



Variability of the Solar XUV Irradiance from the SORCE XPS

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Outline

■ Objective

- How much has the XUV radiation varied during the
SORCE mission?

■ SORCE XPS Instrument Overview

■ Validation of XPS Measurement

■ Flare Variations

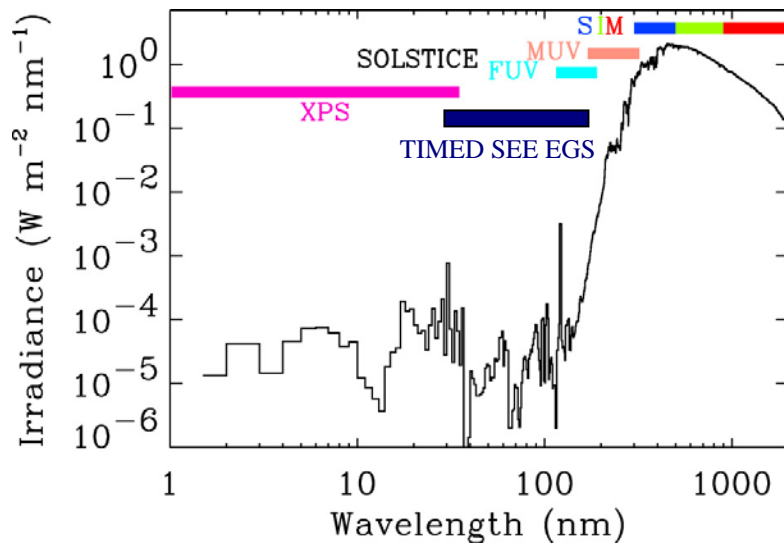
■ Solar Rotation Variations

■ Long-term Variations

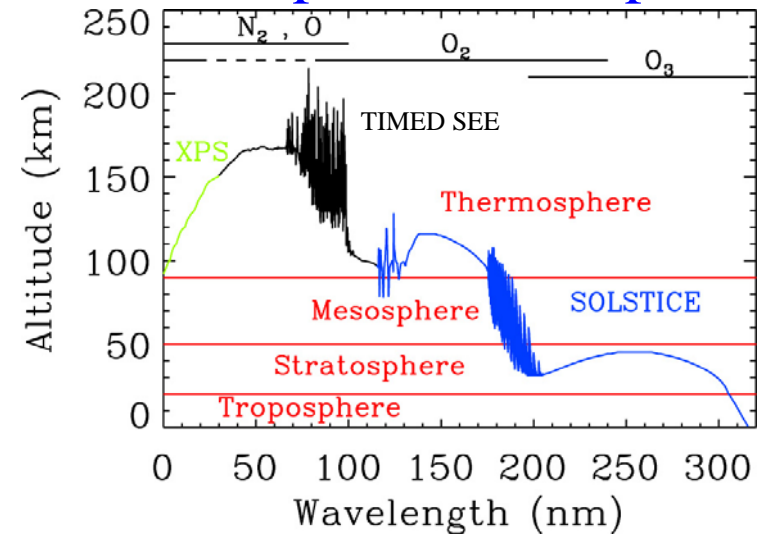
■ Conclusions

XPS Measures the Solar XUV Irradiance

Solar Irradiance



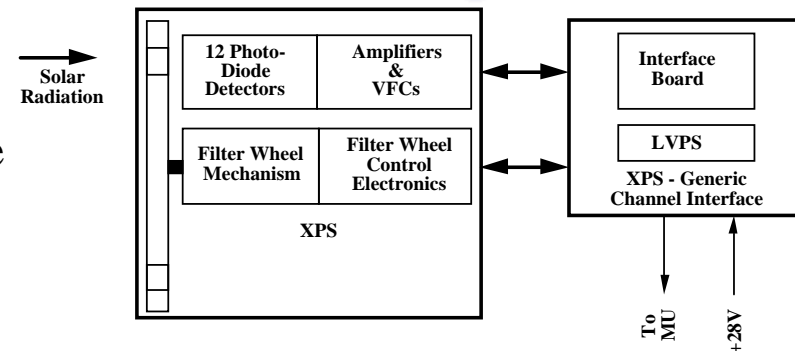
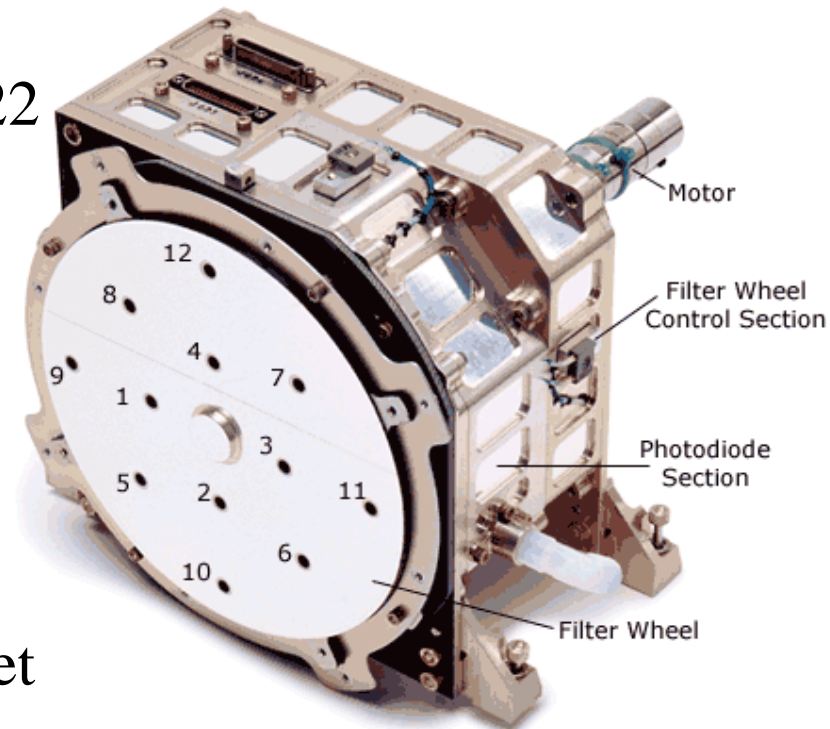
Atmospheric Absorption



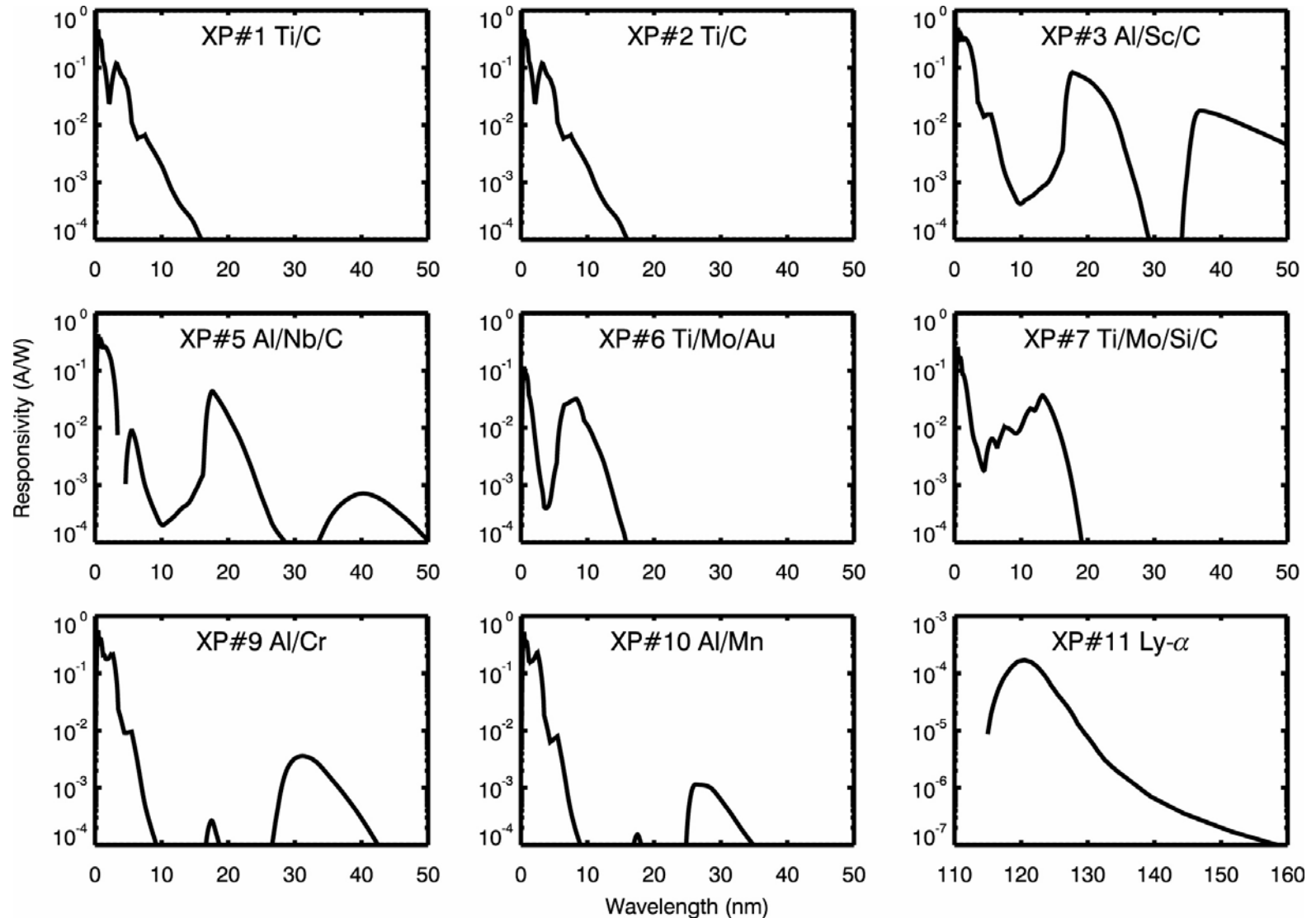
- Determine the solar irradiance and its variability for wavelengths below 30 nm (called soft x-rays or XUV)
- Resolve the solar XUV irradiance with a resolution of 5-10 nm
- Determine the solar XUV irradiance with an absolute accuracy of 20% ($1-\sigma$) or better
- Identify solar flare activity
- Study the solar energy deposition in the upper atmosphere

XUV Photometer System (XPS) Overview

- **Instrument Type:** Filter Photometer
- **Wavelength Range:** 1-35 nm, 121-122 nm
- **Wavelength Resolution:** 5-10 nm
- **12 Channels:** 8 XUV, Ly- α , 3 bare (visible)
- **Absolute Accuracy:** 20%
- **Long-term Accuracy:** 4%
- **Heritage:** TIMED SEE, SNOE, rocket XPS
- **Data Products (Version 6)**
 - Level 2: instrument resolution, 10-sec cadence
 - Level 3: instrument resolution, daily average
 - Level 4: 1-nm resolution, 5-min cadence

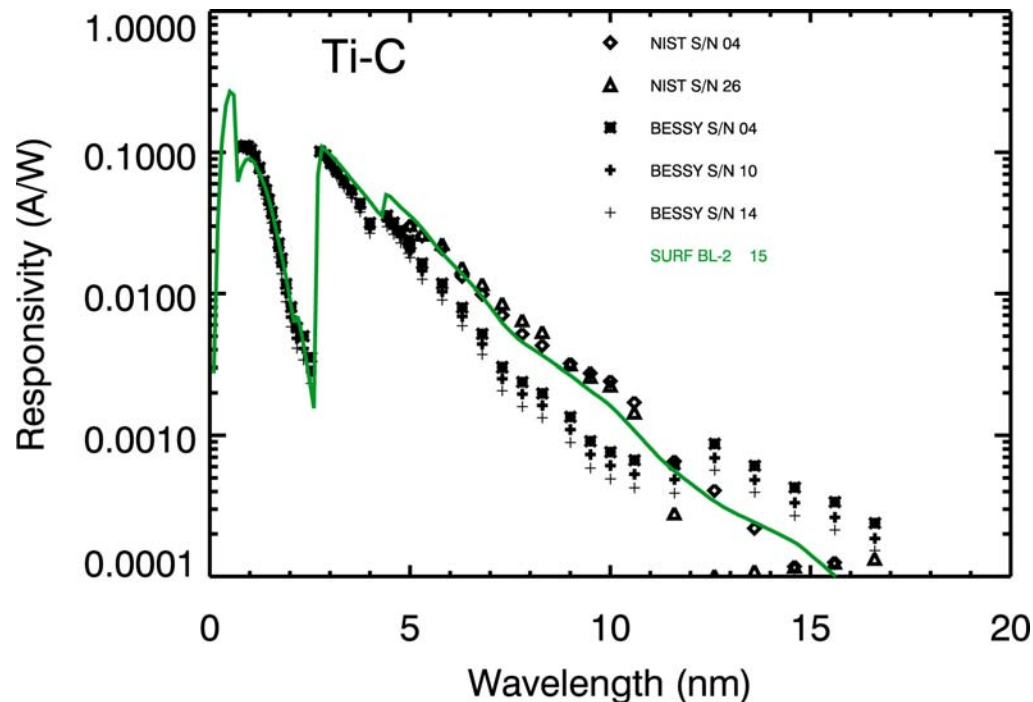


XUV Spectral Bands of XPS Channels



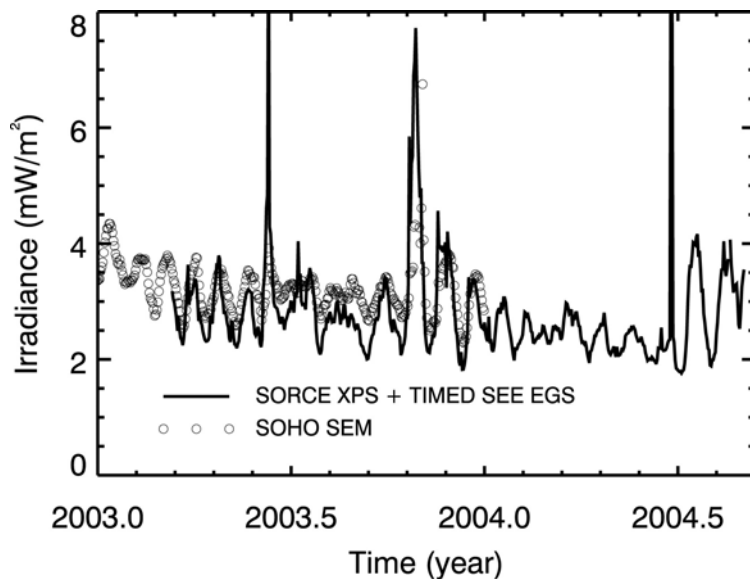
Calibration Issue for XPS

- Different pre-flight calibrations have differences by more than a factor of two at some wavelengths
- Adopted SURF BL-2 results in Version 6 of SORCE XPS

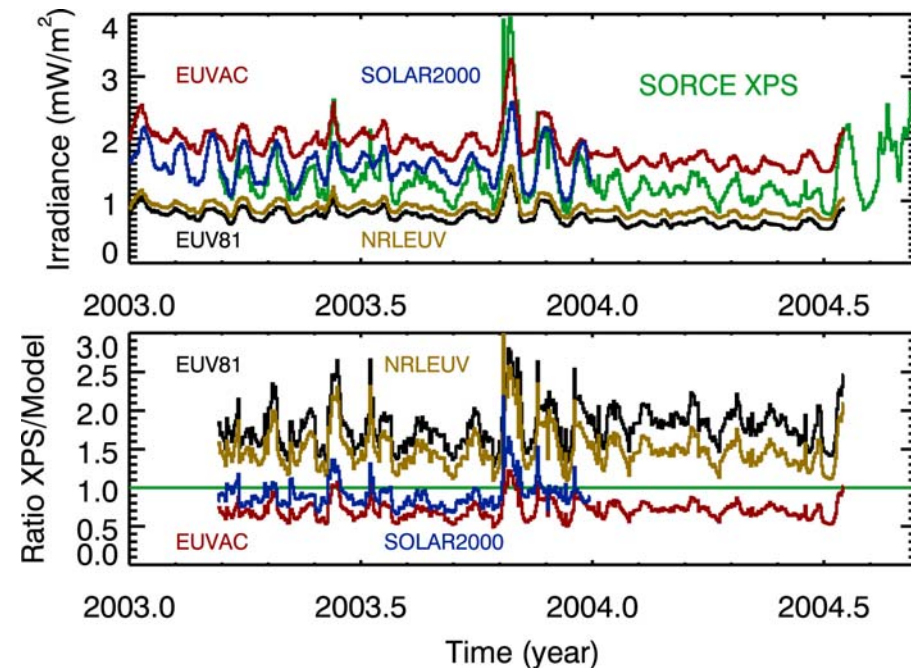


Validation of the XPS Measurements

- SOHO SEM 0-50 nm measurement agrees well with SORCE XPS (0-27 nm) combined with TIMED SEE (27-50 nm)



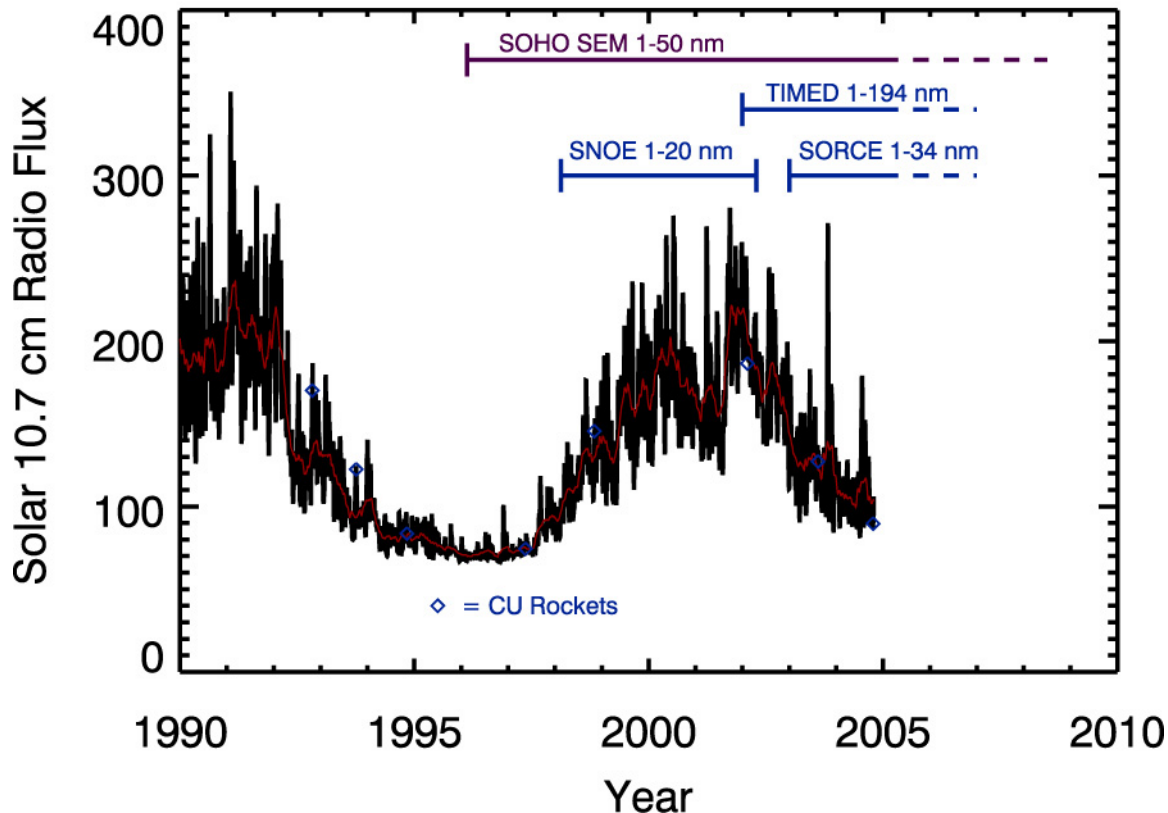
- Significant differences exist between the models and XPS



SORCE Mission Within the Solar Cycle

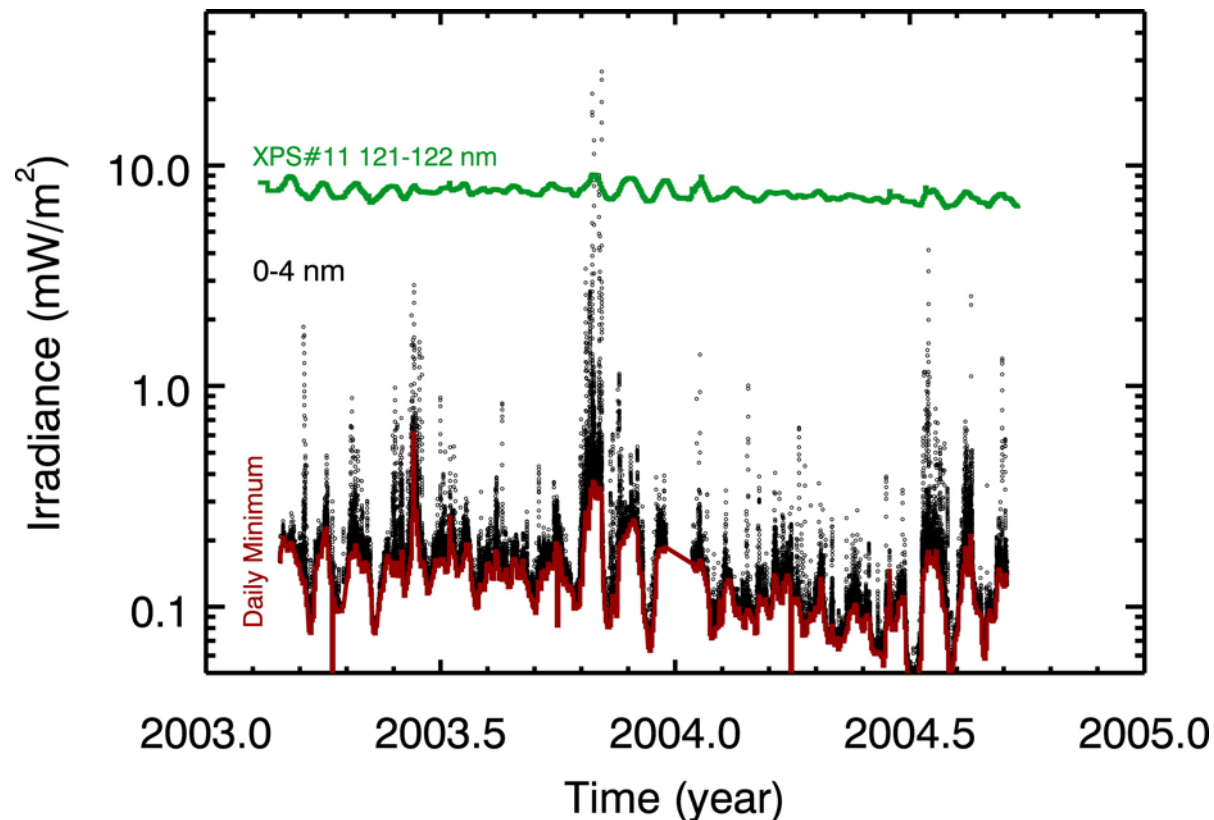
- **SORCE XPS** is providing enhanced spectral resolution in the XUV range as compared to SOHO SEM and TIMED

Recent Solar XUV Measurements



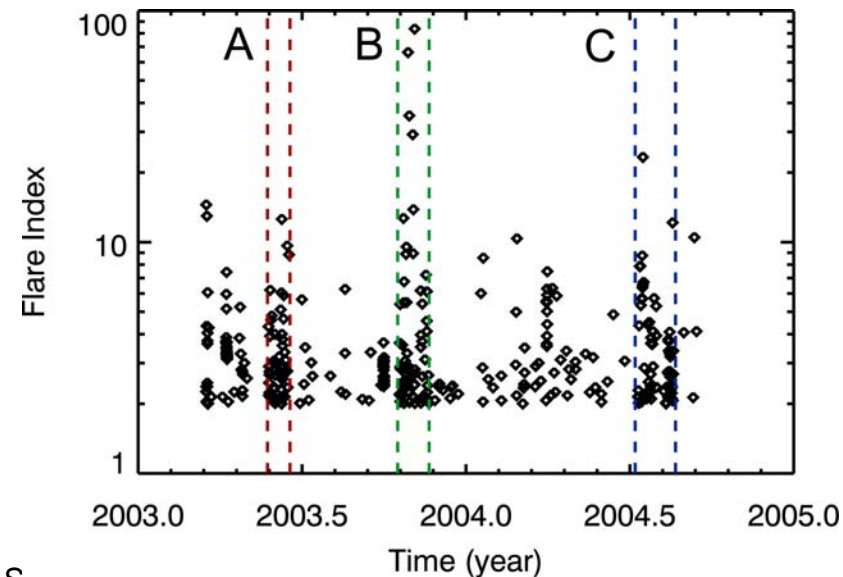
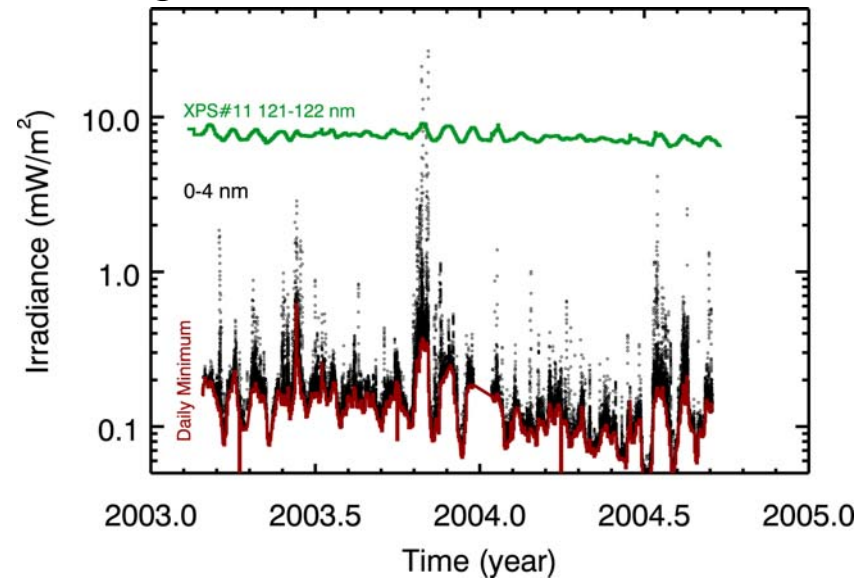
SORCE XPS Example Time Series

- XUV time series is dominated by flare events
- FUV time series is dominated by solar rotation variation



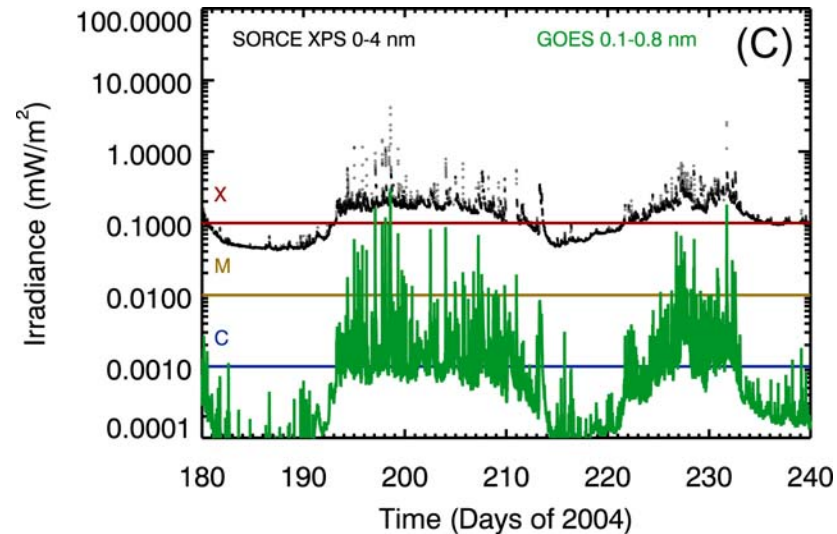
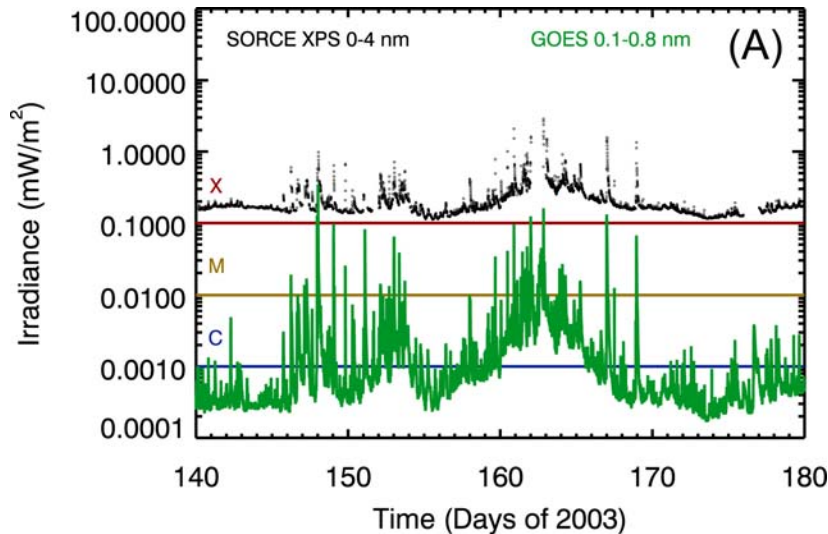
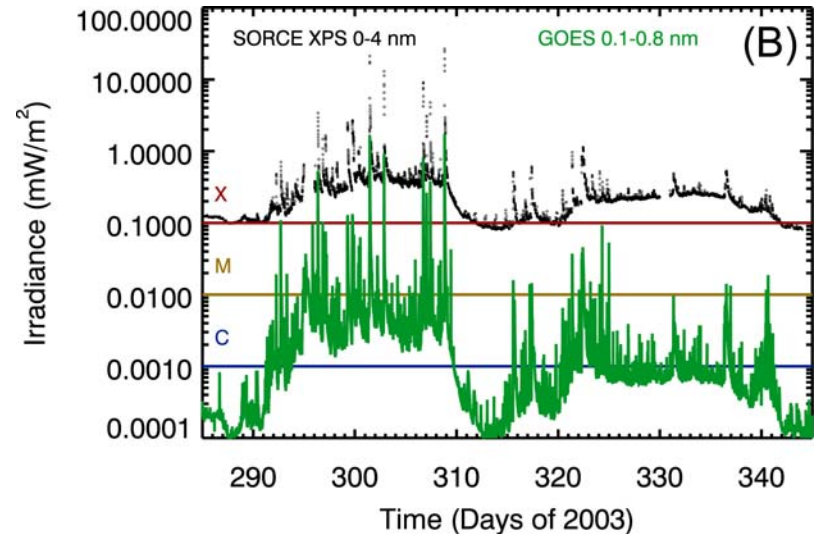
XPS Flare Index Used to Identify Flare Events

- The XPS Flare Index is the ratio of the irradiance to the minimum value of the irradiance for that day
- Flares are identified by a sudden increase
 - 358 flares detected during the SORCE mission when the Flare Index (FI) is greater than 2.0
 - 20 large flares for $FI > 8.0$

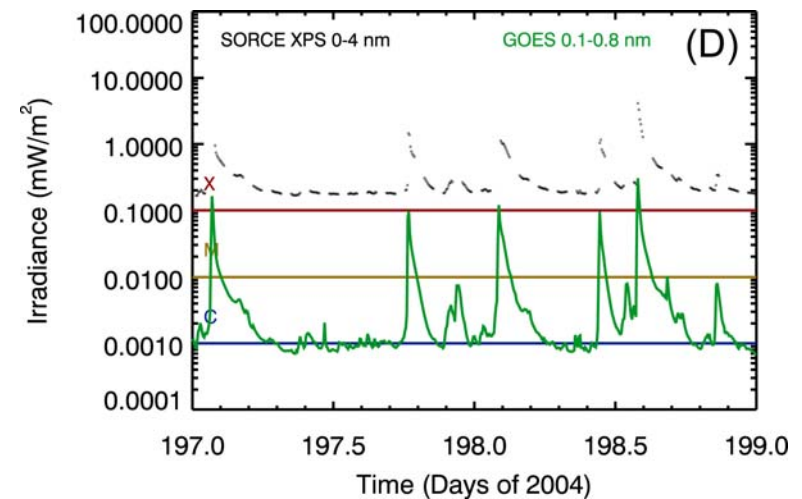
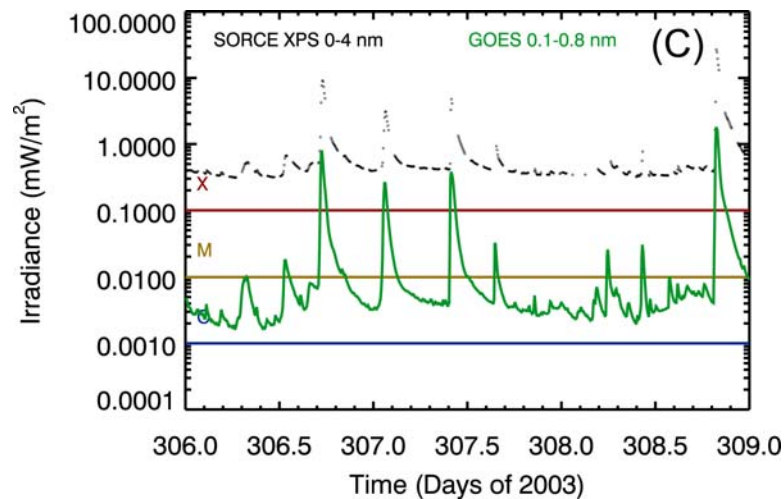
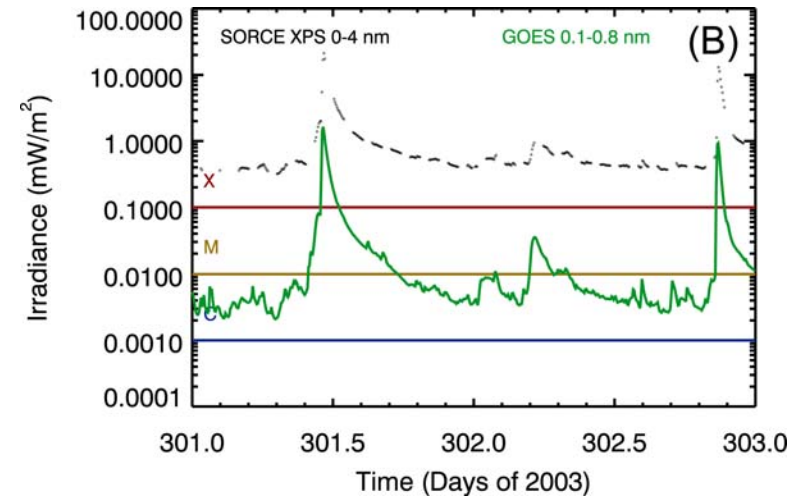
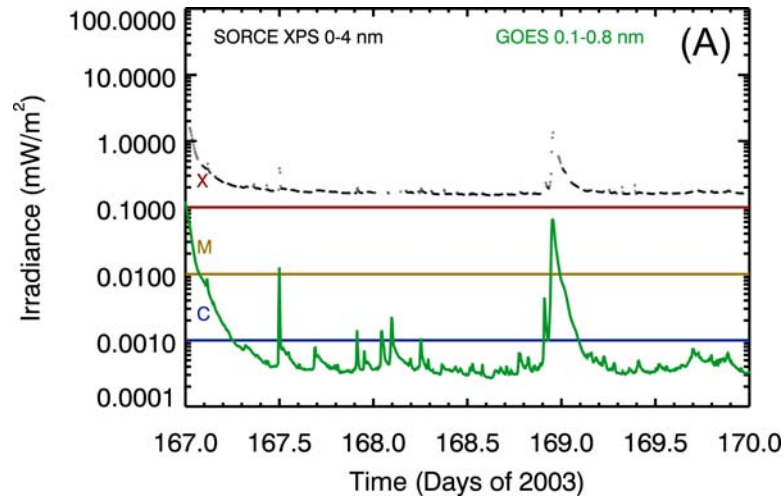


Three Interesting Solar Storm Periods

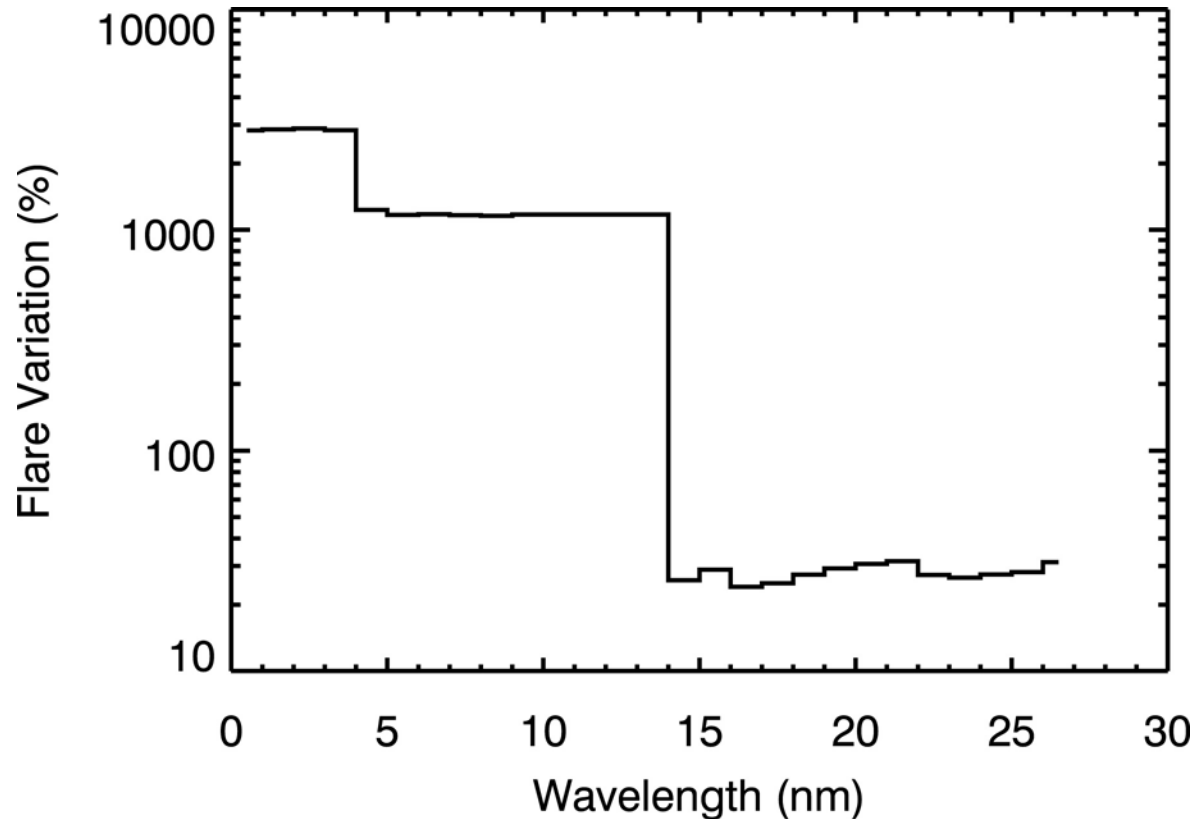
- **A:** 26 May to 17 June 2003
 - DOY 146 - 168
- **B:** 18 Oct. to 20 Nov. 2003
 - DOY 291 - 324
- **C:** 11 July to 19 August 2004
 - DOY 193 - 232



Example Time Series of the Larger Flares

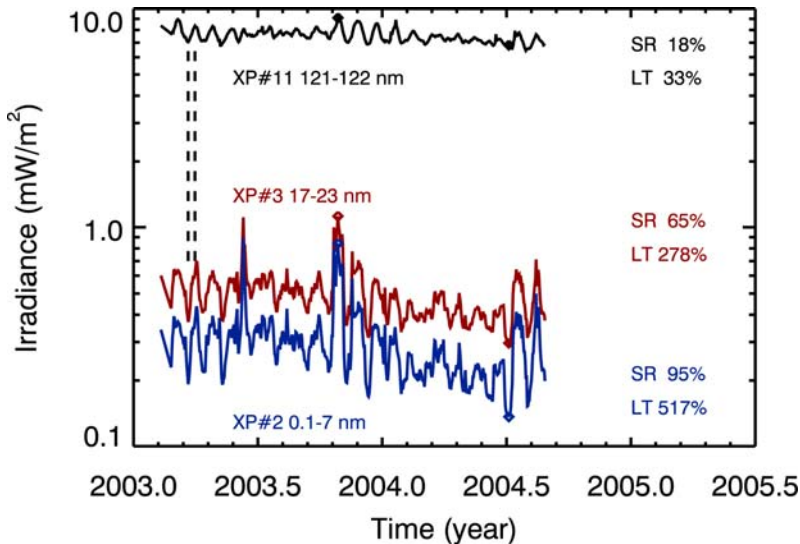


Spectral Variation of the 20 Largest Flares



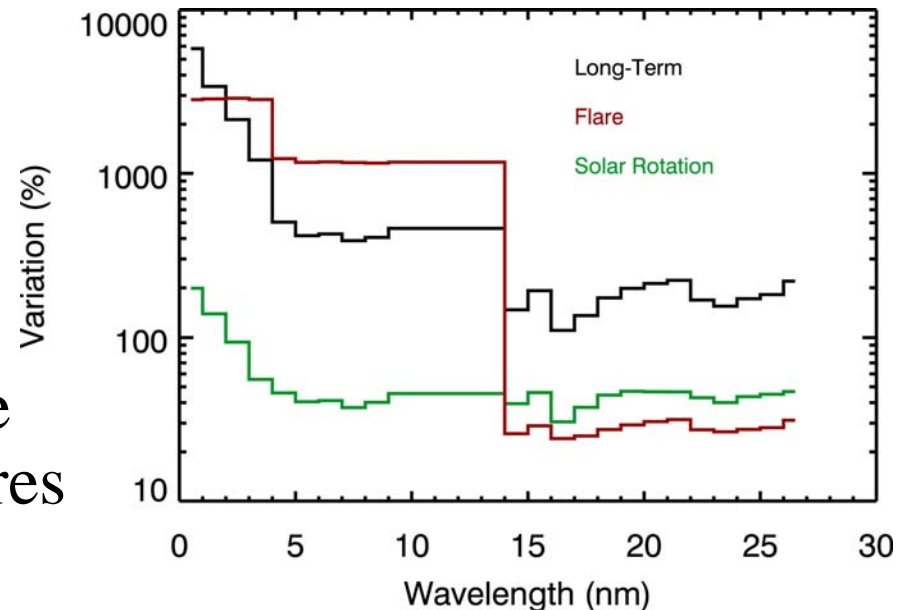
- **SORCE XPS Level 4 data product is in 1-nm intervals, but algorithm scales model in 3 bands: 0-4 nm, 4-14 nm, 14-27 nm**

Longer Term Variations from XPS Measurements



- Solar rotation early in **SORCE** mission did not have large solar storms (dashed lines)
- Long-term variations of about a year are also analyzed (diamond symbols) but they do not represent the full solar cycle variation

- Solar rotation and long-term variations are similar
- Flare variation is as large as long-term variation
- Variation in the 9-13 nm range is expected to be larger for flares



Conclusions

■ Validation Results

- SORCE XPS results have been validated with TIMED SEE and SOHO SEM measurements

■ Flare Variations

- For 20 largest flares during SORCE mission, the average flare variation is more than factor of 10 for $\lambda < 14$ nm

■ Solar Rotation Variations

- 40-200% (λ dependent) for early 2003 solar rotation (moderate size)
- Other solar rotations exhibit smaller or larger variation

■ Solar Cycle Variations

- Factor 2-60 (λ dependent) for 1-year period
- Full solar cycle variation is expected to be larger