

GOES-13, -15, and -16 Solar Energetic Particle Measurement Comparison Plots

Plots showing comparisons among differential flux measurements from the GOES-13 and -15 Energetic Particle Sensors (EPSs) and GOES-16 Solar and Galactic Particle Sensor (SGPS) are in the `./scatter_plots` and `./time_series` directories. The plots are further sorted into SGPS channel (p1-p10) subdirectories. The plots compare EPS and SGPS measurements during the July and September 2017 Solar Particle Events. Since the EPS/EPEAD P1-P7 energy channels do not align with SGPS P1-P10 energy channels, a power law is fit to the EPS fluxes, and SGPS fluxes are compared with the EPS spectrum at SGPS channel effective energies. Additional information about the power law fit and method used to obtain effective energies are given in Kress et al. [2021]. The July 2017 Solar particle event was relatively soft, with SGPS fluxes near or at background levels in SGPS energy channels $>P4$, so July 2017 event plots involving SGPS energy channels P5-P10 are not included.

EPS vs. SGPS Scatter Plots

The scatter plots each show EPS vs. SGPS simultaneous 5 min averaged proton fluxes ($\#/cm^2\text{-str-s-MeV}$). Samples included in the scatter plots are from 06:10:00 - 11:59:55 UT 16 July 2017 (in plots with names appended “16sep17”) and 07:30:00 UT on the 11th to 23:59:55 UT on the 15th of Sept. 2017 (in plots with names appended “11-15sep17”). The 11-15 Sept. 2017 scatter plots only include samples up to when the SGPS channel flux first drops below its background level. In each scatter plot file, the scatter plot data is shown using linear and log scales in the left and right panels respectively (i.e., the same data is shown in both panels).

Linear fits are performed in cases where we expect approximately equivalent SEP flux measurements from the energy channels under comparison (see Kress et al. [2021] Section 8). An Ordinary Least Squares (OLS) fit to the EPS vs. SGPS fluxes is shown by the thick black line (i.e., the same OLS fit is shown by a black line in both panels). The slope, intercept, and correlation coefficient from the OLS fit are given in the text box in the left panel.

A second, nonlinear fit is performed to $\log_{10} j_{EPS}$ vs. $\log_{10}(m * j_{SGPS} + b)$, i.e., a line in linear space with the fit performed in log space. The nonlinear fit is shown by the thick gray trace in the log-log plot (right panel). The slope, intercept, and coefficient of determination from this second fit are given in the text box in the right panel. The purpose of the fit performed in log space is to better fit the data approaching background levels. The slope and intercept values from the nonlinear fit are in most cases within 1% of the values obtained from a weighted least squares fit where the y-data values are used for weights, i.e., the best fit is obtained by minimizing a sum of squares of *relative* errors.

The EPS vs. SGPS scatter plots in each case show comparisons between east *or* west viewing detectors. Despite LT differences up to 2h, fluxes in the same viewing direction become well correlated at energies above ~ 80 MeV in the 11-15 Sept. 2017 scatter plots.

Linear fits to EPS vs. SGPS data are not performed for the SGPS P1-P3 (1.0-6.5 MeV) energy channels. Linear fits are performed for SGPS P4-P7 (6.5-80 MeV), but the linear relation obtained is not solely due to systematic error between EPS and SGPS calibrations, and the results should be used with caution.

Since the west facing GOES-13 P1 channel measurements have not been available since March 2017 due to a noise issue affecting EPEAD's front detector, there are no GOES-13 EPS vs. SGPS scatter plots for SGPS P1, P2A, P2B or P3 energy channels (all bounded by EPS P1 and P2 energies). Also, GOES-13 west fluxes are missing from the SGPS P1, P2A, P2B and P3 time series plots.

SGPS+X vs. SGPS-X Scatter Plots

Scatter plots showing SGPS+X (east) vs. SGPS-X (west) fluxes are also included. SGPS+X vs. SGPS-X fits are performed for P8A-P10 (80-500 MeV) energy channels. Fits to 11-15 Sept. 2017 SGPS+X vs. SGPS-X fluxes are not performed for energy channels below 80 MeV, but these plots are included to show the relation and range of difference between the east and west FOV measurements at different energies in a quiet magnetosphere. Fits are performed for the July 2017 SGPS+X vs. SGPS-X scatter plots, since 06:10:00 - 11:59:55 UT on July 16th is a period of high solar wind dynamic pressure, when we expect isotropic solar energetic particle flux at geosynchronous.

Time Series Plots

The time series plots show SGPS-X, SGPS+X, GOES-13, and -15 EPS east and west fluxes for each SGPS differential energy channel (13 separate plots for each solar particle event). The plots include times from 7:30 UT on 11 Sept. to 23:59:55 UT on 15 Sept, or when SGPS-X fluxes first drop below background level, whichever comes first. Note, the scatter plots include samples (approaching backgrounds) beyond the end-time of the time series plots in some cases. The samples shown in the 16 July 2017 time series plots exactly correspond the samples used in the 16 July 2017 scatter plots.

Reference

Kress, B. T., J. V. Rodriguez, A. Boudouridis, T. G. Onsager, B. K. Dichter, G. E. Galica and S. Tsui, Observations from NOAA's Newest Solar Proton Sensor, Submitted to *Space Weather*, Jan. 2021.