50 Years of GOES XRS Science-Quality Data

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XRS Measurements

The X-Ray Sensor (XRS) has flown on every Geostationary Environmental Operational Satellite (GOES) mission since GOES-1 launched in 1975. XRS measures solar irradiance in the soft X-ray region in two bandpasses: 0.05-0.4 nm (short channel; XRS-A) and 0.1-0.8 nm (long channel; XRS-B).

GOES XRS data is used to forecast the effects of space weather phenomena at Earth.

- Solar flares are strongest in the X-ray spectrum, and can affect telecommunications
- XRS data is the primary input to the NOAA Space Weather Radio Blackout scale
- Flare class is defined by the XRS-B 1-minute averaged irradiance

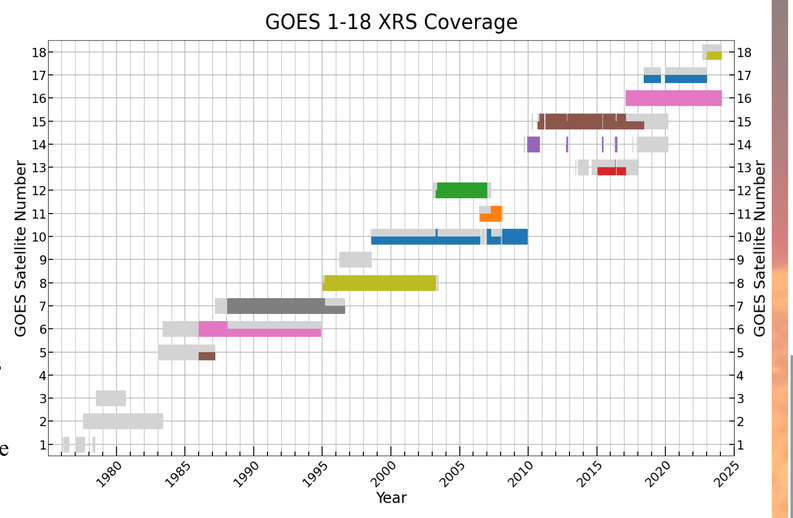

Figure 1. XRS data coverage of each GOES satellite, showing primary (thick color) and secondary (thin color) satellite designation.

XRS Data Products

- High resolution (1-3 second cadence)
- 1-minute and daily averages
- Flare summary
- Flare location (GOES 16-18 only)

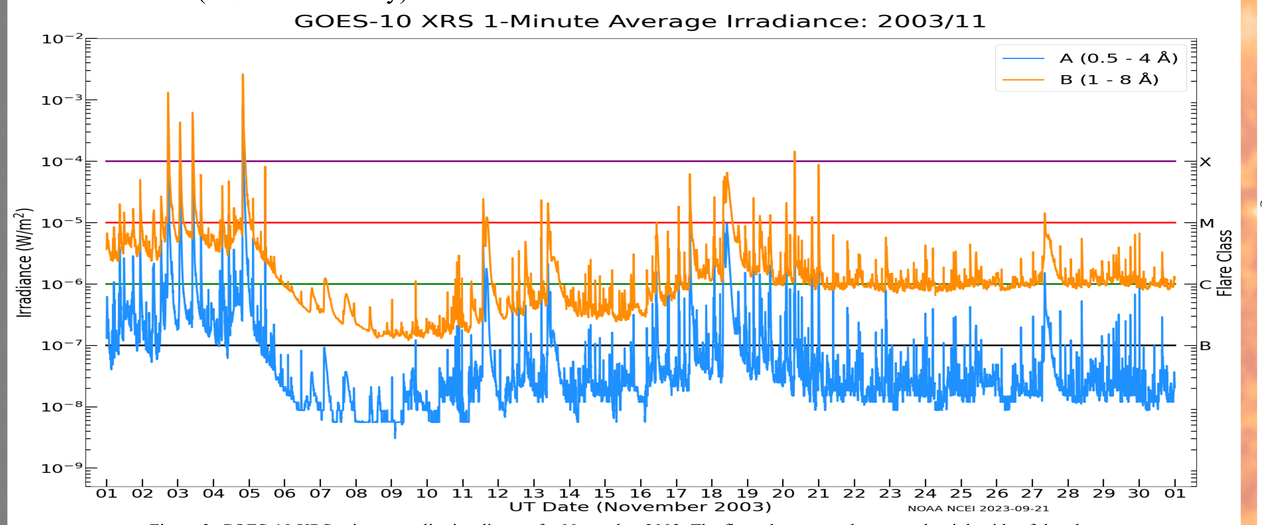

Figure 2. GOES-10 XRS science-quality irradiances for November 2003. The flare classes are shown on the right side of the plot.

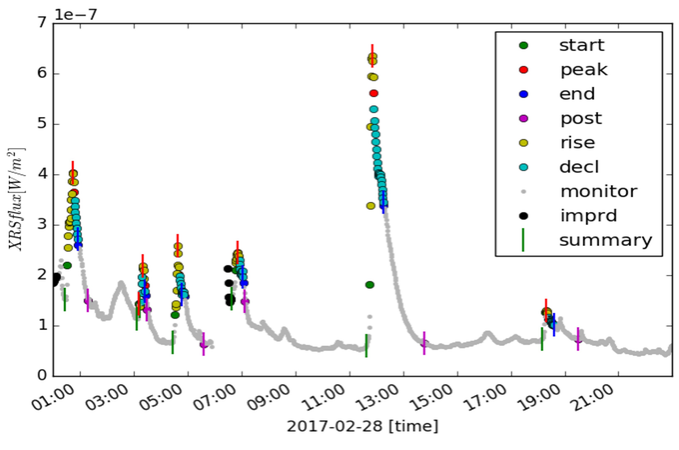

Figure 3. Flare detection (dots) and flare summary (vertical lines) for GOES-16 on February 28, 2017.

Figure 4. Flare locations for GOES-16 on February 10, 2023.

GOES 1-18 Science-Quality vs. Operational Data

Operational Data

- Real-time/low-latency
- Calibration changes cause discontinuities (“stair steps” in time series)

Science-Quality Data

- Contains fewer data gaps and more extensive quality flags than the operational data
- Reprocessed with the latest calibrations

The operational and science-quality records are both continuously updated with the most recent data.

GOES 1-15 Science Quality Data

NOAA NCEI is reprocessing the GOES 1-15 XRS data to create a complete science-quality record of all GOES XRS data. Improvements include:

- Corrected historical SWPC ‘scaling factor’ (no correction needed for GOES 13-18)
- Standardized A-channel bandpass
- Recalculated data quality flags and calibrations
- Fewer data gaps
- New and improved data products in standardized, modern files
- Reprocessing from counts data (except for GOES 8-12, for which counts data is not available)

The **SWPC ‘scaling factor’** is an adjustment factor that was applied to the GOES 8-15 data to normalize the irradiance to GOES 1-7. Subsequent analysis determined this factor was unnecessary, and that instead GOES 1-7 should be corrected.

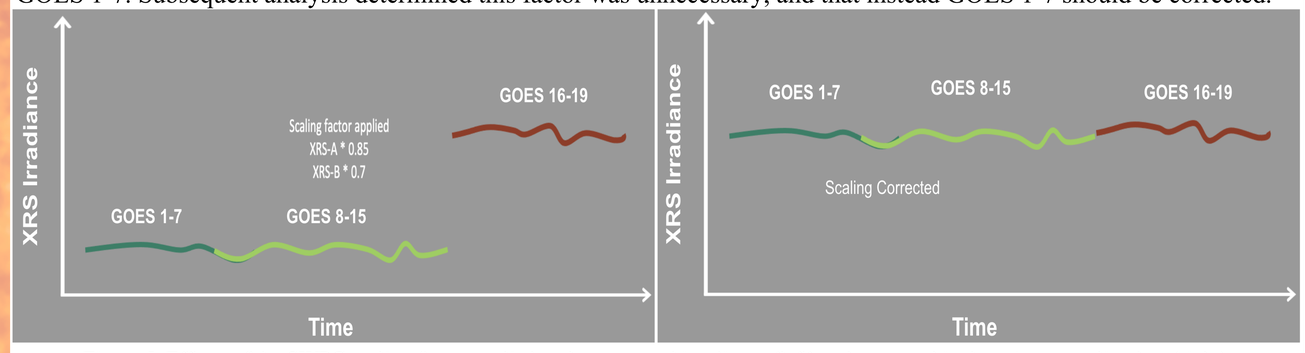

Figure 5. Effects of the SWPC scaling factor applied to the measured irradiance (left) and corrected in the science-quality data (right).

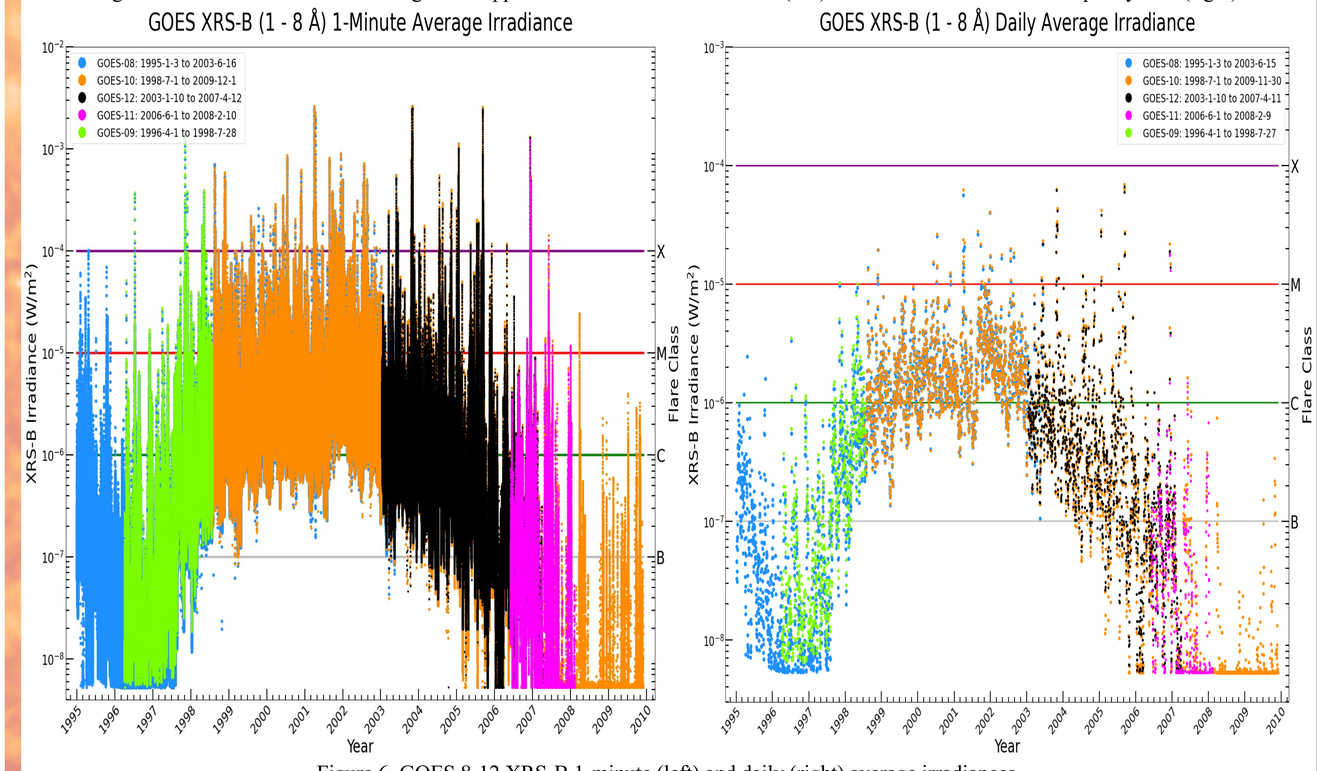

Figure 6. GOES 8-12 XRS-B 1-minute (left) and daily (right) average irradiances.

XRS Science-Quality Data Availability

XRS Data and Documentation: https://www.ngdc.noaa.gov/stp/satellite/goes-r.html

Satellite Series	High-Cadence Irradiance	Average Irradiance	Daily Background	Flare Summary	Flare Location*
GOES 16-18	Available	Available	Available	Available	Available
GOES 13-15	Available	Available	Available	Available	N/A
GOES 8-12	Available**	Available	Available	Available 2024	N/A
GOES 1-7	Available 2024	Available 2024	Available 2024	Available 2024	N/A

*GOES 16-18 XRS has a new capability to measure flare locations; this capability was not on the GOES 1-15 XRS instruments.
**GOES-9 has no high-cadence data. GOES-8 and GOES 10-12 have high-cadence data for approximately 50% of each mission.

Future Products

- Composite Flare Report (available 2024)
  - Continuously updated list of flares from 1974-present
  - Contains flare start/peak/end times, background and peak irradiances, flare classes, and flare locations
  - NetCDF and ASCII file formats
- GOES-19 will launch on June 25, 2024

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