



# 50 Years of GOES XRS Science-Quality Data

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## XRS Instrument

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).

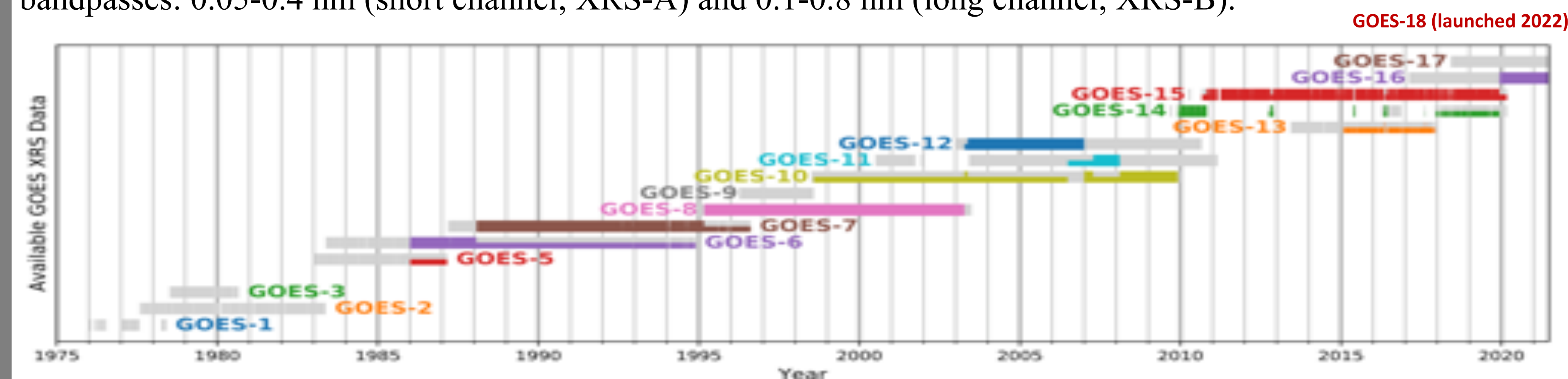


Figure 1. XRS data coverage of each GOES satellite, showing primary (thick color) and secondary (thin color) satellite designation.

## XRS Applications and Products

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

- Solar flares are strongest in the X-ray spectrum, and can affect communications on Earth.
- 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.

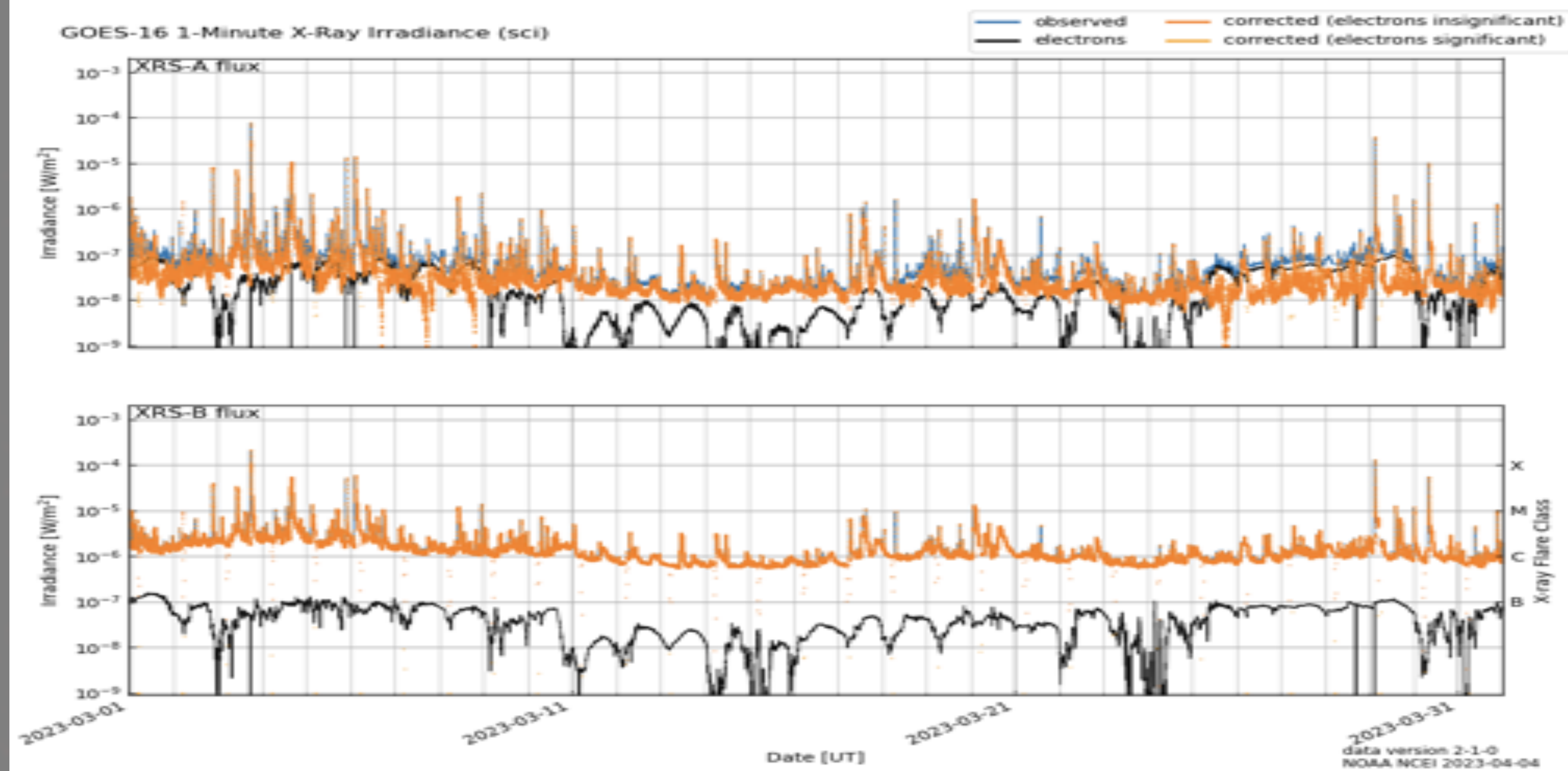


Figure 2. GOES-16 XRS science-quality irradiances for March 2023. The flare classes are shown on the right side of the lower plot.

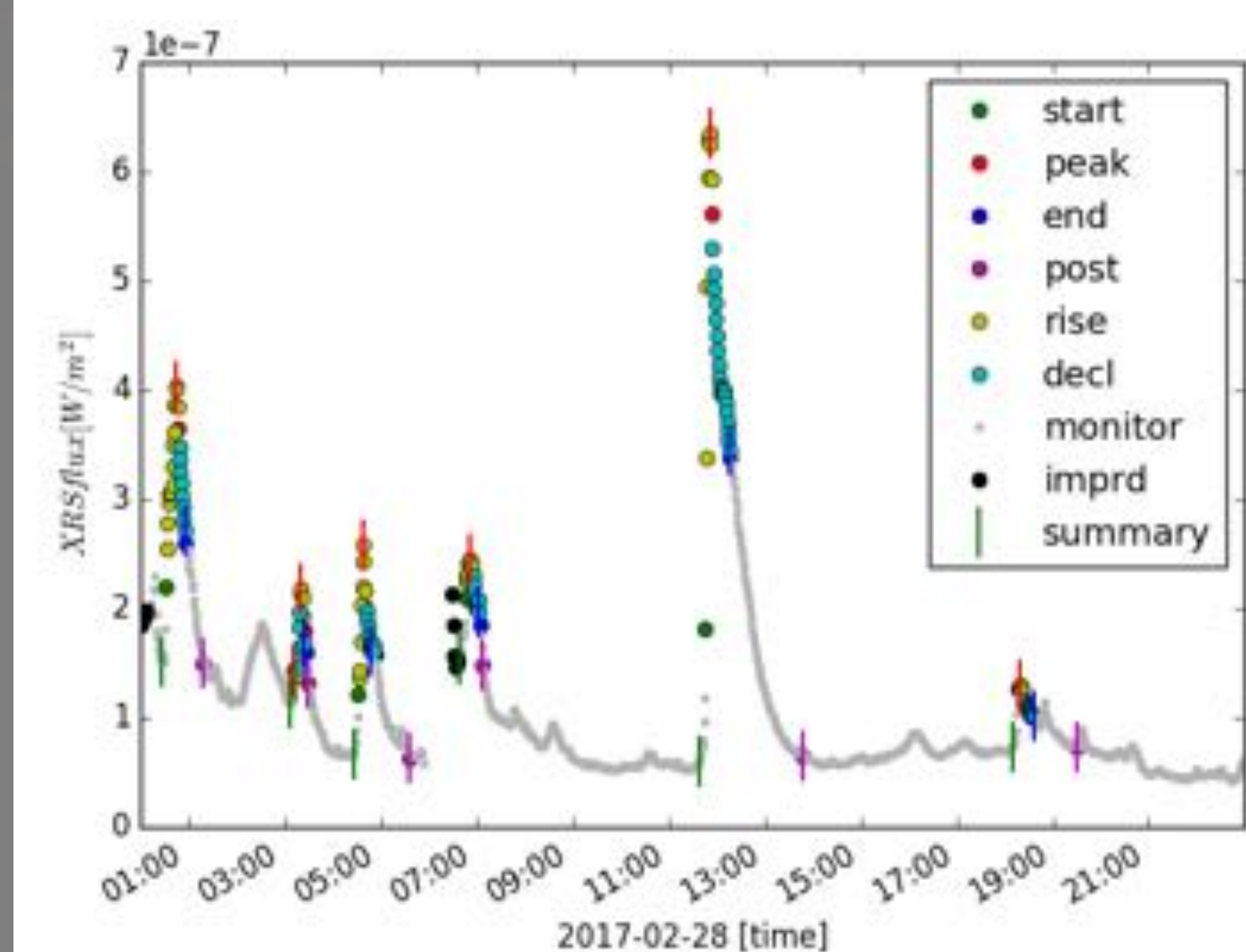


Figure 3. Flare detection (dots) and flare summary (vertical lines) for GOES-16 on February 28, 2017.



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

## GOES 1-15 Data Reprocessing

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

- Removing the historical SWPC 'scaling factor'. (This is already corrected in GOES 16-18 data.)
- Standardizing the A-channel bandpass
- Setting data quality flags
- Filling data gaps
- Producing data in standardized, modern files
- Recalibrating 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.

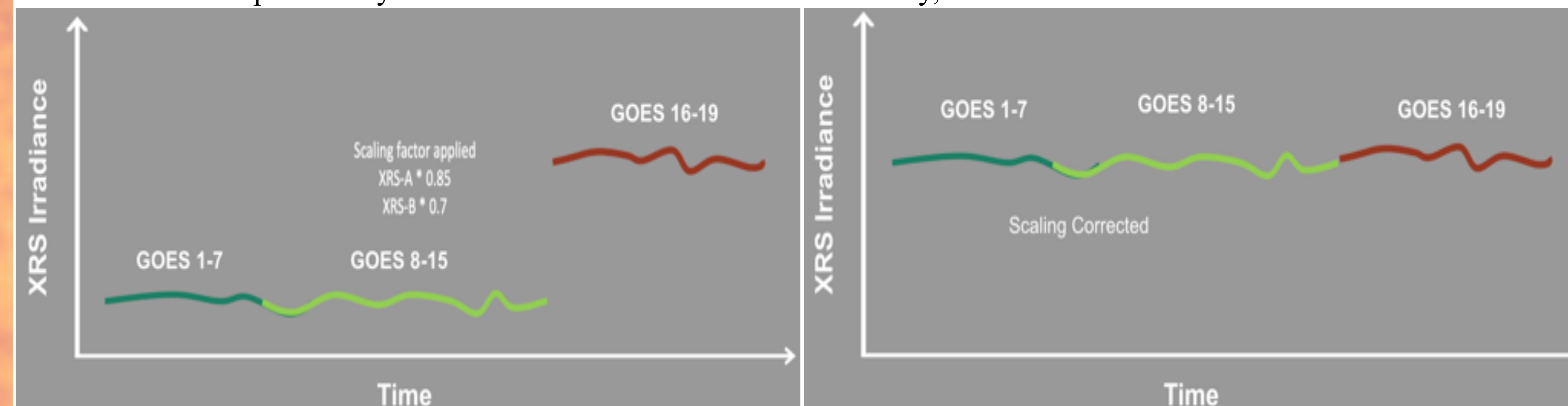


Figure 5. Effects of the SWPC scaling factor applied to the measured irradiance (left) and corrected in the science-quality data (right).

The plots below are examples of the GOES 8-12 high-cadence and average irradiance, color-coded to indicate the data quality flags set at each timestamp.

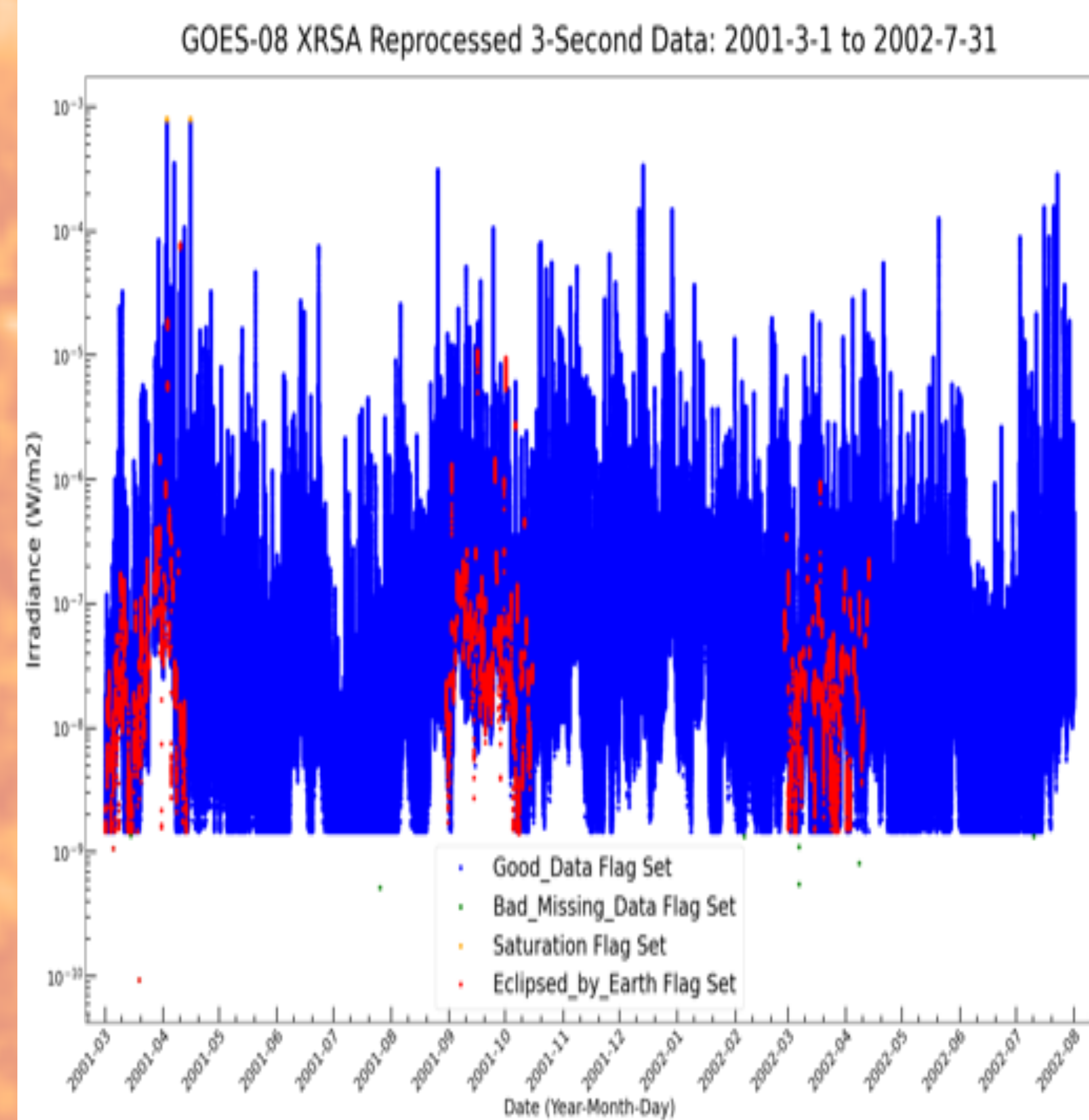


Figure 6. GOES-8 XRS-A 3-second (high-cadence) irradiance.

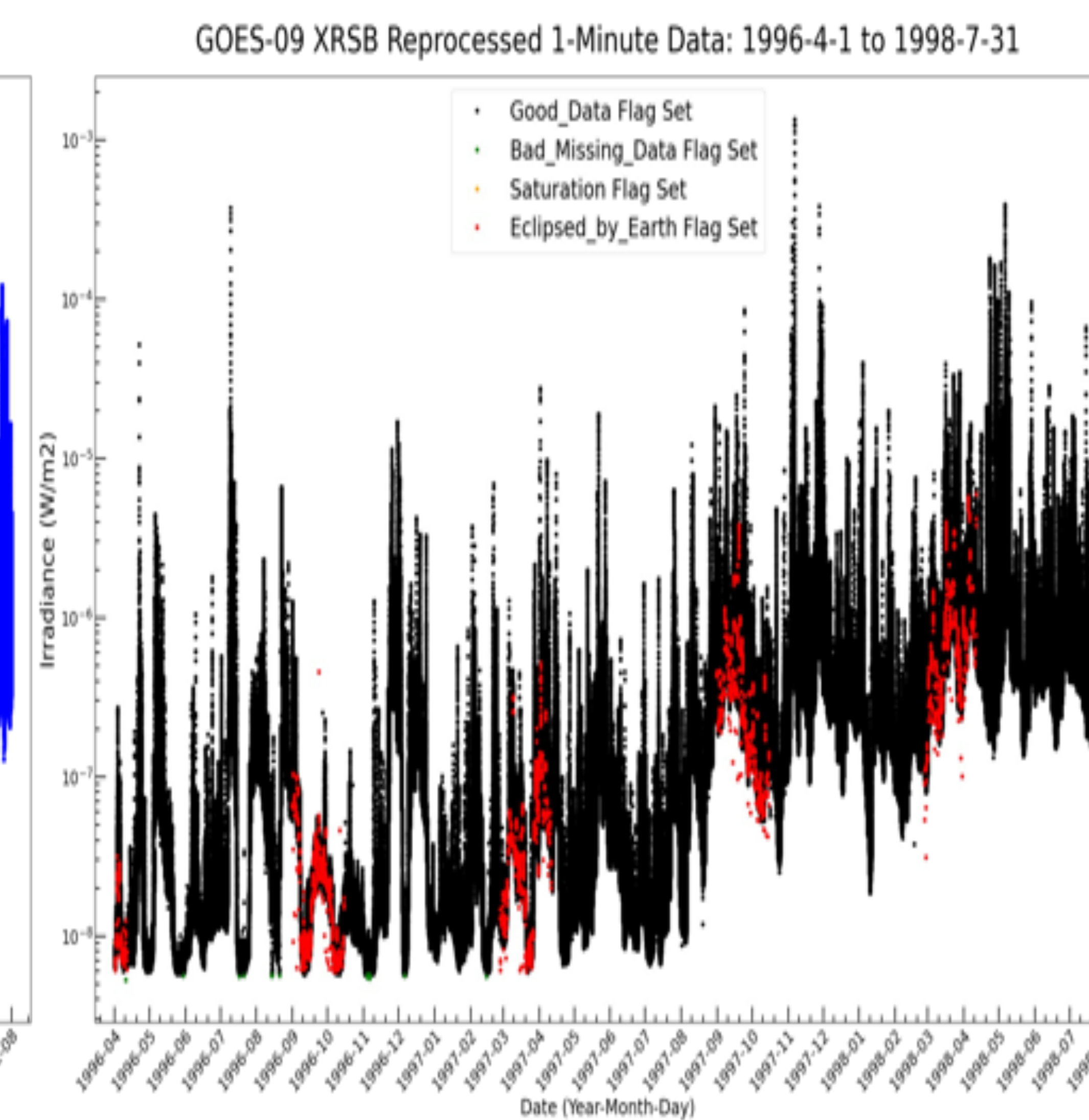


Figure 7. GOES-9 XRS-A 1-minute (average) irradiance.

## 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 Location**	Flare Summary
GOES 16-18	Available	Available	Available	Available	Available
GOES 13-15	Available	Available	Available	N/A	Available
GOES 8-12	Available*	Available in 2023	Available in 2023	N/A	Available in 2023
GOES 1-7	Available in 2023	Available in 2024	Available in 2024	N/A	Available in 2024

\*GOES-9 has no high-cadence data. GOES-8 and GOES 10-12 have high-cadence data for approximately 50% of each mission coverage.

\*\*Flare location data cannot be created for GOES 1-15 because the instrument that determines this data did not fly on these satellites

## Future Products

- Composite flare report
  - Continuously updated list of flares from 1974-present
  - Contains flare start/peak/end times, background and peak irradiances, and flare classes
  - NetCDF and ASCII file formats
- GOES-19 will launch in 2024

## GOES 1-18 Science-Quality vs. Operational Data

### Operational Data

- Real-time/low-latency
- Calibration changes are not retroactively applied

### Science-Quality Data

- Contains fewer data gaps and more extensive quality flags than the operational data
- Reprocessed to apply the latest calibration changes, without discontinuities, to the entire data record

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