Solar Dynamics Observatory (SDO)
Extreme Ultraviolet Variability Experiment (EVE): Version 8 science data product Release Notes

Level 2B Science Data Product README
06/13/2024

Table of Contents

Table of Tables

Introduction

EVE level 2B data files were created at the Laboratory for Atmospheric and Space Physics in Boulder, Colorado for the NASA Solar Dynamics Observatory (SDO) Extreme Ultraviolet Variability Experiment (EVE). The Science Processing and Operations Center (SPOC) is responsible for creating and maintaining access to all EVE products.

Version 8 includes two new header-data units, explained in detail in later sections, to report line irradiance from each of the three channels: MEGS-A slit 1, MEGS-A slit 2, and MEGS-B. This allows lines to be compared from each channel where there's overlap in the bandpass. Some new emission lines have been added in the Version 8 level 2B lines data product. This version change also includes updated long-term degradation corrections for MEGS-B and ESP. This is a new release of EVE Level 2B data products. We have made a significant effort at verification and validation, but if you have any questions or encounter any problems with the data, please let us know about them.

For access and data product issues please contact Don.Woodraska at lasp.colorado.edu.

For science issues please contact Frank.Eparvier at lasp.colorado.edu.

Responsible Data Usage

Please refer to the Goddard Space Flight Center SDO web page for data rights and rules for use: https://sdo.gsfc.nasa.gov/data/rules.php

Reference Publications

More information about the EVE instrument measurements, and calibrations can be found in these references:

Woods, T. N., F. G. Eparvier, R. Hock, A. R. Jones, D. Woodraska, D.Judge, L. Didkovsky, J. Lean, J. Mariska, H. Warren, D. McMullin, P. Chamberlin, G. Berthiaume, S. Bailey, T. Fuller-Rowell, J. Sojka, W. K. Tobiska, and R. Viereck, "Extreme Ultraviolet Variability Experiment (EVE) on the Solar Dynamics Observatory (SDO): Overview of Science Objectives, Instrument Design, Data Products, and Model Developments", *Solar Physics, 275*, 115-143,
doi: 10.1007/s11207-009-9487-6, 2012.
https://lasp.colorado.edu/home/eve/files/2011/06/EVE_Overview_SolarPhys.pdf

Hock, R. A., P. C. Chamberlin, T. N. Woods, D. Crotser, F. G. Eparvier, D. L. Woodraska, and E. C. Woods, "Extreme Ultraviolet Variability Experiment (EVE) Multiple EUV Grating Spectrographs (MEGS): Radiometric Calibrations and Results", *Solar Physics, 275*, 145-178,
doi: 10.1007/s11207-010-9520-9, 2012.
https://lasp.colorado.edu/home/eve/files/2011/06/Final_Sol_Phy_Hock_1April_2010.pdf

Didkovsky, L., D. Judge, S. Wieman, T. Woods, and A. Jones, "EUV SpectroPhotometer (ESP) in Extreme Ultraviolet Variability Experiment (EVE): Algorithms and Calibrations", *Solar Physics, 275*, 179-205,
doi: 10.1007/s11207-009-9485-8, 2012.

Level 2B Science Products

Two types of EVE level 2B products are routinely created: **Spectra** (EVS) and **Lines** (EVL). Level 2B spectra are the merged spectral measurements from the two spectrographs, MEGS A and B. The A detector is designed to measure from 6–17 nm, and 17–37 nm using two filters, while the B detector is designed to measure 37–106. After the MEGS-A anomaly in 2014, MEGS-B was extended down to 33.33 nm. Each of these products spans a full UT day (level 2 is only one hour for each product).

This version includes all measured wavelengths spanning 3.01–106.99 nm, though this extends beyond where there is signal on the detectors, so fill values will be present at the extreme ends of the range. All level 2B irradiances are adjusted to 1 AU. Level 2B lines files contain selected lines derived from the level 2B spectra, ESP diode values, and bands that correspond to other SDO instruments and some derived proxies.

> **WARNINGS**: The MEGS-A detector experienced a capacitor short on May 26, 2014 (day 146) that prevents the detector from working. No solar spectra are measured for wavelengths shorter than 33 nm after that anomaly. MEGS-B has been extended to its shortest possible wavelength of 33.34 nm. EUV spectra are only available when MEGS-B is exposed, usually for 3 hours per day (longer during flare campaigns).

Differences from Previous Versions

Version 8 has several updates from previous versions, including an update to the long-term degradation correction. As with version 7, multiple proxy models were created for each wavelength bin, and most are based only on Lyman-alpha. The long-term proxy model components are derived from rockets representing solar min (2018) and solar max (2023) rocket flight measurements. These are then pinned to the 2010 rocket measurement spectrum. Note that each rocket spectrum has a finite noise and finite calibration uncertainty, and these limit the quality of the absolute irradiance values in version 8. Predicting the degradation for future measurements is difficult, so linear extrapolations of the most recent trends are used for dates beyond May 2024.Version 8 also includes updated long-term degradation corrections for ESP. Improvements have been made to the particle filtering applied to MEGS-B images, and the cutoff between MEGS-A slit 1 and MEGS-A slit 2 has been adjusted slightly to more accurately represent the 17.1 nm region of the spectrum. Additionally, a new header data unit has been added to the level 2B lines data products that includes extracted lines from each of the channels (MEGS-A slit 1, MEGS-A slit 2, and MEGS-B), allowing comparison of lines extracted from multiple channels where the bandpasses overlap. Several new lines have been added in version 8 and are now being extracted in the lines data products.

File Naming Convention

Level 2B products follow this naming convention `EV?_L2B_YYYYDDD_vvv_rr.fit` where:

`EV` designates this as an EVE product
`?` is either `S` (spectrum) or `L` (lines/bands)
`L2B` designates this as a level 2B product
`YYYY` is the year
`DDD` is the day of year (001-366)
`vvv` is the version number (007)
`rr` is the revision number (01-99)

The version number only increments after major software changes or after major calibration updates. These are expected to change after the incorporation of each suborbital rocket calibration flight. When referencing EVE data in scientific papers, users agree to mention this version number.

The revision increments whenever updated information is available. Generally, revision 1 is considered "preliminary". After 30 days, products become "definitive" since no new telemetry can be delivered after this period of time due to the finite storage capacity of the SDO ground station. For most days, revision 1 will be the final revision, but newer revisions take precedence over older ones if they exist.

Level 2B Lines/Bands Products

The EVE level 2B line files contain 8 header data units, containing data and corresponding information pertaining to the extracted solar emission lines. Each file contains one UT day of observations with each observation being reported at a 60-second cadence.

LinesMeta HDU

The LinesMeta data unit contains information about lines derived from the EVE level 2B spectrum. It contains wavelength information describing the line, line temperature, the line name, line type, and other blended lines included within the wavelength range of the line. The

LinesMeta variables are described in Table 1 and the enumerated contents are shown in **Error! Reference source not found.**. This is the order corresponding to the LinesData HDU variables Line_Irradiance, Line_Precision, and Line_Accuracy. Version 8 includes several new lines, and the order of the lines from version 7 has been preserved with the added lines at the end, so the lines are not in order of increasing wavelength (the order of the lines is given in **Error! Reference source not found.** below).

Table 1 LinesMeta Descriptions

Column Name	Data Type	Units	Description
Wave_center	Float	nm	The wavelength of electronic transition
Wave_min	Float	nm	Minimum wavelength of integrated line
Wave_max	Float	nm	Maximum wavelength of integrated line
LogT	Float	Log(K)	Log (base 10) temperature of emission line
Name	String	NA	Element and ionization stage of the dominant emission, e.g. He I
Type	String	NA	The isoelectronic series neutral atom for the dominant ion
Blends	String	NA	A partial ion list that is blended within this line

Note that all wavelengths shorter than 33.33 nm are only available from MEGS-A from 2010 through 2014 day 146 when the MEGS-A power anomaly occurred. The table remains the same dimensions, but the values become fill values after MEGS-A data is unavailable. MEGS-B is used for ALL other lines for the whole mission.

Also, almost all lines contain some blends, but not all are listed here. The NIST atomic spectra database (https://physics.nist.gov/PhysRefData/ASD/lines_form.html) and the CHIANTI line list (https://www.chiantidatabase.org/chianti_linelist.html) can be useful for identifying blends.

Table 2 LinesMeta Enumerated Values

Wave_center	Wave_min	Wave_max	LogT	Name	Type	Blends
9.3926	9.33	9.43	6.81	Fe XVIII	F	
13.124	13.04	13.17	5.57	Fe VIII	K	Fe VIII
13.285	13.23	13.32	6.97	Fe XX	N	Fe XXII
17.107	17.02	17.24	5.81	Fe IX	Ar	
17.7243	17.63	17.83	5.99	Fe X	Cl	Fe VII
18.0407	17.96	18.15	6.07	Fe XI	S	Fe X, Fe VII
19.512	19.43	19.61	6.13	Fe XII	P	
20.2044	20.14	20.32	6.19	Fe XIII	Si	Fe XI, Fe XII
21.1331	21.07	21.2	6.27	Fe XIV	Al	Fe XII
25.6317	25.55	25.68	4.75	He II	H	
28.415	28.3	28.5	6.3	Fe XV	Mg	
30.3783	30.25	30.5	4.7	He II	H	
33.541	33.49	33.61	6.43	Fe XVI	Na	
36.0758	36.03	36.15	6.43	Fe XVI	Na	

36.8076	36.75	36.87	5.99	Mg IX	Be	Fe VIII-XIV
44.57	44.53	44.65	6.44	S XIV	Li	
46.5221	46.47	46.61	5.71	Ne VII	Be	
49.9406	49.89	50.01	6.29	Si XII	Li	
52.1	52.03	52.13	6.28	Si XII	Li	
52.5795	52.53	52.65	4.92	O III	C	O II
53.703	53.65	53.77	3.84	He I	He	
55.437	55.39	55.51	5.19	O IV	B	O IV
56.813	56.73	56.85	6.96	Al XI		Ne V, Fe XX
58.4334	58.39	58.51	4.16	He I	He	
59.224	59.17	59.31	6.89	Fe XIX	O	
59.9598	59.93	60.05	4.92	O III	C	
60.98	60.93	61.05	6.1	Mg X	Li	
62.4943	62.45	62.57	6.05	Mg X	Li	
62.973	62.93	63.05	5.37	O V	Be	
71.8535	71.81	71.93	4.48	O II	N	O II
72.156	72.11	72.21	6.96	Fe XX	N	
77.0409	76.99	77.11	5.81	Ne VIII	Li	
79.0199	78.97	79.09	5.19	O IV	B	O III, O IV
83.55	83.25	83.61	4.52	O II	O III	
94.97	94.93	95.05	3.84	H I	H	
97.2537	97.21	97.31	3.84	H I	H	
97.703	97.65	97.77	4.84	C III	Be	
102.572	102.52	102.64	3.84	H I	H	
103.19	103.15	103.25	5.47	O VI	Li	
10.395	10.31	10.47	6.95	Fe XVIII	F	Ni XXII, Ni XXIII
11.723	11.67	11.81	7.10	Fe XXII	B	Fe XXI
14.837	14.77	14.93	6.20	Ni XI	Ar	Fe XXIII
17.453	17.38	17.52	6.05	Fe X	Cl	
20.383	20.33	20.45	6.30	Fe XIII	Si	
21.516	21.45	21.57	6.40	O V	Be	Ne V
21.710	21.64	21.76	5.90	Fe IX	Ar	
21.912	21.85	21.95	6.30	Fe XIV	Al	
23.387	23.31	23.49	6.40	Fe XV	Mg	Ni XVIII
23.851	23.79	23.95	5.20	O IV	B	O III
24.174	24.12	24.22	5.90	Fe IX	Ar	
24.919	24.89	25.01	6.80	Ni XVII	Na	
26.479	26.37	26.55	6.30	Fe XIV	Al	Fe XVI
27.039	26.97	27.13	5.70	Mg VI	C	Fe XIV
38.421	38.35	38.47	7.05	Fe XX	N	
38.907	38.86	38.96	7.05	Ar XVI	Li	Fe XVII
41.766	41.68	41.83	7.05	S XIV	Li	Fe XV
46.985	46.91	47.07	5.20	Ne IV	N	

50.808	50.67	50.91	4.90	O III	C	
54.199	54.05	54.29	5.20	Ne IV	N	Ca IX, Fe XII
54.389	54.29	54.53	5.20	Ne IV	N	Ca VII, Fe XIV
55.003	54.92	55.10	6.90	Al XI	B	
57.230	57.13	57.31	5.40	Ne V	C	
57.428	57.34	57.48	4.95	C III	Be	
76.040	75.97	76.13	5.30	O V	Be	
76.515	76.41	76.63	5.10	N IV	Be	Fe VII
78.769	78.71	78.89	5.20	O IV	B	S V
84.550	84.52	84.64	7.10	Fe XXII	B	
90.409	90.31	90.51	4.60	C II	Be	
92.320	92.25	92.39	5.10	N IV	Be	
93.338	93.25	93.45	5.30	S VI	Na	
103.761	103.53	103.89	5.40	O VI	Li	C II

BandsMeta HDU

The BandsMeta data unit describes the extracted bands from the EVE spectrum that correspond to the 7 AIA spectral bands, two GOES-14 bands, 4 extracted MEGS spectral bands corresponding to the ESP diodes, two very broad bands used for creating the Q_{EUV} proxy, two MEGS-A broadbands representing each slit, and 3 MEGS-B bands. The BandsMeta data unit is described in the following table. Table 4 shows the order of the data included in the LinesData HDU for the variables Band_Irradiance, Band_Precision, and Band_Accuracy.

Note that all bands are calculated from the MEGS spectrum, to represent the equivalent measurement. Most bands ceased to be measured after the MEGS-A anomaly.

Table 3 BandsMeta Descriptions

Column Name	DataType	Units	Description
Name	String	NA	A name representing the wavelength band. Names can represent different instruments.
Type	String	NA	The band type being emulated such as AIA, GOES, ESP, or MEGS
Low_Wavelength_nm	Float	nm	The minimum wavelength defining the band
High_Wavelength_nm	Float	nm	The maximum wavelength defining the band

Table 4 BandsMeta Enumerated Values

Name	Type	Units	Low_wavelength_nm	High_wavelength_nm
AIA_A94	AIA	Counts /AIA pixel/second	9.275	9.515
AIA_A131	AIA	Counts /AIA pixel/second	12.595	13.475

Name	Type	Units	Low_wavelength_nm	High_wavelength_nm
AIA_A171	AIA	Counts /AIA pixel/second	15.205	18.965
AIA_A193	AIA	Counts /AIA pixel/second	17.715	20.955
AIA_A211	AIA	Counts /AIA pixel/second	19.355	22.755
AIA_A304	AIA	Counts /AIA pixel/second	23.265	37.445
AIA_A335	AIA	Counts /AIA pixel/second	10.325	35.865
GOES-14 EUV-A	GOES	W/m^2	5.005	14.995
GOES-14 EUV-B	GOES	W/m^2	25.005	33.995
MA171	ESP	W/m^2	14.505	22.195
MA257	ESP	W/m^2	22.005	29.195
MA304	ESP	W/m^2	26.715	33.785
MA366	ESP	W/m^2	33.005	38.995
E7-37	MEGS	W/m^2	7.000	37.000
E37-45	MEGS	W/m^2	37.000	45.000
MEGS-A1	MEGS	W/m^2	5.800	17.240
MEGS-A2	MEGS	W/m^2	17.240	33.340
MEGS-B short	MEGS	W/m^2	33.340	61.000
MEGS-B both	MEGS	W/m^2	61.000	79.100
MEGS-B long	MEGS	W/m^2	79.100	107.000

DiodeMeta HDU

The DiodeMeta data unit contains information about spectral bands derived from EVE level 2B spectra that corresponds to measurements made by EVE diodes from ESP and MEGS P. The diode measurements are averaged down to the 60-second spectrum cadence to provide a more convenient way to compare the data to other EVE measurements. The DiodeMeta data unit is described in Table 5 and represent the same order of information included in the LinesData HDU Diode_Irradiance, Diode_Stdev, Diode_Precision, and Diode_Accuracy variables.

Table 5 DiodeMeta Description

Column Name	DataType	Description
Name	String	The diode or diode group name
Type	String	The instrument ESP or MEGS-P
Units	String	W/m^2

Table 6 DiodeMeta Enumerated Values

Name	Type
Quad Diode (0.1–7.0 nm)	ESP

Channel 8 (16.64–21.5 nm)	ESP
Channel 2 (22.28–28.78 nm)	ESP
Channel 9 (27.16–33.8 nm)	ESP
Channel 1 (33.3–40.04 nm)*	ESP
Lyman-alpha (121–122 nm)	MEGS-P

* The Channel 1 irradiance has a low shunt resistance that is problematic, but solar cycle changes can be measured.

The diode bandpasses are broadband and may include many other emissions. The MEGS-P Lyman-alpha diode is sensitive to a band about 7 nm wide around 121.6 nm, however, the Lyman-alpha calibration is adjusted to the 1 nm band from 121–122 nm.

The name "Quad Diode" refers to the zero-order, central quadrant diode that is designed to measure soft X-rays. More detailed ESP information is in the ESP level 1 README file.

QuadMeta HDU

The ESP central (zero order) diode is a quadrant diode. In addition to irradiance, it contains information about the center of brightness for the 0.1-7 nm bandpass. The relative quadrant contributions to the whole signal are provided in the Quad_Fraction variable in the LinesData HDU. It provides a relative measure of the distribution of irradiance. During flare periods, the difference of flare and pre-flare measurements can be used to indicate the flare position.

Table 7 QuadMeta Description

Column Name	DataType	Description
Name	String	Quadrant diode number
Type	String	Instrument ESP

Table 8 QuadMeta Enumerated Values

Name	Type	Position
Q0	ESP	Northeast
Q1	ESP	Northwest
Q2	ESP	Southeast
Q3	ESP	Southwest

Note that ESP is not centered with the guide telescope, so the central order is not perfectly split. For dim flares this non-centering could impact positioning information more on one side than the other. Also, the ESP slit is 10 times taller in cross-dispersion (East-West) than in the dispersion direction (North-South).

ChannelLinesMeta HDU

Similar to the LinesMeta data unit, the ChannelLinesMeta data unit contains information about lines derived from the EVE level 2B spectrum. It contains wavelength information describing the line, line temperature, the line name, line type, and other blended lines included within the wavelength range of the line. The ChannelLinesMeta variables are identical to those described in Table 1 LinesMeta Descriptions, and the contents are shown in Table 10 ChannelLinesMeta Enumerated Values. This is the order corresponding to the ChannelLinesData HDU variables for irradiance, precision, and accuracy from each channel: MEGSA1_LINE_IRRADIANCE, MEGSA1_LINE_PRECISION, MEGSA1_LINE_ACCURACY, MEGSA2_LINE_IRRADIANCE, MEGSA2_LINE_PRECISION, MEGSA2_LINE_ACCURACY, MEGSB_LINE_IRRADIANCE, MEGSB_LINE_PRECISION, and MEGSB_LINE_ACCURACY.

Table 9 ChannelLinesMeta Descriptions

Column Name	DataType	Units	Description
Wave_center	Float	nm	The wavelength of electronic transition
Wave_min	Float	nm	Minimum wavelength of integrated line
Wave_max	Float	nm	Maximum wavelength of integrated line
LogT	Float	Log(K)	Log (base 10) temperature of emission line
Name	String	NA	Element and ionization stage of the dominant emission, such as He I
Type	String	NA	The isoelectronic series neutral atom for the dominant ion
Blends	String	NA	A partial ion list that is blended within this line

As with the lines in the LinesMeta HDU, almost all lines contain some blends, but not all are listed here.

Table 10 ChannelLinesMeta Enumerated Values

Wave_center	Wave_min	Wave_max	LogT	Name	Type	Blends
9.3926	9.33	9.43	6.81	Fe XVIII	F	
10.395	10.31	10.47	6.95	Fe XVIII	F	Ni XXII, Ni XXIII
11.723	11.67	11.81	7.10	Fe XXII	B	Fe XXI
13.124	13.04	13.17	5.57	Fe VIII	K	Fe VIII
13.285	13.23	13.32	6.97	Fe XX	N	Fe XXII
14.837	14.77	14.93	6.20	Ni XI	Ar	Fe XXIII
17.107	17.02	17.24	5.81	Fe IX	Ar	
17.453	17.38	17.52	6.05	Fe X	Cl	
17.7243	17.63	17.83	5.99	Fe X	Cl	Fe VII
18.0407	17.96	18.15	6.07	Fe XI	S	Fe X, Fe VII
19.512	19.43	19.61	6.13	Fe XII	P	
20.2044	20.14	20.32	6.19	Fe XIII	Si	Fe XI, Fe XII
20.383	20.33	20.45	6.30	Fe XIII	Si	

Wave_center	Wave_min	Wave_max	LogT	Name	Type	Blends
21.1331	21.07	21.2	6.27	Fe XIV	Al	Fe XII
21.516	21.45	21.57	6.40	O V	Be	Ne V
21.710	21.64	21.76	5.90	Fe IX	Ar	
21.912	21.85	21.95	6.30	Fe XIV	Al	
23.387	23.31	23.49	6.40	Fe XV	Mg	Ni XVIII
23.851	23.79	23.95	5.20	O IV	B	O III
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25.6317	25.55	25.68	4.75	He II	H	
26.479	26.37	26.55	6.30	Fe XIV	Al	Fe XVI
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28.415	28.3	28.5	6.3	Fe XV	Mg	
30.3783	30.25	30.5	4.7	He II	H	
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38.421	38.35	38.47	7.05	Fe XX	N	
38.907	38.86	38.96	7.05	Ar XVI	Li	Fe XVII
41.766	41.68	41.83	7.05	S XIV	Li	Fe XV
44.57	44.53	44.65	6.44	S XIV	Li	
46.5221	46.47	46.61	5.71	Ne VII	Be	
46.985	46.91	47.07	5.20	Ne IV	N	
49.9406	49.89	50.01	6.29	Si XII	Li	
50.808	50.67	50.91	4.90	O III	C	
52.1	52.03	52.13	6.28	Si XII	Li	
52.5795	52.53	52.65	4.92	O III	C	O II
53.703	53.65	53.77	3.84	He I	He	
54.199	54.05	54.29	5.20	Ne IV	N	Ca IX, Fe XII
54.389	54.29	54.53	5.20	Ne IV	N	Ca VII, Fe XIV
55.003	54.92	55.10	6.90	Al XI	B	
55.437	55.39	55.51	5.19	O IV	B	O IV
56.813	56.73	56.85	6.96	Al XI	Li	Ne V, Fe XX
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62.4943	62.45	62.57	6.05	Mg X	Li	
62.973	62.93	63.05	5.37	O V	Be	
71.8535	71.81	71.93	4.48	O II	N	O II
72.156	72.11	72.21	6.96	Fe XX	N	

Wave_center	Wave_min	Wave_max	LogT	Name	Type	Blends
76.040	75.97	76.13	5.30	O V	Be	
76.515	76.41	76.63	5.10	N IV	Be	Fe VII
77.0409	76.99	77.11	5.81	Ne VIII	Li	
78.769	78.71	78.89	5.20	O IV	B	S V
79.0199	78.97	79.09	5.19	O IV	B	O III, O IV
83.55	83.25	83.61	4.52	O II	N	O III
84.550	84.52	84.64	7.10	Fe XXII	B	
90.409	90.31	90.51	4.60	C II	Be	
92.320	92.25	92.39	5.10	N IV	Be	
93.338	93.25	93.45	5.30	S VI	Na	
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97.2537	97.21	97.31	3.84	H I	H	
97.703	97.65	97.77	4.84	C III	Be	
102.572	102.52	102.64	3.84	H I	H	
103.19	103.15	103.25	5.47	O VI	Li	
103.761	103.53	103.89	5.40	O VI	Li	C II

LinesDataUnits HDU

The data in the LinesData HDU has units described as strings in LinesDataUnits. The LinesDataUnits contents are listed in Table 11.

Table 11 LinesDataUnits Enumerated Values

Column Name	DataType	Value
TAI	String	seconds // International Atomic Time seconds since Jan 1, 1958 at center of integration
YYYYDOY	String	date // 4-digit year and 3-digit UT day of year where Jan 1=001
SOD	String	seconds // seconds of the UT day at the center of the integration
FLAGS	String	None // 0=good, other values indicate data may be suspect
SC_FLAGS	String	None // 0=good, other value indicate spacecraft events like eclipses, lunar transits, etc.
LINE_IRRADIANCE	String	W m^-2 // Power per unit area at 1-AU over the integrated line with no background subtraction, MEGS-A provides the spectrum shorter than 33.33 nm and MEGS-B longer than 33.33 nm
LINE_PRECISION	String	None // Relative precision is fractional where 0.2=20%
LINE_ACCURACY	String	None // Relative accuracy is fractional where 0.2=20%
BAND_IRRADIANCE	String	Mixed: W m^-2 or avg counts AIApixel^-1 second^-1 // Power per unit area at 1-AU over the integrated band with MEGS-A providing the spectrum shorter than 37 nm and MEGS-B longer than 37 nm, note that AIA bands are counts per AIA pixel at 1-AU
BAND_PRECISION	String	None // Relative precision is fractional where 0.2=20%
BAND_ACCURACY	String	None // Relative accuracy is fractional where 0.2=20.%
DIODE_IRRADIANCE	String	W m^-2 // Power per unit area at 1-AU measured by the diode
DIODE_STDEV	String	None // Relative one-sigma spread of 4 Hz integrations over the 10 second window
DIODE_PRECISION	String	None // Relative precision is fractional where 0.2=20%
DIODE_ACCURACY	String	None // Relative accuracy is fractional where 0.2=20%

QUAD_FRACTION	String	None // Fraction of the 0.1-7 nm irradiance in each of the quadrant diodes with the sum=1., useful for finding location of center of irradiance
QUAD_STDEV	String	None // Relative one-sigma spread of 4 Hz integrations over the 10 second window
QUAD_PRECISION	String	None // Relative precision is fractional where 0.2=20%
QUAD_ACCURACY	String	None // Relative accuracy is fractional where 0.2=20%

LinesData HDU

The LinesData data unit contains the science measurements of the lines, bands and diodes. The extracted lines and bands are integrated from the irradiance spectrum (EVS). No background spectrum or blended lines are removed, so the magnitude and variability include those contributions.

The diode measurements (MEGS-P and ESP) are averaged to 60 second time intervals to match the spectrum cadence.

Table 12 LinesData Descriptions

Column Name	DataType	Description
TAI	Double	Seconds since Jan 1, 1958
YYYYDOY	Long	UTC year and day of year
SOD	Double	UTC seconds of day at the center of the observation
FLAGS	Byte	Processing bit flags, multiple bits may be set at the same time. 0=all present/good, Bit 0 set = MEGS-A missing, (decimal 1) Bit 1 set = MEGS-B missing, (decimal 2) Bit 2 set = ESP missing, (decimal 4) Bit 3 set = MEGS-P missing, (decimal 8) Bit 4 set = Too many MEGS-A integrations, (decimal 16) Bit 5 set = Too many MEGS-B integrations, (decimal 32) Bit 6 set = Too many ESP integrations, (decimal 64) Bit 7 set = Too many MEGS-P integrations (decimal 128) If the spacecraft clock jumps backwards additional integrations can occur.
SC_FLAGS	Byte	Spacecraft flags, 0=good, 4 LSBs are an enumeration with 12 decimal values 0 = Clear, no obstructions 1 = Warmup during post-eclipse 2 = Penumbra of Earth atmosphere 3 = Umbra of Earth atmosphere 4 = Mercury penumbra 5 = Mercury umbra 6 = Venus penumbra 7 = Venus umbra 8 = Lunar penumbra 9 = Lunar umbra 10 = Earth penumbra (solid earth) 11 = Earth umbra (solid earth) Upper 4-bit nibble uses 1 bit

		32 = Spacecraft pointing over 1 arcmin from sun center (Maneuver)
LINE_IRRADIANCE	Float	Line irradiances in the order specified in the LinesMeta table
LINE_PRECISION	Float	Count rate-based error propagation
LINE_ACCURACY	Float	Total uncertainty including calibration uncertainty
BAND_IRRADIANCE	Float	Irradiance or counts in the band defined in the BandsMeta table
BAND_PRECISION	Float	Count rate-based uncertainty from error propagation
BAND_ACCURACY	Float	Total uncertainty including calibration uncertainty
DIODE_IRRADIANCE	Float	Diode irradiance in the order specified in the DiodesMeta table
DIODE_STDEV	Float	One-sigma spread of measurements in the 10-second time interval
DIODE_PRECISION	Float	Count rate-based uncertainty from error propagation
DIODE_ACCURACY	Float	Total uncertainty including calibration uncertainty
QUAD_FRACTION	Float	Fraction of the signal in each quadrant diode over 10 seconds
QUAD_STDEV	Float	One-sigma spread in each quadrant diode
QUAD_PRECISION	Float	Count rate-based uncertainty from error propagation
QUAD_ACCURACY	Float	Total uncertainty in each quadrant

Lines are integrated from low to high bounds, and the 4 Hz photometer data are averaged down to the same timescale as the spectrum, nominally 60 seconds for level 2B. No continuum is subtracted from the line irradiances.

ChannelLinesData HDU

The ChannelLinesData HDU contains the extracted line irradiances from each channel: MEGS-A slit 1, MEGS-A slit 2, and MEGS-B.

Table 13 ChannelLinesData Descriptions

Column Name	DataType	Description
TAI	Double	Seconds since Jan 1, 1958
YYYYDOY	Long	UTC year and day of year
SOD	Double	UTC seconds of day at the center of the observation
FLAGS	Byte	Processing bit flags, multiple bits may be set at the same time. 0=all present/good Bit 0 set = MEGS-A missing, (decimal 1) Bit 1 set = MEGS-B missing, (decimal 2) Bit 2 set = ESP missing, (decimal 4) Bit 3 set = MEGS-P missing, (decimal 8) Bit 4 set = Too many MEGS-A integrations, (decimal 16) Bit 5 set = Too many MEGS-B integrations, (decimal 32) Bit 6 set = Too many ESP integrations, (decimal 64) Bit 7 set = Too many MEGS-P integrations (decimal 128) If the spacecraft clock jumps backwards, additional integrations can occur.
SC_FLAGS	Byte	Spacecraft flags, 0=good, 4 LSBs are an enumeration with 12 decimal values 0 = Clear, no obstructions 1 = Warmup during post-eclipse 2 = Penumbra of Earth atmosphere 3 = Umbra of Earth atmosphere

		4 = Mercury penumbra 5 = Mercury umbra 6 = Venus penumbra 7 = Venus umbra 8 = Lunar penumbra 9 = Lunar umbra 10 = Earth penumbra (solid earth) 11 = Earth umbra (solid earth) Upper 4-bit nibble uses 1 bit 32 = Spacecraft pointing over 1 arcmin from sun center (Maneuver)
MEGSA1_LINE_IRRADIANCE	Float	Line irradiances as extracted from MEGS-A slit 1 in the order specified in the ChannelLinesMeta table
MEGSA1_LINE_PRECISION	Float	Count rate-based error propagation for MEGS-A slit 1
MEGSA1_LINE_ACCURACY	Float	Total uncertainty including calibration uncertainty for MEGS-A slit 1
MEGSA2_LINE_IRRADIANCE	Float	Line irradiances as extracted from MEGS-A slit 1 in the order specified in the ChannelLinesMeta table
MEGSA2_LINE_PRECISION	Float	Count rate-based error propagation for MEGS-A slit 1
MEGSA2_LINE_ACCURACY	Float	Total uncertainty including calibration uncertainty for MEGS-A slit 1
MEGSB_LINE_IRRADIANCE	Float	Line irradiances as extracted from MEGS-A slit 1 in the order specified in the ChannelLinesMeta table
MEGSB_LINE_PRECISION	Float	Count rate-based error propagation for MEGS-A slit 1
MEGSB_LINE_ACCURACY	Float	Total uncertainty including calibration uncertainty for MEGS-B

Level 2B Spectra Products

The level 2B spectrum files contain 3 header data units, SpectrumMeta, SpectrumUnits, and Spectrum. These data units contain the fully calibrated 60-second spectral irradiance values along with supplemental information.

The SpectrumMeta data unit contains two arrays, one being the center wavelengths of each spectral bin. The other array contains the estimate of accuracy of the irradiance on a per bin basis. Note, the accuracy array will be moved to the Spectrum data unit in future versions.

Table 14 SpectrumMeta Description

Column Name	Type	Description
Wavelength	Float	Wavelength in nm is the center value of each irradiance bin in the Spectrum table.
Accuracy	Float	The relative accuracy of the entire MEGS instrument at each wavelength.

The SpectrumUnits data unit provides information on the units for each element in the Spectrum data unit. The table below describes each entry.

Table 15 SpectrumUnits Description

Column Name	Type	Description
TAI	String	Seconds // International Atomic Time seconds since Jan 1, 1958 at center of time interval
YYYYDOY	String	NA // 4-digit year and 3-digit day of year designator with Jan 1 = 001
SOD	String	Seconds // seconds of the UT day at the center of the time interval
FLAGS	String	NA // 0=good, other values indicate data may be suspect
SC_FLAGS	String	NA // 0=good, other values indicate data may be suspect
INT_TIME	String	Seconds // the duration of the exposure
IRRADIANCE	String	W m^-2 nm^-1 // Solar Spectral Irradiance, power per unit area per nanometer at 1-AU with MEGS-A providing the shorter wavelength portion of the spectrum when available
COUNT_RATE	String	Counts s^-1 // Dark corrected counts per pixel per second
PRECISION	String	NA // Relative precision, multiply by the irradiance to get irradiance units
BIN_FLAGS	String	NA // Flag for each spectral bin 0=good, 255=missing

The Spectrum data unit contains the actual data for the observation period. It holds the irradiance spectrum as well as other values as described in the following table.

Table 16 Spectrum Table Description

Column Name	Type	Description
TAI	Double	Seconds since Jan 1, 1958
YYYYDOY	Long	UTC year and day of year
SOD	Double	UTC seconds of day at the center of the observation
FLAGS	Byte	Processing bit flags, multiple bits may be set at the same time. 0=all present/good, Bit 0 set = MEGS-A missing, (decimal 1) Bit 1 set = MEGS-B missing, (decimal 2) Bit 2 set = ESP missing, (decimal 4) Bit 3 set = MEGS-P missing, (decimal 8) Bit 4 set = Too many MEGS-A integrations, (decimal 16) Bit 5 set = Too many MEGS-B integrations, (decimal 32) Bit 6 set = Too many ESP integrations, (decimal 64) Bit 7 set = Too many MEGS-P integrations (decimal 128) If the spacecraft clock jumps backwards additional integrations can occur.

SC_FLAGS	Byte	Spacecraft flags, 0=good, 4 LSBs are an enumeration with 12 decimal values 0 = Clear, no obstructions 1 = Warmup during post-eclipse 2 = Penumbra of Earth atmosphere 3 = Umbra of Earth atmosphere 4 = Mercury penumbra 5 = Mercury umbra 6 = Venus penumbra 7 = Venus umbra 8 = Lunar penumbra 9 = Lunar umbra 10 = Earth penumbra (solid earth) 11 = Earth umbra (solid earth) Upper 4-bit nibble uses 1 bit 32 = Spacecraft pointing over 1 arcmin from sun center (Maneuver)
INT_TIME	Double	The integration time is an integer multiple of 10 seconds.
IRRADIANCE	Float	The solar spectral irradiance adjusted to 1-AU merged from MEGS-A and MEGS-B when available.
COUNT_RATE	Float	The counts per pixel per second.
PRECISION	Float	The relative precision of the spectral measurement.
BIN_FLAGS	Byte	The flags for each spectral bin where 0=good.

Data Processing

All data products are generated at LASP, and the Level 2B products described in this document are all publicly available at the EVE website. We caution users to carefully consider their data needs. The level 2B products are free for responsible public use; however, downloading the entire dataset is not a good solution for most users.

FITS Definition and Software

The EVE Level 2B products are stored in the scientific format called FITS as binary tables. FITS was first introduced in 1979. As one of the oldest scientific data formats, it continues to be widely used and expanded.

> FITS reference: FITS: A Flexible Image Transport System, Wells, D. C., Greisen, E. W., and Harten, R. H., Astronomy & Astrophysics Supplement Series, 44, 363 - 370, 1981. https://ui.adsabs.harvard.edu/abs/1981A&AS...44..363W

> FITS Binary Table reference: Binary Table Extension to FITS, Cotton, W. D., Tody, D. B., and Pence, W. D., Astronomy & Astrophysics Supplement Series, 113, 159 - 166, 1995. http://adsabs.harvard.edu/full/1995A%26AS..113..159C

Additional detailed documentation is available online, for example:
https://heasarc.gsfc.nasa.gov/docs/software.html
https://fits.gsfc.nasa.gov/fits_documentation.html

LASP provides an IDL function called eve_read_whole_fits.pro which allows easy reading of any EVE data product that is in FITS format. This file contains a complete set of all of the relevant software from the GSFC IDL astronomy library that is needed. Users with newer version of the IDL astronomy library can use mrdfits directly. The read_whole_fits.pro file may be downloaded from the EVE web site at
https://lasp.colorado.edu/eve/data_access/eve_data/software/eve_read_whole_fits.pro

For IDL, you may also use mrdfits.pro available at:
https://idlastro.gsfc.nasa.gov/mrdfits.html

User Guide and Examples in IDL

Level 2B data products are stored in FITS format and may be read by a variety of software. In the following examples, we use the LASP provided IDL function called eve_read_whole_fits.pro (based on an older version of mrdfits.pro) which allows easy reading of any EVE data product that is in FITS format.

Reading a Level 2B Spectrum File and Plotting a Spectrum

To read in a level 2B spectrum data product (EVS), provide the function with the desired filename.

```
IDL> data = eve_read_whole_fits( 'EVS_L2B_2018230_008_01.fit.gz' )
```

To see a list of the structure tag names, run the IDL help command:

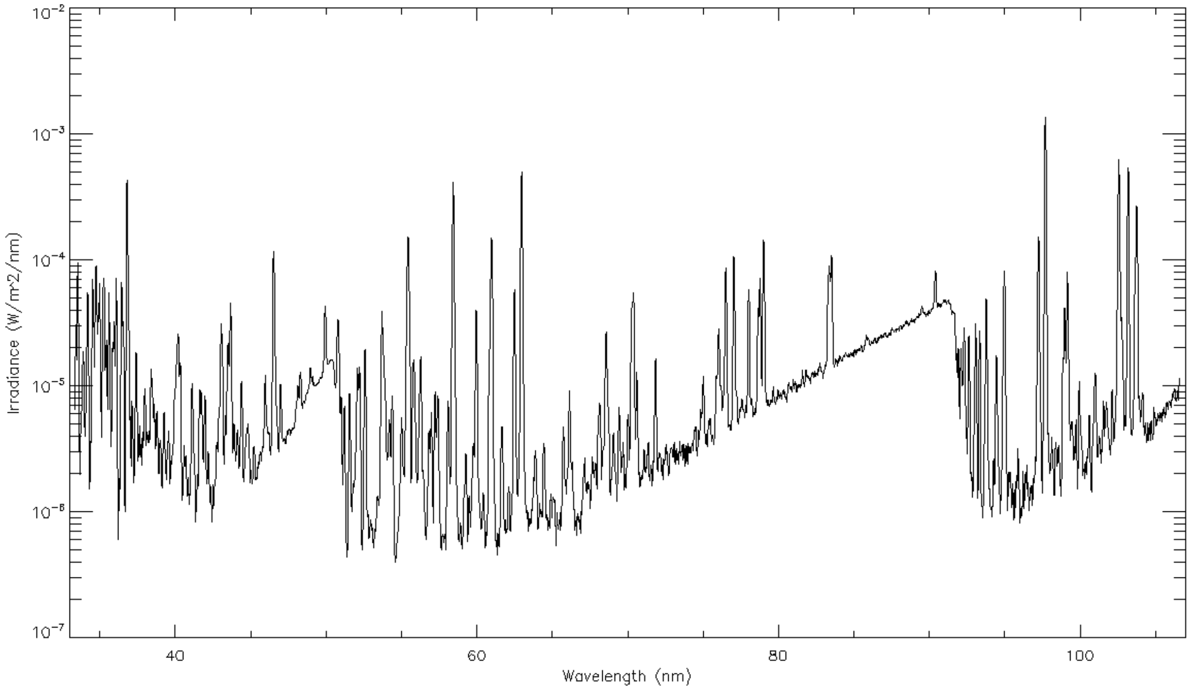
```
IDL> help, data, /structure
   PRIMARY          LONG                      0
   PRIMARY_HEAD     STRING    Array[5]
   SPECTRUMMETA     STRUCT    -> <Anonymous> Array[5200]
   SPECTRUMMETA_HEADER
                    STRING    Array[29]
   SPECTRUMUNITS    STRUCT    -> <Anonymous> Array[1]
   SPECTRUMUNITS_HEADER
                    STRING    Array[41]
   SPECTRUM         STRUCT    -> <Anonymous> Array[1440]
   SPECTRUM_HEADER  STRING    Array[116]
```

As described above, the wavelength information is stored in the `data.spectrummeta` structure. We use index 0 in this example, since we know this file has data at the start of the day. To plot the spectra, run the following command:

```
IDL> plot, data.spectrummeta.wavelength, data.spectrum[0].irradiance, $
 yrange=[1.0e-7, 1.0e-2], /ylog, charsize=1.5, $
 xtitle='Wavelength (nm)', ytitle='Irradiance (W/m^2/nm)'
```

This command should produce a plot similar to Figure 1.

Figure 1 Example EVE solar spectrum



Here the first time interval has a spectrum in data.spectrum[0], but most days start later since MEGS-B exposures are limited to reduce degradation.

```
IDL> help,data.spectrum,/structure
** Structure <3858808>, 10 tags, length=67640, data length=67630, refs=2:
   TAI              DOUBLE       1.9132417e+09
   YYYYDOY          LONG           2018230
   SOD              DOUBLE           30.000000
   FLAGS            BYTE         1
   SC_FLAGS         BYTE         0
   INT_TIME         DOUBLE           60.000000
   IRRADIANCE       FLOAT     Array[5200]
   COUNT_RATE       FLOAT     Array[5200]
   PRECISION        FLOAT     Array[5200]
   BIN_FLAGS        BYTE      Array[5200]
```

Reading a Level 2B Lines File and Plotting a Timeseries

Reading and plotting the level 2B lines, bands, and diode file (EVL) is similar to the spectrum files. To read in the lines file for , issue the following command:

```
IDL> data = eve_read_whole_fits( 'EVL_L2B_2013133_008_01.fit.gz' )
```

To see a listing of tags in the structure, run the following command:

```
IDL> help, data, /structure
** Structure <4643a88>, 18 tags, length=5583864, data length=5566580, refs=1:
   PRIMARY          LONG                     0
   PRIMARY_HEAD     STRING    Array[5]
   LINESMETA        STRUCT    -> <Anonymous> Array[71]
   LINESMETA_HEADER
                    STRING    Array[57]
```

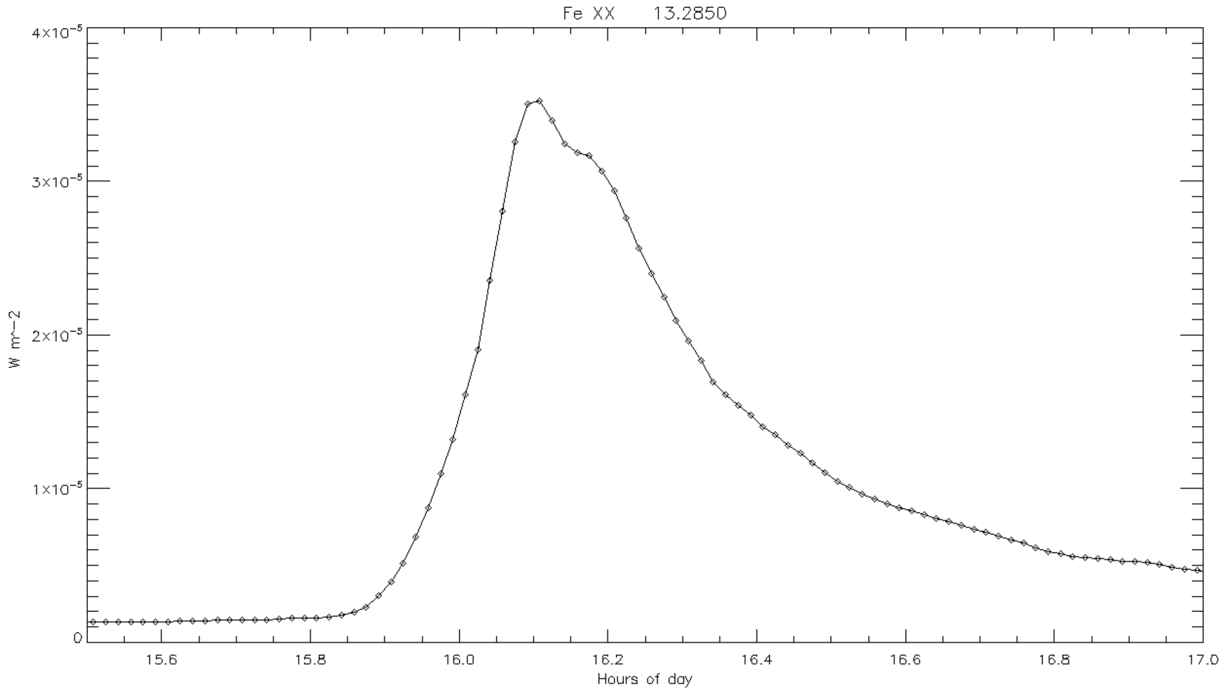
```
BANDSMETA       STRUCT    -> <Anonymous> Array[20]
BANDSMETA_HEADER
                STRING    Array[34]
DIODEMETA       STRUCT    -> <Anonymous> Array[6]
DIODEMETA_HEADER
                STRING    Array[37]
QUADMETA        STRUCT    -> <Anonymous> Array[4]
QUADMETA_HEADER STRING    Array[27]
CHANNELLINESMETA
                STRUCT    -> <Anonymous> Array[71]
CHANNELLINESMETA_HEADER
                STRING    Array[51]
LINESDATA       STRUCT    -> <Anonymous> Array[1440]
LINESDATA_HEADER
                STRING    Array[144]
LINESDATAUNITS  STRUCT    -> <Anonymous> Array[1]
LINESDATAUNITS_HEADER
                STRING    Array[77]
CHANNELLINESDATA
                STRUCT    -> <Anonymous> Array[1440]
CHANNELLINESDATA_HEADER
                STRING    Array[127]
```

The reader software returns a structure of structures. The substructures correspond to each HDU in the FITS file. The 9 HDUs in the file are Primary (unused), LinesMeta, BandsMeta, DiodeMeta, QuadMeta, ChannelLinesMeta, LinesData, LinesDataUnits, and ChannelLinesData. There are measurements in the LinesData and ChannelLinesData structures, and all the rest are metadata. The HDU #0 is left empty since it is convention to only include images in the first HDU.

In this example we plot the Fe XX line which is at index number 2 in the line_irradiance and linesmeta arrays.

```
IDL> plot, data.LINESDATA.SOD / 3600.0, data.LINESDATA.LINE_IRRADIANCE[2], $
   xtitle='Hours of day', psym=-4, $
   ytitle=(strsplit(data.LINESDATAUNITS.LINE_IRRADIANCE,'//',/extract))[0], $
   title=data.LINESMETA[2].NAME+' '+STRTRIM(data.LINESMETA[2].WAVE_CENTER,2), $
   yrange=[0.0, 4.0e-5], xmargin=[12,3], xstyle=1, xrange=[15.5,17], charsize=1.5
```

Figure 2 Example time series plot of Fe XX



View https://lasp.colorado.edu/eve/data_access/wp-content/eve_data/software/Three Steps For EVE Data.pdf for a description on how to download and read EVE level 2 data.

The metadata regarding the line name, wavelength ranges, temperature, and other useful information are contained in the linesmeta. These can be accessed to generate a table as follows:

```
IDL> for i=0,n_elements(data.linesmeta)-1 do $
   print,data.linesmeta[i].name, $
   data.linesmeta[i].wave_center, $
   data.linesmeta[i].logt, i
Fe XVIII      9.39260      6.81000       0
Fe VIII      13.1240       5.57000       1
Fe XX        13.2850       6.97000       2
Fe IX        17.1073       5.81000       3
Fe X         17.7243       5.99000       4
Fe XI        18.0407       6.07000       5
Fe XII       19.5120       6.13000       6
Fe XIII      20.2044       6.19000       7
Fe XIV       21.1331       6.27000       8
He II        25.6317       4.75000       9
Fe XV        28.4150       6.30000      10
He II        30.3783       4.70000      11
Fe XVI       33.5410       6.43000      12
Fe XVI       36.0758       6.43000      13
Mg IX        36.8076       5.99000      14
S XIV        44.5700       6.44000      15
Ne VII       46.5221       5.71000      16
Si XII       49.9406       6.29000      17
Si XII       52.1000       6.28000      18
O III        52.5795       4.92000      19
He I         53.7030       3.84000      20
O IV         55.4370       5.19000      21
Al XI        56.8130       6.96000      22
He I         58.4334       4.16000      23
Fe XIX       59.2240       6.89000      24
O III        59.9598       4.92000      25
```

Mg X	60.9800	6.10000	26
Mg X	62.4943	6.05000	27
O V	62.9730	5.37000	28
O II	71.8535	4.48000	29
Fe XX	72.1560	6.96000	30
Ne VIII	77.0409	5.81000	31
O IV	79.0199	5.19000	32
O II	83.5500	4.52000	33
H I	94.9700	3.84000	34
H I	97.2537	3.84000	35
C III	97.7030	4.84000	36
H I	102.572	3.84000	37
O VI	103.190	5.47000	38
Fe XVIII	10.3948	6.95000	39
Fe XXII	11.7230	7.10000	40
Ni XI	14.8377	6.20000	41
Fe X	17.4531	6.05000	42
Fe XIII	20.3826	6.30000	43
O V	21.5167	6.40000	44
Fe IX	21.7101	5.90000	45
Fe XIV	21.9130	6.30000	46
Fe XV	23.3866	6.40000	47
O IV	23.8570	5.20000	48
Fe IX	24.1739	5.90000	49
Ni XVIII	24.9189	6.80000	50
Fe XIV	26.4788	6.30000	51
Mg VI	27.0390	5.70000	52
Fe XX	38.4209	7.05000	53
Ar XVI	38.9066	7.05000	54
S XIV	41.7660	7.05000	55
Ne IV	46.9850	5.20000	56
O III	50.8080	4.90000	57
Fe XX	54.1990	7.05000	58
Ne IV	54.3886	5.20000	59
Al XI	55.0031	6.90000	60
Ne V	57.2335	5.40000	61
C III	57.4281	4.95000	62
O V	76.0446	5.30000	63
N IV	76.5152	5.10000	64
O IV	78.7690	5.20000	65
Fe XXII	84.5552	7.10000	66
C II	90.4090	4.60000	67
N IV	92.3225	5.10000	68
S VI	93.3378	5.30000	69
O VI	103.761	5.40000	70

Note that this line list differs from the version 7 line list, and that new lines for version 8 are added to the end to preserve the order of the lines from version 7.

The new HDUs (ChannelLinesMeta and ChannelLinesData) have lines that are extracted from each channel, allowing comparison of emission lines where overlap exists in the bandpasses of two different channels. For example, it is possible to look at the 17 nm with multiple Fe emission lines from both MEGS-A slit 1 and MEGS-A slit 2 using the channel lines.

SolarSoft

SolarSoft and IDL users may wish to download the EVE SolarSoft software package. It is available at our web site by browsing the Documentation page that includes installation instructions.
https://lasp.colorado.edu/eve/data_access/eve-documentation/index.html

Additional information about SolarSoft can be found through the LMSAL website, https://www.lmsal.com/solarsoft. Note that the EVE SolarSoft package can be run in IDL without SolarSoft.

Data Availability and Data Gaps

Daily calibrations are performed that last a total of about 30 minutes; however, the channel calibrations are staggered so that one of the science channels is always observing the Sun during the daily calibration. These daily calibrations allow for EVE to directly measure dark signals on the detectors to track changes. For the CCDs, the flatfield LEDs are also used. On Sundays, a slightly longer calibration is performed to increase statistics.

Two annual eclipse outage periods of about 3 weeks occur as the spacecraft orbit aligns with the Earth and Sun. These can last up to 72 minutes each day. After longer eclipses (10+ minutes), some thermal settling causes a wavelength shift on MEGS-A that is not yet corrected. Around the 2 eclipse seasons, additional off-pointing maneuvers are performed including EVE cruciform scans (9 hours), EVE FOV maps (~2 hours), plus maneuvers for the other instruments and the guide telescopes.

The spacecraft is also subject to being blocked by the moon, but this is infrequent. Other infrequent activities include momentum management, and station-keeping thruster firings.

CCD bakeouts have occurred earlier in the mission in attempts to recover instrument sensitivity for MEGS-B. The first bakeout started on June 16 (day 167), 2010 and continued through June 18 (day 169), 2010. The second CCD bakeout was much longer lasting from September 23 (day 266) through September 28 (day 271), 2010. After each bakeout, there is a period of several days where the detectors change rapidly, and this is not corrected in version 3. No future bakeouts will be scheduled.

To minimize the degradation on the MEGS-B detector, MEGS-B only observes the sun for 3 hours per day and the timing of the observation has changed throughout the mission. When not observing the Sun, the MEGS-B portion of the spectra is filled with −1.0 when MEGS-A data is available. After the MEGS-A anomaly when no MEGS-B data are available, the spectra file is no longer generated (missing MEGS-A and MEGS-B). The lines/bands file is generated because the ESP data remain continuously available.

Detailed daily information is provided in the Science Operations Mission Log and is available at this location: https://lasp.colorado.edu/eve/data_access/evewebdata/EVE_sciopslog.html

Data availability can be assessed using the calendars on the EVE website for the particular product and year of interest. This link is for level 2B data for 2024. Green cells indicate data is available.
https://lasp.colorado.edu/eve/data_access/evewebdata/misc/eve_calendars/calendar_level2b_2024.html

Other Notes

The spectra bins should not be used individually for analysis due to the possibility of small - scale wavelength shifts. Rather, users should integrate over the features of interest. MEGS-A (5-37 nm) is the most sensitive to these small wavelength shifts, but they also occur in MEGS-B.

Since the MEGS-A 30.4 line has suffered detector burn-in and filter degradation, the line shape itself is being adjusted. This is likely to affect attempts to observe Doppler shifts. We recommend using the count rate spectrum to investigate the incredibly small line shifts.

The MEGS-P Lyman-alpha diode measurement is susceptible to low energy particles. Our initial attempt to remove the low energy particle noise using the dark diode needs refinement. Rather than exclude this measurement, we filter it based on those periods of increased particle noise. Therefore, the MEGS-P Lyman-alpha measurement is sometimes very complete. The Lyman-alpha measurement uses the same filter mechanism as MEGS-B, so it is also operating with the same reduced-exposure scenario. The periods of high potential large contributions from particles are fixed to earth’s magnetic field, so the UT time shifts about 3:56 each day.

History of MEGS-B Initial Calibration and Continuing Degradation

The history of degradation tracking for MEGS-B is long. The first light spectrum in 2010 from MEGS-B showed about 1/8 of the expected values on the longer wavelength side of the CCD based on ground calibration results. MEGS-B ground calibrations are not representative of observed flight behavior. The responsivity has been inferred from simultaneous suborbital rocket instrument measurements. Multiple rocket flights are needed to provide tracking of degradation for MEGS-B.

Continuous solar exposure of MEGS-B for the first 2 weeks of the mission resulted in additional unexpected rapid degradation of about 1% per day. Solar exposure time for MEGS-B was severely restricted to decrease the degradation rate soon after this was discovered. Multiple short-term daily exposure schemes were implemented in operations, where short enough exposure allowed some recovery to occur. Eventually a balance was struck to maximize solar exposure and minimize degradation changes. The exposure timing was also altered to move with sideral time to avoid the worst particle background times to increase the chances of obtaining good measurements.

Several CCD bakeouts were performed from 2010 through 2012 to try to recover the observed signal loss, and while some signal was temporarily recovered the previous degradation trends were no longer correct. Multiple bakeouts in close succession failed to recover additional signal in the second bakeout. Each bakeout started a new trend with rapid changes that slowed over time leading to multiple time intervals for curve fitting. The last bakeout was in 2012 which unexpectedly decreased the responsivity on MEGS-A.

Seemingly small changes in operations for the case heater cause the MEGS-B lines to move. This is a detectable continuous change after eclipse exit that lasts for several hours. The MEGS-A failure also caused a temperature change to MEGS-B that abruptly moved all the lines. The impact of this, and other changes, is that small changes in the line location at the detector cause bright lines to illuminate less degraded detector pixels. Some lines have experienced signal losses of over 80% since the beginning of the mission. Small motion can cause the degradation correction to no longer be valid. None of this was corrected in version 6 or earlier versions. Version 8 can only correct this in the past. Future motion is not correctable in version 8.