SDO / GOES X-ray Flare Watch

Overview of SDO EVE real-time data web page at LASP/CU

April 4, 2012

1. Introduction

A popular flare classification uses the brightness of the solar X-ray irradiance as measured by the GOES X-Ray Sensor (XRS) B channel (0.1-0.8 nm band). The SDO EVE EUV SpectroPhometer (ESP) has channels that can be used as reasonable proxies for the solar X-ray irradiance provided by GOES XRS. The ESP zeroth order channel has Ti/Al/C filter to measure the solar irradiance in the 0.1-7 nm band. This channel consists of a quadrant photodiode and thus can also be used for flare location detection. The other ESP channels are first order channels with about 4 nm bandpass centered near 17 nm, 26 nm, 30 nm, and 37 nm.

SDO EVE is operated 24-7 from GEO. The SDO science data are taken with 10-sec cadence and even better for ESP at rate of 4 Hz. The SDO EVE processing has latency of about 5 minutes for the science data (Ka-band data) but only about 5 seconds for the housekeeping data (S-band data). The EVE Level 0CS data product uses the limited set of ESP data from the S-band so that it has about 5-second latency. The EVE Level 0CS has the ESP data averaged into 1-minute intervals and also calculates proxies for GOES XRS channels (XRS-A: 0.05-0.4 nm and XRS-B: 0.1-0.8 nm) as displayed on this web page.

The simple proxy models of ESP for the GOES X-ray irradiance are described in the below sections 3 and 4. The ESP proxy models provide good results for flare peaks of C, M, and X class flares but are much less accurate for non-flare times. These proxy models are especially useful for space weather operations when GOES XRS data are not available (e.g. during their eclipse periods).

For more information about SDO EVE and its data: http://lasp.colorado.edu/eve/

For GOES XRS data: http://www.swpc.noaa.gov/Data/

2. Web Page Graphics

Solar X-ray Irradiance plot (left): This plot shows the time series of the GOES-15 X-ray irradiance and the ESP X-ray proxies over 3 days. This plot uses 1-minute averaged data and updates every minute with about 15-sec latency.   The ESP X-ray proxies are expected to agree best with the GOES-15 X-ray measurements during flare peaks.

Flare Meter (top-right): This meter highlights the largest flare observed during the past 24 hours. The green zone is for flares below a level of C5. The orange zone is for flares between C5 and M5 and represent modest size flares that may also have coronal mass ejections (CMEs) associated with them. The red zone is for large flares with brightness of M5 or higher, and these large flares almost always have a CME too. These large flares are of high concern for space weather operations due the magnitude of the X-ray and EUV irradiance that arrives to Earth in 8 minutes and also for the Earth-directed CMEs that could arrive to Earth in 1-4 days later.

SAM Movie (bottom-right): The EVE Solar Aspect Monitor (SAM) is a low-resolution X-ray imager that highlights the X-ray activity on the solar disk. A rectangle is drawn on the SAM image to show where the largest flare in the last 24 hours was located on the solar disk.
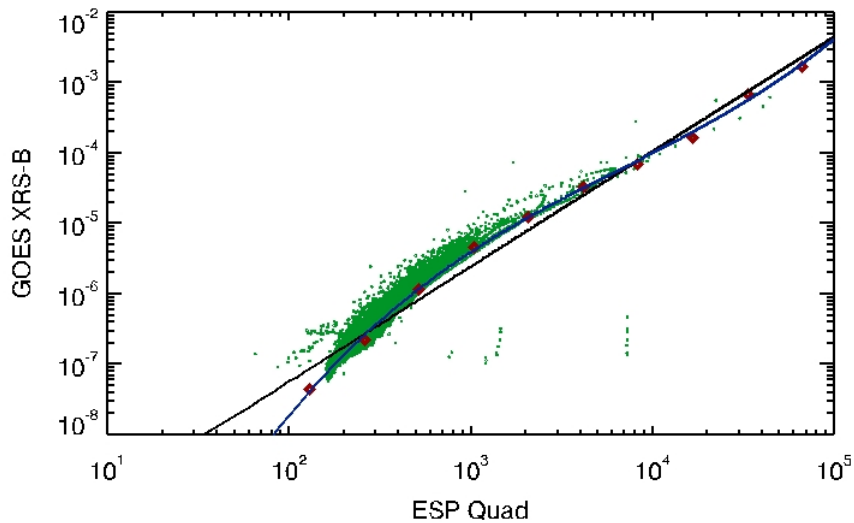
3. Proxy for XRS-B 0.1-0.8 nm Irradiance using EVE L0CS (raw ESP counts)

A power law fit between ESP zeroth order channel and GOES XRS-B provides a reasonably good proxy for the 0.1-0.8 nm irradiance. The ESP_{0-7nm} is sum of the four ESP quadrant diode counts corrected for dark signal (ESP_Dark * 4). A log-log fit with third degree polynomial function (blue line in plot below) is best fit and can represent well the XRS-B levels from B1 to X20. A linear fit (black line) is also reasonable but will have larger differences, notably at the low end and for C class flares. Now that SDO mission is over a more complete range of solar cycle levels (B1-X7 flares), these fits should be much better than the previous fit that was limited to C and M class flares.

$$ESP = \log_{10}\left(ESP_{0-7nm}[QuadSumCounts] - ESP_{Dark} * 4\right)$$

$$F_B(ESP) = -19.6529 + 9.52992 * ESP - 2.16084 * ESP^2 + 0.189092 * ESP^3$$

$$XRS - B(0.1 - 0.8nm) = 10^{F_B(ESP)}$$

4. Proxy for XRS-A 0.05-0.4 nm Irradiance using EVE L0CS (raw ESP counts)

A power law fit between ESP zeroth order channel and GOES XRS-A provides a fair proxy for the 0.05-0.4 nm irradiance. The ESP_{0-7nm} is sum of the four ESP quadrant diode counts corrected for dark signal. A log-log fit with third degree polynomial function (blue line in plot below) is best fit and can represent well the XRS-A levels. A linear fit (black line) is also shown.

$$ESP = \log_{10}\left(ESP_{0-7nm}[QuadSumCounts] - ESP_{Dark} * 4\right)$$

$$F_A(ESP) = -43.1341 + 26.6440 * ESP - 6.51211 * ESP^2 + 0.563281 * ESP^3$$

$$XRS - A(0.05 - 0.4nm) = 10^{F_A(ESP)}$$