Readme for GOES-R EUVS Level 2 Data

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20 November 2023

1 Summary

The GOES-R Extreme Ultraviolet and X-Ray Irradiance Sensors (EXIS) Extreme Ultraviolet Sensor (EUVS) Level 2 (L2) data is primarily based on 30-second cadence extreme ultraviolet measurements from the EUVS Level 1b (L1b) data. EXIS was designed and built by the Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado Boulder. The L2 products are available in netCDF format as science-quality data produced by the NOAA National Center for Environmental Information (NCEI) and as real-time operational data similar to that used at the NOAA Space Weather Prediction Center (SWPC). **Users are advised to use the science-quality version of the data rather than the operational data.** The science-quality dataset differs from the operational product in that it incorporates retrospective fixes for issues in the operational product and updated calibrations, and the data have been reprocessed since the start of the mission. Both the science-quality and the operational data sets contain recovered data due to spurious dropouts.

This Readme provides a brief overview of the L2 products and discusses the data caveats. Links to the EUVS data, Readme's, a User's Guide for the L2 algorithms, plots, and other documentation can be found at `https://www.ngdc.noaa.gov/stp/satellite/goes-r.html`.

Extended coronal imaging (ECI) tests were performed for Solar Ultraviolet Imager (SUVI) on GOES-17, in the fall of 2019 and during other shorter periods. To do this, the platform shared by SUVI and EXIS was repeatedly slewed at a high cadence across a wide field-of-view. For EUVS, this resulted in a high fraction of data gaps as well as new spatial and temporal degradation trends during this period which require further analysis and long-term trending measurements to correct.

Users of the GOES-R EUVS L2 data are responsible for inspecting the data and understanding the known caveats prior to use. Technical questions about this data can be sent to *janet.machol@noaa.gov*, while data access questions should be sent to *pamela.wyatt@noaa.gov* or josh.riley@noaa.gov.

2 EUVS L2 Products Overview

The GOES-R EUVS instrument (Eparvier et al., 2009; Snow et al., 2009) makes extreme ultraviolet (EUV) and far ultraviolet (FUV) high spectral-resolution measurements of distinct solar emission lines representative of different layers of the solar atmosphere. EUVS measurements are made for seven solar lines and the Mg II core-to-wing ratio (Mg II index) as shown in Table 1. An empirical proxy model (Thiemann et al., 2019) uses the EUVS measurements to reconstruct an EUV spectrum from 5 to 127 nm. The model outputs solar spectral irradiance (SSI), i.e., the solar irradiance as a function of wavelength, which can be used in conjunction with wavelength- and altitude-dependent absorption cross sections as inputs to atmospheric models (e.g., Solomon and Qian, 2005).

Table 1: Main Solar Lines Measured by EUVS.

Wavelength (nm)	Lines(s)	Source Region
25.632	He II	Transition region
28.415	Fe XV	Corona
30.378	He II	Transition region
117.5	C III	Chromosphere
121.567	H I	Transition region
133.57	C II	Chromosphere
140.5	Si IV, O IV	Transition region
279.5528, 280.2704*	Mg II h, k	Chromosphere

* The Mg II index is derived from measurements near 280 nm.

The EUVS L2 products are listed in Table 2. Two products are currently available, and more will become available later this year.

Table 2: EUVS L2 Products

Product	Name	Description	Available Now
high resolution	hires	irradiances, currents at highest resolution	no
1-min averages	avg1m	irradiances, MgII index, spectral model at 1-min cadence	yes
daily averages	avg1d	daily averages of irradiances, MgII index, spectral model	yes

3 Data Caveats

The following is a list of caveats for the EUVS L2 science-quality data.

1. The solar array currents variable is bad for all GOES-17 data.

2. There are small discrepancies in some of the line irradiances after eclipses due to uncorrected temperature impacts.

3. Some bands in the spectral model have jumps when entering and exiting the geocoronal period. The model will be revised with improvements in a future data version.

4. The Mg II index may have small improvements in the future to account for non-linear behavior in the wings and lines and to remove spikes in the data.

5. The eclipse flag was set too narrowly around eclipses for the line irradiances in February and March 2017. This also impacts the spectral model.

6. An annual cycle oscillation artifact impacts four of the EUVS line irradiances with a maximum peak near the winter solstice. For GOES-16, the approximate magnitudes of the artifact are ±1.5% (117 nm), ±1.3% (121 nm), ±1% (133 nm) and ±0.9% (140 nm). These oscillations will also impact the spectral model. Similar oscillations occur in the GOES-17 irradiances. This artifact will be removed in a future version of the data.

7. There are multi-hour post eclipse thermal dips in the spectral lines and some model bins. The effect is most pronounced in the 25.6, 117.5, 133.5 and 140.5 nm lines. Due to the overlying geocoronal dip, it is unclear if this artifact occurs for the 121.6 nm line.

8. EUVS data is not good during periods of extended coronal imaging (ECI) for SUVI. These dates are

   GOES-16: 2018-02-12, 2011802-13

   GOES-17: 2018-04-30, 2018-06-04 through 2018-06-07, 2018-08-06 through 2018-09-13, 2019-08-28 through 2019-12-16, 2021-04-27 through 2021-04-30.

   GOES-18: 2022-08-11 through 2022-09-08

9. Eclipse penumbra events occurring without a full eclipse are not flagged. This results in dips in the irradiances with no associated flags. This will be corrected in the future.

10. Solar array current decreases by 1-3% during arc jet firing, which occurs for roughly one hour per day.

11. Mercury transits are not flagged. There are only two Mercury transits in the GOES mission lifetimes (11 November 2019 and 13 November 2032) and they cause no noticeable decrease in irradiance.

12. Users of the EUVS L2 operational data are referred to the EUVS L1b Operational Data Readme for additional caveats. Note that EUVS L2 operational data are not available prior to 12/10/2019.

13. GOES-18 science-quality data has a data gap from 2022-06-20 through 2022-08-11 due to a processing issue. This data should become available in early 2024.

14. The final day of GOES-17 science-quality data, 2023-01-10, is missing the solar line irradiances due to a processing issue. This data should become available in early 2024.

4 Science-Quality Versus Operational EUVS Data

The science-quality L2 data products differ from the operational L2 products used in operations at SWPC in completeness and quality. The science-quality data incorporate the most up-to-date calibrations and algorithm fixes and they are reprocessed since the start of the mission. The science-quality L2 data products are created from the science-quality L1b data. Both the science-quality and the operational data include some recovered data that was missing in the real-time operational products. The operational L1b and L2 data, especially from the earlier dates, contain significant issues that are not retroactively corrected, and therefore should be used with great caution and not for scientific analysis.

The start date for the GOES-16 science-quality EUVS L1b and L2 data is 7 February 2017. The science-quality data directories have names which end in "_science" and the file names have prefixes of "sci_". The science-quality data has a latency of three days.

The operational data are in directories without the "_science" suffixes, and the operational filenames have prefixes of "ops_" for L1b data and 'dn-' for L2 data. The operational data can be accessed from the parent directories of the science-quality data. This data has a latency of one day.

5 Versions of Science-Quality Data

Version numbers for the science-quality L2 EUVS data are listed in Table 3. For each new version, the version numbers are updated for all of the L2 products. Products impacted by the specific changes are listed parenthetically in the table.

Table 3: Science-quality L2 data versions

Version	Release date	Revisions
1-0-4	20 Sep 2023	Increases valid ranges for avg1m and avg1d irradiances and Mg II. Fixes timestamps in avg1d. Initial GOES-18 release. Uses v1-0-2 L1b data.
1-0-2	20 Dec 2022	Resolved minor error in data quality flagging and 0.5 second time error. Uses v1-0-1 L1b data.
1-0-1	4 May 2022	Uses v1-0-0 science L1b data. See L1b ReadMe for changes. Resolved minor errors in data quality flagging.
0-0-0	25 April 2021	Initial public data release.

6 Acknowledgements

We acknowledge contributions from T. Eden, F. Eparvier, J. Marcus Hughes, A. Jones, W. McClintock, J. Mothersbaugh, J. Riley, M. Snow, D. Woodraska, T. Woods, and P. Wyatt.

7 References

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