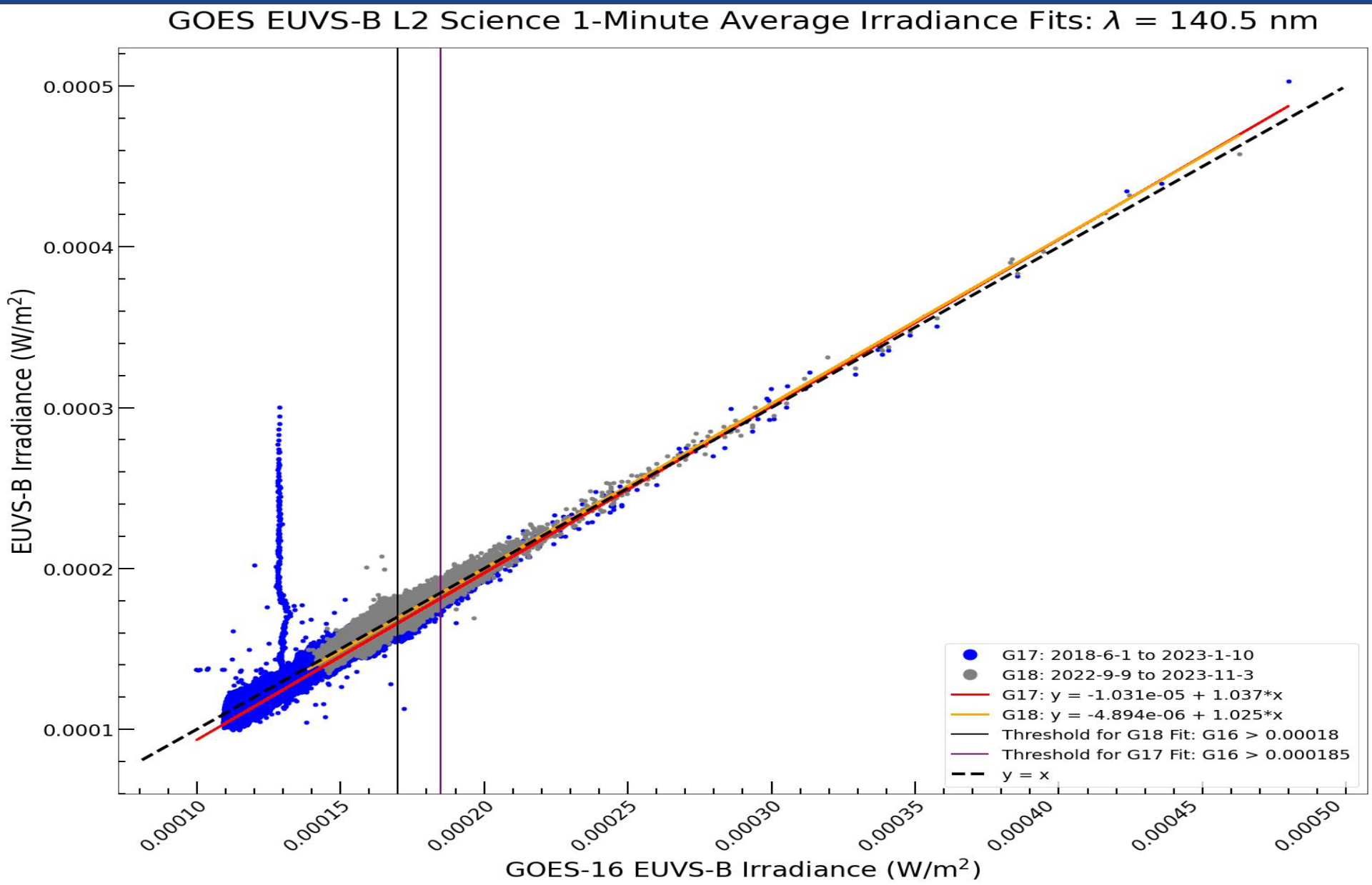
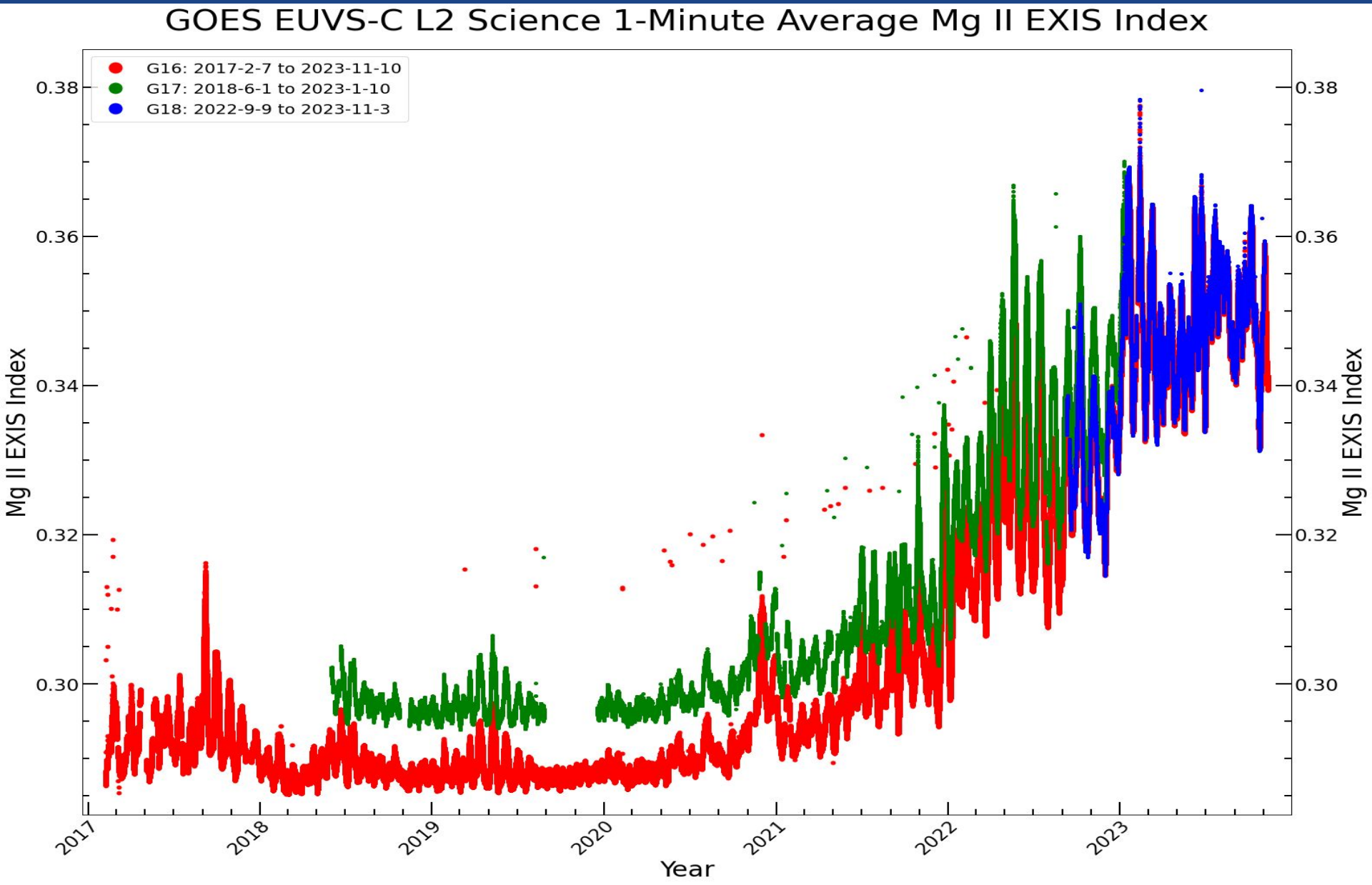


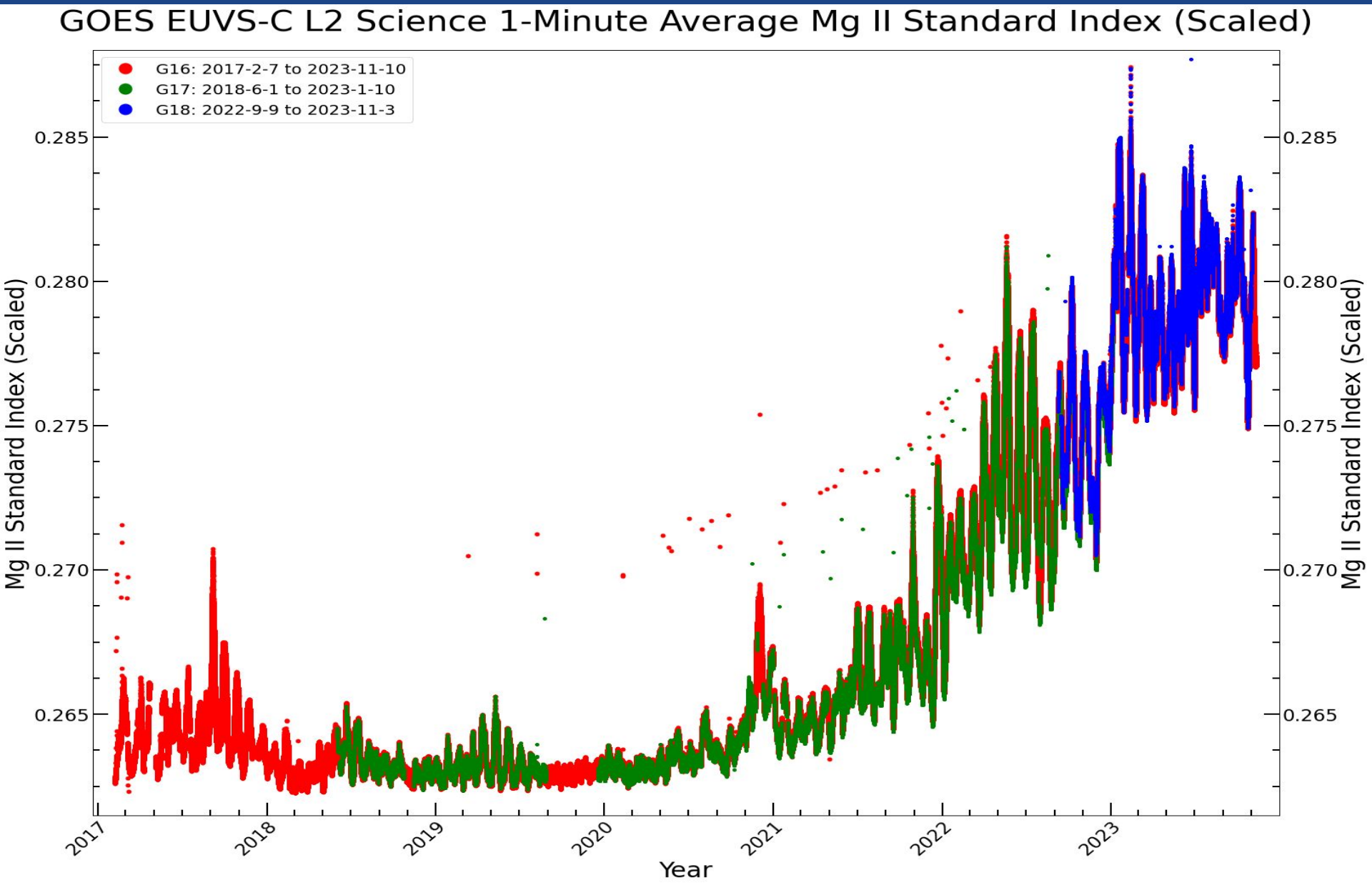
PLPT #14: EUVS-B



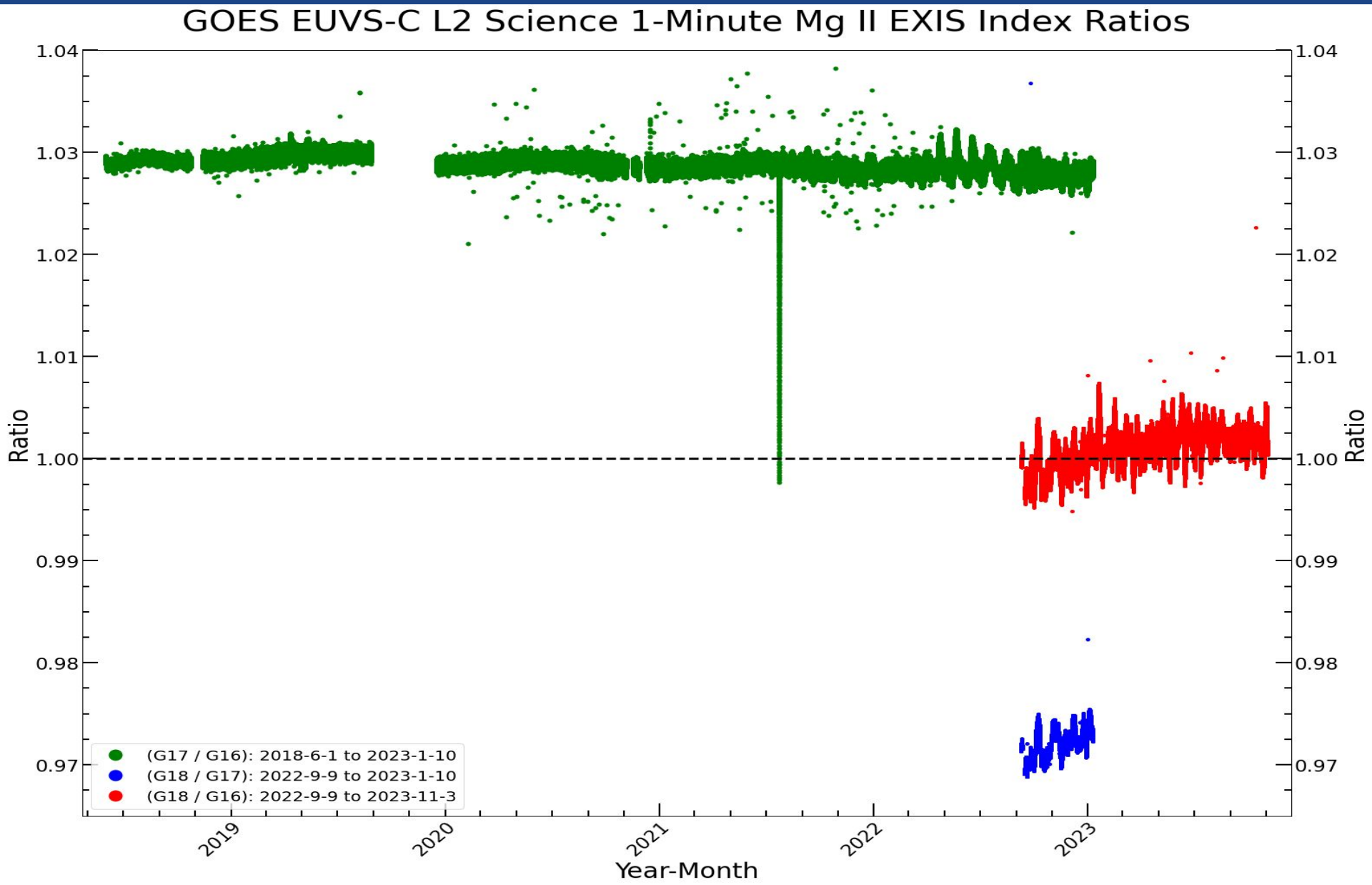
PLPT #14: EUVS-C/Mg II



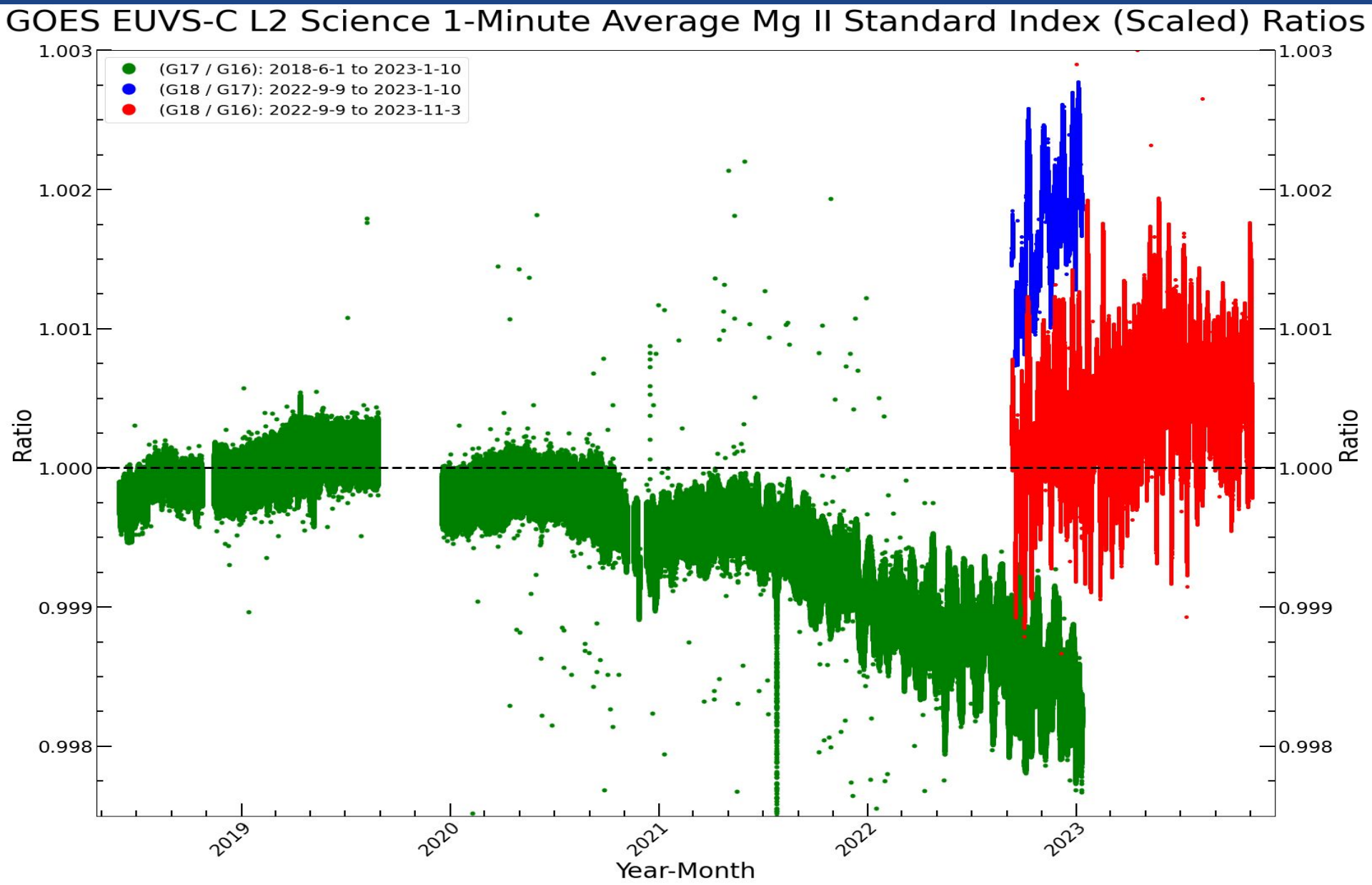
PLPT #14: EUVS-C/Mg II



PLPT #14: EUVS-C/Mg II



PLPT #14: EUVS-C/Mg II



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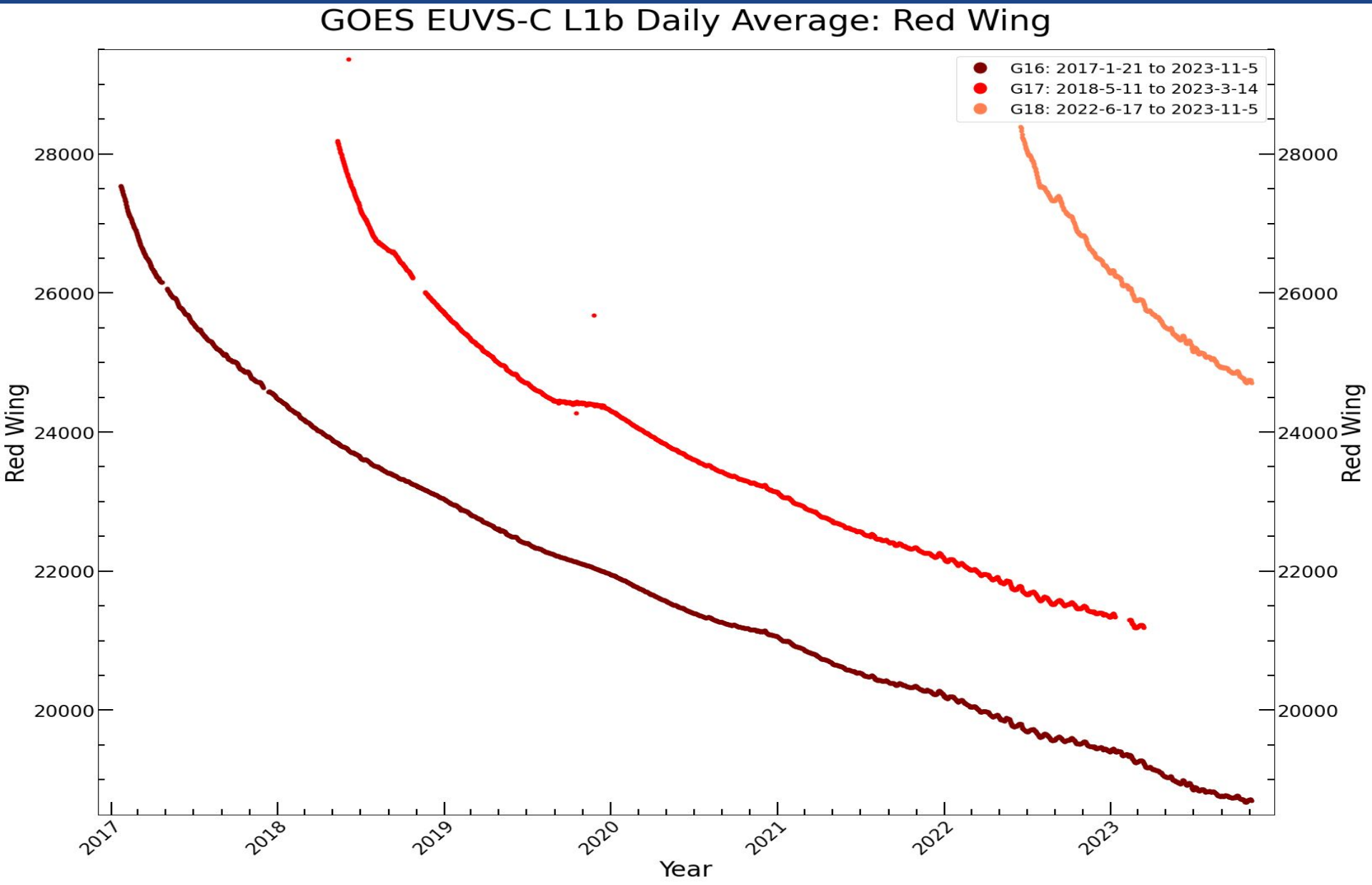
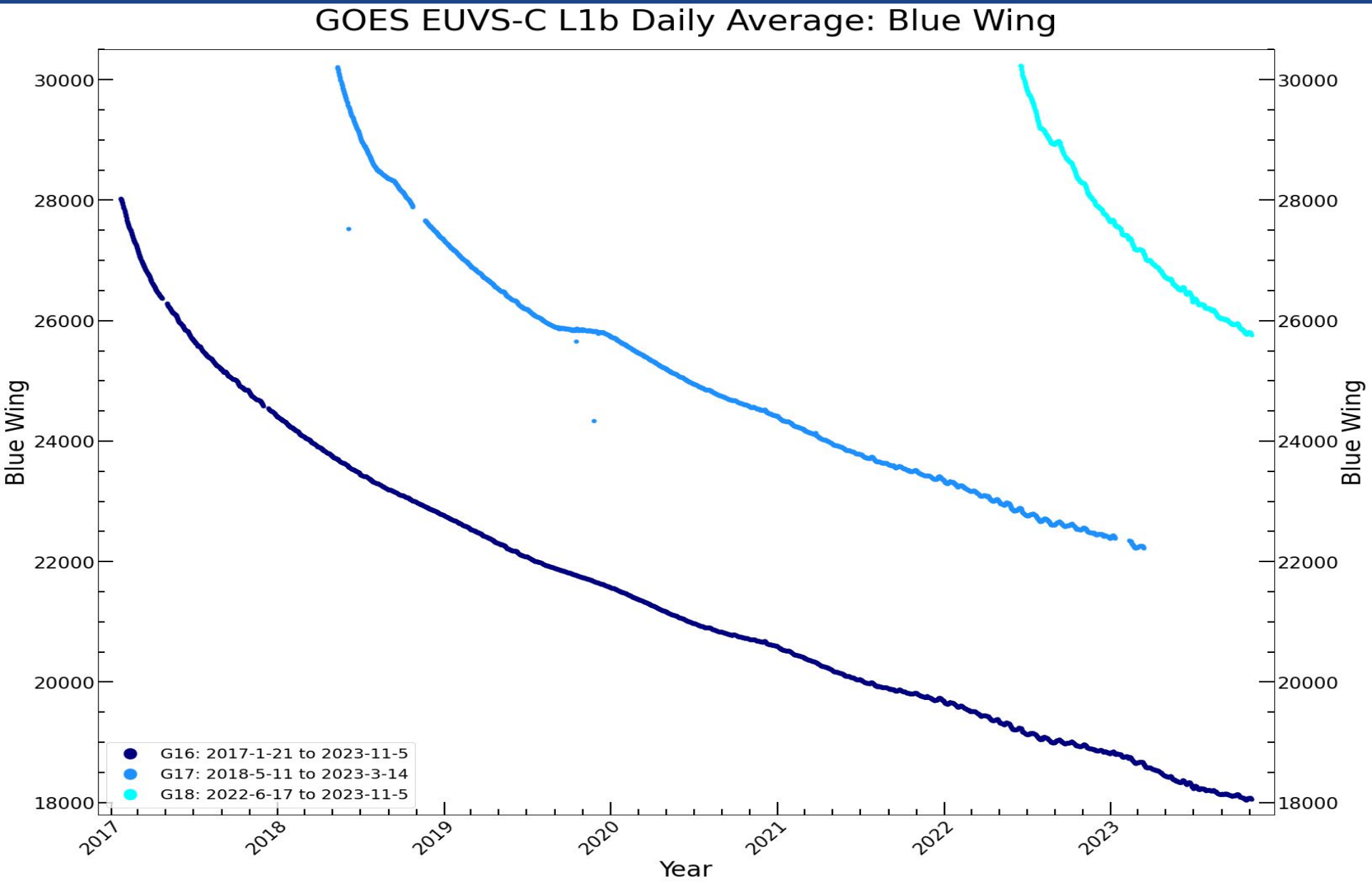
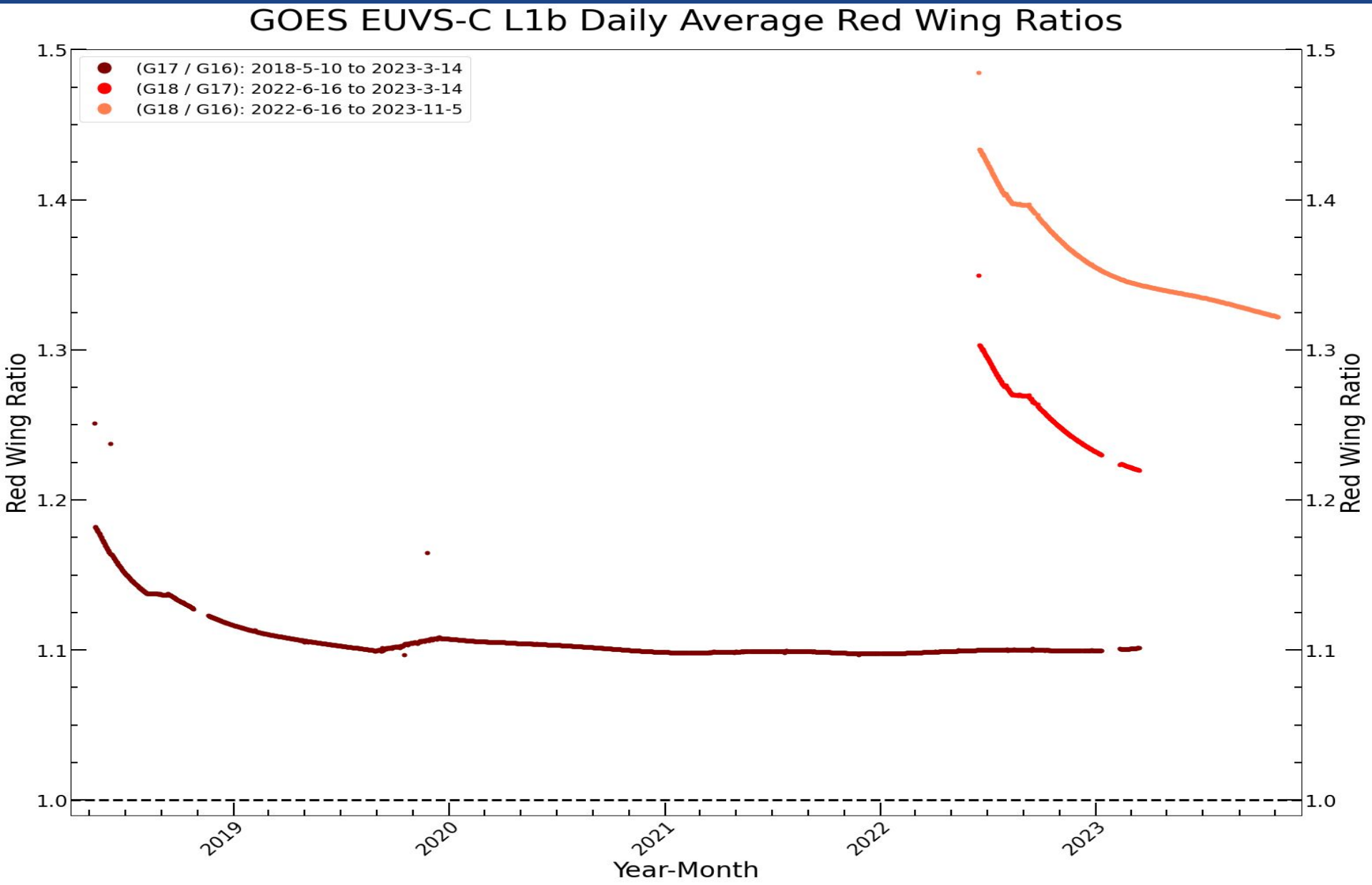


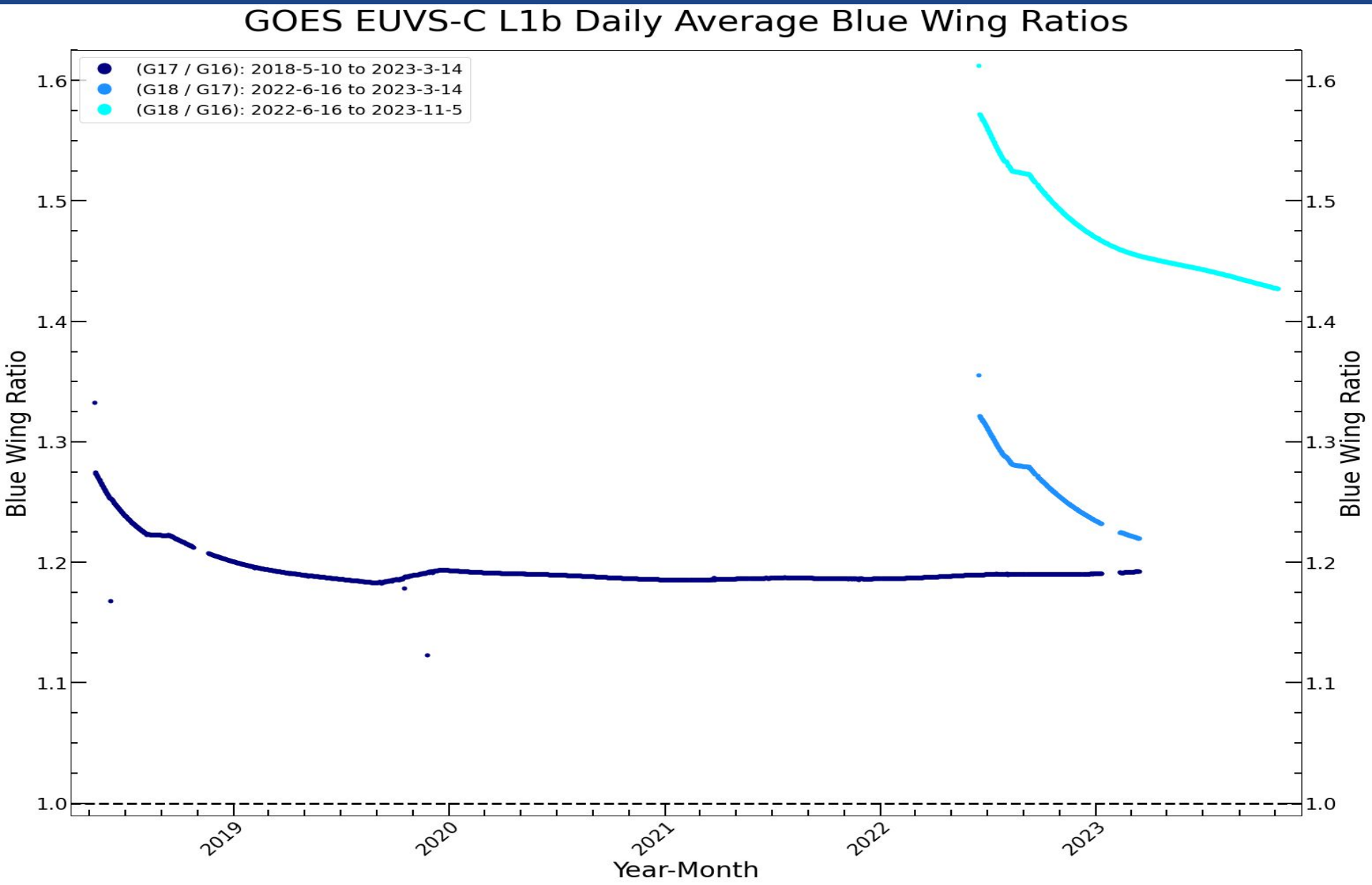
PLPT #14: EUVS-C



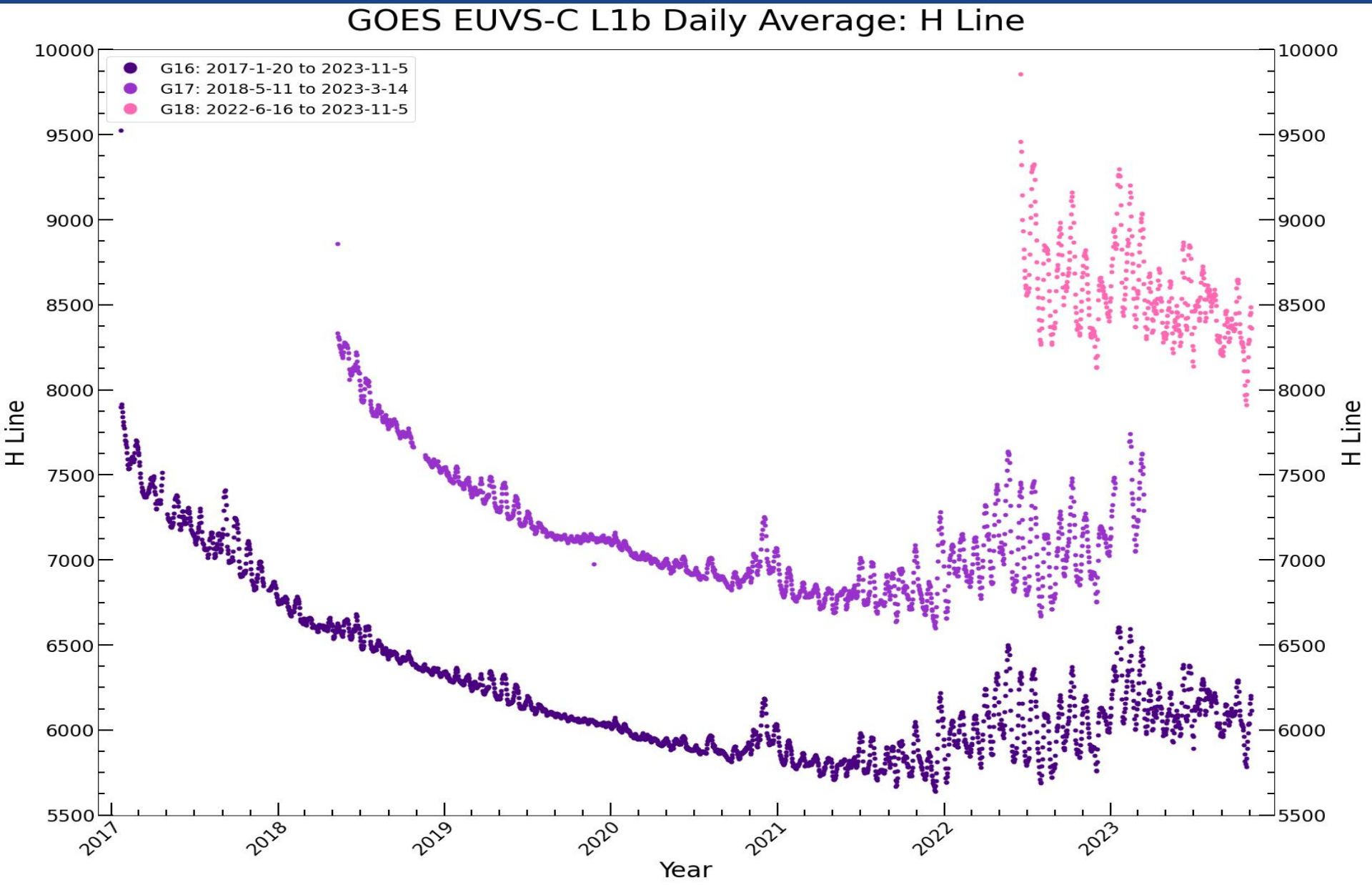
PLPT #14: EUVS-C



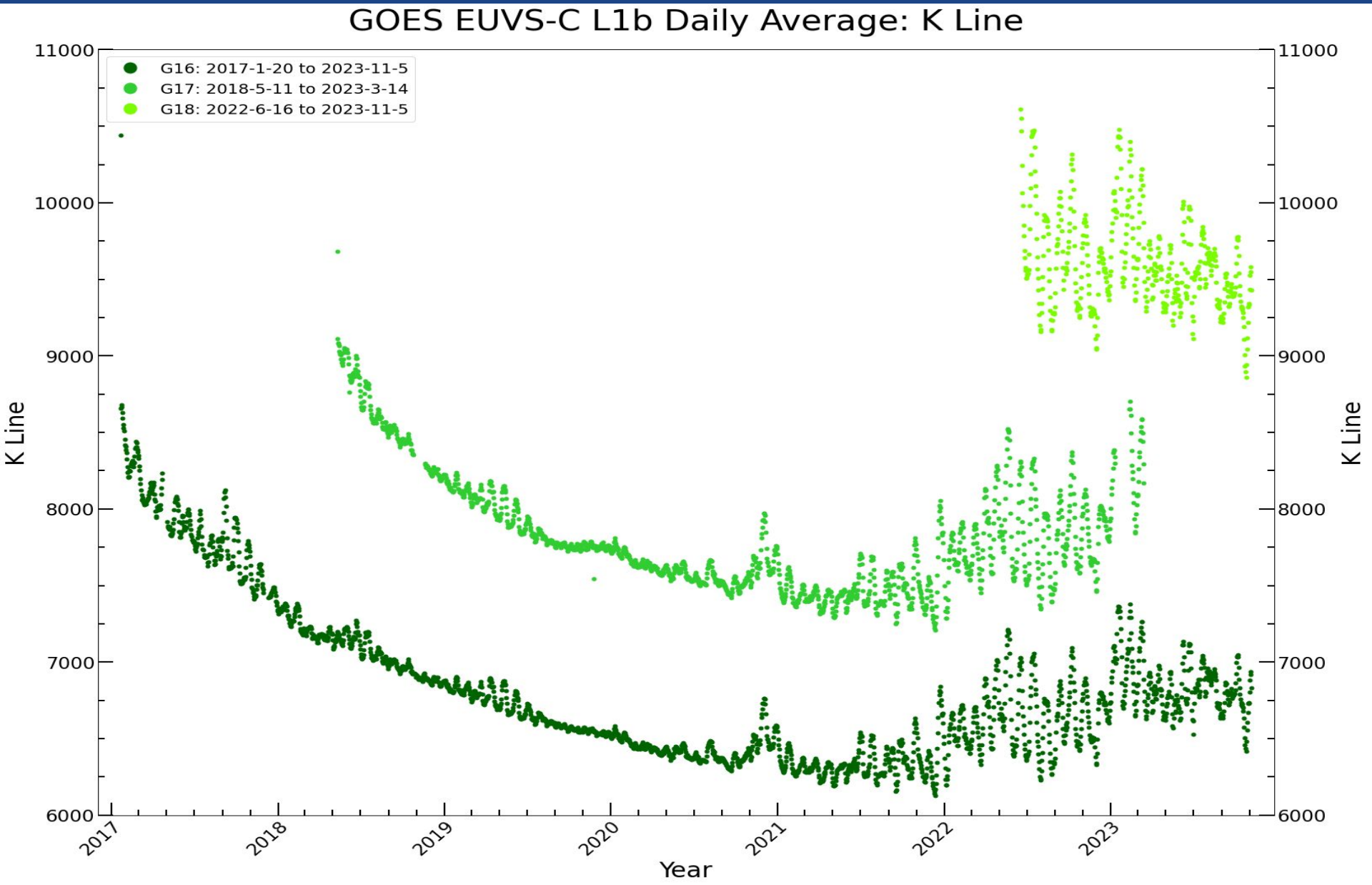
PLPT #14: EUVS-C



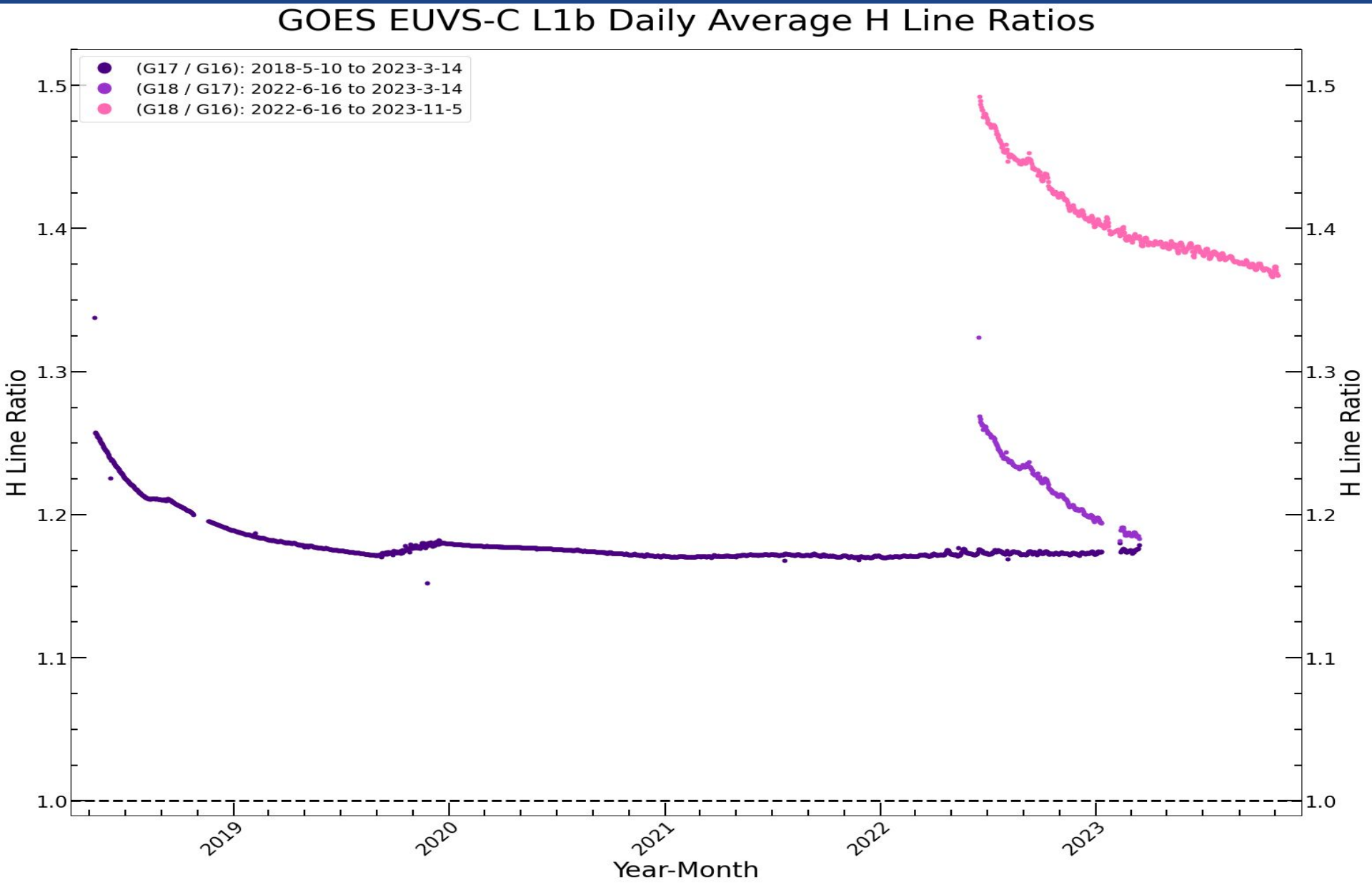
PLPT #14: EUVS-C



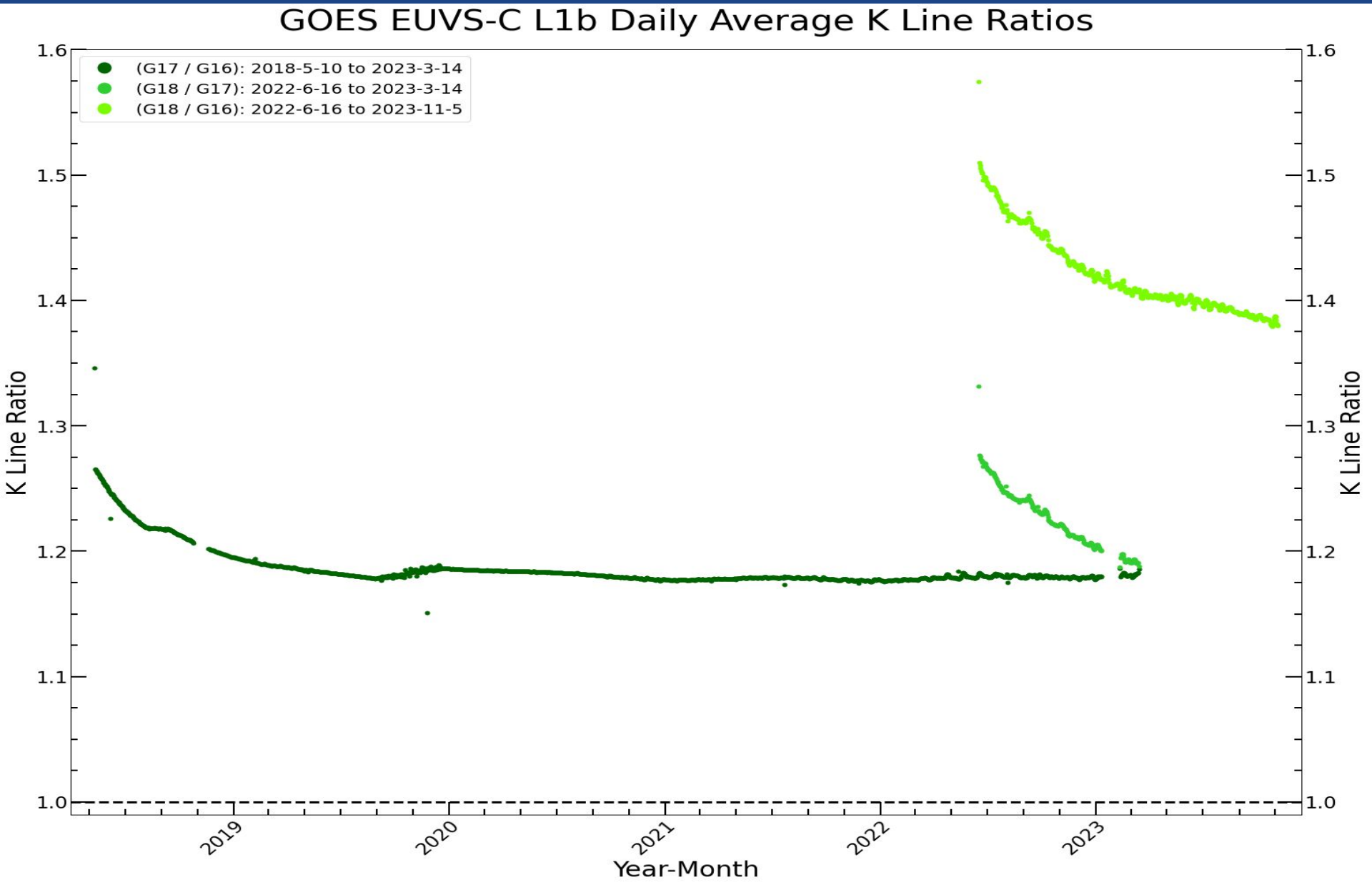
PLPT #14: EUVS-C



PLPT #14: EUVS-C

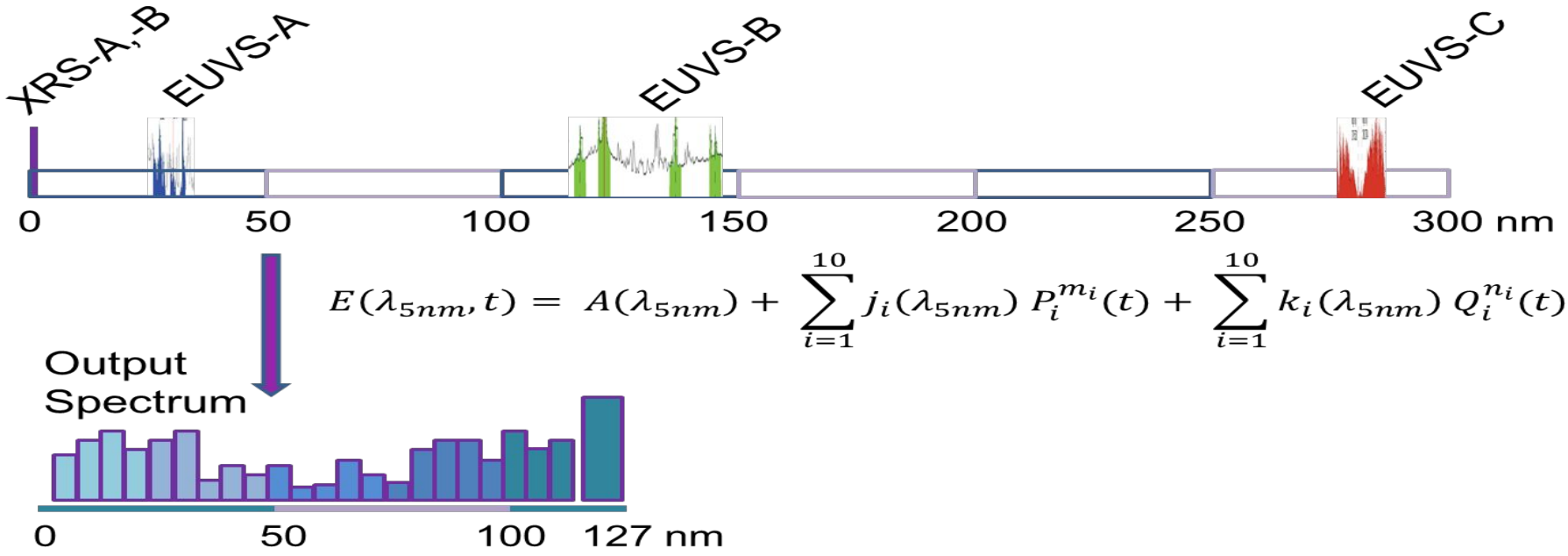


PLPT #14: EUVS-C

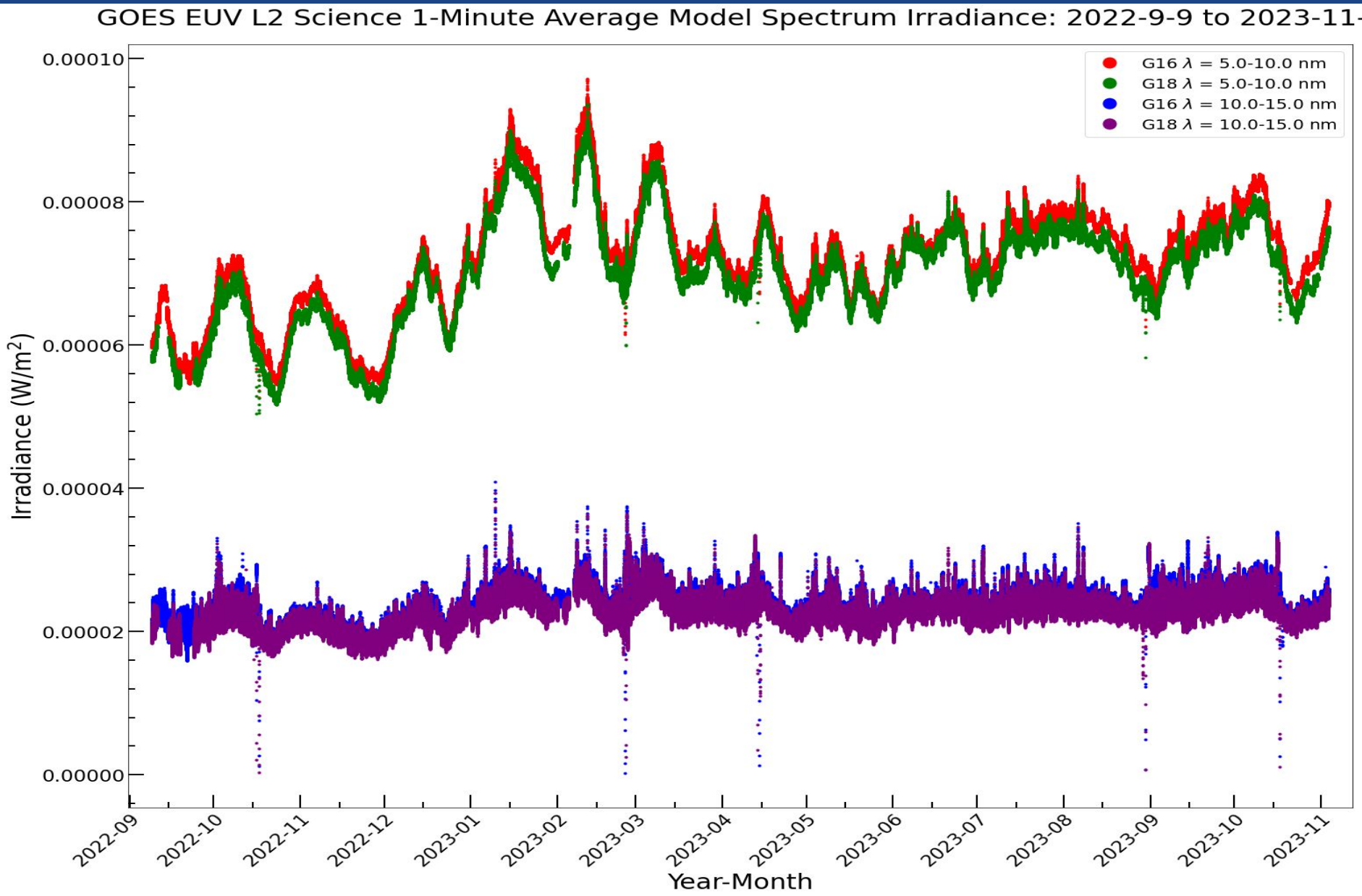


PLPT #14: EUV Model Spectrum

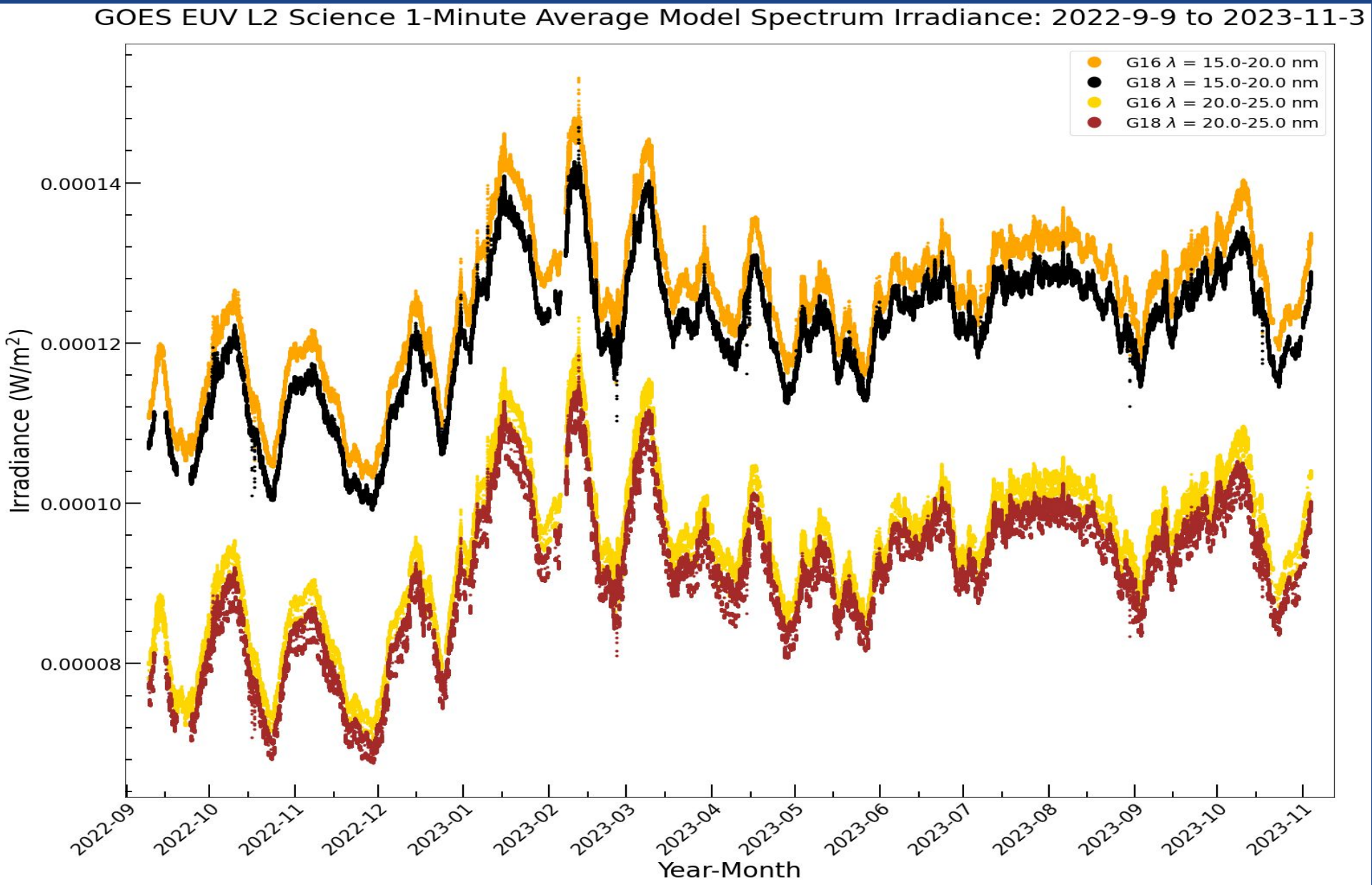
- The same model spectrum coefficients are in use for all 3 satellites (GOES-16, GOES-17, GOES-18)
- Plots show G16 and G18 irradiance vs. time in each of the 23 wavelength bins
- Model described in:
  - The GOES-R EUVS Model for EUV Irradiance Variability, E.M.B. Thiemann, et al., J. Space Weather and Space Climate, 2019.



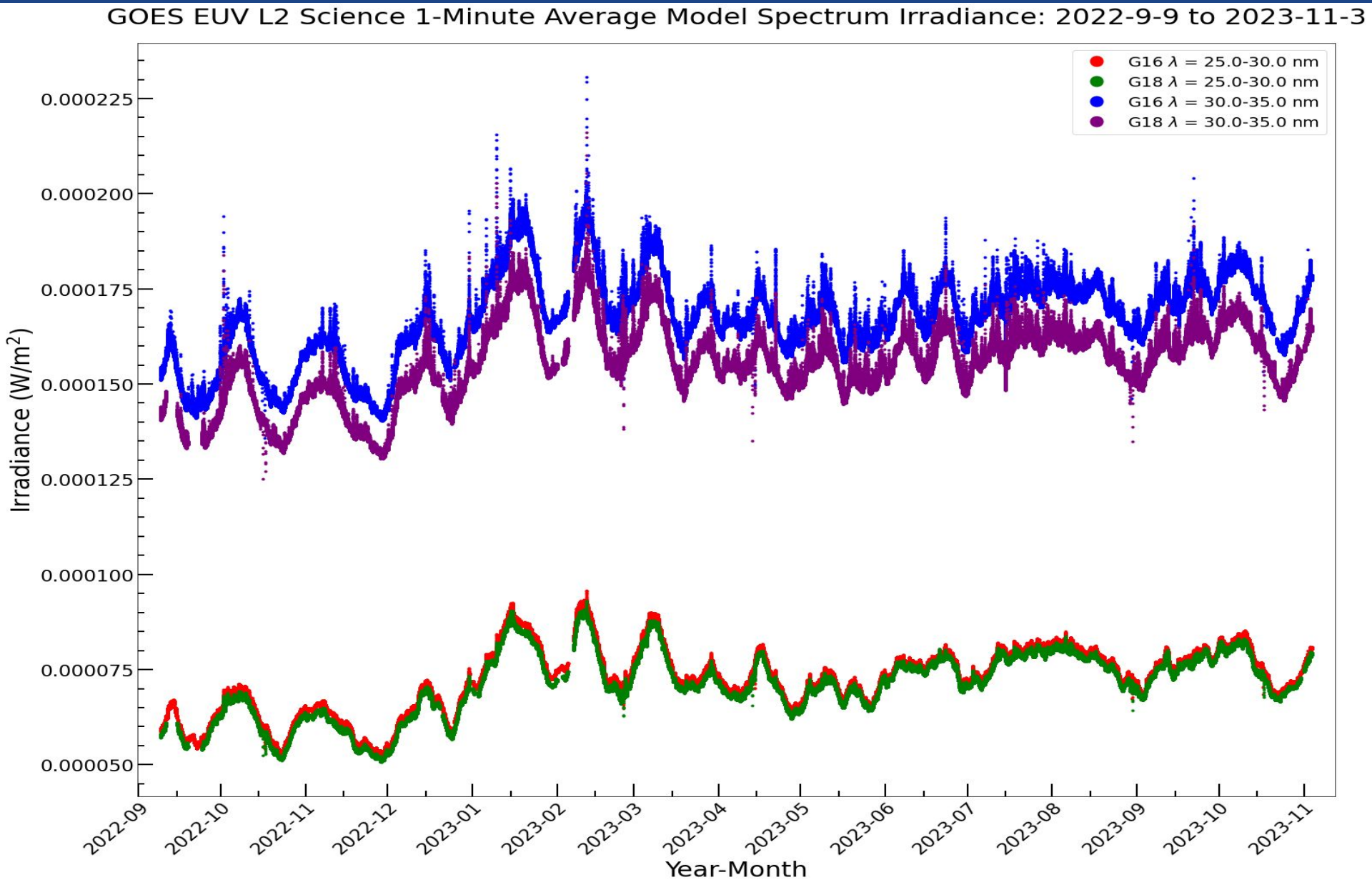
PLPT #14: EUV Model Spectrum



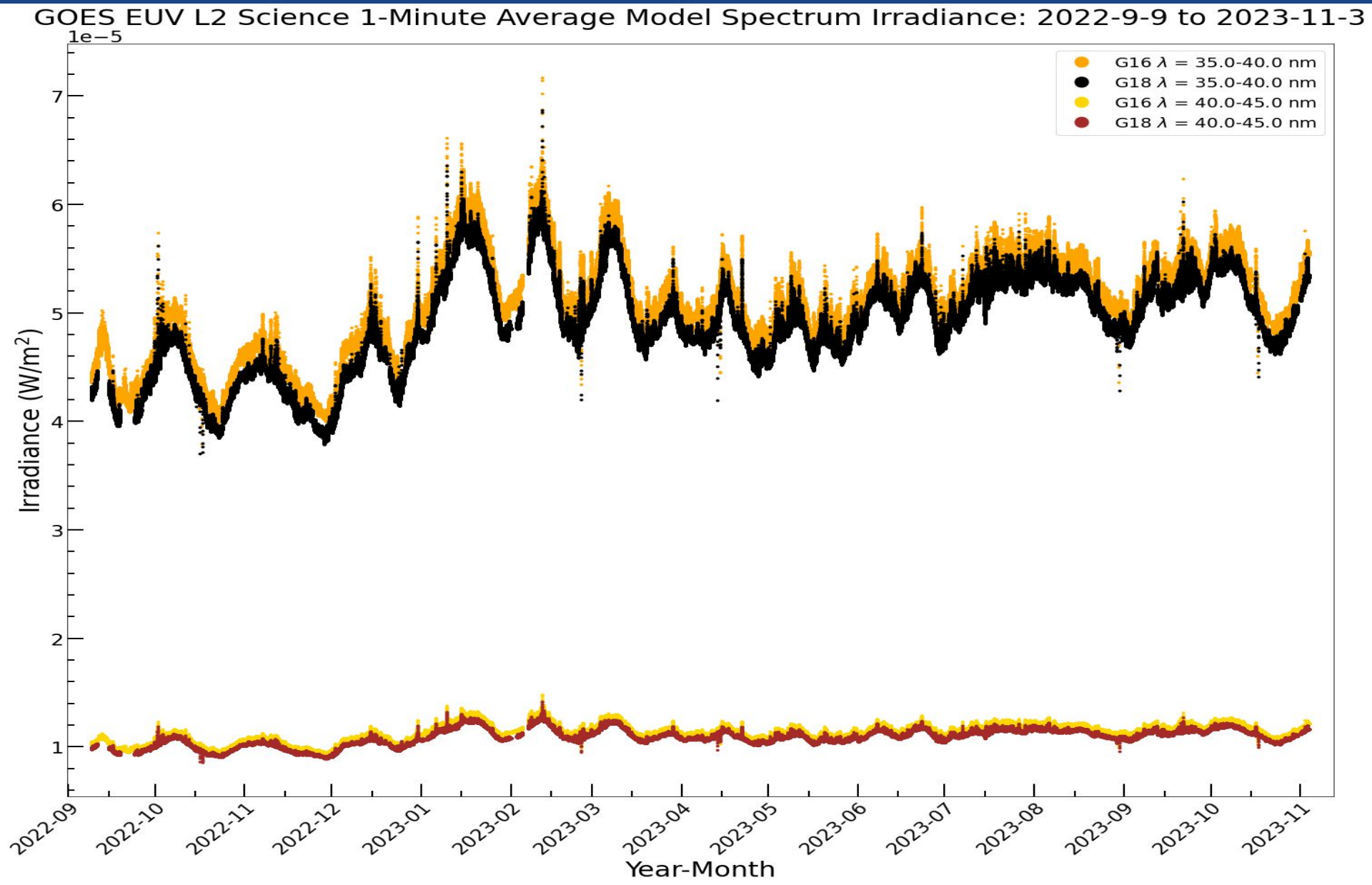
PLPT #14: EUV Model Spectrum



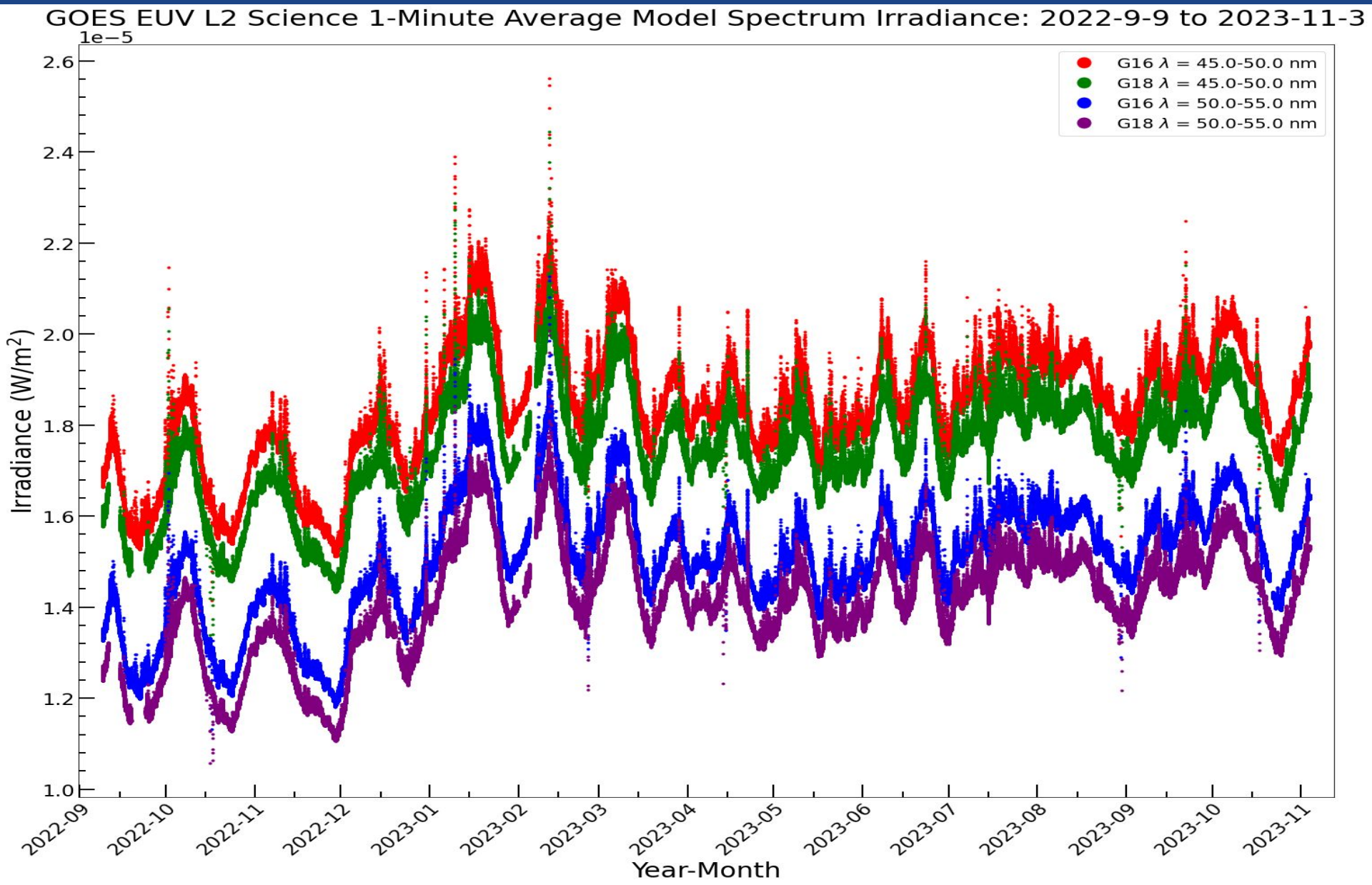
PLPT #14: EUV Model Spectrum



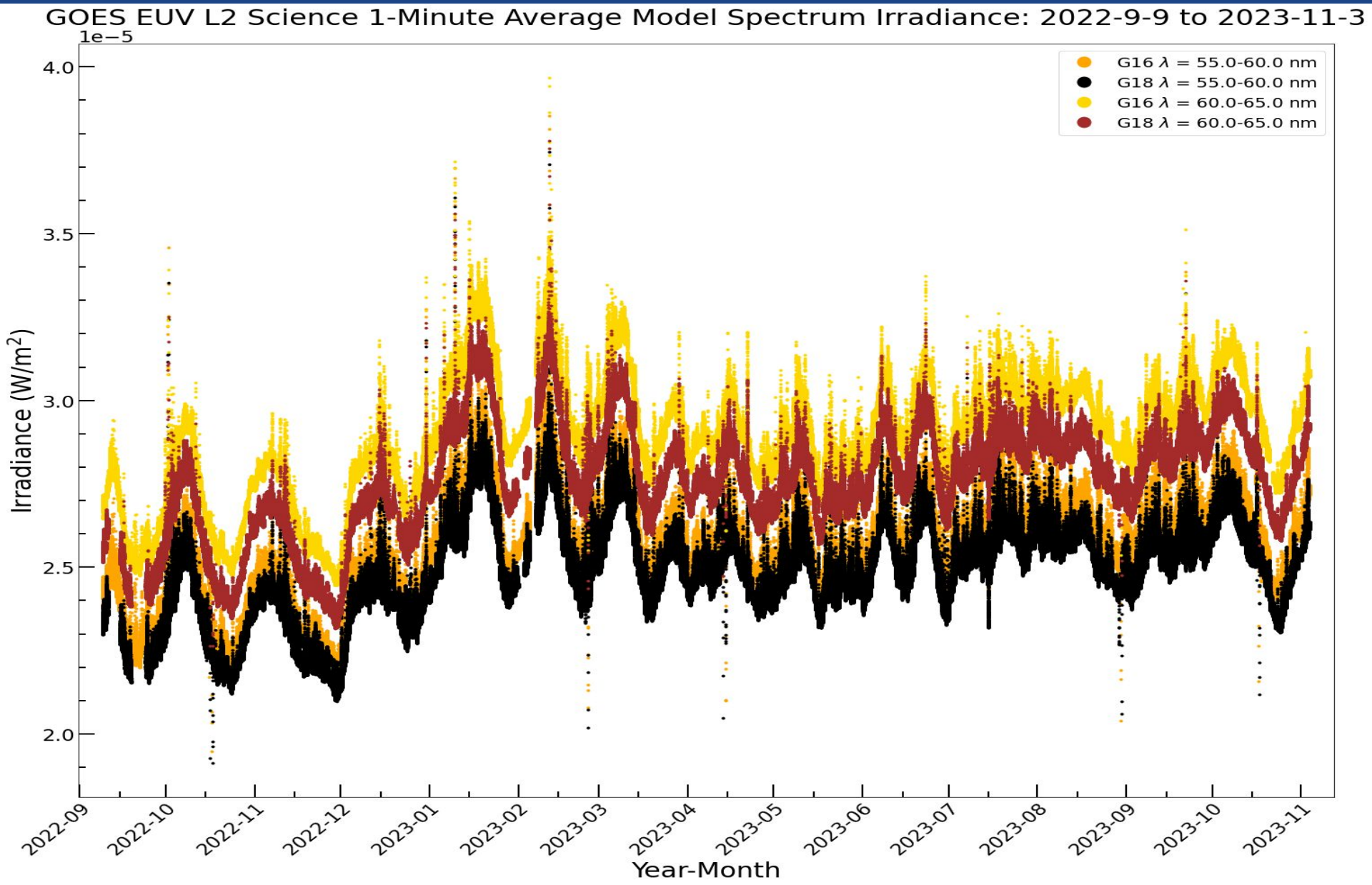
PLPT #14: EUV Model Spectrum



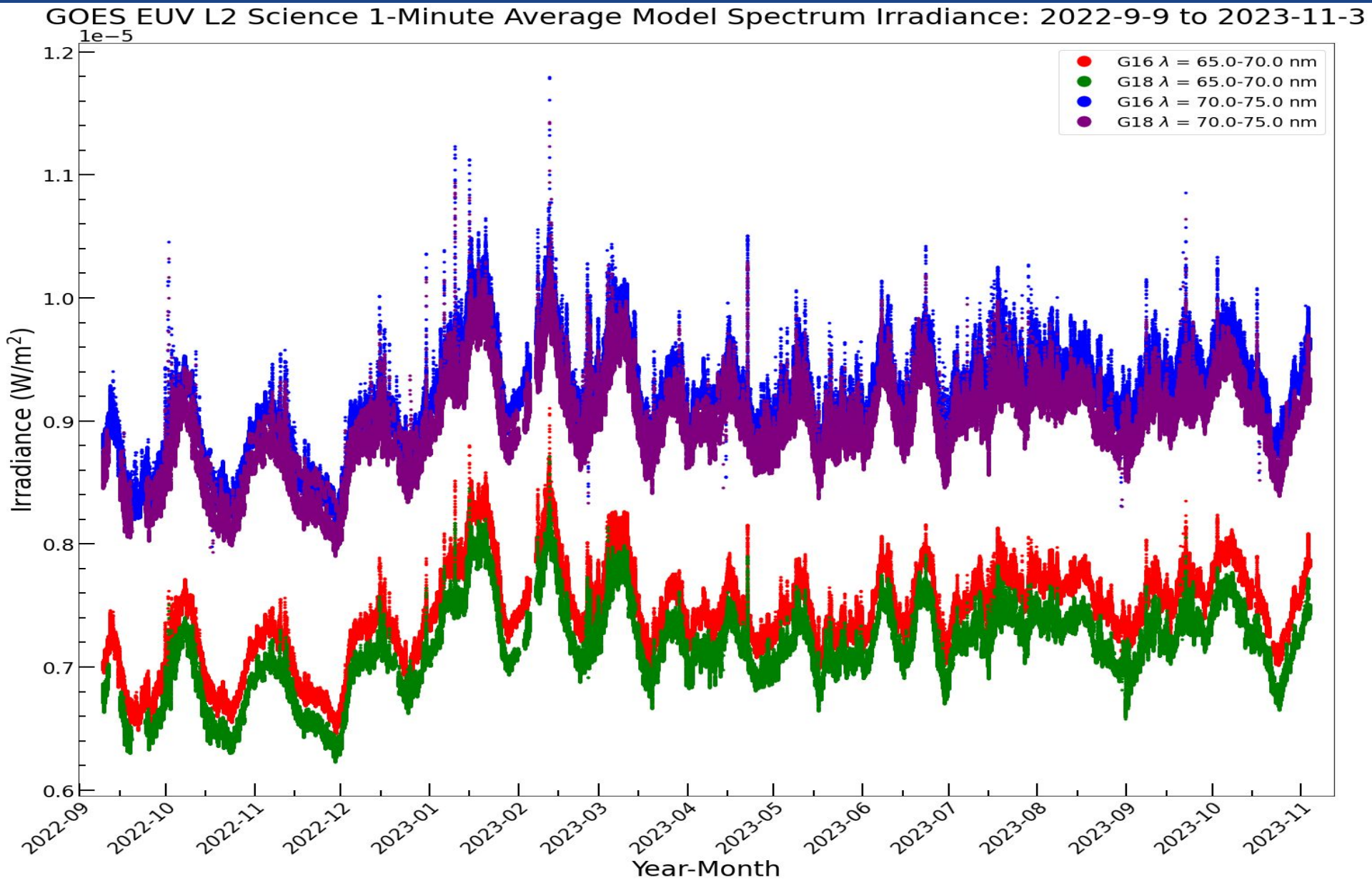
PLPT #14: EUV Model Spectrum



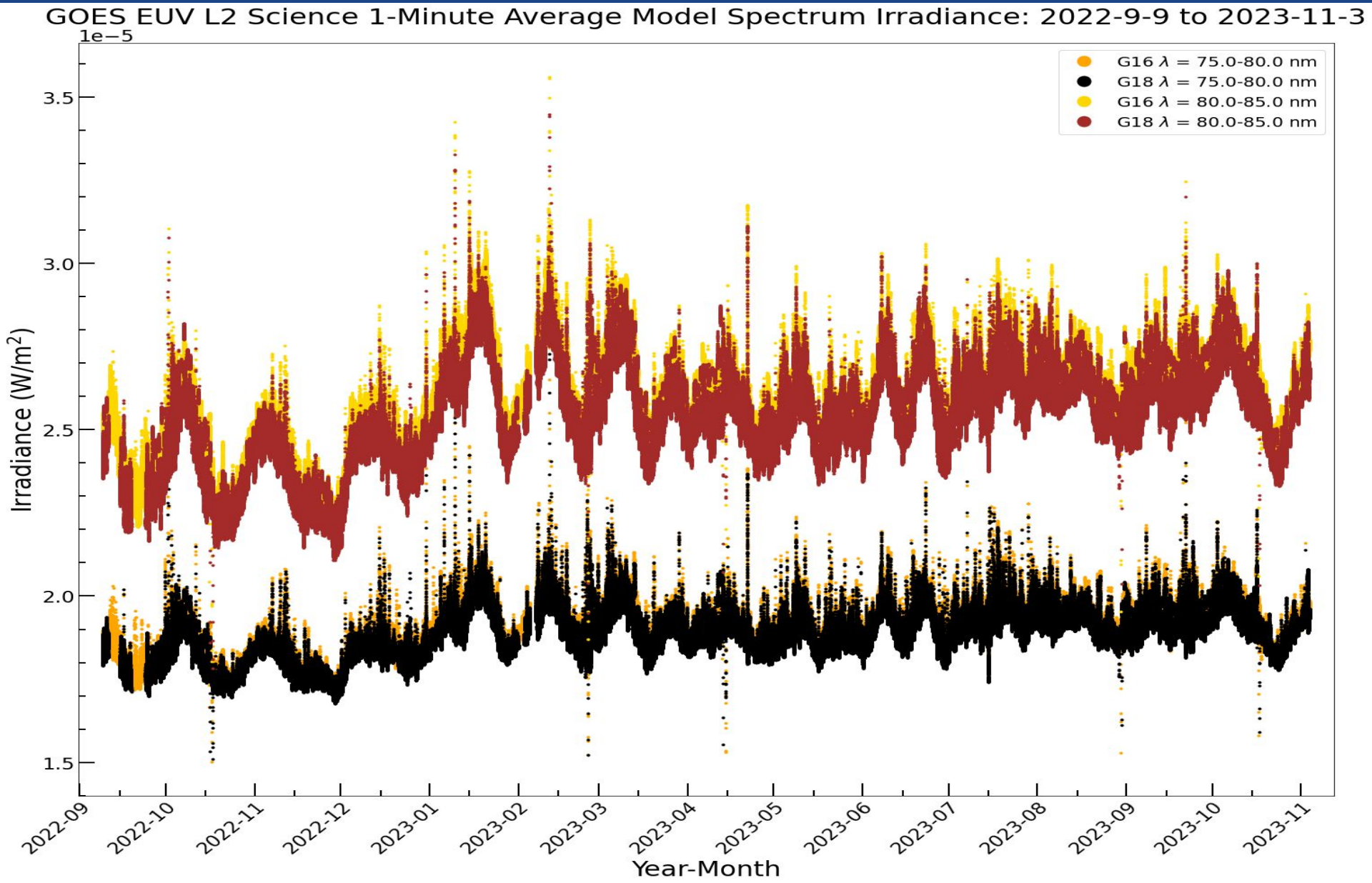
PLPT #14: EUV Model Spectrum



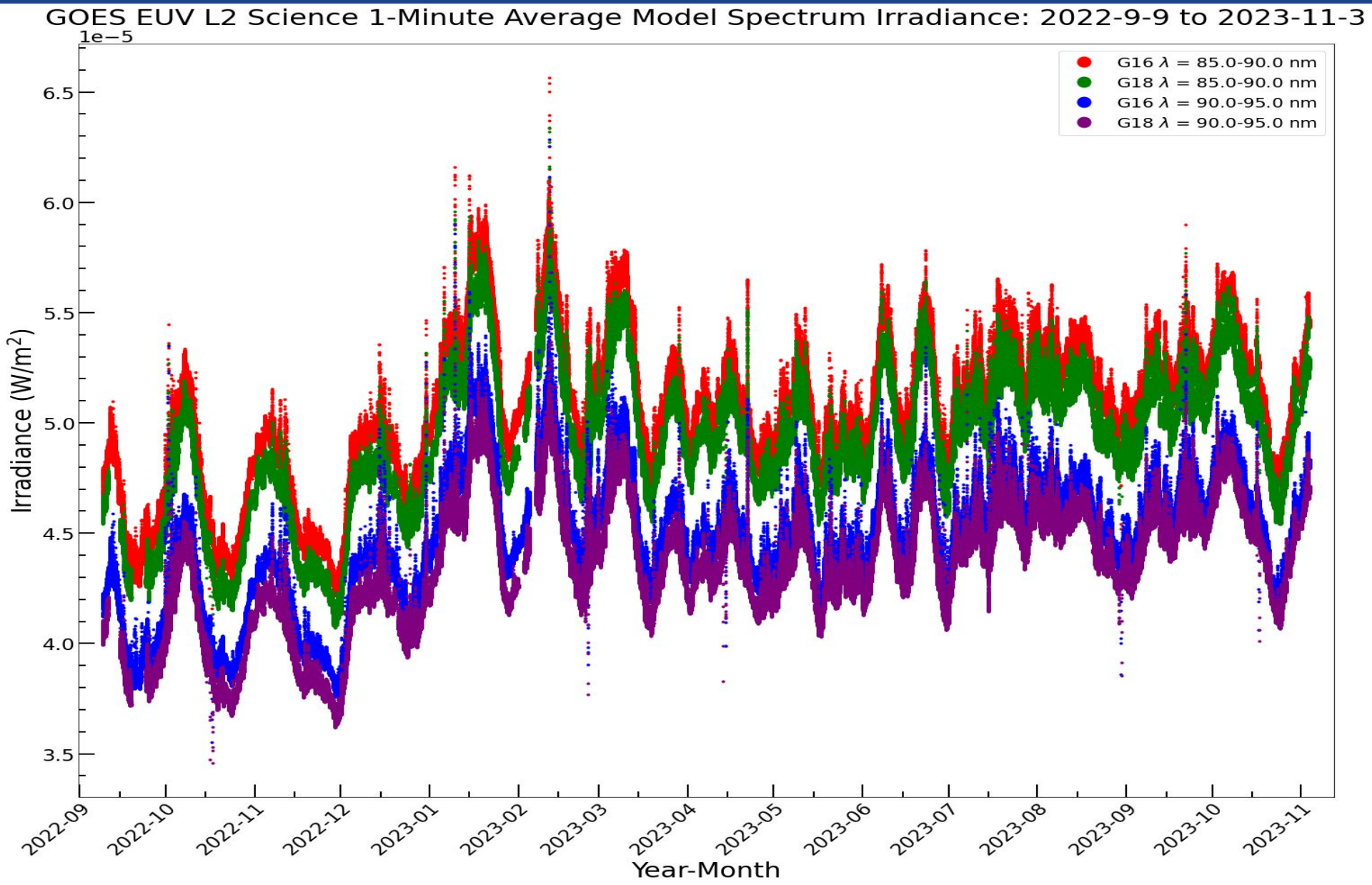
PLPT #14: EUV Model Spectrum



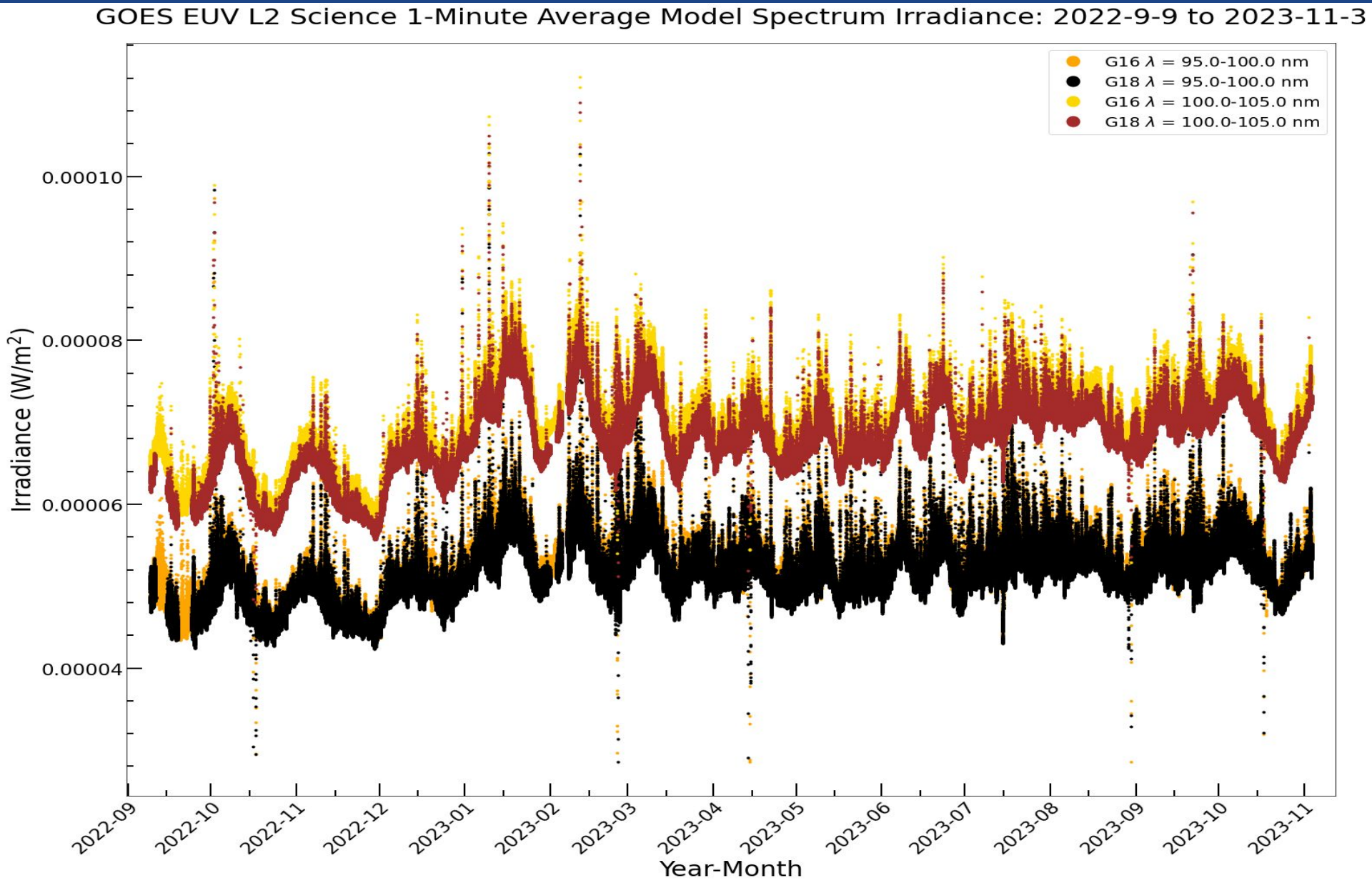
PLPT #14: EUV Model Spectrum



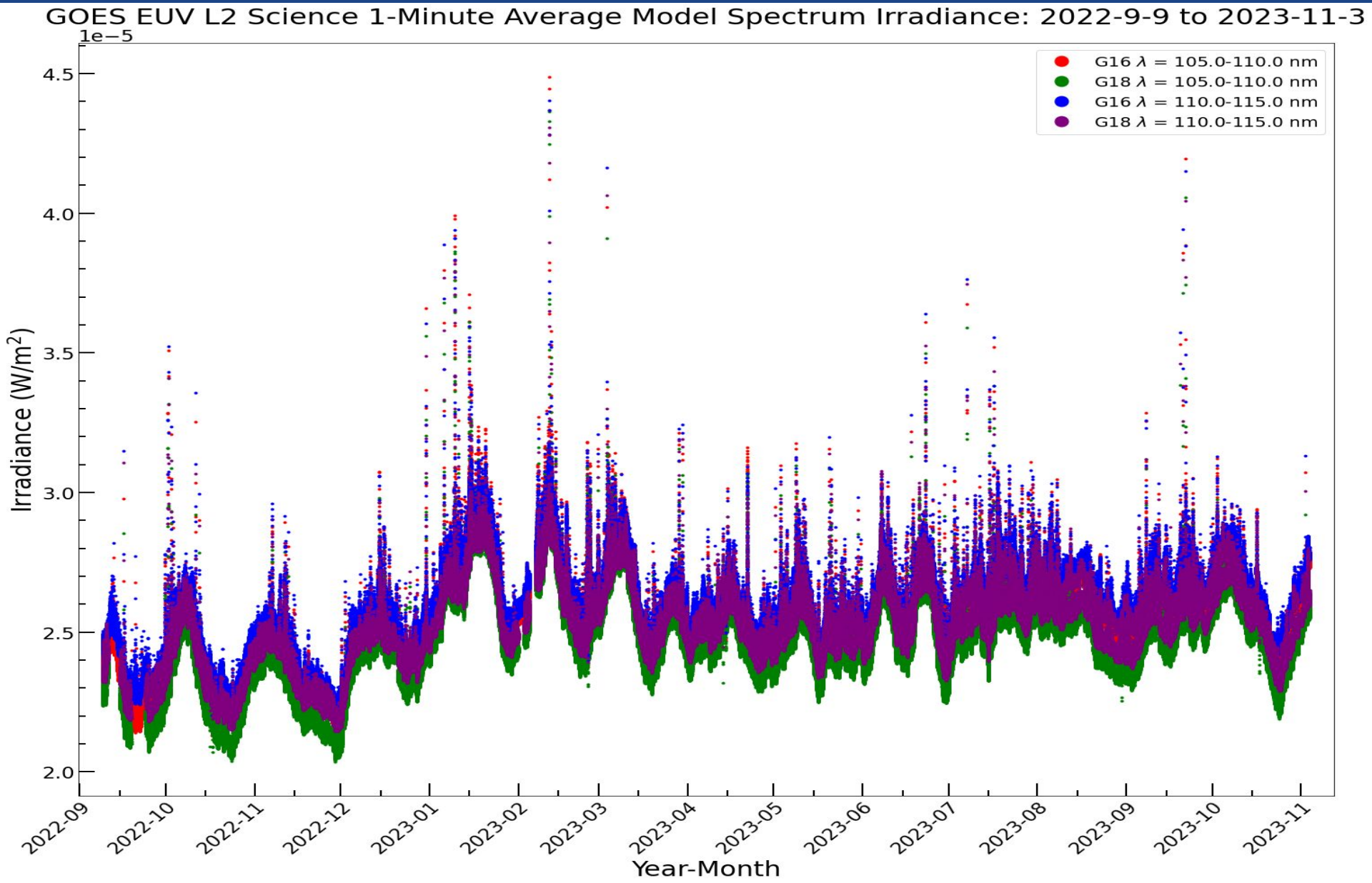
PLPT #14: EUV Model Spectrum



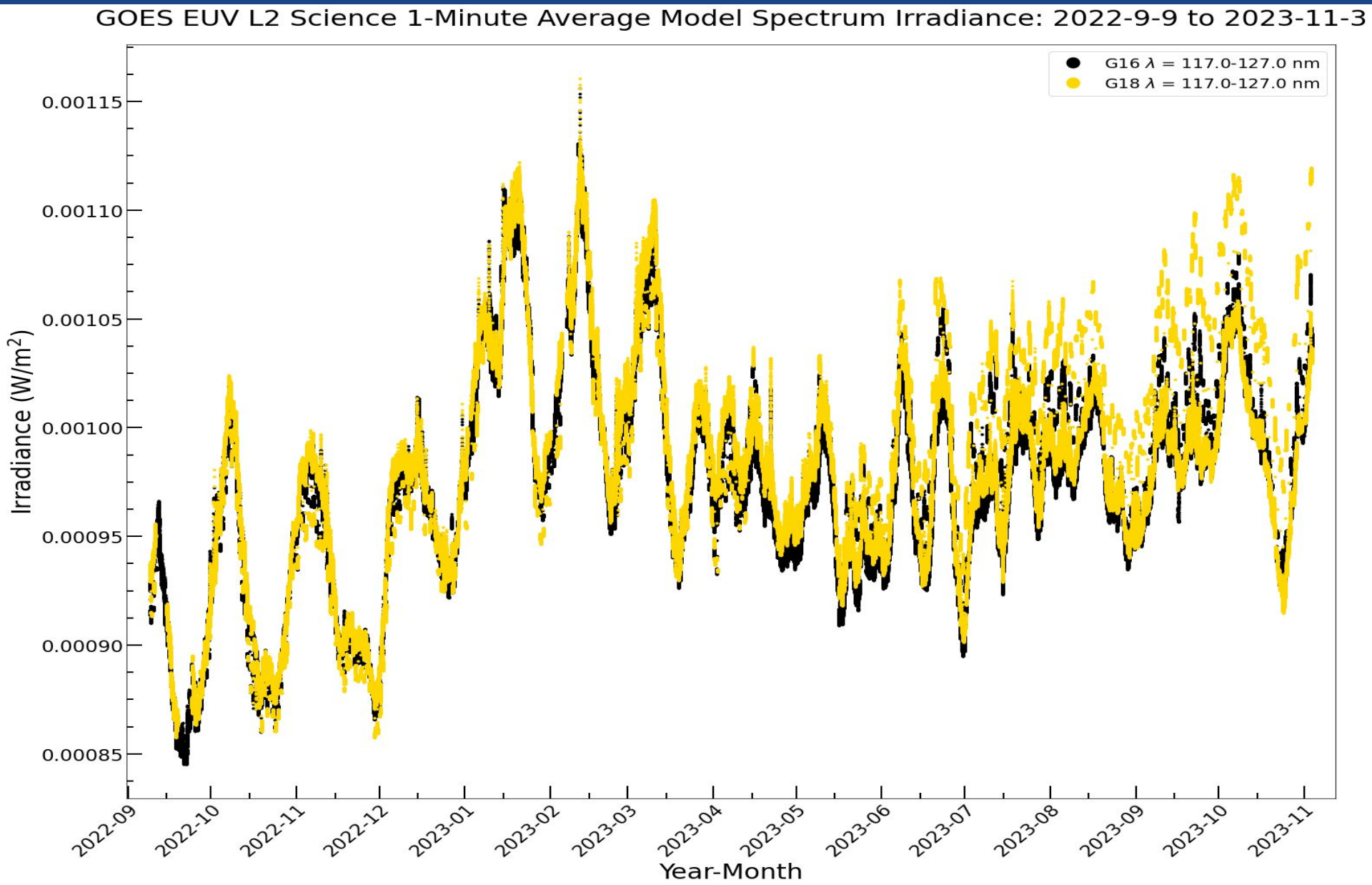
PLPT #14: EUV Model Spectrum



PLPT #14: EUV Model Spectrum



PLPT #14: EUV Model Spectrum



PLPT #14: EUV Model Spectrum

- Model spectrum data is highly dependent on input data
- Irradiance will not necessarily agree between satellites
- An approximate comparison is to take the ratio of one satellite to the other
- The table shows the mission-averaged (G18/G16) ratio for the duration of the G18 mission

Wavelength Bin	G18 / G16
5-10 nm	0.971
10-15 nm	0.966
15-20 nm	0.968
20-25 nm	0.967
25-30 nm	0.980
30-35 nm	0.930
35-40 nm	0.963
40-45 nm	0.960

Wavelength Bin	G18 / G16
45-50 nm	0.950
50-55 nm	0.940
55-60 nm	0.970
60-65 nm	0.954
65-70 nm	0.964
70-75 nm	0.977
75-80 nm	0.992
80-85 nm	0.979

Wavelength Bin	G18 / G16
85-90 nm	0.972
90-95 nm	0.971
95-100 nm	0.989
100-105 nm	0.969
105-110 nm	0.961
110-115 nm	0.969
117-127 nm	1.008

STATUS AT PROVISIONAL VALIDATION

EUVS GPA Issues at Provisional Validation

ADR	Issue	Data Impact	Description / Impacts	OE Delivery Date	Status at Full Review
872	Solar array currents incorrect in GOES-17	Minor	Solar array currents variables are incorrect. Telemetry issue.	WR 6780 is in work for DO.12.01.00	**Closed**
1144	EUVS during lunar transit	Moderate	Spectral lines and Mg II set to fill values during eclipse and lunar transit (detailed in GOES-17 EUVS Full Validation PS-PVR)	WR 8764 is in work for DO.12.00.00	**Open; Solution in Progress**
1157	EUVS metadata	Minor	Minor changes to metadata- variable long names and global attribute names	To be addressed by PRO PASS in a PR	**Closed**
1158	EUVS calibration flag change	Minor	Modify quality flags to clearly label calibrations	WR 8763 is in work for DO.12.00.00	**Closed**
1161	Penumbra-only flag	Moderate	Add flag to indicate penumbra event without eclipse to SC_eclipse_flag (detailed in GOES-17 EUVS Full Validation PS-PVR)	In analysis under Flight WR 8837 with PRO support. Likely an MM procedural update.	**Open; In Analysis**
1171	Increase ECEF_Z range	Minor	Impacts all Space Weather instruments	WR 9326 is in work for DO.12.00.00	**Closed**

EUVS Instrument Issues at Provisional Validation

#	Title	Description	Comments to Users
1	EUVS-C Spike Removal	Spikes can add noise to the data	L1b code additions will be determined
2	EUVS-C Systematic Behavior	Effects of Doppler and seasonal variation and degradation trends	Wing and line behavior will be investigated
3	Spectral Model Jumps	Jumps in spectral model bins that use 121.6 nm irradiance	New LUT with different coefficients for Case 1 will be generated
4	Oscillation Artifact	Annual cycle oscillation in EUVS-B line irradiances: 117 nm and 140 nm	Under investigation

SUMMARY OF REMAINING ISSUES

EUVS GPA Status at Full Validation

- 131 EUVS-related ADRs have been closed since 2016
- 10 EUVS ADRs closed since GOES-18 Provisional Validation PS-PVR (November 2022)
  - These include data file metadata updates and routine instrument calibration LUTs
- 2 EUVS ADRs are currently open. None of these have significant impacts to data processing or quality.

Remaining EUVS GPA Issues

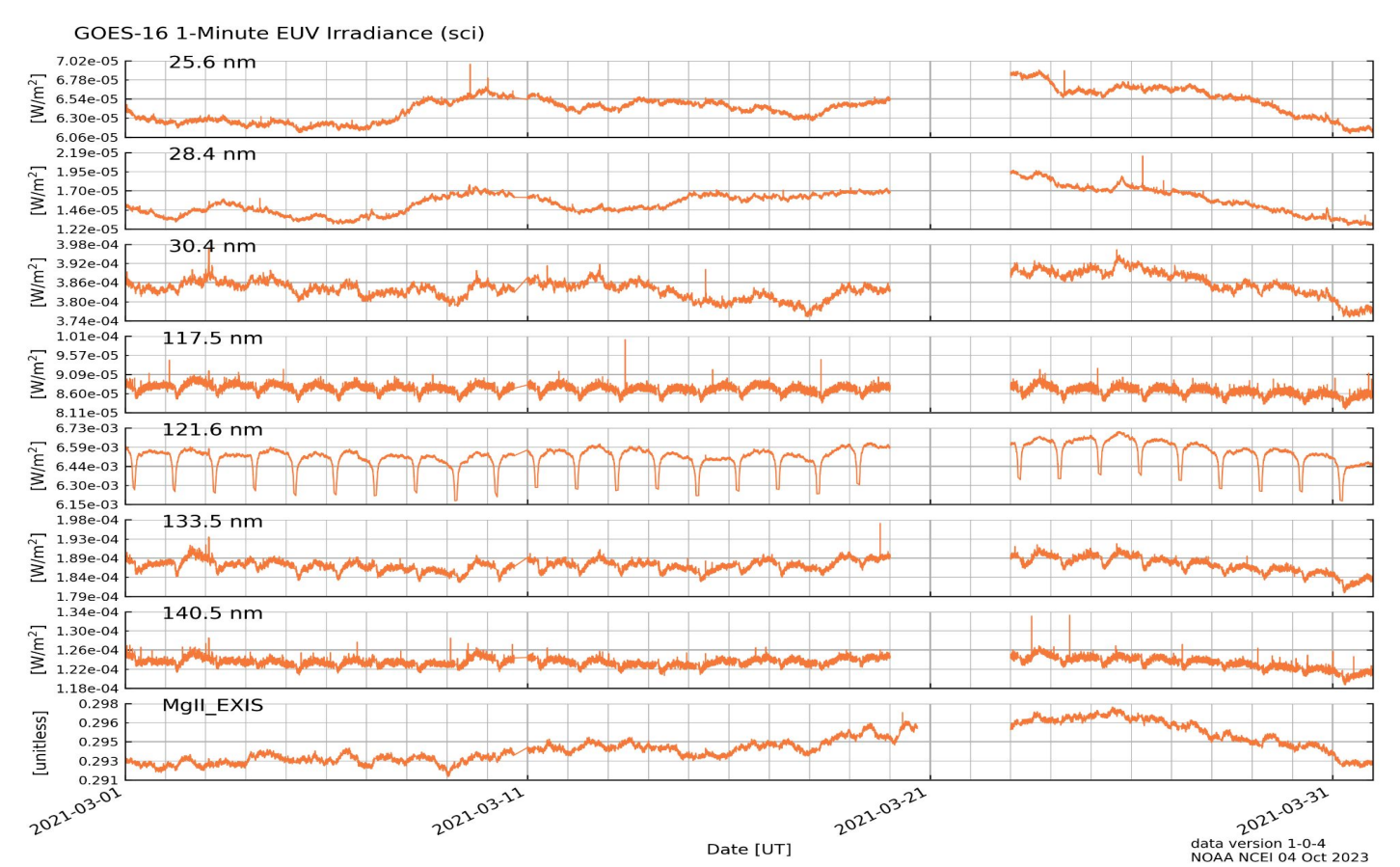
ADR	Issue	Data Impact	Description / Impacts	OE Delivery Date
1144	EUVS during lunar transit	Moderate	Spectral lines and Mg II set to fill values during eclipse and lunar transit (detailed in GOES-17 EUVS Full Validation PS-PVR)	WR 8764 is in work for DO.13.00.00
1161	Penumbra-only flag	Moderate	Add flag to indicate penumbra event without eclipse to SC_eclipse_flag (detailed in GOES-17 EUVS Full Validation PS-PVR)	In analysis under Flight WR 8837 with PRO support. Likely an MM procedural update.

Remaining EUVS Instrument Issues

#	Title	Description	Comments to Users
1	EUVS-C Spike Removal	Spikes can add noise to the data	Correction (new code) is ready for implementation and under consideration
2	EUVS-C Systematic Behavior	Effects of Doppler and seasonal variation and degradation trends	Wing and line behavior will be investigated
3	Spectral Model Jumps	Jumps in spectral model bins that use 121.6 nm irradiance	New LUT with different coefficients for Case 1 will be generated
4	Oscillation Artifact	Annual cycle oscillation in EUVS-B line irradiances: 117 nm and 140 nm	Under investigation

Remaining EUVS Instrument Issues

#	Title	Description	Comments to Users
5	EUVS Temperature Correction	Irradiances show a multi-hour dip after each eclipse. This artifact should be removed with improved temperature correction.	Under investigation



Future EUVS GPA Updates

- EUVS-A RevG LUT update was installed November 3, 2023
- NCEI will produce and deliver all future GOES-18 EUVS LUT updates
  - EUVS-A and EUVS-B LUTs are routinely updated after every eclipse season
  - These will include updates to the temperature, dark drift and degradation calibration tables

FULL MATURITY ASSESSMENT

Performance Baseline

MRD* ID	Quantity	MRD Requirement	GOES-16 (Full)	GOES-17 (Full)	GOES-18 (Full)	Related PLPTs	Status
577	EUVS Long-term Stability Life of Mission)	< ±5% or ability to track	Track Changes			15, 16, 17	PASS
2027	EUVS Product Measurement Range	EUVS-A: 0.5x Solar Min to 10x Solar Max ($1.4x10^{-5}$ to $5.3x10^{-2}$ W/m^2) EUVS-B: 0.5x Solar Min to 10x Solar Max ($1.4x10^{-5}$ to $5.3x10^{-2}$ W/m^2)	EUVS-A: $4.7x10^{-7}$ to 0.93 W/m^2 EUVS-B: $1.8x10^{-6}$ to 1.64 W/m^2	EUVS-A: $6.3x10^{-7}$ to 1.03 W/m^2 EUVS-B: $1.4x10^{-6}$ to 1.19 W/m^2	EUVS-A: $2.4x10^{-6}$ to 3.05 W/m^2 EUVS-B: $4.9x10^{-6}$ to 12.24 W/m^2	3	PASS**
2028	EUVS Product Measurement Accuracy	< 20%	EUVS-A: ≤ 2.7% EUVS-B: ≤ 7.7%	EUVS-A: ≤ 4.0% EUVS-B: ≤ 5.9%	EUVS-A: ≤8.9% EUVS-B: ≤12.9%	3	PASS**
2031	EUVS Product Measurement Precision	< 20% at min flux	EUVS-A: ≤ 2.9% EUVS-B: ≤ 9.4%	EUVS-A: ≤3.3% EUVS-B: ≤5.9%	EUVS-A: ≤ 4.5% EUVS-B: ≤ 4.8%	3	PASS**
2032	EUVS Long-term Stability	< ±5% or ability to track	Track Changes			15, 16, 17	PASS

- *MRD = Mission Requirements Document
- **Established in GOES-18 EUVS Provisional Validation Review

Full Validation

Preparation Activities	Assessment
Validation, quality assessment, and anomaly resolution activities are ongoing.	Validation activities are ongoing. Results have been discussed with SWPC. Release of data by NCEI has enabled research community participation.
Incremental product improvements may still be occurring.	Product improvements will result from the resolution to issues given on the slides titled "Remaining EUVS GPA Issues" and "Remaining EUVS Instrument Issues."
Users are engaged and user feedback is assessed.	Discussions with SWPC and the science community are ongoing.

Full Validation

End State	Assessment
Product performance for all products is defined and documented over a wide range of representative conditions via ongoing ground truth and validation efforts.	EUVS irradiance measurements from GOES-16, 17 and 18 have been inter-compared with each other. The GOES-18 EUVS instrument was calibrated at NIST. Products are documented in ReadMe and User Guide documents.
Products are operationally optimized, as necessary, considering mission parameters of cost, schedule, and technical competence as compared to user expectations.	Except as described on the slide titled "Ongoing Investigations", the products are operationally optimized. Regular monitoring, on-orbit calibrations and LUT updates will maintain this optimization.
All known product *anomalies are documented and shared* with the user community.	Anomalies are listed in the caveats section in the L1b ReadMe documents at the NCEI GOES-R web site (link below).
Product is operational.	L2 products: 1-minute averages and daily averages (line irradiances, Mg II index, and proxy spectrum) ● All products available for GOES-16, GOES-17 and GOES-18 L1b Products: 30-second data (line irradiances, Mg II index, and proxy spectrum) ● All products available for GOES-16, GOES-17 and GOES-18 L2 products in development: Flare summary, high temporal/spectral resolution measurement All data is available at https://www.ngdc.noaa.gov/stp/satellite/goes-r.html

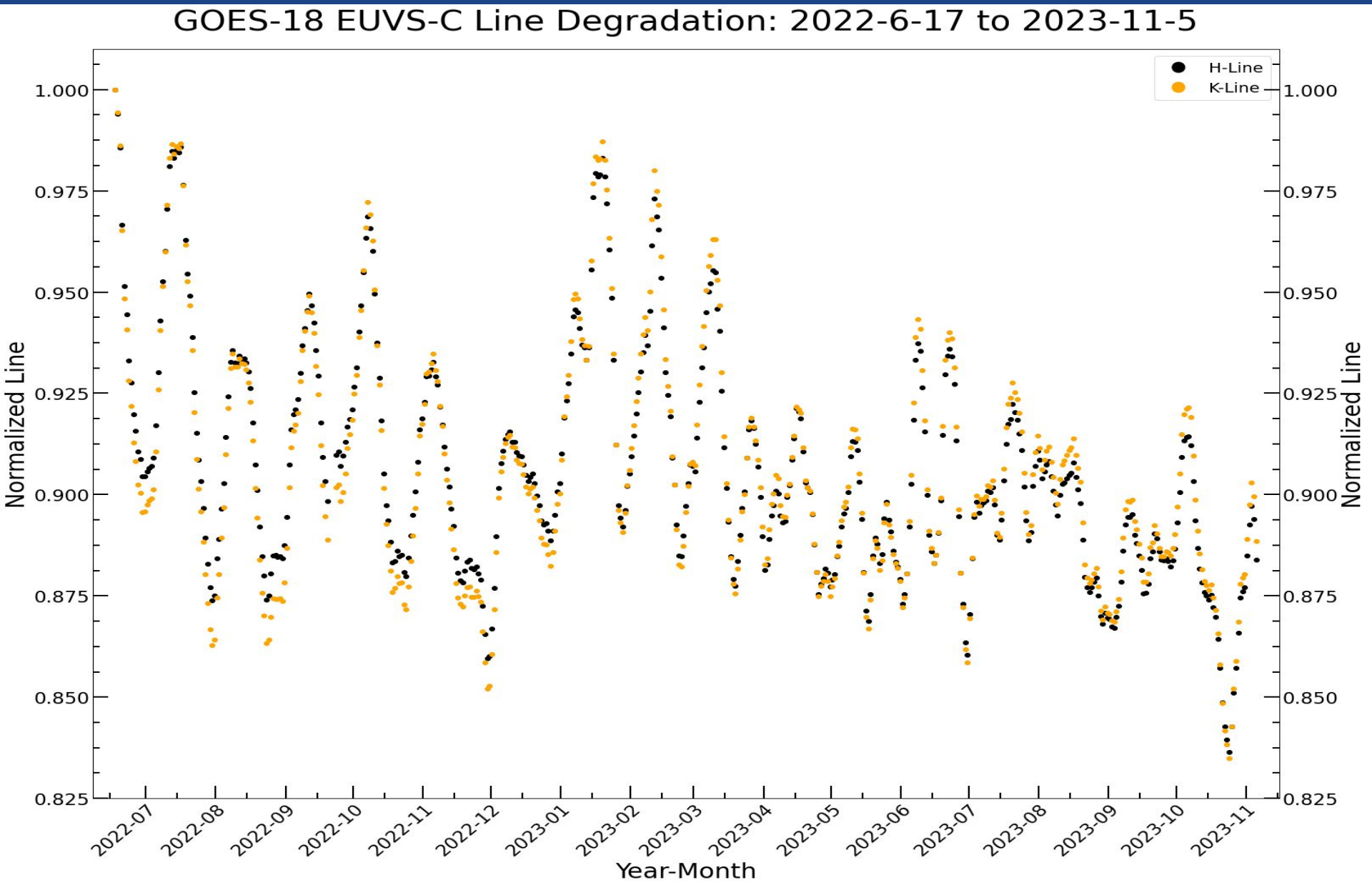
Full Validation

- GOES-18 EXIS became operational as the GOES-West satellite on January 4, 2023
- All sensors are performing very well
- Calibration LUTs are updated regularly
- Paths toward diagnoses and fixes of issues have been identified
- Publicly available EUVS data from NCEI:
  - GOES-16: operational and science-quality
  - GOES-17: operational and science-quality
  - GOES-18: operational and science-quality

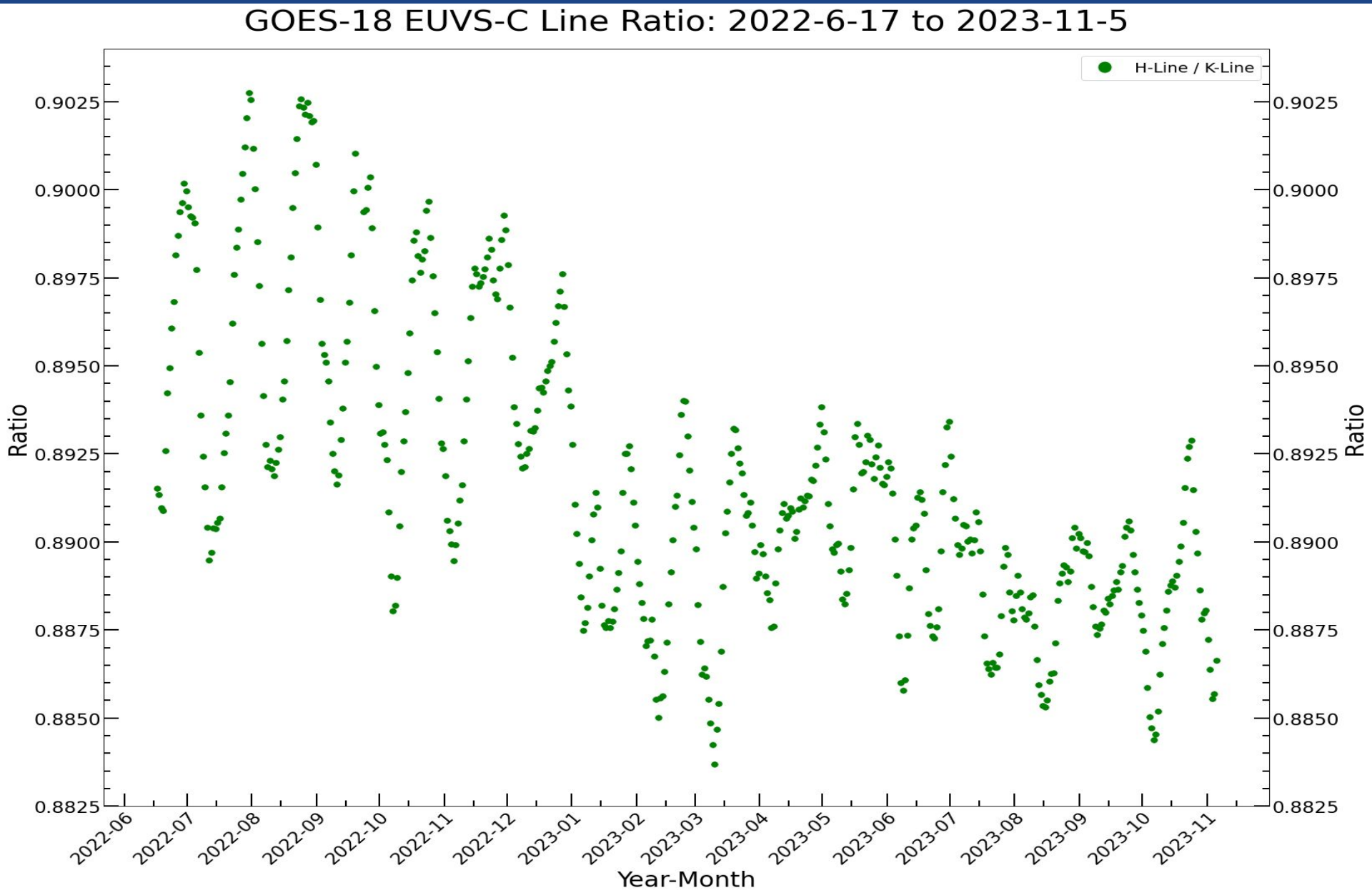
NCEI-CO recommends that GOES-18 EUVS L1b data be transitioned to Full Status at this time

ADDITIONAL INFORMATION

PLPT #17: EUVS-C Degradation Trending



PLPT #17: EUVS-C Degradation Trending



EXIS Calibrations

- Nominal Weekly: 90-second comparison with secondary
  - EUVS-A/B Measure and trend darks and gain
  - EUVS-A Measure and trend primary filter changes
  - EUVS-A/B/C Measure and trend flatfield
  - EUVS -C Measure and trend primary channel offset
- Quarterly Cruciform
  - XRS, EUVS-A/B/C Measure and trend FOV map
  - XRS, SPS Measure and trend internal gain, dark
- Quarterly Other
  - XRS, EUVS-A/B Measure radiation k factors
  - SPS Check for radiation sensitivity
  - EUVS-C Check radiation filtering, Mg II scaling
  - XRS Find cross-over thresholds for A1-A2 and B1-B2. Check impact on ratios.
  - XRS Determine NOAA scaling, L1b uncertainties
  - EUVS L1b model baseline and uncertainties
  - EUVS Check for bootstrap relationships and degradations
- Longterm Comparisons
  - XRS Compare flare locations from XRS and SUVI
  - XRS, EUVS Compare measurements with other satellites

EXIS Calibrations

Name	Priority	Schedule / repeat	Instrument	Affects LUT?	NCEI Handover?
Bundle HDF5 files for delivery	N/A	As needed	All	Yes	Yes
EUVS-A filter degradation	High	6 months	EUVS-A	Yes	Yes
EUVS-A/B dark drift	High	6 months (consider checking every 3 months)	EUVS-A/B	Yes	Yes
FOV	Low	Quarterly after each maneuver	All	No	Yes
EUVS-B degradation	High	6 months	EUVS-B	Yes	Yes
EUVS-C dark	High	6 months	EUVS-C	Yes	Yes
Thermal dark correction	High	6 months (after eclipse seasons)	EUVS-A/B	Yes	Yes
EUVS-C degradation	Low	6 months	EUVS-C	No	No
EUVS-C readout noise	Low	Quarterly	EUVS-C	No	Yes
EUVS-A flatfield	Low	Annually	EUVS-A	Yes	Yes
EUVS-B flatfield	Low	Annually	EUVS-B	Yes	Yes
EUVS-A gain	Low	6 months (weekly cals)	EUVS-A	Yes	Yes
EUVS-B gain	Low	6 months (weekly cals)	EUVS-B	Yes	Yes
XRS gain	Low	Annually (quarterly cals)	XRS	Yes	Yes
SPS gain	Low	Annually (quarterly cals)	SPS	Yes	Yes
SPS darks	Low	Annually (eclipses)	SPS	Yes	Yes
Science packet telemetry trending	Low	Weekly	All	No	No
XRS darks	Medium	Quarterly (off-point)/6 months for eclipse season.	XRS	Yes	No
XRS inter-satellite flare peak comparisons	Low	6 months	XRS	No	No
EUVS-C particle filtering	Low	As needed	EUVS-C	No	No
Cruciform	Low	Quarterly	All	No	No

Current EUVS LUTs in Operational Data

GOES-16

EUVSA_Cal_INR(FM1A_CDRL79RevS_PR_12_03_01)
EUVSB_Cal_INR(FM1A_CDRL79RevS_PR_12_03_01)
EUVSC_Cal_INR(FM1A_CDRL79RevM_PR_12_02_01)
EUVSPEC_Cal_INR(FM1A_CDRL79RevJ_DO_10_01_00)
Yearly_1AU_Correction_Table(2023)

GOES-17

EUVSA_Cal_INR(FM2A_CDRL79RevN_PR_09_08_36)
EUVSB_Cal_INR(FM2A_CDRL79RevN_PR_09_08_36)
EUVSC_Cal_INR(FM2A_CDRL79RevK_PR_09_08_01)
EUVSPEC_Cal_INR(FM2A_CDRL79RevH_DO_10_01_00)
Yearly_1AU_Correction_Table(2023)

GOES-18

EUVSA_Cal_INR(FM3A_CDRL79RevG_PR_12_08_01)
EUVSB_Cal_INR(FM3A_CDRL79RevF_PR_12_03_02)
EUVSC_Cal_INR(FM3A_CDRL79RevD_PR_12_02_01)
EUVSPEC_Cal_INR(FM3A_CDRL79RevC_PR_12_02_01)
Yearly_1AU_Correction_Table(2023)

Current EUVS LUTs in Science-Quality Data

GOES-16

EUVSA_Cal_INR_(fm1_CDRL79revS_tdep).h5
EUVSB_Cal_INR_(fm1_CDRL79revS_tdep).h5
EUVSC_Cal_INR_(fm1_CDRL79revM_tdep).h5
EUVSPEC_Cal_INR_(fm1_CDRL79revJ_tdep).h5
Yearly_1AU_Correction_Table(2023)-725803200.0.h5

GOES-17

EUVSA_Cal_INR_(fm2_CDRL79revO_tdep).h5
EUVSB_Cal_INR_(fm2_CDRL79revO_tdep).h5
EUVSC_Cal_INR_(fm2_CDRL79revK_tdep).h5
EUVSPEC_Cal_INR_(fm2_CDRL79revH_tdep).h5
Yearly_1AU_Correction_Table(2023)-725803200.0.h5

GOES-18

EUVSA_Cal_INR_(fm3_CDRL79revG_tdep).h5
EUVSB_Cal_INR_(fm3_CDRL79revF_tdep).h5
EUVSC_Cal_INR_(fm3_CDRL79revD_tdep).h5
EUVSPEC_Cal_INR_(fm3_CDRL79revC_tdep).h5
Yearly_1AU_Correction_Table(2023)-725803200.0.h5