

## README file for Extreme ultraviolet Spectro-Photometer (ESP) Level 1 version 4 release (12/15/13)

WELCOME TO THE EVE/ESP LEVEL-1 DATA PRODUCT!

Files in this directory 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. ESP Level 1 data products are generated using algorithms created at the Univ. of Southern California Space Sciences Center in Los Angeles, CA.

This is the fourth public release of ESP Level 1 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, (Don.Woodraska at lasp.colorado.edu). For science issues please contact Leonid Didkovsky (leonid at usc.edu).

### ESP Overview:

The Extreme ultraviolet Spectro-Photometer uses a transmission grating, thin film filters and multiple silicon photodiodes to measure solar irradiance in 5 discrete wavelength bands. These bands include first order diffraction measurements of 34.3 – 38.5 nm, 28.0 – 32.7 nm, 23.4 – 28.1 nm, 17.5 – 21.1 nm as well as zero-order measurements, obtained by 4 photodiodes in a quad configuration, of 0.1-7 nm. Additionally a fully-obscured “dark” photodiode is used as part of a correction for background signal related to high energy particles. Under normal operation, ESP provides these measurements with 0.25 sec time resolution.

ESP band of 34.3 – 38.5 nm demonstrates significant noise pattern related to the increased instability of the detector’s shunt resistance. We do not recommend using this band’s data for short-time evaluation of solar irradiance.

More information about the ESP instrument, measurements, and calibrations can be found in:

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, p. 182, doi: 10.1007/s11207-009-9485-8, Dec. 2009.

<http://www-rcf.usc.edu/~leonid/papers/SolPhys2010.pdf>

## Product Overview:

The ESP Level 1 irradiance data are fully calibrated and corrected for particle background, visible light leakage, degradation in sensitivity, and spacecraft location (corrected to 1-AU). A suborbital sounding rocket payload is flown once a year for EVE absolute calibrations. The first suborbital flight after the launch of SDO was on May 3, 2010 followed by flights on June 23, 2012, and on October 21, 2013. Daily on-orbit calibrations are performed to track changes in detector dark current, filter condition, e.g. its degradation, and electrometer gain.

Each data file covers a time span of 24 hours with 4 measurement/sec cadence. Level 1 data is available with about 1 day latency.

## Data Availability/Gaps:

EVE/ESP provides nearly continuous solar observations with the following exceptions:

**Daily calibrations:** Calibration of the entire EVE instrument lasts a total of about 30 minutes, with the ESP portion lasting approximately 2.5 minutes. Daily calibrations for the EVE science channels are staggered so at least one of the other EVE science channels remains in observation mode during the period of ESP calibration.

**Eclipse outage periods:** Two annual eclipse outage periods of a few weeks occur as the spacecraft orbit aligns with the earth and sun. These can last up to 72 minutes each day. 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.

**Lunar transits and other infrequent activities:** 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.

## Naming Convention:

Level 1 products follow this naming convention: [esp\\_L1\\_YYYYDOY\\_004.fit](#)

## Level 1 Irradiance Products:

Level 1 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](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](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](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/>

For IDL, we use `mrdfits.pro`.

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

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

An IDL example to read the first fits file from a group of files and print a mean (daily) value for Ch9 (30 nm):

>

```
names=file_search('esp_L1_2013*_004.fit')
```

```
D_TABLE = MRDFITS( names[0], 1, /unsigned, /silent, status=status )
```

```
PRINT,' Mean Irradiance [W/m^2] for Ch9 =',mean(D_TABLE.ch_30)
```

```
>
```

In this example D\_TABLE contains all variables stored in the fits file.