TIMED Solar EUV Experiment:

Phase E Annual Report for 2007

Submitted for NASA Grant NAG5-11408
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SEE Science Team

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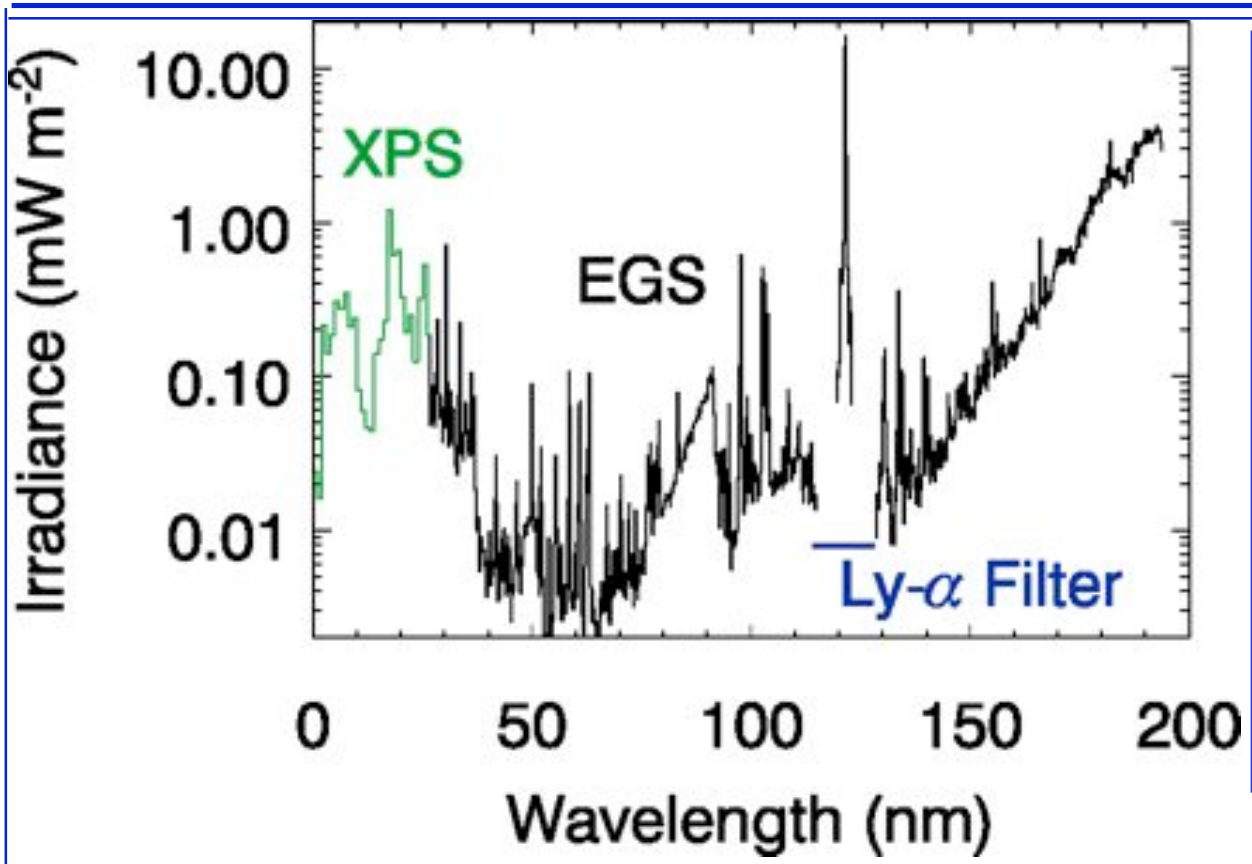
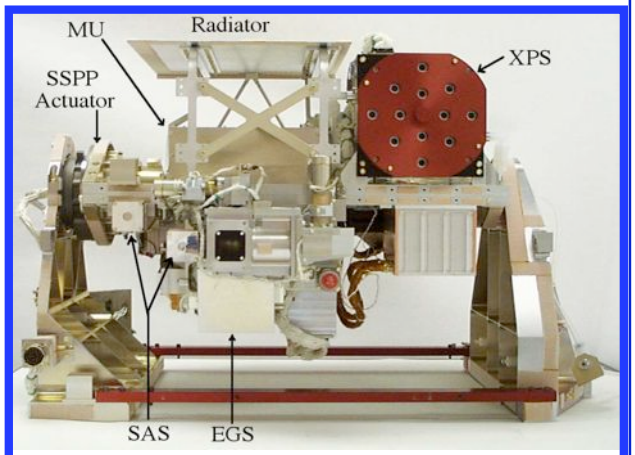
Report Outline

- SEE Instrument Operations and Instrument Status
- SEE Data Products
- New XPS Level 4 Data Product and Results
- SEE Science Overview
- Summary of SEE Results
  - Solar Cycle Variability
  - XXX
  - XXX
- Summary of SEE Related Talks and Papers
- Future Plans for SEE Team

Overview of Operations and Data Processing

SEE Measures the Solar VUV Irradiance





EGS = EUV Grating Spectrograph
Rowland-circle grating spectrograph with 64x1024 CODACON (MCP-based) detector

XPS = XUV Photometer System
Set of 12 Si photodiodes - 8 for XUV, 1 for Ly-α, and 3 for window calibrations

XUV	EUV	FUV

EGS 27-194 nm with Δλ=0.4 nm

XPS 0.1-34 nm with Δλ=7-10 nm and Ly-α (121.6 nm) with Δλ=2 nm

FUV = Far UltraViolet: 115-200 nm
EUV = Extreme UltraViolet: 30-115 nm
XUV = X-ray UltraViolet: 0-30 nm

EGS = EUV Grating Spectrograph
XPS = XUV Photometer System

Summary of SEE Flight Operations

- Planned Experiments (through Oct 31, 2007)
  - Number of normal solar experiments = XXX
- Actual Experiments (through Oct 31, 2007)
  - Number of normal solar experiments = XXX (XX%)
- Calibration rockets provide degradation rates for SEE
  - NASA 36.192 launched on Feb. 8, 2002, complete success
    - Rocket results incorporated into Version 6 data
  - NASA 36.205 launched on Aug. 12, 2003, complete success
    - Rocket results incorporated into Version 7 data
  - NASA 36.217 launched on Oct. 15, 2004, complete success
    - Rocket results incorporated into Version 8 data
  - NASA 36.233 launched on Oct. 28, 2006
    - Partial success (only 0.1-36 nm and 121.6 nm irradiance measured)
    - Reflight scheduled for April 2008

List of SEE Data Gaps - Very Few Gaps

Date	State	Sensor(s)	Science Data Affected
March 1, 2002	Safe Mode	Both	Part day
March 2, 2002	Safe Mode	Both	All day
March 4, 2002	Ground SW Anomaly	EGS	All day
March 5, 2002	Ground SW Anomaly	EGS	Part day
March 19, 2002	Safe Mode	Both	Part day
March 29, 2002	Safe Mode	Both	Part day
July 24 - 30, 2002	XPS Filter Wheel Anomaly	XPS	All days
Nov. 18-19, 2002	Leonid Safing	Both	Part day
Sept. 16 - 21, 2004	TIMED Flight Software Load	Both	Sept. 16,21: Part day Sept. 17-20: All day
Sept. 29 - Oct. 1, 2004	TIMED Flight Software Load	Both	Sept. 29, Oct. 1: Part day Sept. 30: All day
May 4, 2005	Lost data due to HK rate being at 5 sec (normally 15 sec)	Both	Part day (after SSR allocation reached)

Status of SEE Instruments

No recent changes for SEE

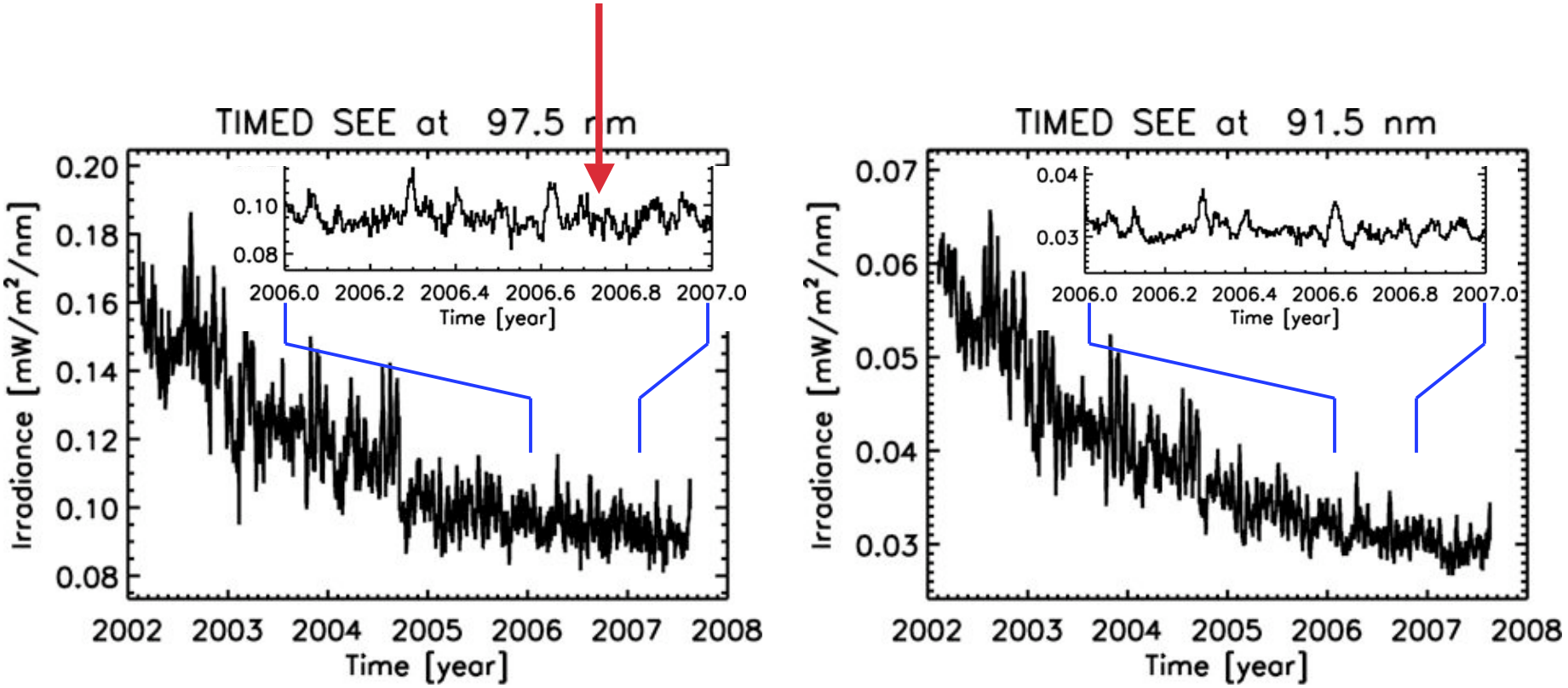
- **EUV Grating Spectrograph (EGS) - fully functional**
  - The EUV ($\lambda < 115$ nm) has degradation mostly at the bright lines on the CODACON (MCP-based) detector, but it is being tracked with on-board redundant channel and flat-field detector lamp weekly experiments
  - The FUV (115-195 nm) has small recovery rate that is corrected using UARS, SORCE, and XPS comparisons
- **XUV Photometer System (XPS) - 3 channels functional**
  - Fully functional until 2002/205 when there was a filter wheel anomaly (filter wheel stuck in position 6)
  - Three channels providing solar measurements
  - No spectral gaps in the XUV though because of new XPS Level 4 algorithm
- **Microprocessor Unit (MU) - fully functional**
- **SEE Solar Pointing Platform (SSPP) - fully functional**

Potential Life Issues for SEE

- EGS (grating spectrograph)
  - MCP-based detector has significant degradation at a few wavelengths (~5% of spectral range). Accuracy already degraded at those wavelengths. Degradation has slowed down with time, but still expect this degradation to continue during extended mission.
  - No degradation or anomalies for HV supply or slit changer mechanism; expect them to perform well for several more years
- XPS (set of photometers)
  - None : filter wheel mechanism is not used anymore
  - Lower priority than EGS as have SORCE XPS
- SSPP (pointing platform)
  - No degradation or anomalies for SSPP; expect it to perform well for several more years

Example EGS Effect at 97.5 nm

- The C III 97.7 nm emission has brightest signal for EGS detector and has degraded the most. Day-to-day noise has increased over time; consequently, the solar rotation variation is more noisy than at other wavelengths.

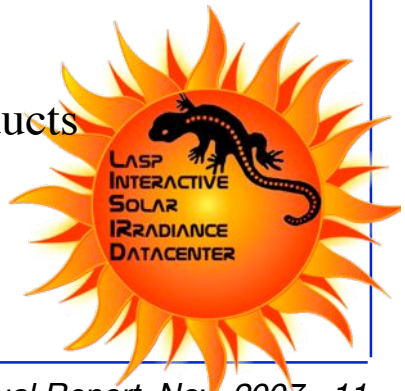


SEE Data Products

SEE Version 9 Data

- Version 9 released in April 2007
  - EGS revisions
    - Improved flagging of data affected by energetic particles (in polar regions)
    - Updated FUV degradation rates from comparison to SORCE
    - Did NOT update EUV degradation rates (incomplete EUV coverage for cal rocket)
  - XPS revisions
    - Updated radiometric calibrations and updated XUV degradation rates
    - New XPS Level 4 algorithm using GOES XRS for flare temperature and CHIANTI model
      - Also improves Level 3A 0-27 nm irradiance results for flares
  - **New SEE EGS Level 2B occultation data product**
    - Produce atmospheric transmission from EGS solar occultation measurements (60-500 km range)

- **LASP Interactive Solar IRradiance Datacenter (LISIRD)**
  - Relatively new data center at LASP for its solar irradiance data products
    - SME, UARS SOLSTICE, TIMED SEE, SORCE, rocket experiments
    - Future missions: Glory TIM, SDO EVE
  - http://lasp.colorado.edu/LISIRD/



Summary of SEE Data Products

http://lasp.colorado.edu/see/

- Download data for individual days or merged set for the full mission
- Download IDL read / plot code
- Plot / browse data (ION script interface)

Data Product	Period	Description
SEE L2A SpWx	Orbit	8 solar indices (emissions/bands) for SpWx Ops
SEE L3	Day	1-nm spectrum from 0.5 nm to 194.5 nm, 38 emission lines, XPS 9 bands
SEE L3A	Orbit	Same as L3 but for orbit average (3-min avg)
EGS L2, L2A	D & O	0.1-nm spectrum from 27 nm to 195 nm
XPS L2, L2A	D & O	XPS 9 bands
XPS L4, L4A	D & O	0.1-nm spectral model from 0 to 40 nm
EGS L2B (Occ)	Orbit	Atmospheric transmission (single altitude)
Composite Ly-α	Day	H I Lyman-α irradiance from 1947 to present

Example TIMED SEE Data Web Page (Table)

SEE Data

Title	Description	Data Types				Helpful IDL Procedures
		Calendar	FTP Directory	Merged NetCDF	Plot/Browse	
Space Weather README	SpWx	NA	2002 2003 2004 2005 2006 2007	NA	latest plots	plot_see_spwx.pro plots space weather data plot_see_spwx.zip contains complete IDL code bundle
Level 3 README	L3	2002 2003 2004 2005 2006 2007	2002 2003 2004 2005 2006 2007	L3	Plot Browse	plot_see.pro plots level 3 data (works with the level 3 merged data file) plot_see_code.zip plots level 3 data for planet applications (works with the level 3 merged data file)
Level 3A README	L3A	2002 2003 2004 2005 2006 2007	2002 2003 2004 2005 2006 2007	L3A	Plot Browse	plot_see3a.pro plots level 3a data (works with the level 3A merged data file)
Level 2 XPS README	XPS	2002 2003 2004 2005 2006 2007	2002 2003 2004 2005 2006 2007	L2 XPS	Plot	plotxps_ts.pro Plots a time series of XPS Level 2 data
Level 2a XPS README	XPS_2A	2002 2003 2004 2005 2006 2007	2002 2003 2004 2005 2006 2007		Plot	plotxps_2a_ts.pro Plots a time series of XPS Level 2a data
Level 2 EGS README	EGS	2002 2003 2004 2005 2006 2007	2002 2003 2004 2005 2006 2007	L2 EGS	Plot	plotegs_ts.pro Plots a time series of EGS Level 2 data plotegs_sp.pro Plots a daily averaged spectrum from one EGS Level 2 data file
Level 2a EGS README	EGS_2A	2002 2003 2004 2005 2006 2007	2002 2003 2004 2005 2006 2007		Plot	plotegs_2a_ts.pro Plots a time series of EGS Level 2a data plotegs_2a_sp.pro Plots all observation average spectra from one EGS Level 2a data file

Example TIMED SEE Data Browser

User Input

Select a date range

Start Year: 2002 Start Date: 039 or /

End Year: 2007 End Date: 299 or /

e.g. 2002/039 was 02/08, (the first rocket underflight calibration)

Select wavelength range OR Solar line OR XPS diode

Start (nm)	End (nm)	Solar Lines (EGS)	XPS Diode
21 22 23 24 25 26 27 28 29 30	22 23 24 25 26 27 28 29 30 31	28.4 nm Fe XV 30.4 nm He II 33.5 nm Fe XVI 36.1 nm Fe XVI 36.8 nm Mg IX 41.7 nm Fe XV 46.5 nm Ne VII 49.9 nm Si XII 52.1 nm Si XII 53.7 nm He I	1 Ti/C 0.1- 7.0 2 Ti/C 0.1- 7.0 3 Al/Sc/C 17.0- 23.0 5 Ti/Pd 0.1- 10.0 6 Ti/Zr/Au 0.1- 10.0 7 Al/Nb/C 17.0- 21.0 9 Al/Mn 0.1- 7.0 10 Cr/Al 0.1- 7.0 11 Ly-alpha 121.0-122.0

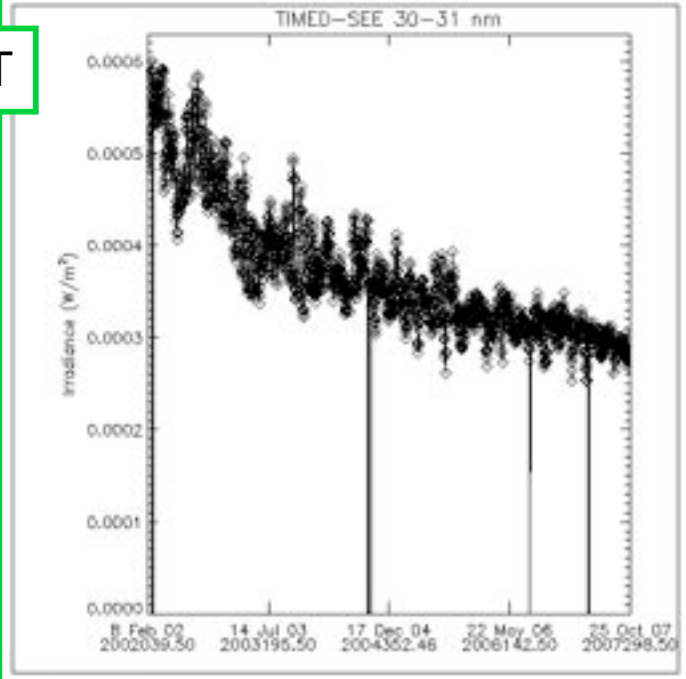
Hide TEXT ☐
Hide PLOT ☐

Select the type of data to be viewed

- ○ All spectra in date range
- ◉ Selected wavelength time series
- ○ Selected line time series
- ○ XPS diode time series

Remove 1-AU correction ☐

PLOT



TEXT LISTING

```
ngth range = 30 to 31 nm
year: 2002 DOY: 039 mm/dd: 02/08
year: 2007 DOY: 299 mm/dd: 10/26
=009

YEAR DOY MM DD YFRAC     JULIAN    Irradiance(W/m^2)

2002 039 02 08 2002.1055 2452314.0 0.00000e+00
2002 040 02 09 2002.1082 2452315.0 5.48618e-04
2002 041 02 10 2002.1110 2452316.0 5.44895e-04
2002 042 02 11 2002.1137 2452317.0 5.24766e-04
2002 043 02 12 2002.1164 2452318.0 5.18884e-04
2002 044 02 13 2002.1192 2452319.0 4.98147e-04
2002 045 02 14 2002.1219 2452320.0 4.98030e-04
2002 046 02 15 2002.1247 2452321.0 4.82201e-04
2002 047 02 16 2002.1274 2452322.0 4.94120e-04
2002 048 02 17 2002.1301 2452323.0 5.17029e-04
2002 049 02 18 2002.1329 2452324.0 5.27856e-04
2002 050 02 19 2002.1356 2452325.0 5.38333e-04
2002 051 02 20 2002.1384 2452326.0 5.61549e-04
2002 052 02 21 2002.1411 2452327.0 5.71010e-04
```

Example SEE Flare Catalog

TIMED-SEE Flare Catalog

This page is a catalog of flare events observed by TIMED-SEE. Each row contains NOAA SEC flare information from the daily edited event reports for periods when TIMED-SEE was observing the sun anywhere between the start and stop times of these events. Events have been filtered to exclude periods when no appreciable increases were detected by SEE. Catalog last updated on Wed Sep 26 16:47:09 2007. An excel-compatible CSV file is also available.

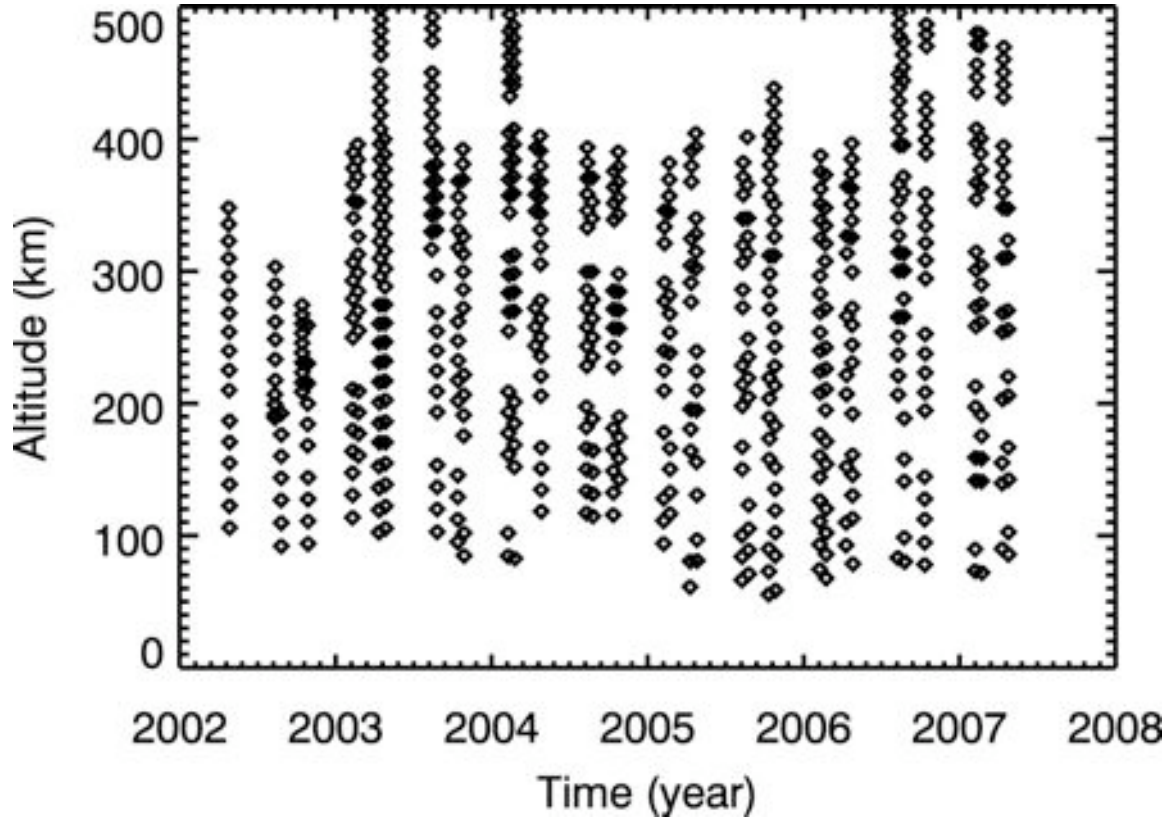
Show/hide column descriptions. Columns can be sorted by clicking on the column headings.

A comprehensive list of SEE data products are available for download.

Year/Doy mo-dd	start hhmm	peak	stop	Class	Solar Longitude (deg)	Solar Latitude (deg)	Region	Event	SEE-XPS Index ▲	SEE-EGS Index	SEE obs (seconds after peak)	SEE data	Plot
2003/308 11-04	1929	1953	2006	X 17.4	19	-83	0486	8080	61.11	2.13	-282	Level 3A data	Plot SEE L3A
2003/301 10-28	0951	1110	1124	X 17.2	-16	-8	0486	5120	30.77	2.37	454	Level 3A data	Plot SEE L3A
2005/020 01-20	0636	0701	0726	X 7.1	14	61	0720	4270	24.53	1.28	-79	Level 3A data	Plot SEE L3A
2005/256 09-13	1919	1927	2057	X 1.5	-9	-10	0808	9710	15.06	1.41	2944	Level 3A data	Plot SEE L3A
2003/306 11-02	1703	1725	1739	X 8.3	14	-56	0486	7360	15.00	1.42	694	Level 3A data	Plot SEE L3A
2003/147 05-27	2256	2307	2313	X 1.3	7	-17	0365	5610	11.03	1.40	110	Level 3A data	Plot SEE L3A
2005/015 01-15	2225	2302	2331	X 2.6	15	5	0720	3090	10.81	1.11	1315	Level 3A data	Plot SEE L3A
2005/253 09-10	2130	2211	2243	X 2.1	-13	-47	0808	8920	9.82	1.13	1773	Level 3A data	Plot SEE L3A
2003/149 05-29	0051	0105	0112	X 1.2	6	-37	0365	6110	9.10	1.68	-71	Level 3A data	Plot SEE L3A
2005/133 05-13	1613	1657	1728	M 8.0	-12	11	0759	9150	8.91	1.13	1194	Level 3A data	Plot SEE L3A
2003/166 06-15	2325	2356	0025	X 1.3	-7	-80	0386	2580	8.65	1.19	124	Level 3A data	Plot SEE L3A

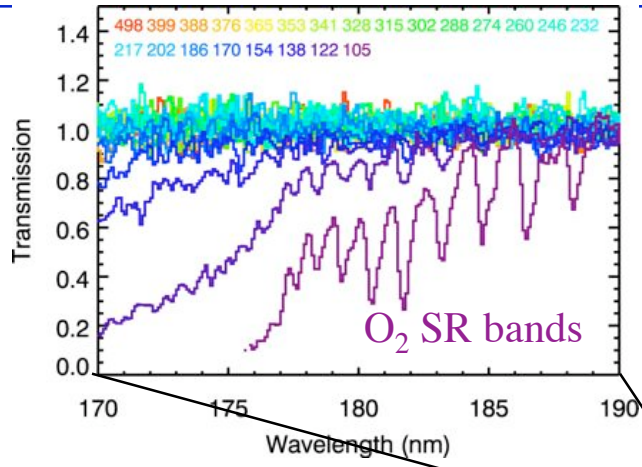
EGS Solar Occultation Observations

- With TIMED orbit and SEE pointing platform (1-axis only), the solar occultation observations are available for a couple weeks about every 2 months
- Each 3-min EGS observation is essentially at a single tangent altitude
- New EGS Level 2B data product contains the solar occultation transmissions

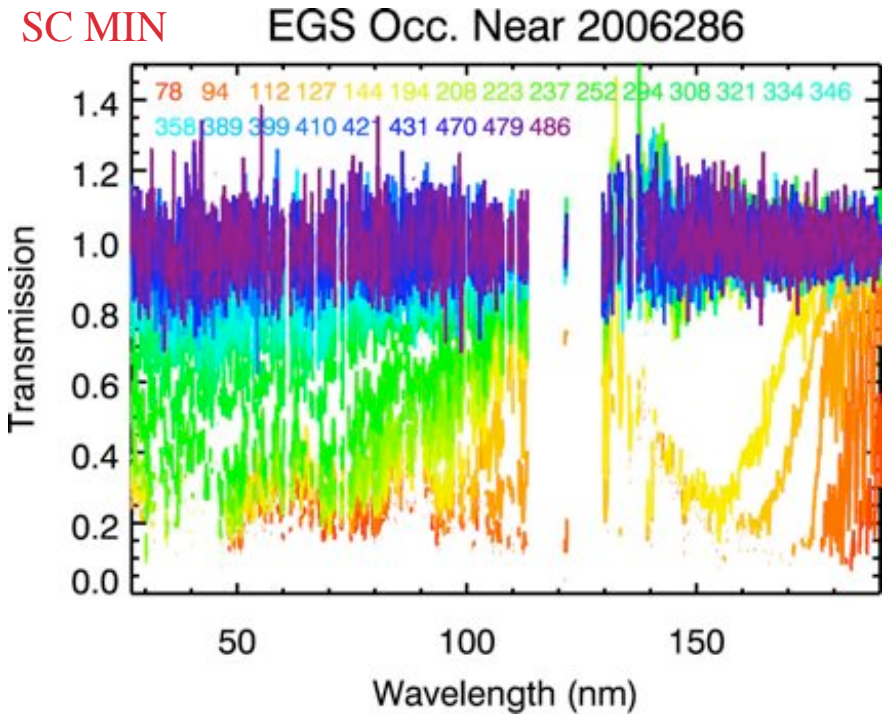


EGS Occultation Data Examples

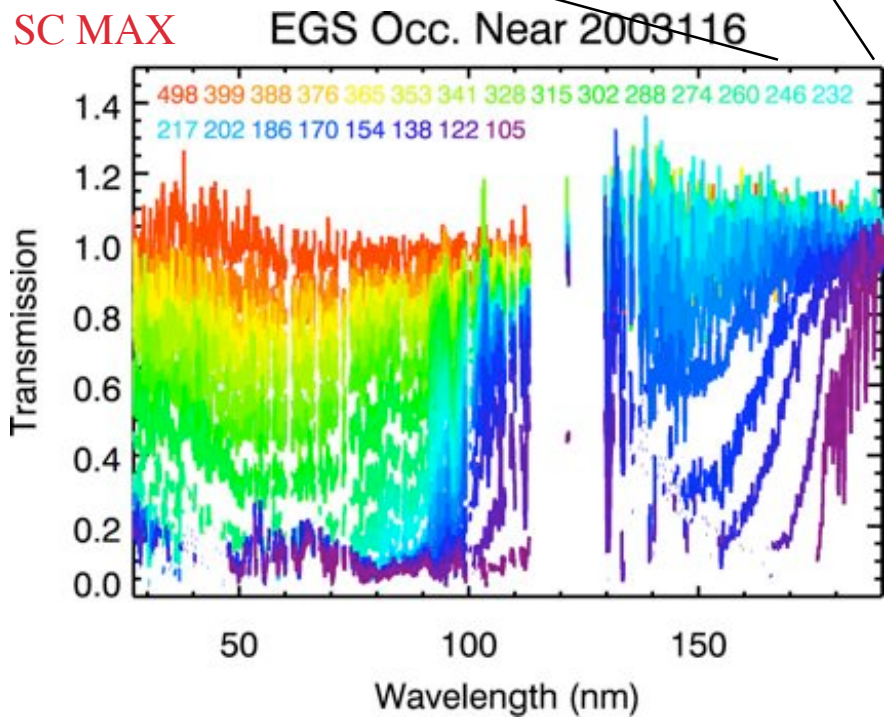
- Different altitudes focus on different wavelengths
- Different times gives different phase of solar cycle



SC MIN

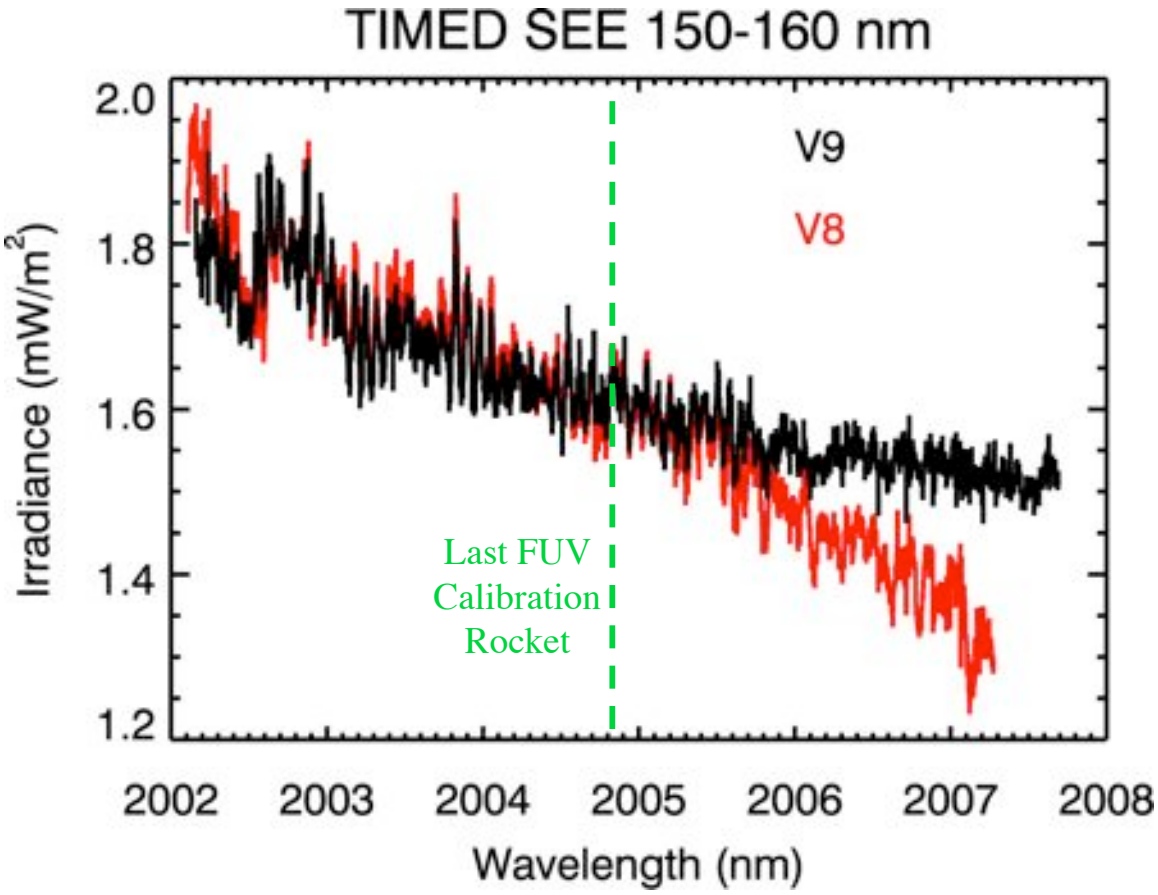


SC MAX



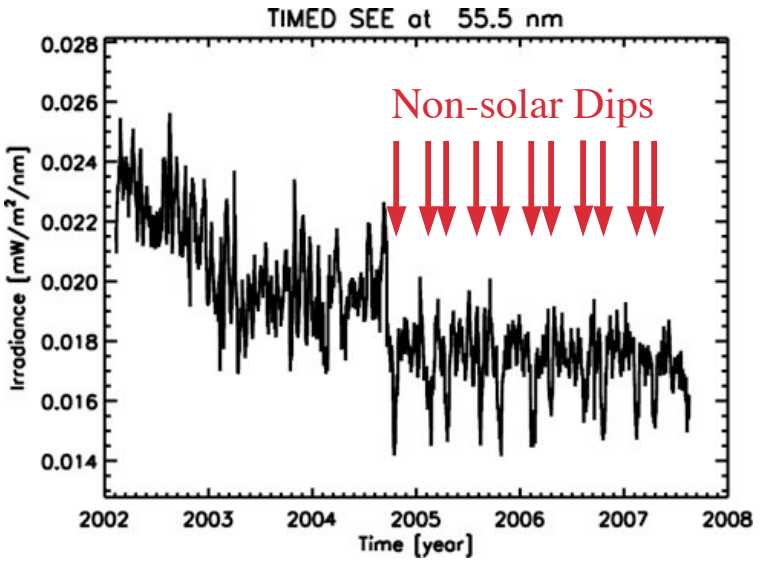
EGS Validation: FUV Trend Updated

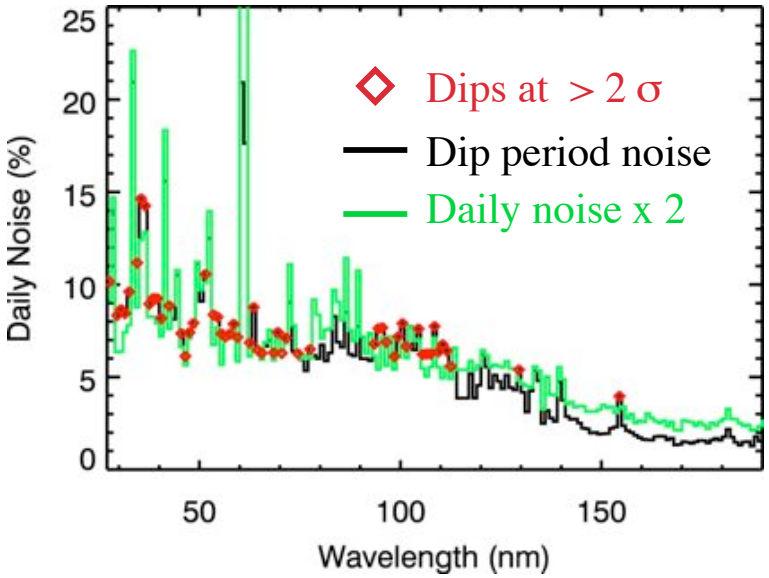
- Version 9 data improved the FUV range by using the SORCE SOLSTICE results for the long-term degradation trend
- SEE depends on SORCE for FUV calibration beyond 2005 (no FUV calibration rockets planned)

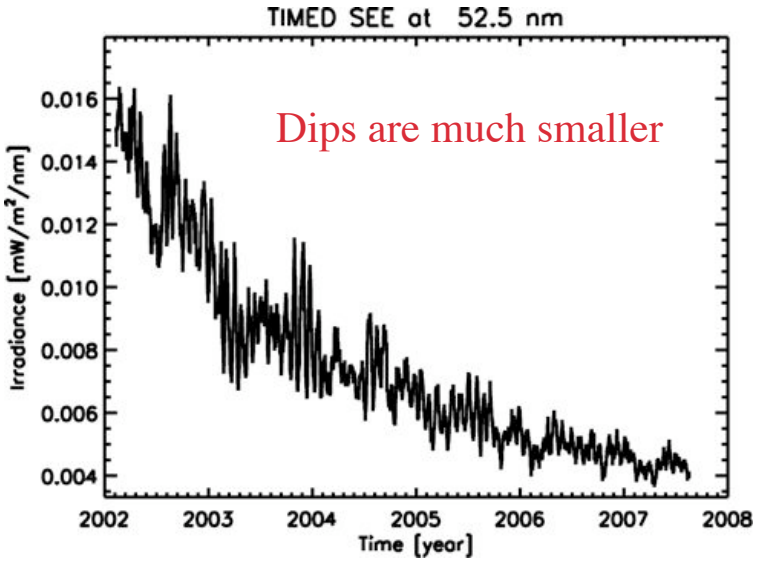


EGS Validation: Dips in the EUV

- Dips in EGS time series
  - Started in late 2004
  - 4 dips per year
  - Mostly in EUV range
  - Perhaps related to FOV correction, but not solved yet







XPS Validation

- Version 9 includes updated XPS calibration and new algorithm for XPS Level 4 data product

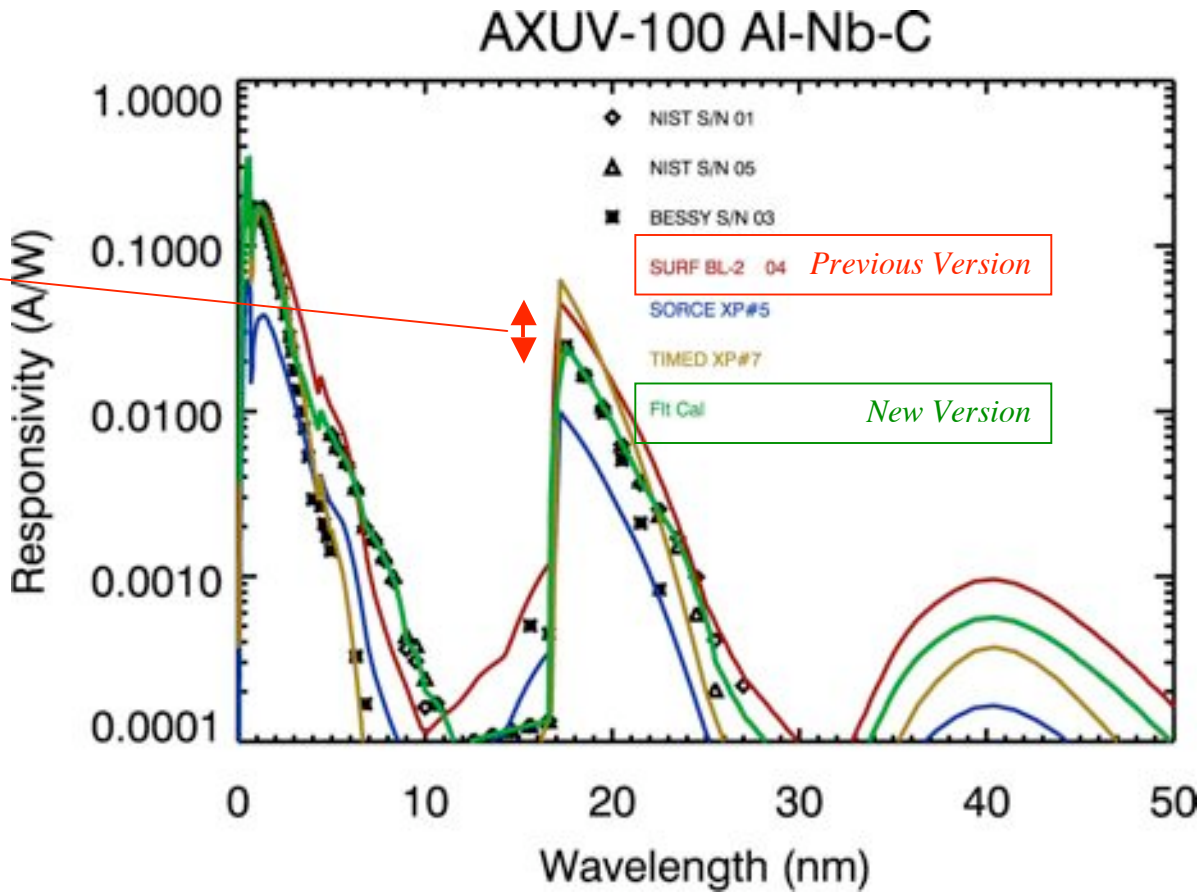
- New XPS Level 4 algorithm (use of CHIANTI spectral models) have been validated with EGS spectral measurements longward of 27 nm and with other solar measurements

XPS Revised Calibration
Example for Al/Nb/C Photometer

- Previous calibration used the SURF BL-2 results
- New calibration uses PTB BESSY at 1-3 nm, SURF BL-9 at 5-26 nm, and SURF BL-2 to fill gaps

Small changes (<10%) at $\lambda < 17$ nm

Factor of 1.5 increase in irradiance for $\lambda > 17$ nm



Future SEE Data Products

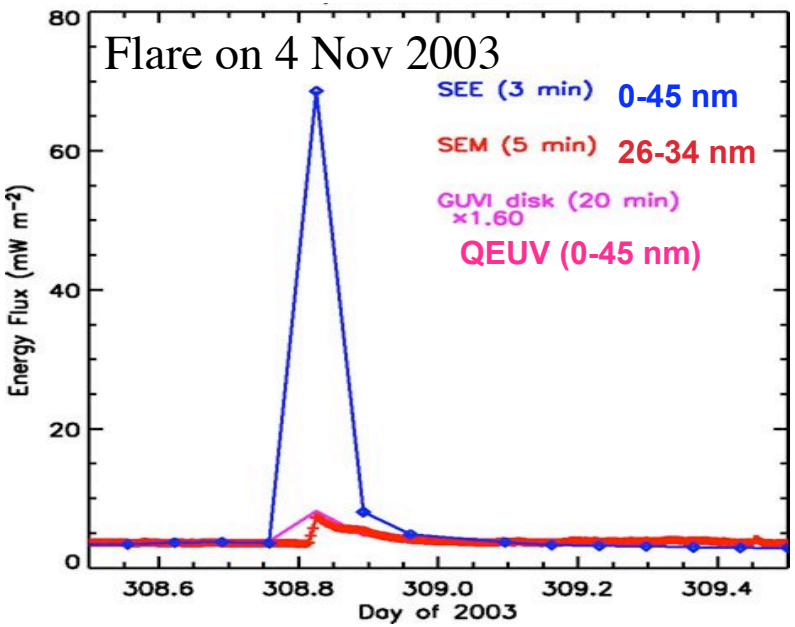
- No new SEE data products are planned
- Future SEE data versions (about once a year)
  - Update instrument degradation functions (calibration rocket in Apr. 2008)
  - Address EGS time series dips at some EUV wavelengths

- Updated solar irradiance models (using SEE Version 9 data)
  - FISM - Phil Chamberlin
    - 0-190 nm with 1-min cadence (flares)
    - Updated with latest SEE and SORCE latest data versions
  - SIP (SOLAR2000) - Kent Tobiska
    - Updated with flare components
    - Updated with lastest data versions

New XPS Level 4 Data Product and Results

New XPS Algorithm Needed for Flares

Motivation: Improve results for flares



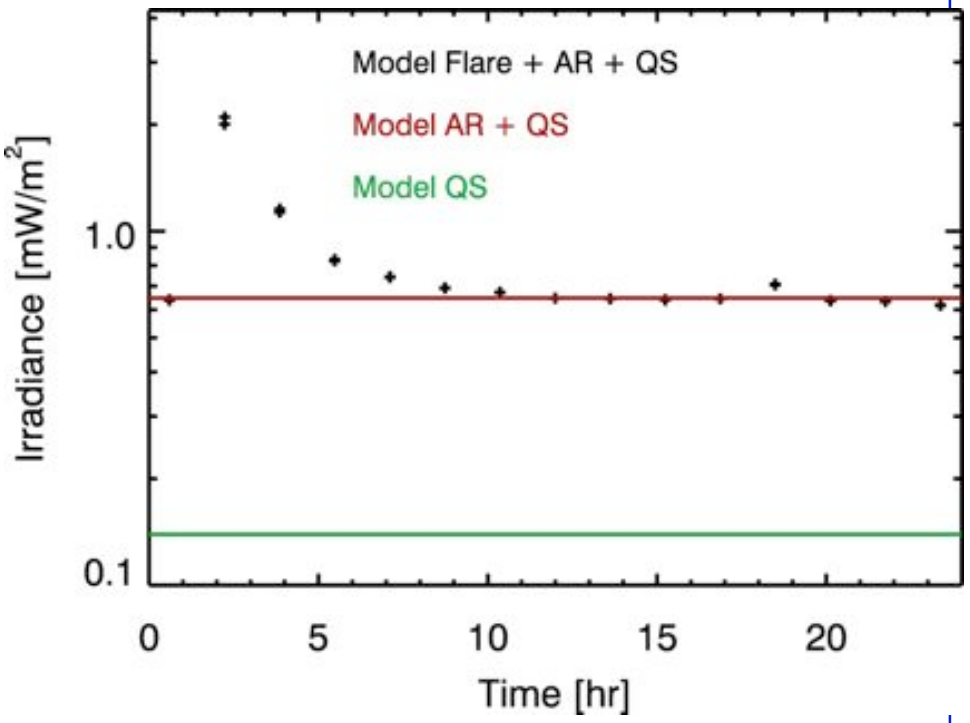
- Old SEE version 8 data over predicted the irradiance during flares

- New algorithm / product for version 9 uses combination of CHIANTI spectral models in the 0-40 nm range to match the XPS signals

New XPS Level 4 Algorithm

- Changed spectral model for XPS Level 4 processing
  - Use CHIANTI spectral model results scaled to XPS#1 & 2 signal (current)

- Daily Components (2)
  - Quiet Sun (QS), Coronal Hole (CH), and Active Region (AR) DEM used
  - MIN_REF = (QS + CH) / 2 based on solar minimum data ($SF_{QS} \leq 1.0$)
  - Daily Variability = Scale Factor (fractional area) of AR spectrum
    - based on minimum signal of XPS#1-2 for each day ($SF_{AR} \sim 0 - 0.1$)
- Flare Component
  - GOES XRS-B / XRS-A ratio defines plasma temperature for flare
  - **CHIANTI iso-thermal spectrum** used at this temperature (1-min cadence)
  - Residual XPS#1 & 2 signal provides magnitude for flare spectrum ($SF_{Flare} \sim 0 - 100$)

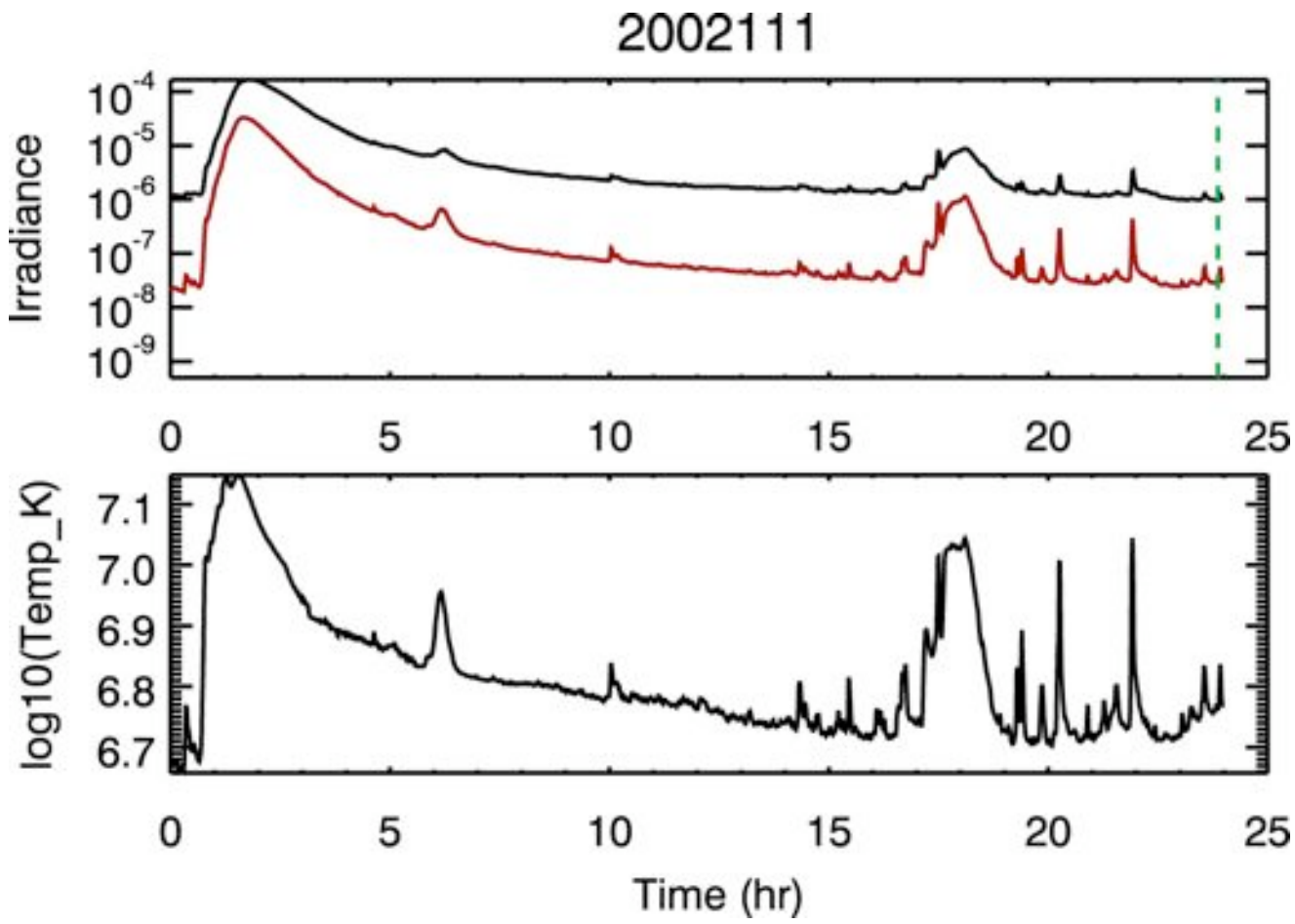


Example Plasma Temperature for 2002/111

GOES XRS-B

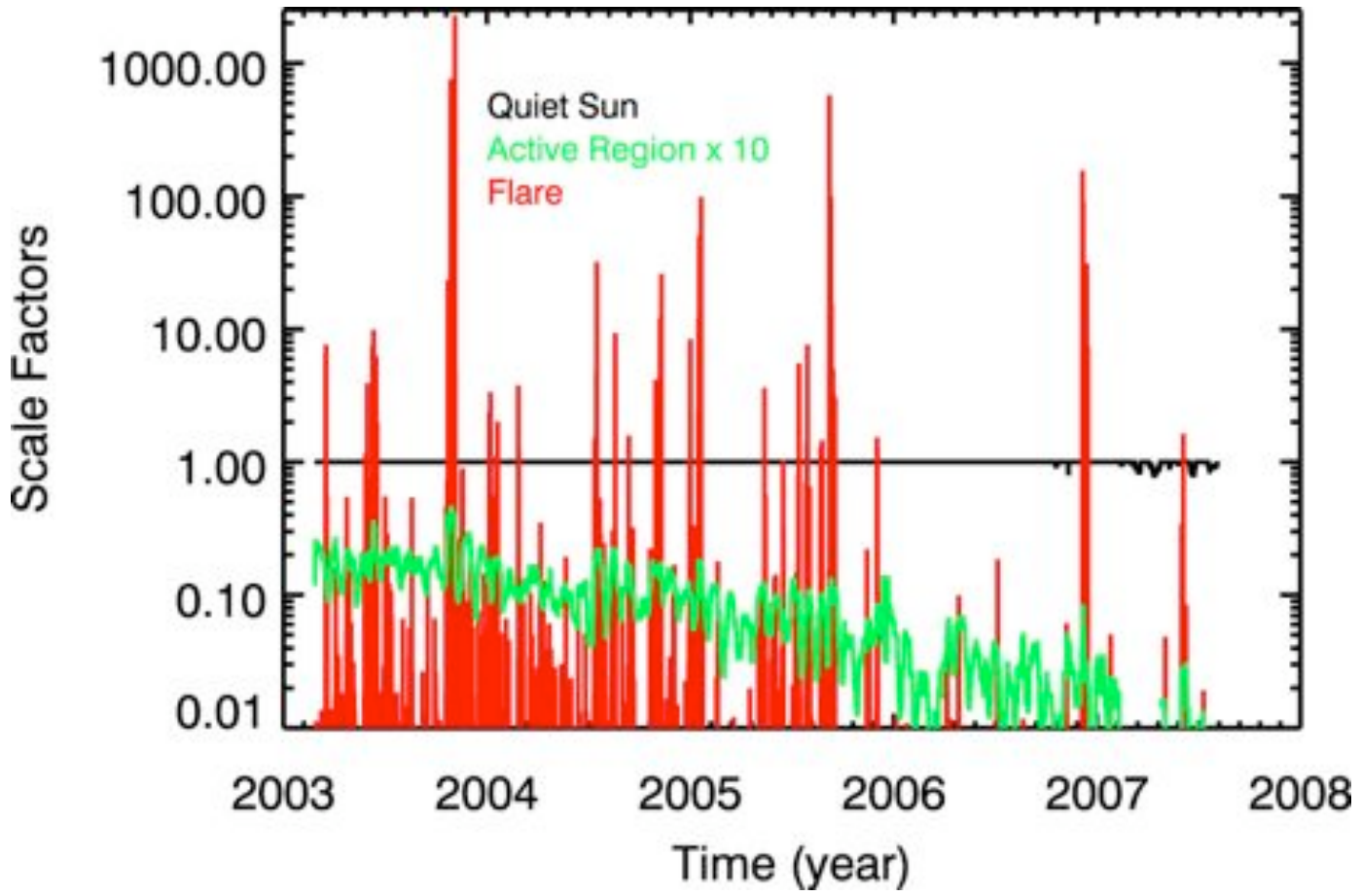
GOES XRS-A

Ratio gives plasma Temperature with 1-min cadence (H. Garcia)



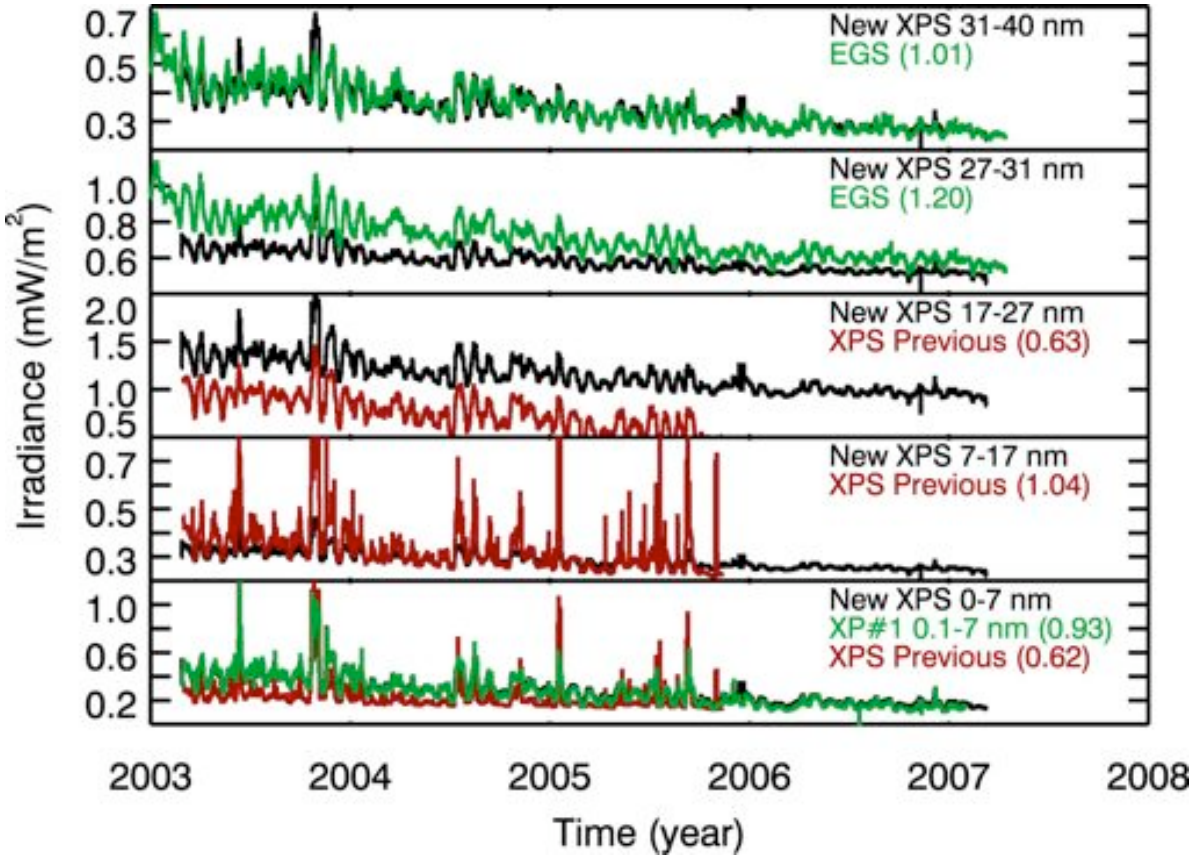
Scale Factors are Indicators of Variability

- Active Region SF = solar rotation and solar cycle indicator
- Flare SF = flare activity indicator



XPS L4 Compared to EGS and Previous XPS Version

- Good agreement with EGS except for He 30.4 nm (CHIANTI not adequate for optical thick emissions)
- Excellent agreement with XP#1 at 0-7 nm
  - Expected since using XP#1 signal for scaling CHIANTI spectra (MIN, AR, Flare spectra)
- Less variability in the 7-17 nm range than previous version
- Increased irradiance in the 17-27 nm range (new calibration)



Model not adequate for He 30.4 nm

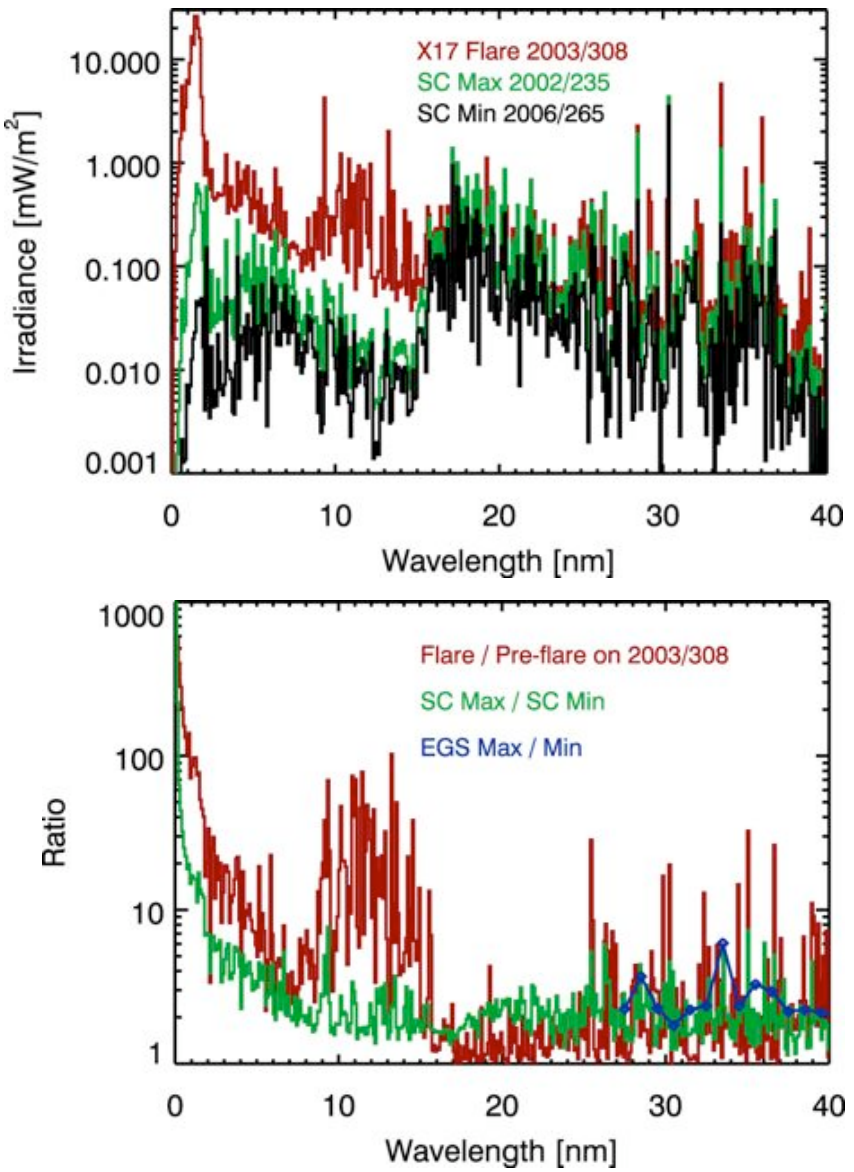
Higher with new calibration

New version has less variability

XP#1 and L4 **daily** values are in excellent agreement

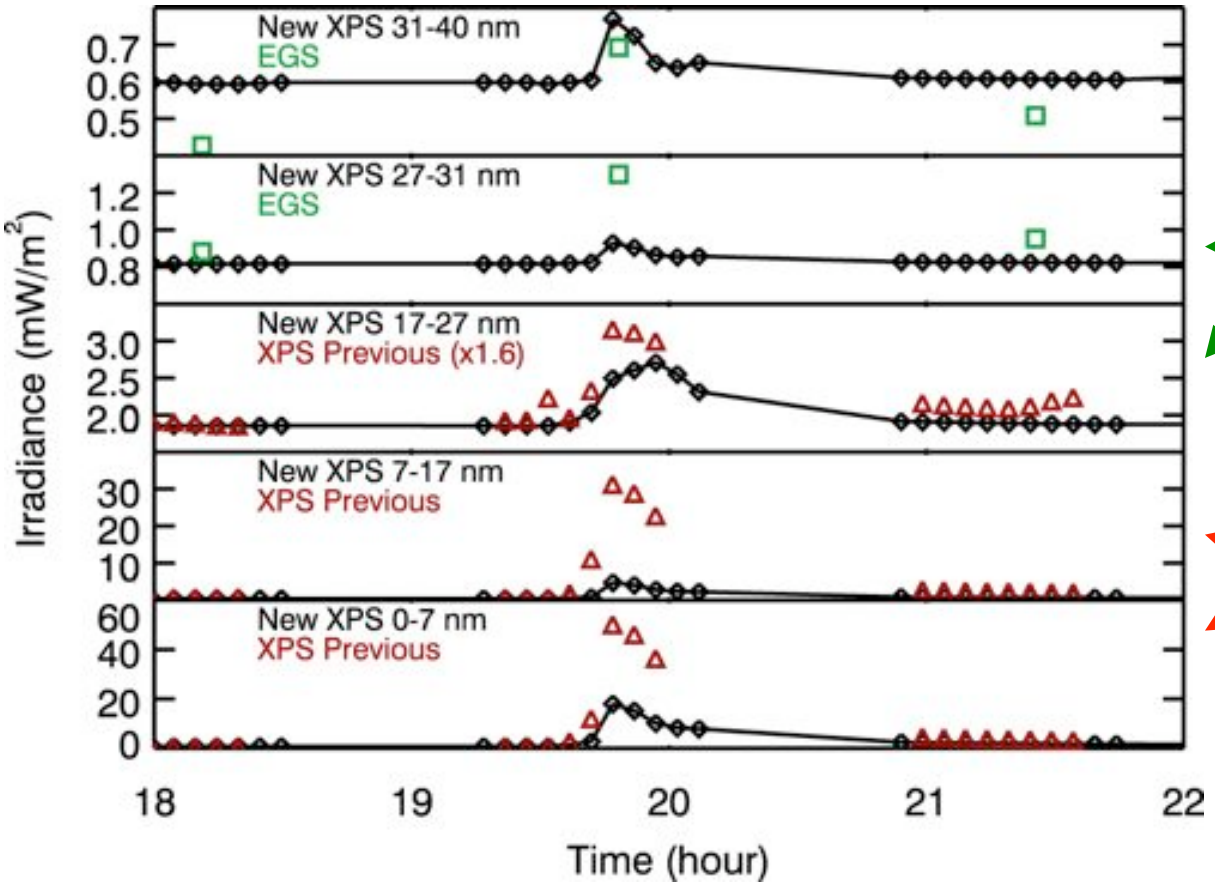
Higher Spectral Resolution (0.1 nm)

- Note that XPS L4 spectra are *model* results, not directly measured
  - XPS bands are 7-10 nm
- Solar cycle variations are consistent with EGS (27-40 nm) and XPS broad band results
- Flare variations indicate larger changes at $\lambda < 17$ nm
  - Especially at $\lambda < 2$ nm and at 9-15 nm



Flare Variations are Less in New XPS Version

- New XPS data products are expected to be more consistent with atmospheric results during flare events



Similar, small flare variations (i.e., good flare agreement)

Reduced by x 3.5 for 7-17 nm

Reduced flare variability

Reduced by x 2.1 for 0-7 nm

Example Flare Result for Day 2003/308

- Flare variations for the X-17 flare

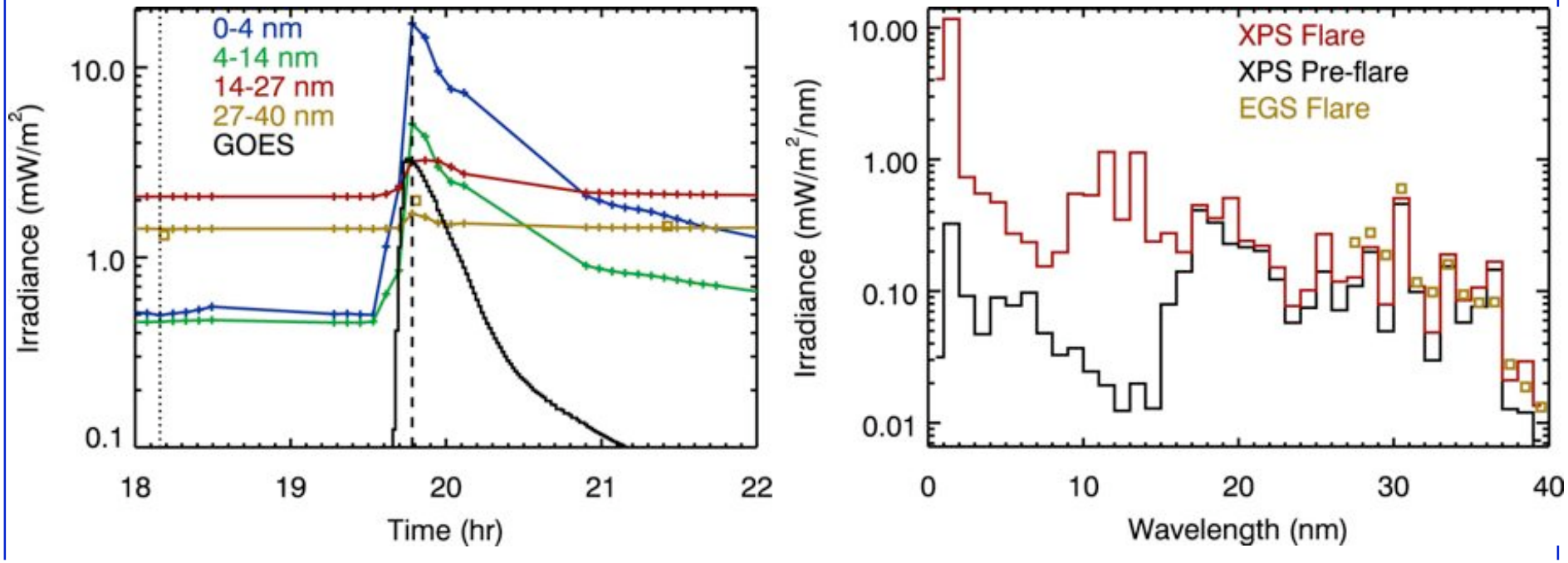
  0-1 nm : x 107

  1-5 nm : x 35

  5-15 nm : x 10

  15-27 nm : x 1.3

  27-40 nm : x 2.0



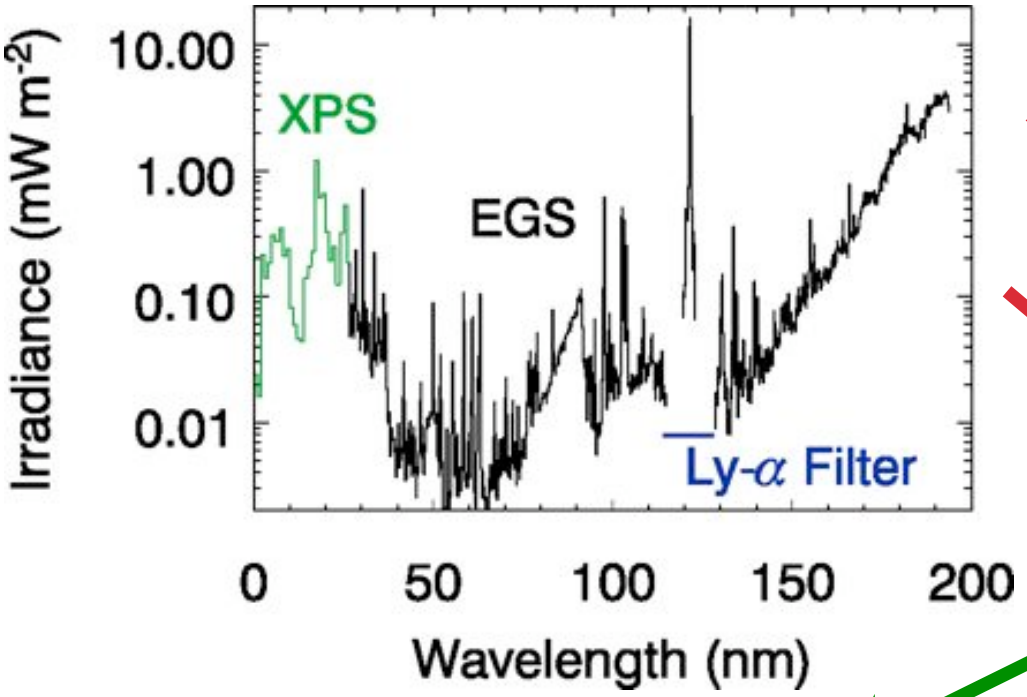
Summary for New XPS Level 4 Product

- New XPS L4 algorithm (CHIANTI spectral model with flare component) is improved over previous L4 product (daily spectral model)
- XPS L4 model in the 27-40 nm range agree well with EGS measurements, except for 30.4 nm as CHIANTI model inadequate for the He II optically thick emission
- Flare variations are significantly reduced, as expected from atmospheric measurements
- Updated calibration affects the 17-27 nm range mostly, increased irradiance by factor of ~1.5

SEE Science Overview

SEE Science Plans

Solar UV Irradiance Measurements



Obj. #1

Validations

Internal Calibrations,
Underflight Calibrations
SOHO, SNOE,
UARS, SORCE

Eparvier, Woods, Bailey, Rottman

Obj. #2

Solar UV Variability

Function of wavelength
Over time scales of minutes to years

All

Obj. #4

Modeling Solar Variation

Study variations related to active region evolution derived from solar images
Improve the **NRLEUV, SOLAR2000,** and **SunRise** solar irradiance models

Lean, Tobiska, Chamberlin, Woods

Obj. #3

Obj. #5

Study Earth's Response

Photoelectron analysis with FAST data and using the ***glow*** model
Atmospheric response studies using HAO's **TIM-GCM**

Solomon, Roble, Bailey, Eparvier

Overview of SEE Science Objectives

1. Accurately and precisely determine the time-dependent solar vacuum ultraviolet (VUV: below 200 nm) spectral irradiance
2. Study solar VUV variability (27-day rotations, solar cycle changes) and its sources
3. Study the solar-terrestrial relationships utilizing atmospheric models, primarily the TIME-GCM at HAO/NCAR
4. Improve proxy models of the solar VUV irradiance
5. Determine the thermospheric neutral densities (O_2, N_2 and O) from solar occultations

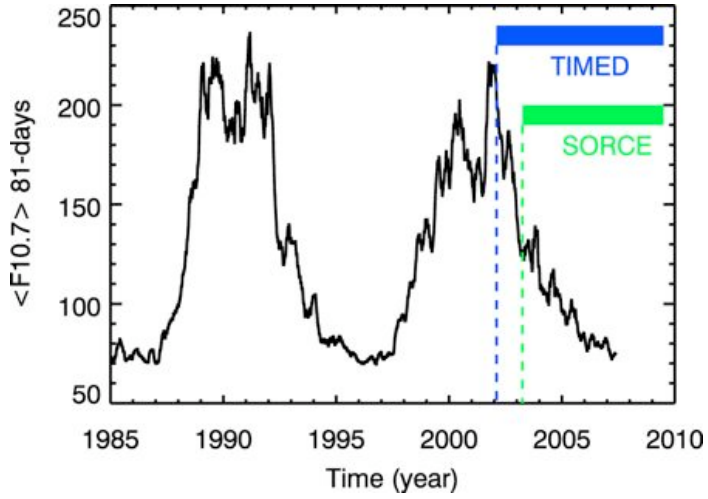
Summary of SEE Results - 1

- **Objective 1: solar VUV spectral irradiance measurements**
  - Daily measurements since Jan. 22, 2002 with very few gaps
  - SEE solar EUV irradiance (version 9) and GUVI QEUV (0-45 nm) have much less differences with recent improvements / calibrations for GUVI QEUV and for new XPS Level 4 algorithm for the 0.1-27 nm range [Woods, Meier, Lean]
- **Objective 2: solar variability**
  - Updated results on solar rotation and solar cycle variations [Woods et al.]
  - Updated results on flare variability as SEE has observed >500 flares
    - New flare catalog on-line to make access to SEE's flare data quick and easy [Chamberlin, Woods]
- **Objective 3: model solar response in Earth's atmosphere**
  - Use of SEE solar data and FAST photoelectron data [Peterson, Richards]
  - Use of HAO TIME-GCM for atmospheric response to SEE's solar input [Solomon, Roble, Qian, Lu]
  - Analysis of GUVI FUV airglow data during flare events [Strickland, Lean, Woods]
  - Satellite drag modeling / analysis indicating importance of solar EUV and FUV [Tobiska, Bowman, Solomon, Qian, Woodraska, Sutton, Forbes]

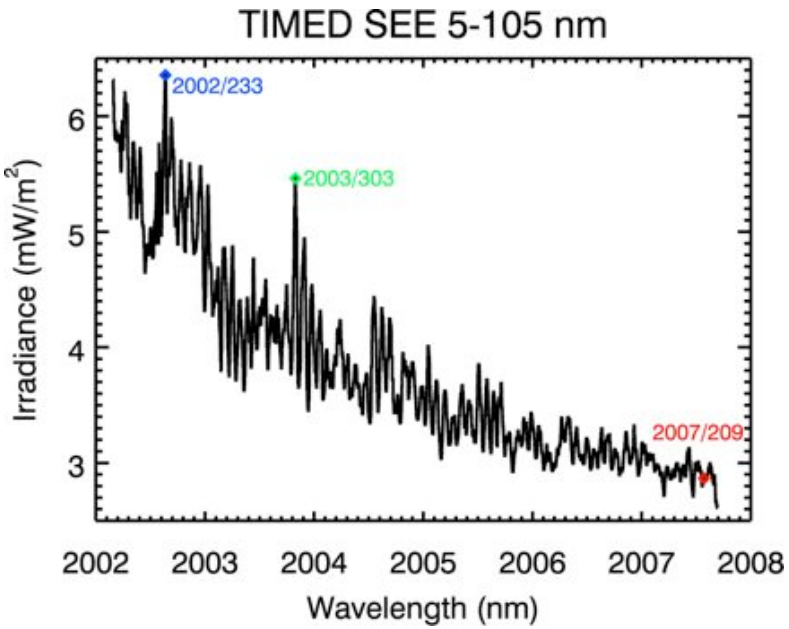
Summary of SEE Results - 2

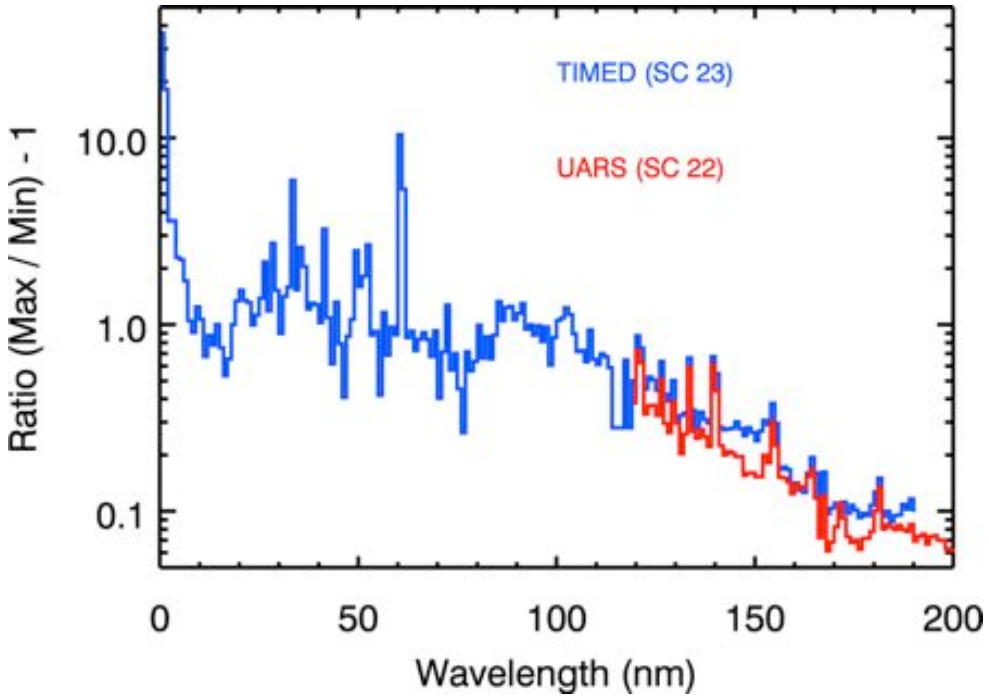
- **Objective 4: solar irradiance modeling**
  - SOLAR2000 (S2K) model improvements [Tobiska]
  - NRLEUV model improvements [Lean, Warren]
  - HEUVAC model improvements [Richards]
  - Flare Irradiance Spectral Model (FISM) improvements [Chamberlin]
    - SEE data used to parameterize FISM - daily components and 1-min flare components
- **Objective 5: atmospheric density from solar occultations**
  - New EGS Level 2B solar occultation data product released (version 9) [Eparvier]

Solar Cycle Irradiance Variations



- TIMED Max = 2002/233
- SORCE Max = 2003/303
- Min (so far) = 2007/209





SEE SCIENCE RESULTS SLIDES…

- Add slides from Co-Is and ones that summarizes papers published in 2007…

SEE Related Talks and Papers

SEE Related Talks in 2007

- AGU Fall Meeting: Dec. 06, 4 talks / posters
- GUVI-SABER Workshop: Feb. 07, 2 talks
- IUGG Meeting, Italy: July 07, 1 talk
- ILWS Meeting: Sep. 07, 4 talks / posters
- TIMED SWG Meeting: Sep. 07, 8 talks

SEE Related Papers in 2007 - 1

- Strickland, D. J., J. L. Lean, R. E. Daniell, Jr., H. K. Knight, W. K. Woo, R. R. Meier, P. R. Straus, T. N. Woods, F. G. Eparvier, D. R. McMullin, A. B. Christensen, D. Morrison, and L. J. Paxton, Constraining and validating the Oct/Nov 2003 X-Class EUV flare Enhancements with observations of FUV dayglow and E-region electron densities, *J. Geophys. Res*., in press, 2006.
- Woodraska, D., T. Woods, and F. Eparvier, Comparison of TIMED Satellite Drag with Solar EUV Experiment (SEE) Measurements, *J. Spacecraft and Rockets*, submitted, 2006.
- Woods, T. N., New results from recent measurements of the solar ultraviolet irradiance, *Adv. Space Res*., submitted, 2006.
- Chamberlin, P., T. N. Woods, and F. G. Eparvier, New flare model using recent measurements of the solar ultraviolet irradiance, *Adv. Space Res*., submitted, 2006.
- Peterson, W. K., P. C. Chamberlin, T. N. Woods, and P. Richards, Variations of the solar flux in the 1 to 50 nm range over a solar rotation inferred from observations of photoelectrons with energies from 0.01 to 1 keV from the FAST satellite, *Adv. Space Res*., submitted, 2006.
- Eparvier, F. G., T. N. Woods, and P. C. Chamberlin, Solar EUV irradiance: where have we been and where are we going?, *Adv. Space Res*, submitted, 2006.
- Solomon, S., L. Qian, R. Roble, and T. Woods, Modeling the global ionosphere using measured solar ultraviolet irradiance, *Adv. Space Res*, submitted, 2006.
- Qian, L., S. C. Solomon, R. G. Roble, B. R. Bowman, and F. A. Marcos, Thermospheric neutral density response to solar forcing, *Adv. Space Res*, submitted, 2006.
- Fuller-Rowell, T., M. Codrescu, and N. Maruyama, Impact of variability on the thermosphere ionosphere system: from flares to solar cycle timescales, *Adv. Space Res*, submitted, 2006.
- Chamberlin, P. C., T. N. Woods, and F. G. Eparvier, Flare Irradiance Spectral Model (FISM) use for space weather applications, *International Living With a Star (ILWS) Workshop Proceedings*, Goa, India, submitted, 2006.

SEE Related Papers in 2007 - 2

SEE Related Papers in 2007 - 3

Conclusions and Future Plans

Summary of SEE Observations

- TIMED SEE has been very successful in obtaining new, accurate measurements of the solar EUV irradiance
  - SEE data available from http: //lasp.colorado.edu/see/
- More than 500 flares have been observed by SEE
  - Extreme flare periods are April 2002, July 2002, May-June 2003, Oct.-Nov. 2003, July 2004, Jan. 2005, Sept. 2005, and Dec. 2006
  - Large flares vary as much as 11-year solar cycle variations
  - New flare models have been developed with SEE observations
- More than 75 solar rotations have been observed by SEE
  - Variability of 5-70% observed (wavelength dependent)
- TIMED mission has observed solar maximum and minimum activity during solar cycle 23
  - Extended TIMED mission would observe solar cycle rising activity, perhaps starting in 2009

SEE Plans for 2008

- Daily mission operations and data processing for SEE
  - Release of Version 10 data products is expected in 2008
- SEE calibration rocket being flown in April 2008
  - Last calibration rocket funded by TIMED
  - Future, additional underflight calibrations will be by SDO EVE calibration rockets that should start on an annual basis in early 2009
- Provide SEE data and model products for space weather operations
  - Already providing SEE Space Weather data product to Air Force and NOAA SEC for daily space weather operations
  - Phil Chamberlin plans to make FISM output available near real-time for space weather operations using SEE's daily Space Weather product and the 1-min cadence GOES X-ray measurements
- Detailed modeling of Earth's response to solar irradiance changes
  - Composition, dynamics, temperature using TIME-GCM for solar cycle variations
  - More detailed comparison to FAST photoelectron measurements during flare events
- Occultation data analysis
  - Analyze EGS Level 2B data for thermospheric densities of O, O_2, and N_2