

Solar Dynamics Observatory (SDO) Extreme Ultraviolet Variability Experiment (EVE): Release notes for version 6 science data products

Level 3 Science Data Products 6/15/17

Table of Contents

Introduction	1
Responsible Data Usage:	2
Reference Publications	2
Level 3 Science Products	2
Naming Convention	3
Merged File Naming Convention	3
Level 3 Daily Averaged Data	4
Data Processing	7
FITS Definition and Software	7
Explanation and Examples in IDL.....	7
Data Availability and Data Gaps.....	18
Version Release Notes	19
Other Notes	20

Introduction

EVE level 3 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.

This version change includes updated long-term degradation corrections for MEGS-B and ESP. A small dark adjustment was applied to MEGS-A and MEGS-B that lowers the irradiance by a quarter of a standard deviation, so it is most noticeable in the very dim regions. The MEGS-P (Lyman-alpha) diode measurements have been updated to replace the Kalman filter with a Fourier transform filter, and the calibration has been updated to match SORCE SOLSTICE version 15.

This is a new release of EVE Level 3 data products. We have made every 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@lasp.colorado.edu.

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

Responsible Data Usage:

SDO Mission scientific and model results are open to all, however users should contact the PI or designated EVE team member early in an analysis project to discuss appropriate use of instrument data results. Appropriate acknowledgement to institutions, personnel, and funding agencies should be given. Version numbers should also be specified. Pre-prints of publications and conference abstracts should be widely distributed to interested parties within the mission.

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.
http://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.

http://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 3 Science Products

Level 3 spectra are the merged spectral measurements from the two spectrographs, MEGS-A and MEGS-B. The A detector is designed to measure from about 6-17 nm and 17-37 nm using two filters on two different parts of the detector. The B detector can measure from about 33 to 105 nm using a double dispersion grating design with

no filters. All level 3 irradiances are adjusted to 1 AU. The level 3 products contain daily averages of the level 2 spectrum measurements at the same wavelength sampling as level 2. The level 3 products also contain daily average measurements of the diodes, extracted bands, and selected lines reports in the level 2 products. The level 3 data products are available as one file per day, and also as merged dataset files that are updated daily with new measurements. The mission length merged datasets are provided at three sampling sizes for user convenience; specifically, native level 2 sampling, 1 Angstrom, and 1 nm. See the section "Merged Datasets" below for more details.

For an in-depth discussion of EVE instrumentation please visit <http://lasp.colorado.edu/home/eve/science/instrument/>.

Naming Convention

Level 3 products follow this naming convention

`EVE_L3_YYYYDDD_vvv_rr.fit` where:

EVE designates this as an EVE product

L3 designates this as a level 3 product

YYYY is the year

DDD is the day of year (001-366)

vvv is the version number (006)

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 are 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 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.

Merged File Naming Convention

Level 3 merged products have the following naming convention that has similar date and version elements as described above.

`EVE_L3_merged_YYYYDDD_vvv.fit`

Contains the full resolution (0.02 nm) sampling.

`EVE_L3_merged_1nm_YYYYDDD_vvv.fit`

Contains the spectrum resampled to a 1 nm grid with 0.5-nm bin centers.

EVE_L3_merged_1a_YYYYDDD_vvv.fit

Contains the spectrum resampled to 1 angstrom with 0.5-angstrom bin centers.

For automation scripts, links are created with static names that point to selected files. Browse this URL

http://lasp.colorado.edu/eve/data_access/evewebdataproducts/merged/ to locate the links that start with "latest_EVE_L3_merged".

Note that all merged files are also available in NetCDF 3 format, and can also be downloaded as IDL sav files. The NetCDF and IDL sav files are generated from the FITS files, since FITS is the officially supported data format.

Level 3 Daily Averaged Data

Each daily file spans one UT day centered at noon UTC. Regardless of data collection time, all good data within the 24-hour window is averaged together.

The EVE level 3 files contain 6 FITS header data units, containing data and corresponding metadata information pertaining to daily averaged spectra, diode measurements, lines, and bands.

The SpectrumMeta data unit contains one array representing the center wavelengths of each spectral bin. The previous version had accuracy as a second array in this HDU, but that was moved into the data HDU in version 5 data products.

SpectrumMeta:

Column Name	Type	Description
Wavelengths	Float (array)	Center wavelength for each bin

The LinesMeta data unit contains information about lines derived from the EVE level 2 full resolution spectrum. It contains wavelength information describing the line, line temperature, the line name, line type, and other lines included within the wavelength band of the line as described in the following table.

LinesMeta:

Column Name	Type	Description
wave_center	Float	Center wavelength of line
wave_min	Float	Minimum wavelength of line
wave_max	Float	Maximum wavelength of line
LogT	Float	Log (base 10) temperature of line (K)
Name	String	Line name example (Fe XVIII)
Type	String	Type of line example (F)
Blend	String	Other lines included in this line

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 broadbands 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.

BandsMeta:

Column Name	Type	Description
Name	String	Name of the band example (AIA_304)
Type	String	SDO instrument example (AIA)

The DiodeMeta data unit contains information about spectral bands derived from EVE level 2 spectra that corresponds to measurements made by EVE diodes from ESP and MEGS P. The DiodeMeta data unit is described in the following table.

DiodeMeta:

Column Name	Type	Description
Name	String	Name of the band example (171)
Type	String	SDO instrument example (ESP)

The ESP central quad diode contains information about the center of brightness for the 0.1-7 nm bandpass. These are normalized to provide a relative measure of the distribution of irradiance.

QuadMeta:

Column Name	Type	Description
Name	String	Name of the band example (Q0)
Type	String	SDO instrument example (ESP)

The last Data HDU contains the actual data. It holds the irradiance spectrum as well as other values as described in the following table.

Data:

Column Name	Type	Description
YYYYDOY	Long	4-digit year and 3-digit day of year of the observation
Capture	ULong	Seconds in the day where the spectrum is measured.
MEGSA_Valid	ULong	Number of valid spectral measurements from MEGS-A (primary science filter)
MEGSB_Valid	ULong	Number of valid spectral measurements from MEGS-B (filter wheel open)
SP_Irradiance	Float (array)	Power per unit area at 1-AU in $W/m^2/nm$. 5200 element array containing the irradiance for each wavelength bin
SP_StDev	Float	Relative one-sigma spread, the standard deviation for each bin (fractional)

	(array)	
SP_Precision	Float (array)	Relative Precision information for each bin. This represents the uncertainty based only on counting statistics. (fractional)
SP_Accuracy	Float (array)	Relative uncertainty representing the NIST combined standard uncertainty. This includes all known contributing factors including the absolute calibration. (fractional)
SP_Flags	UInt (array)	5200 element array containing quality information for each bin (refer to level 2 data product documentation for descriptions)
Line_Irradiance	Double (array)	Power per unit area at 1-AU over the integrated line with no background subtraction.
Line_StDev	Float (array)	Relative one-sigma spread, the standard deviation for each line (fractional)
Line_Precision	Float (array)	Relative Precision information for each line. This represents the uncertainty based only on counting statistics. (fractional)
Line_Accuracy	Float (array)	Relative uncertainty representing the NIST combined standard uncertainty (fractional)
Band_Irradiance	Float (array)	Power per unit area at 1-AU over the integrated band from the combined MEGS-A and B spectrum. Note that the AIA bands are in counts per second per pixel, not irradiance.
Band_StDev	Float (array)	Relative one-sigma spread, the standard deviation for each band (fractional)
Band_Precision	Float (array)	Relative Precision information for each band. This represents the uncertainty based only on counting statistics. (fractional)
Band_Accuracy	Float (array)	Relative uncertainty representing the NIST combined standard uncertainty (fractional)
Diode_Irradiance	Float (array)	Power per unit area at 1-AU measured by the diodes.
Diode_StDev	Float (array)	Relative one-sigma spread, the standard deviation for each diode (fractional)
Diode_Precision	Float (array)	Relative Precision information for each diode. This represents the uncertainty based only on counting statistics. (fractional)
Diode_Accuracy	Float (array)	Relative uncertainty representing the NIST combined standard uncertainty (fractional)
Quad_Fraction	Float (array)	The fraction of the total signal on each quadrant diode comprising the 0.1-7 nm measurement.
Quad_StDev	Float (array)	Relative one-sigma spread, the standard deviation for each of the ESP central order quadrant diodes (fractional)
Quad_Precision	Float (array)	Relative Precision information for each bin. This represents the uncertainty based only on counting statistics. (fractional)

Data Processing

All data products are generated at LASP, and the Level 3 products described in this document are all publicly available at the EVE website. We caution users to carefully consider their data needs. The level 3 products are free for responsible public use; however, downloading the entire dataset from one of the merged files is probably the best solution for most users.

FITS Definition and Software

The EVE Level 3 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.

http://adsabs.harvard.edu/cgi-bin/nph-bib_query?bibcode=1981A%26AS...44..363W&db_key=AST&high=3db47576cf05627

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/cgi-bin/nph-bib_query?bibcode=1995A%26AS..113..159C&db_key=AST&high=3db47576cf06210

Additional detailed documentation is available on-line.

http://fits.gsfc.nasa.gov/fits_documentation.html

Standard reader software is available from GSFC for many different languages. A graphical program called "fv" is useful for browsing the contents without writing any programs.

<http://heasarc.gsfc.nasa.gov/docs/software/ftools/fv/>

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. `read_whole_fits.pro` may be downloaded here http://lasp.colorado.edu/eve/data_access/software/eve_read_whole_fits.pro.

For IDL, you may also use `mrdfits.pro` available at:

<http://idlastro.gsfc.nasa.gov/mrdfits.html>

<http://idlastro.gsfc.nasa.gov/fitsio.html>

Explanation and Examples in IDL

Level 3 data products are stored in FITS format and may be read by a variety of software, see the documentation section at <http://lasp.colorado.edu/home/eve/data/data-access/> for more details. 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. The software `eve_read_whole_fits.pro` may be downloaded here http://lasp.colorado.edu/eve/data_access/software/eve_read_whole_fits.pro.

Reading a file

We will use the function in the following examples.

To read in a level 3 data product, simply provide the function with the desired filename.

```
IDL> data = eve_read_whole_fits( 'EVE_L3_2010123_006_01.fit' )
```

The variable called `data` is a structure containing data and metadata. To see the structure contents, perform the following command:

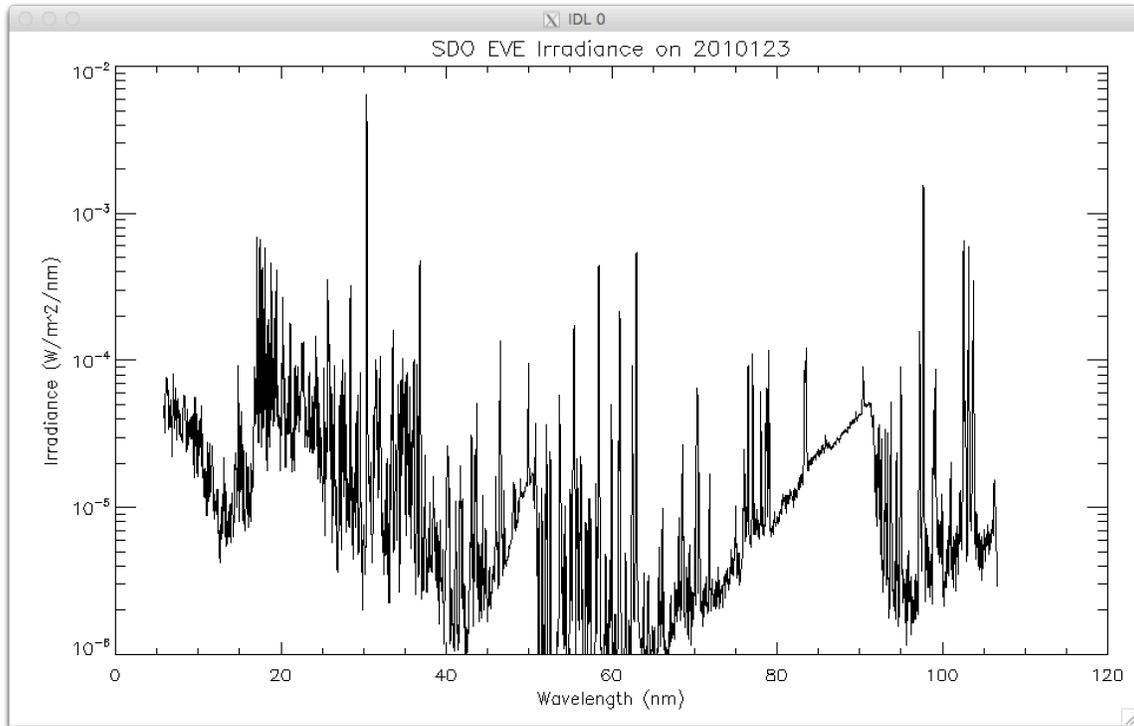
```
IDL> help,data,/struct
** Structure <17ea5928>, 14 tags, length=123496, data length=123486, refs=1:
PRIMARY          LONG          0
PRIMARY_HEAD     STRING       Array[5]
SPECTRUMMETA     STRUCT      -> <Anonymous> Array[5200]
SPECTRUMMETA_HEADER
                  STRING       Array[28]
LINESMETA        STRUCT      -> <Anonymous> Array[39]
LINESMETA_HEADER
                  STRING       Array[48]
BANDSMETA        STRUCT      -> <Anonymous> Array[20]
BANDSMETA_HEADER
                  STRING       Array[32]
DIODEMETA        STRUCT      -> <Anonymous> Array[6]
DIODEMETA_HEADER
                  STRING       Array[27]
QUADMETA         STRUCT      -> <Anonymous> Array[4]
QUADMETA_HEADER  STRING       Array[27]
DATA             STRUCT      -> <Anonymous> Array[1]
DATA_HEADER      STRING       Array[105]
```

Making a plot

As described above, the wavelength information is stored in the `data.spectrummeta` structure. To plot the daily averaged spectrum, issue the following command:

```
IDL> plot,data.spectrummeta.wavelength, data.data.sp_irradiance,yrange=[1e-6,1e-2],/ylog,charsize=1.5,xtitle='Wavelength (nm)',ytitle='Irradiance (W/m^2/nm)', title='SDO EVE Irradiance on '+strtrim(data.data.yyydoy,2)
```

This command will produce a plot similar to the following:



Diving deeper into the data

The metadata regarding the line name, wavelength ranges, temperature, and other useful information are contained in the linesmeta HDU. These are stored the same way as the level 2 data files, and 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         17.1070     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       53.7000    3.84000    20
O IV          55.4370     5.19000     21
```

Fe XX	56.7870	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

Note that this line list differs from the version 4 line list. Nine new lines are shown in bold with blue color. These additional MEGS-B lines were added to replace the ones that were lost after the MEGS-A anomaly. Most of the new lines are coronal but there are a few cooler lines as well. The lines between 33.5410 nm and 36.8076 nm are now measured by MEGS-B after the MEGS-A anomaly. We believe there is uncorrected degradation in MEGS-A for at least the 36.8076 nm emission line and the time series shows a step.

During MEGS-B observations 27 lines are now extracted (33.541-103.190 nm).

FITS file header metadata

The FITS file header metadata is accessible in the `data_header` structure:

```
IDL> for i=0,n_elements(data.data_header)-1 do print,data.data_header[i]
XTENSION= 'BINTABLE' /Binary table written by MWRFITS v1.11
BITPIX = 8 /Required value
NAXIS = 2 /Required value
NAXIS1 = 94938 /Number of bytes per row
NAXIS2 = 1 /Number of rows
PCOUNT = 0 /Normally 0 (no varying arrays)
GCOUNT = 1 /Required value
TFIELDS = 25 /Number of columns in table
COMMENT
COMMENT *** End of mandatory fields ***
COMMENT
ORIGIN = ' SDO/EVE SPOC' // LASP, University of Colorado, Boulder
DATE = '2017-05-05T18:52:19.000Z' // UTC file creation time (per ISO8601)
TAI_OBS = 1651536034.000 // TAI time at start of obs
DATE_OBS= '2010-05-03T00:00:00.000Z' // UTC at start of obs
T_OBS = '2010-05-03T12:00:00.000Z' // UTC at center of obs
EXPTIME = 86400.000 // seconds exposed, or integration time
TIME = 0.000 // UTC seconds of day at start of obs
TELESCOP= ' SDO/EVE'
INSTRUME= ' EVE_MEGS_ESP'
VERSION = 006 // major code/cal version
REVISION= 1 // reprocess number
FILENAME= 'EVE_L3_2010123_006_01.fit'
COMMENT
COMMENT *** Column names ***
COMMENT
```

```

TTYPE1 = 'YYYYDOY ' /
TTYPE2 = 'CAPTURE ' /
TTYPE3 = 'MEGSA_VALID' /
TTYPE4 = 'MEGSB_VALID' /
TTYPE5 = 'SP_IRRADIANCE' /
TTYPE6 = 'SP_STDEV' /
TTYPE7 = 'SP_PRECISION' /
TTYPE8 = 'SP_ACCURACY' /
TTYPE9 = 'SP_FLAGS' /
TTYPE10 = 'LINE_IRRADIANCE' /
TTYPE11 = 'LINE_STDEV' /
TTYPE12 = 'LINE_PRECISION' /
TTYPE13 = 'LINE_ACCURACY' /
TTYPE14 = 'LINE_FLAGS' /
TTYPE15 = 'BAND_IRRADIANCE' /
TTYPE16 = 'BAND_STDEV' /
TTYPE17 = 'BAND_PRECISION' /
TTYPE18 = 'BAND_ACCURACY' /
TTYPE19 = 'DIODE_IRRADIANCE' /
TTYPE20 = 'DIODE_STDEV' /
TTYPE21 = 'DIODE_PRECISION' /
TTYPE22 = 'DIODE_ACCURACY' /
TTYPE23 = 'QUAD_FRACTION' /
TTYPE24 = 'QUAD_STDEV' /
TTYPE25 = 'QUAD_PRECISION' /
COMMENT
COMMENT *** Column formats ***
COMMENT
TFORM1 = 'J ' /
TFORM2 = 'J ' /
TFORM3 = 'J ' /
TFORM4 = 'J ' /
TFORM5 = '5200E ' /
TFORM6 = '5200E ' /
TFORM7 = '5200E ' /
TFORM8 = '5200E ' /
TFORM9 = '5200I ' /
TFORM10 = '39D ' /
TFORM11 = '39E ' /
TFORM12 = '39E ' /
TFORM13 = '39E ' /
TFORM14 = '39I ' /
TFORM15 = '20E ' /
TFORM16 = '20E ' /
TFORM17 = '20E ' /
TFORM18 = '20E ' /
TFORM19 = '6E ' /
TFORM20 = '6E ' /
TFORM21 = '6E ' /
TFORM22 = '6E ' /
TFORM23 = '4E ' /
TFORM24 = '4E ' /
TFORM25 = '4E ' /
COMMENT
COMMENT *** Unsigned integer column scalings *
COMMENT
TSCAL2 = 1 /
TSCAL3 = 1 /
TSCAL4 = 1 /
TSCAL9 = 1 /
TSCAL14 = 1 /
TZERO2 = 0 /Modified by MRDFITS V2.20
TZERO3 = 0 /Modified by MRDFITS V2.20

```

```

TZERO4 = 0 /Modified by MRDFITS V2.20
TZERO9 = 0 /Modified by MRDFITS V2.20
TZERO14 = 0 /Modified by MRDFITS V2.20
COMMENT Website reference http://lasp.colorado.edu/home/eve
COMMENT EVE Principal Investigator T. N. Woods
COMMENT Laboratory for Atmospheric and Space Physics
COMMENT 1234 Innovation Drive, Boulder, CO 80303
COMMENT SDO Mission scientific and model results are open to all.
COMMENT Users should contact the PI or designated EVE team member early in an
COMMENT analysis project to discuss appropriate use of instrument data results.
COMMENT Appropriate acknowledgement to institutions, personnel, and funding
COMMENT agencies should be given. Version numbers should also be specified.
COMMENT Pre-prints of publications and conference abstracts should be widely
COMMENT distributed to interested parties within the mission.
EXTNAME = 'Data'
END

```

FITS spectrum header metadata

The FITS spectrum header metadata is accessible in the `spectrummeta_header` structure:

```

IDL> for i=0,n_elements(data.spectrummeta_header)-1 do
print,data.spectrummeta_header[i]
XTENSION= 'BINTABLE' /Binary table written by MWFITS v1.11
BITPIX = 8 /Required value
NAXIS = 2 /Required value
NAXIS1 = 4 /Number of bytes per row
NAXIS2 = 5200 /Number of rows
PCOUNT = 0 /Normally 0 (no varying arrays)
GCOUNT = 1 /Required value
TFIELDS = 1 /Number of columns in table
COMMENT
COMMENT *** End of mandatory fields ***
COMMENT
EXTNAME = 'SpectrumMeta'
TUNIT1 = 'nm'
COMMENT
COMMENT *** Column names ***
COMMENT
TTYPE1 = 'WAVELENGTH' /
COMMENT
COMMENT *** Column formats ***
COMMENT
TFORM1 = 'E ' /
COMMENT Wavelength (nm) is the center value of each bin of sp_irradiance
COMMENT in the Data table
COMMENT Accuracy is the relative accuracy of the entire MEGS measurement at
COMMENT each wavelength.
COMMENT Precision is the relative precision of the entire MEGS measurement at
COMMENT each wavelength.
END

IDL> help,data.spectrummeta,/str
** Structure <1ea4f8e8>, 1 tags, length=4, data length=4, refs=2:
WAVELENGTH FLOAT 3.01000

```

FITS lines header metadata

The FITS lines header metadata is accessible in the `linesmeta_header` structure:

```

IDL> for i=0,n_elements(data.linesmeta_header)-1 do
print,data.linesmeta_header[i]
XTENSION= 'BINTABLE'          /Binary table written by MWRFITS v1.11
BITPIX   =                      8 /Required value
NAXIS    =                      2 /Required value
NAXIS1   =                     42 /Number of bytes per row
NAXIS2   =                     39 /Number of rows
PCOUNT   =                      0 /Normally 0 (no varying arrays)
GCOUNT   =                      1 /Required value
TFIELDS  =                      7 /Number of columns in table
COMMENT
COMMENT  *** End of mandatory fields ***
COMMENT
EXTNAME  = 'LinesMeta'
TUNIT1  = 'nm'
TUNIT2  = 'nm'
TUNIT3  = 'nm'
TUNIT4  = 'log(K) '
COMMENT
COMMENT  *** Column names ***
COMMENT
TTYPER1  = 'WAVE_CENTER'      /
TTYPER2  = 'WAVE_MIN'        /
TTYPER3  = 'WAVE_MAX'        /
TTYPER4  = 'LOGT'            /
TTYPER5  = 'NAME'            /
TTYPER6  = 'TYPE'            /
TTYPER7  = 'BLENDS'          /
COMMENT
COMMENT  *** Column formats ***
COMMENT
TFORM1   = 'E'               /
TFORM2   = 'E'               /
TFORM3   = 'E'               /
TFORM4   = 'E'               /
TFORM5   = '8A'              /
TFORM6   = '5A'              /
TFORM7   = '13A'             /
COMMENT  For every element in the LINE_* column in the Data table, there is
COMMENT  one row here describing the spectral line for that element
COMMENT  wave_center is the nominal 'center' or 'peak'
COMMENT  wave_min is the lower edge of the integration window
COMMENT  wave_max is the upper edge of the integration window
COMMENT  logt is the base-10 log of the temperature of this line in Kelvin
COMMENT  name is the primary ion
COMMENT  type is the electron configuration of the primary ion
COMMENT  blends is other ions that may be in this line
COMMENT  lines below 37nm are derived from MEGS A
COMMENT  lines above 37nm are derived from MEGS B
END

```

```

IDL> help,data.linesmeta,/str
** Structure <lea4e058>, 7 tags, length=64, data length=64, refs=2:
  WAVE_CENTER    FLOAT          9.39260
  WAVE_MIN       FLOAT          9.33000
  WAVE_MAX       FLOAT          9.43000
  LOGT           FLOAT          6.81000
  NAME           STRING         'Fe XVIII'
  TYPE           STRING         'F'
  BLENDS         STRING         ' '

```

FITS bands header metadata

The FITS bands header metadata is accessible in the `bandsmeta_header` structure:

```
IDL> for i=0,n_elements(data.bandsmeta_header)-1 do
print,data.bandsmeta_header[i]
XTENSION= 'BINTABLE'           /Binary table written by MWRFITS v1.11
BITPIX   =                      8 /Required value
NAXIS    =                      2 /Required value
NAXIS1   =                     25 /Number of bytes per row
NAXIS2   =                     20 /Number of rows
PCOUNT   =                      0 /Normally 0 (no varying arrays)
GCOUNT   =                      1 /Required value
TFIELDS  =                      4 /Number of columns in table
COMMENT
COMMENT  *** End of mandatory fields ***
COMMENT
EXTNAME  = 'BandsMeta'
COMMENT
COMMENT  *** Column names ***
COMMENT
TTYPE1   = 'NAME      '         /
TTYPE2   = 'TYPE      '         /
TTYPE3   = 'LOW_WAVELENGTH_NM' /
TTYPE4   = 'HIGH_WAVELENGTH_NM' /
COMMENT
COMMENT  *** Column formats ***
COMMENT
TFORM1   = 'I3A      '         /
TFORM2   = '4A       '         /
TFORM3   = 'E        '         /
TFORM4   = 'E        '         /
COMMENT  For every element in the BAND_* column in the Data table, there is
COMMENT  one row here describing the band.
COMMENT  name is the name of the band
COMMENT  type describes the source of the band weighting
COMMENT  No matter the type, all irradiance data used here comes from MEGS
A/B
END
```

```
IDL> help,data.bandsmeta,/str
** Structure <lea5db88>, 4 tags, length=40, data length=40, refs=2:
NAME      STRING      'AIA_A94  '
TYPE      STRING      'AIA  '
LOW_WAVELENGTH_NM
           FLOAT              9.27500
HIGH_WAVELENGTH_NM
           FLOAT              9.51500
```

FITS diode header metadata

The FITS diode header metadata is accessible in the `diodemeta_header` structure:

```
IDL> for i=0,n_elements(data.diodemeta_header)-1 do
print,data.diodemeta_header[i]
XTENSION= 'BINTABLE'           /Binary table written by MWRFITS v1.11
BITPIX   =                      8 /Required value
NAXIS    =                      2 /Required value
NAXIS1   =                     10 /Number of bytes per row
```

```

NAXIS2 =                6 /Number of rows
PCOUNT =                0 /Normally 0 (no varying arrays)
GCOUNT =                1 /Required value
TFIELDS =               2 /Number of columns in table
COMMENT
COMMENT *** End of mandatory fields ***
COMMENT
EXTNAME = 'DiodeMeta'
COMMENT
COMMENT *** Column names ***
COMMENT
TTYPE1 = 'NAME      ' /
TTYPE2 = 'TYPE      ' /
COMMENT
COMMENT *** Column formats ***
COMMENT
TFORM1 = '4A      ' /
TFORM2 = '6A      ' /
COMMENT For every element in the DIODE_* column in the Data table, there
COMMENT is one row here describing the diode.
COMMENT name is a designation for the diode bandpass
COMMENT type describes the source of the band
END

```

```

IDL> help,data.diodemeta,/str
** Structure <1ea5d9b8>, 2 tags, length=32, data length=32, refs=2:
  NAME          STRING      'Quad'
  TYPE          STRING      'ESP  '

```

FITS quadrant diode header metadata

The FITS quad diode header metadata is accessible in the `quadmeta_header` structure:

```

IDL> for i=0,n_elements(data.quadmeta_header)-1 do
print,data.quadmeta_header[i]
XTENSION= 'BINTABLE' /Binary table written by MWRFITS v1.11
BITPIX =                8 /Required value
NAXIS =                 2 /Required value
NAXIS1 =                5 /Number of bytes per row
NAXIS2 =                4 /Number of rows
PCOUNT =                0 /Normally 0 (no varying arrays)
GCOUNT =                1 /Required value
TFIELDS =               2 /Number of columns in table
COMMENT
COMMENT *** End of mandatory fields ***
COMMENT
EXTNAME = 'QuadMeta'
COMMENT
COMMENT *** Column names ***
COMMENT
TTYPE1 = 'NAME      ' /
TTYPE2 = 'TYPE      ' /
COMMENT
COMMENT *** Column formats ***
COMMENT
TFORM1 = '2A      ' /
TFORM2 = '3A      ' /
COMMENT For every element in the QUAD_* column in the Data table, there is
COMMENT one row here describing the quadrant.

```

```
COMMENT name is the name of the quadrant
COMMENT type is the instrument channel (always ESP)
END
```

```
IDL> help,data.quadmeta,/str
** Structure <lea32ee8>, 2 tags, length=32, data length=32, refs=2:
   NAME          STRING      'Q0'
   TYPE          STRING      'ESP'
```

FITS data header metadata (the actual data)

The FITS data header metadata is accessible in the data_header structure:

```
IDL> for i=0,n_elements(data.data_header)-1 do print,data.data_header[i]
XTENSION= 'BINTABLE'           /Binary table written by MWRFITS v1.11
BITPIX   =                      8 /Required value
NAXIS    =                      2 /Required value
NAXIS1   =          94938 /Number of bytes per row
NAXIS2   =                      1 /Number of rows
PCOUNT   =                      0 /Normally 0 (no varying arrays)
GCOUNT   =                      1 /Required value
TFIELDS  =          25 /Number of columns in table
COMMENT
COMMENT   *** End of mandatory fields ***
COMMENT
ORIGIN    = '          SDO/EVE SPOC' // LASP, University of Colorado, Boulder
DATE      = '2017-05-05T18:52:19.000Z' // UTC file creation time (per ISO8601)
TAI_OBS   =          1651536034.000 // TAI time at start of obs
DATE_OBS  = '2010-05-03T00:00:00.000Z' // UTC at start of obs
T_OBS     = '2010-05-03T12:00:00.000Z' // UTC at center of obs
EXPTIME   =          86400.000 // seconds exposed, or integration time
TIME      =          0.000 // UTC seconds of day at start of obs
TELESCOP= '          SDO/EVE'
INSTRUME= '          EVE_MEGS_ESP'
VERSION   =                      006 // major code/cal version
REVISION  =                      1 // reprocess number
FILENAME= 'EVE_L3_2010123_006_01.fit'
COMMENT
COMMENT   *** Column names ***
COMMENT
TTYPE1   = 'YYYYDOY '          /
TTYPE2   = 'CAPTURE '          /
TTYPE3   = 'MEGSA_VALID'       /
TTYPE4   = 'MEGSB_VALID'       /
TTYPE5   = 'SP_IRRADIANCE'     /
TTYPE6   = 'SP_STDEV'          /
TTYPE7   = 'SP_PRECISION'      /
TTYPE8   = 'SP_ACCURACY'       /
TTYPE9   = 'SP_FLAGS'          /
TTYPE10  = 'LINE_IRRADIANCE'   /
TTYPE11  = 'LINE_STDEV'        /
TTYPE12  = 'LINE_PRECISION'    /
TTYPE13  = 'LINE_ACCURACY'     /
TTYPE14  = 'LINE_FLAGS'        /
TTYPE15  = 'BAND_IRRADIANCE'   /
TTYPE16  = 'BAND_STDEV'        /
TTYPE17  = 'BAND_PRECISION'    /
TTYPE18  = 'BAND_ACCURACY'     /
TTYPE19  = 'DIODE_IRRADIANCE'  /
TTYPE20  = 'DIODE_STDEV'       /
TTYPE21  = 'DIODE_PRECISION'   /
```

```

TTYPE22 = 'DIODE_ACCURACY'      /
TTYPE23 = 'QUAD_FRACTION'      /
TTYPE24 = 'QUAD_STDEV'         /
TTYPE25 = 'QUAD_PRECISION'     /
COMMENT
COMMENT *** Column formats ***
COMMENT
TFORM1  = 'J'                   /
TFORM2  = 'J'                   /
TFORM3  = 'J'                   /
TFORM4  = 'J'                   /
TFORM5  = '5200E'               /
TFORM6  = '5200E'               /
TFORM7  = '5200E'               /
TFORM8  = '5200E'               /
TFORM9  = '5200I'               /
TFORM10 = '39D'                 /
TFORM11 = '39E'                 /
TFORM12 = '39E'                 /
TFORM13 = '39E'                 /
TFORM14 = '39I'                 /
TFORM15 = '20E'                 /
TFORM16 = '20E'                 /
TFORM17 = '20E'                 /
TFORM18 = '20E'                 /
TFORM19 = '6E'                  /
TFORM20 = '6E'                  /
TFORM21 = '6E'                  /
TFORM22 = '6E'                  /
TFORM23 = '4E'                  /
TFORM24 = '4E'                  /
TFORM25 = '4E'                  /
COMMENT
COMMENT *** Unsigned integer column scalings *
COMMENT
TSCAL2  =                       1 /
TSCAL3  =                       1 /
TSCAL4  =                       1 /
TSCAL9  =                       1 /
TSCAL14 =                       1 /
TZERO2  =                       0 /Modified by MRDFITS V2.20
TZERO3  =                       0 /Modified by MRDFITS V2.20
TZERO4  =                       0 /Modified by MRDFITS V2.20
TZERO9  =                       0 /Modified by MRDFITS V2.20
TZERO14 =                       0 /Modified by MRDFITS V2.20
COMMENT Website reference http://lasp.colorado.edu/home/eve
COMMENT EVE Principal Investigator T. N. Woods
COMMENT Laboratory for Atmospheric and Space Physics
COMMENT 1234 Innovation Drive, Boulder, CO 80303
COMMENT SDO Mission scientific and model results are open to all.
COMMENT Users should contact the PI or designated EVE team member early in an
COMMENT analysis project to discuss appropriate use of instrument data results.
COMMENT Appropriate acknowledgement to institutions, personnel, and funding
COMMENT agencies should be given. Version numbers should also be specified.
COMMENT Pre-prints of publications and conference abstracts should be widely
COMMENT distributed to interested parties within the mission.
EXTNAME = 'Data'
END

```

```
IDL> help,data.data,/str
```

```

** Structure <lea707b8>, 25 tags, length=94944, data length=94938, refs=2:
   YYYYDOY      LONG      2010123
   CAPTURE      ULONG      86390

```

MEGSA_VALID	ULONG	8639
MEGSB_VALID	ULONG	8639
SP_IRRADIANCE	FLOAT	Array[5200]
SP_STDEV	FLOAT	Array[5200]
SP_PRECISION	FLOAT	Array[5200]
SP_ACCURACY	FLOAT	Array[5200]
SP_FLAGS	UINT	Array[5200]
LINE_IRRADIANCE	DOUBLE	Array[39]
LINE_STDEV	FLOAT	Array[39]
LINE_PRECISION	FLOAT	Array[39]
LINE_ACCURACY	FLOAT	Array[39]
LINE_FLAGS	UINT	Array[39]
BAND_IRRADIANCE	FLOAT	Array[20]
BAND_STDEV	FLOAT	Array[20]
BAND_PRECISION	FLOAT	Array[20]
BAND_ACCURACY	FLOAT	Array[20]
DIODE_IRRADIANCE		
	FLOAT	Array[6]
DIODE_STDEV	FLOAT	Array[6]
DIODE_PRECISION	FLOAT	Array[6]
DIODE_ACCURACY	FLOAT	Array[6]
QUAD_FRACTION	FLOAT	Array[4]
QUAD_STDEV	FLOAT	Array[4]
QUAD_PRECISION	FLOAT	Array[4]

SolarSoft

SolarSoft and IDL users may wish to download the EVE SolarSoft software package. It is available at our web site by browsing the EVE Data Access page.

<http://lasp.colorado.edu/home/eve/data/data-access/>

Additional information about SolarSoft can be found through the LMSAL website,

<http://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. The EVE SPOC provides an on-line table for users to identify when non-nominal operations activities have occurred.

http://lasp.colorado.edu/eve/data_access/evewebdata/EVE_sciopslog.html

A web-based calendar interface is available with one year pages.

http://lasp.colorado.edu/eve/data_access/evewebdata/misc/eve_calendars/calendar_level3_2017.html

CCD bakeouts have occurred as needed to maintain instrument sensitivity. 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 2 to 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 (2014146) when no MEGS-B data are available, the spectra file is no longer generated. The lines/bands file is generated because the ESP data remains continuously available.

Detailed daily information is provided in the Science Operations Mission Log and is available at this location:

http://lasp.colorado.edu/eve/data_access/evewebdata/EVE_sciopslog.html

Version Release Notes

The ESP 30.4nm diode data is now used to correct the trend for the MEGS-A 30.4 nm line, currently the only highly degraded line on the MEGS-A detector. Data from calibration rocket 36.258 is used to pin the calibration on 2010 day123.

We have applied the rocket calibration to MEGS-B in an attempt to recover some of the information that seems to be getting lost in the application of the pre-flight SURF responsivity. This process involved creating a modified responsivity that differs from the ground measurements for wavelengths shorter than 40 nm and longer than 60 nm. This compensates for unexpected sensitivity losses witnessed in early operations at long wavelengths prior to observing the sun for the first time. It also compensates for wavelength uncertainties and lower count rates during the calibration that affect the shorter wavelengths. Degradation trends in MEGS-B are estimated by comparing count rates measured to multiple linear regression proxy models using ESP, MEGS-P, and the 10.7 cm radio flux. The ratio provides a dimensionless degradation trend that is pinned to the first rocket.

In the version 6 EVE products MEGS-P Lyman-alpha was adjusted to agree with SORCE SOLSTICE version 15.

MEGS-B dark values and long-term degradation trends were updated (see the level 2 readme for more information).

The extracted bands used to produce an effective AIA count rate have not been updated to use newer AIA response functions that would spill over onto the MEGS-B wavelength region. Since MEGS-B is not available all day for most days, including the contribution would cause significant steps up and down in a time series (resulting from the availability of MEGS-B data.)

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.

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 that can cause increases that last several hours. 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 observed on the dark diode. 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 exposure times now move about 3:56 each day to avoid the worst particle contamination time periods.

Also, due to random large particle hits, the Lyman-alpha measurement experiences high frequency noise at 4 Hz. The data is filtered using a Fourier transform filter to remove the highest frequency spikes. Unfortunately, the Lyman-alpha measurement can be very noisy, so it is most useful after averaging to a daily value.