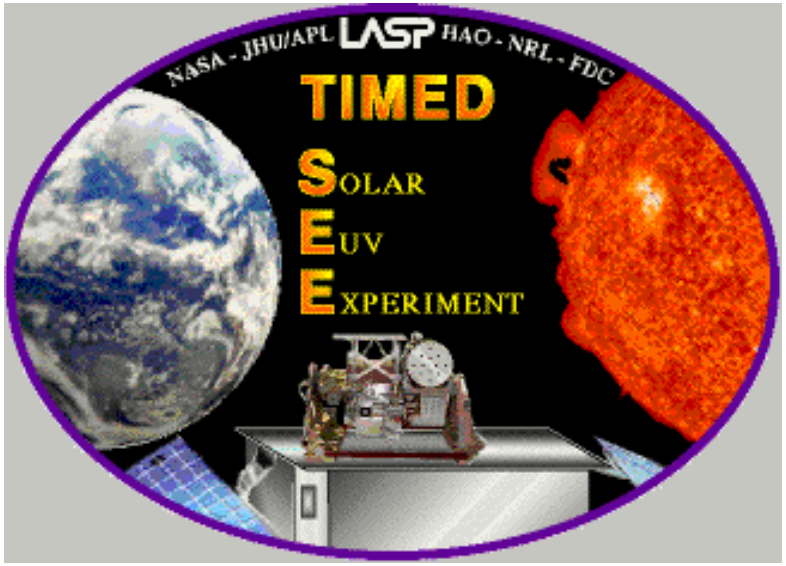
How TIMED-SEE uses other FUV irradiance data



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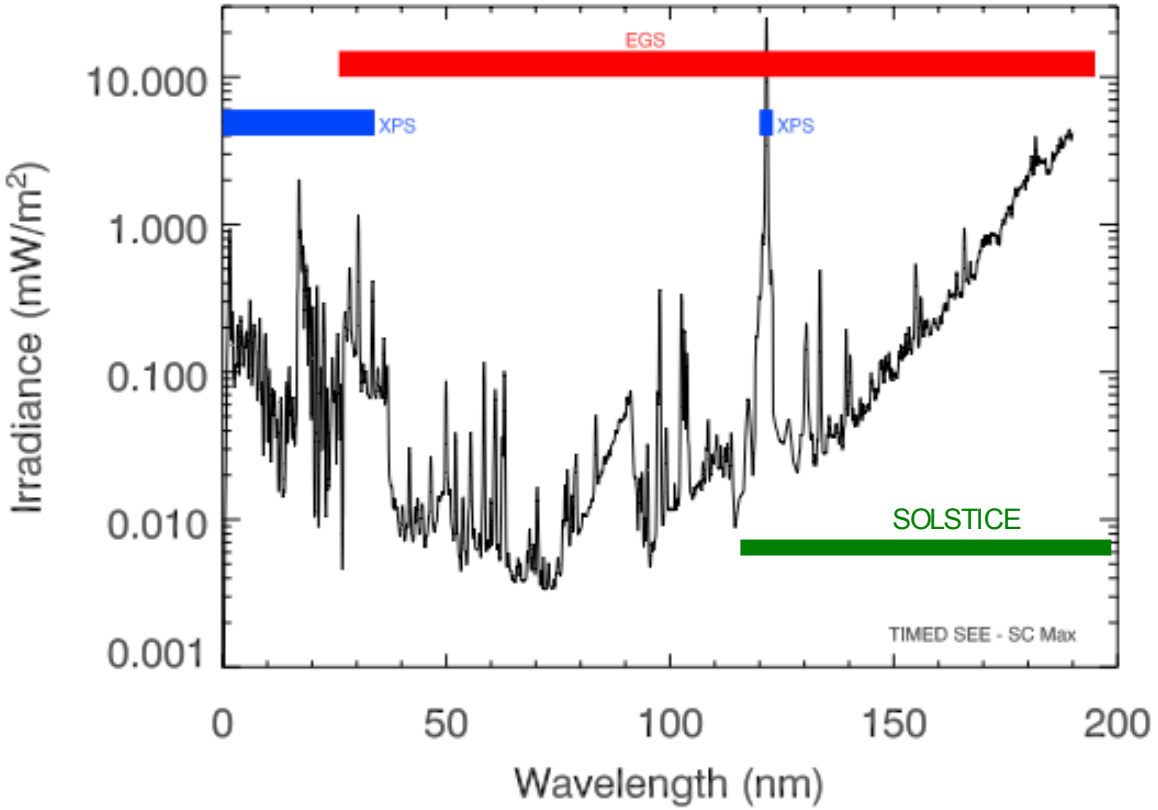
TIMED Solar EUV Experiment



EGS:

- EUV Grating Spectrograph,
- Rowland-circle grating design
- 64x1024 pixel CODACON (MCP-based detector)
- 27-194 nm at $\Delta\lambda$=0.4 nm
- Special filter for Ly-α (121.6 nm)

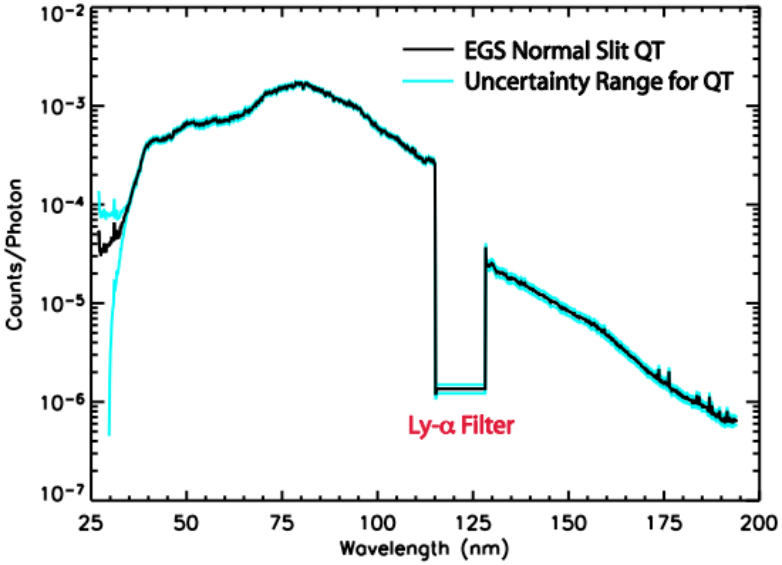
XPS:

- XUV Photometer System,
- Set of 12 Si photodiodes
- 0.1-34 nm at $\Delta\lambda$=7-10 nm
- Ly-α (121.6 nm) at $\Delta\lambda$=2 nm

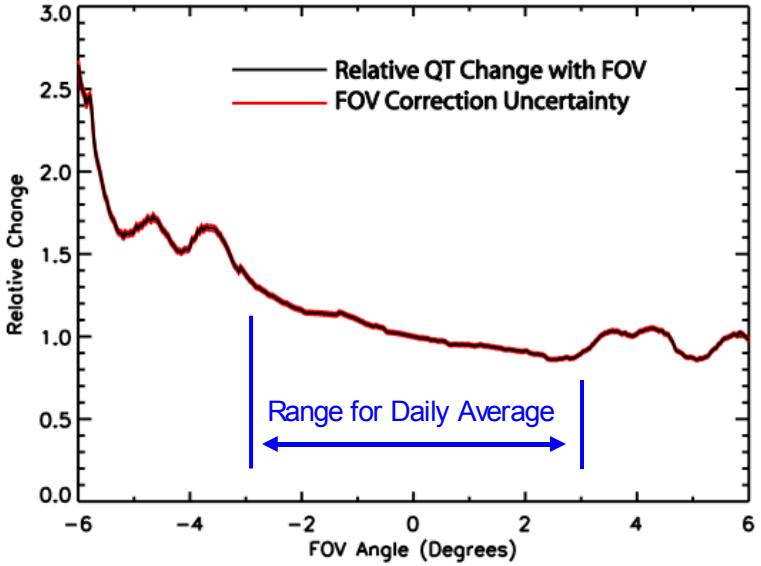
- SEE observes the Sun for ~3 minutes of every 97-min orbit.
- SEE has operated from 22 Jan 2002 to the present.
- SEE data products are available from http://lasp.colorado.edu/see/

SEE Pre-Flight Calibrations

- Pre-flight calibration at NIST SURF-III in Gaithersburg, Maryland (to a few %).
  - Sensitivity (QT) as a function of wavelength and FOV angles



Sample EGS QT measurement made at NIST SURF-III.



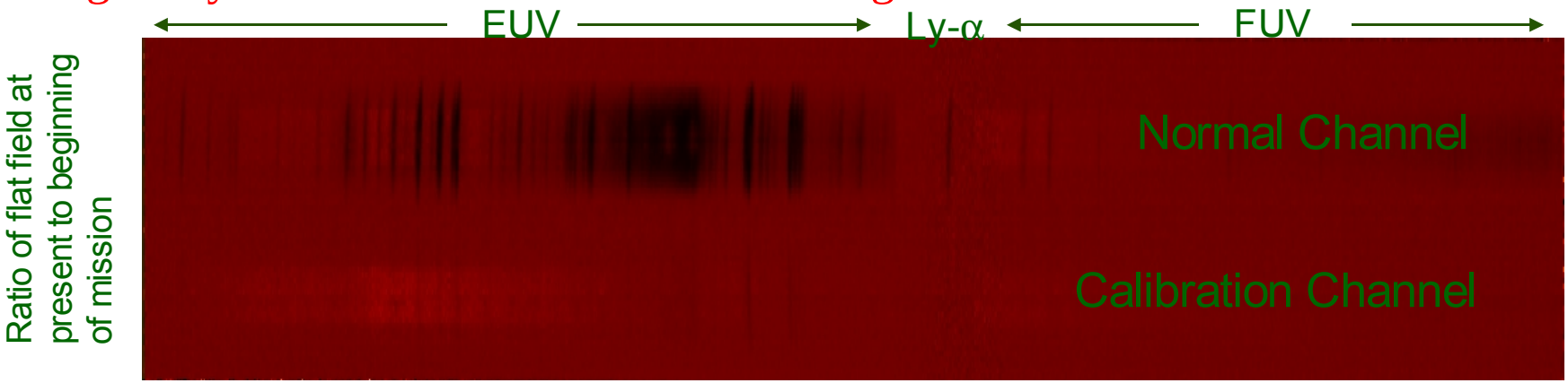
Sample EGS sensitivity variation over FOV.

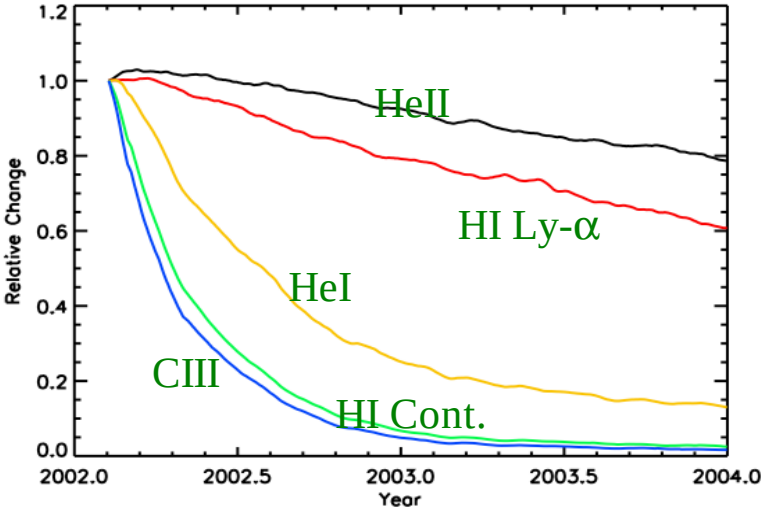
EGS In-Flight Calibrations

- On-Board Tracking of Relative Changes:
  - Redundant channel:
    - Calibration Channel uses different slit and and different areas on same grating and same detector.
    - Primary Channel used every orbit, redundant channels used for 2 orbits every week (1:52 duty cycle)
  - Other On-board Tracking:
    - Weekly detector flat fields with internal Hg lamp
    - Regular FOV maps (using Sun as source)
    - Wavelength scale set using solar spectrum itself
- Re-Calibration (Tracking of Long-Term Changes)
  - Regular Sounding Rocket Underflights
    - Same instruments as on SEE, calibrated @ NIST pre- and post-flight
    - Allows transfer of absolute calibration from ground to both channels
    - Flights on 08-Feb-2002, 12-Aug-2003, 15-Oct-2004
    - Launch on 23-Oct-2006 is last one planned for TIMED mission
      - Uses SDO-EVE rocket instrument and XPS, but no EGS (EVE covers 0.1-105 nm plus Ly-α)
      - Plan regular underflight calibrations for SDO EVE starting in late 2008

Weekly Tracking

- Weekly flat fields and calibration channel comparisons are used to adjust daily high-duty channel irradiances for relative degradation.

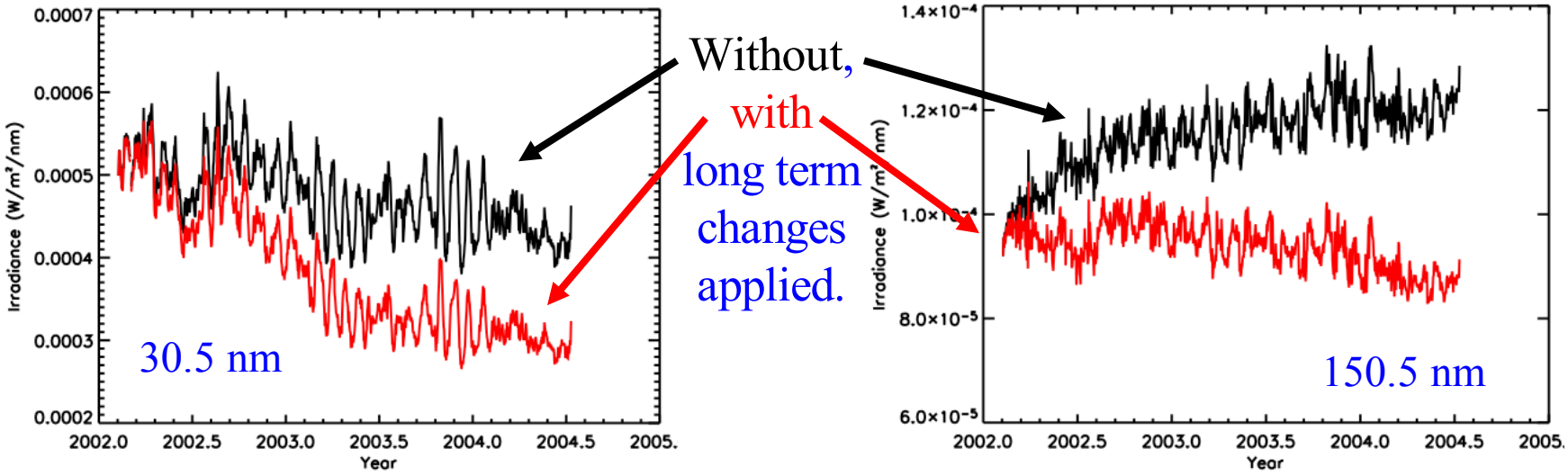




- Degradation greatest for largest signals (e.g. CIII 97.7 nm and HI continuum ~90 nm)
- Still get good signals even in most degraded lines.
- Only a small amount of degradation is seen in the calibration channel.

Long Term Changes

- **EUV:**
  - See lots of degradation in bright lines and H continuum (weekly fits with flatfields and redundant channel)
  - See some increase in sensitivity where degradation doesn't occur (linear fit between rockets)
- **FUV:**
  - See little degradation in FUV portion of spectrum
  - See large (~10%/year) increase in sensitivity in both primary and redundant channels (time-dependent fit with SUSIM/SOLSTICE composite reference)



Long-Term FUV Correction

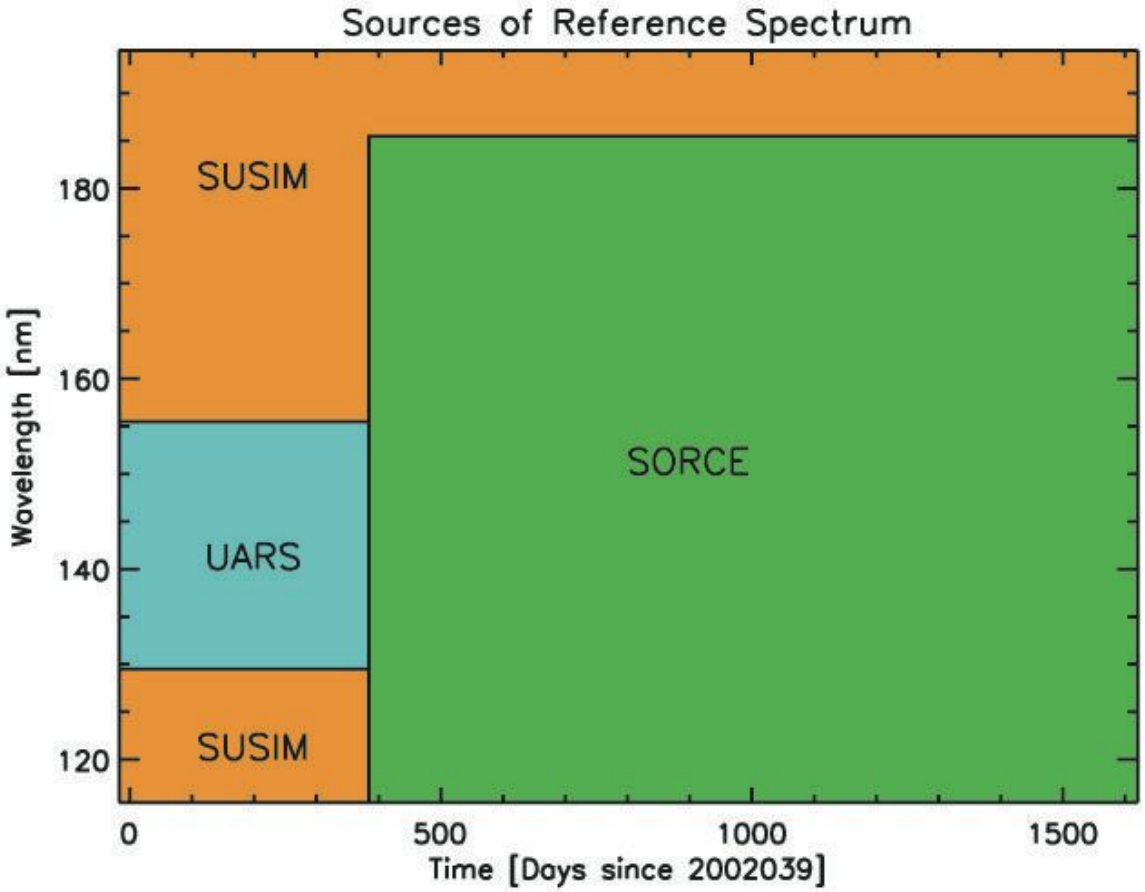
- **Version 6:** First applied almost linear correction based on comparison with rockets
- **Version 7:** Realized that linear fit was over-correcting, switched to fit based on comparison with UARS-SUSIM and SORCE-SOLSTICE:
  - produced composite FUV daily average time series
    - SUSIM prior to 2003/060, SOLSTICE after spliced by scaling to match in few months overlap
    - normalized to unity on 2002/039 (first SEE rocket date) so absolute calibration is not dependent on SUSIM or SOLSTICE
  - ratioed composite to SEE daily averages
  - fit ratios at Ly-α and for 5-nm bins from 130-195 nm
  - apply correction to SEE data by interpolating between 5-nm bins onto 1-nm bins
- **Version 8:** Updated time-series fits using more SORCE-SOLSTICE data

A New Long-Term Correction is Needed

- Fits need updating with more recent SORCE data
  - correction looks OK at many wavelengths, but is wandering off with others
- UARS SOLSTICE data is now available
  - fills in 130-155 nm range where SUSIM uncertainty is higher
- Wavelength binning has issues
  - Using 5-nm bins has introduced a bias towards longer wavelengths of bins (sawtooth effect)

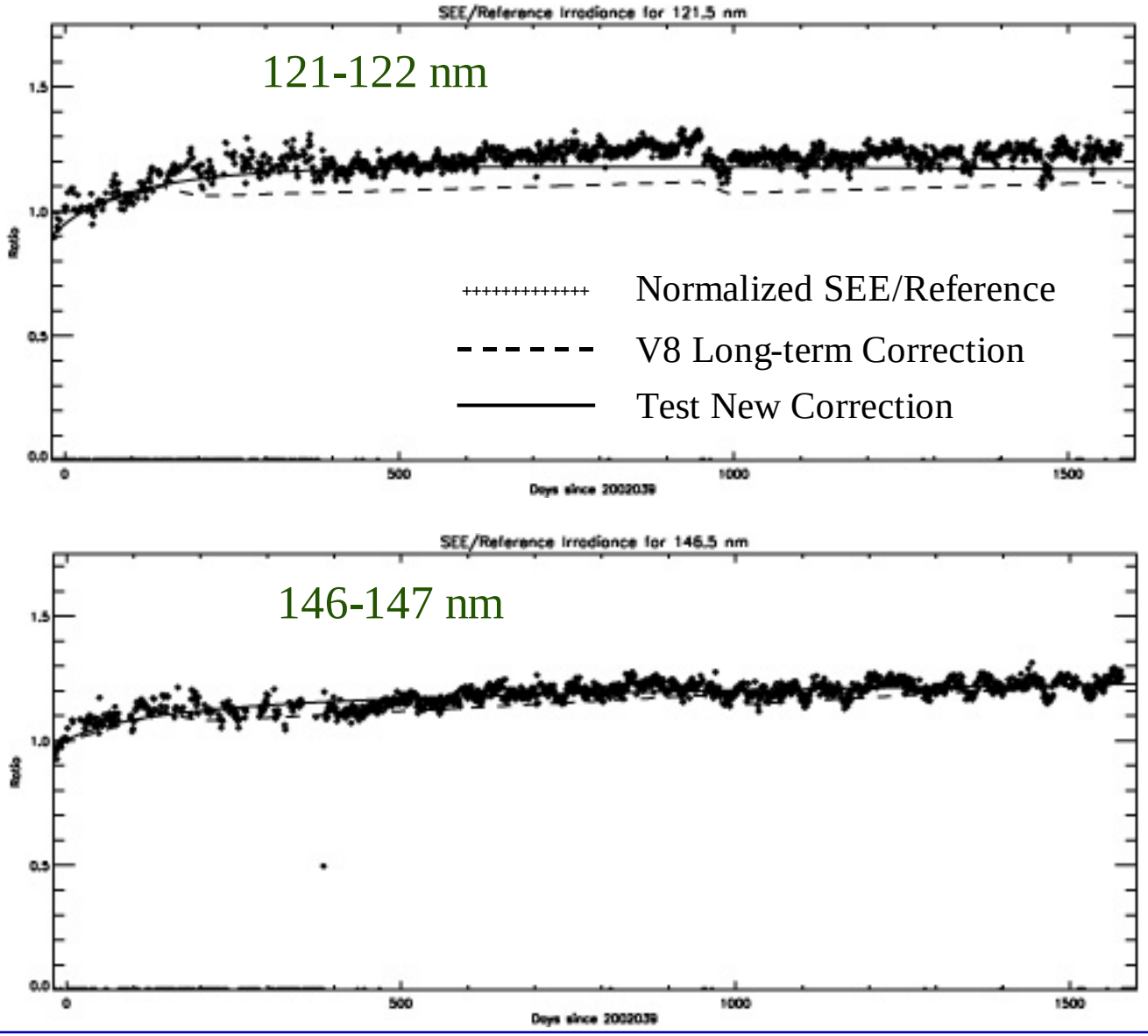
Making an New Long-term Reference

Since SORCE doesn't cover the full time-span or wavelength range of SEE-EGS, a new composite reference spectrum was made for comparison.



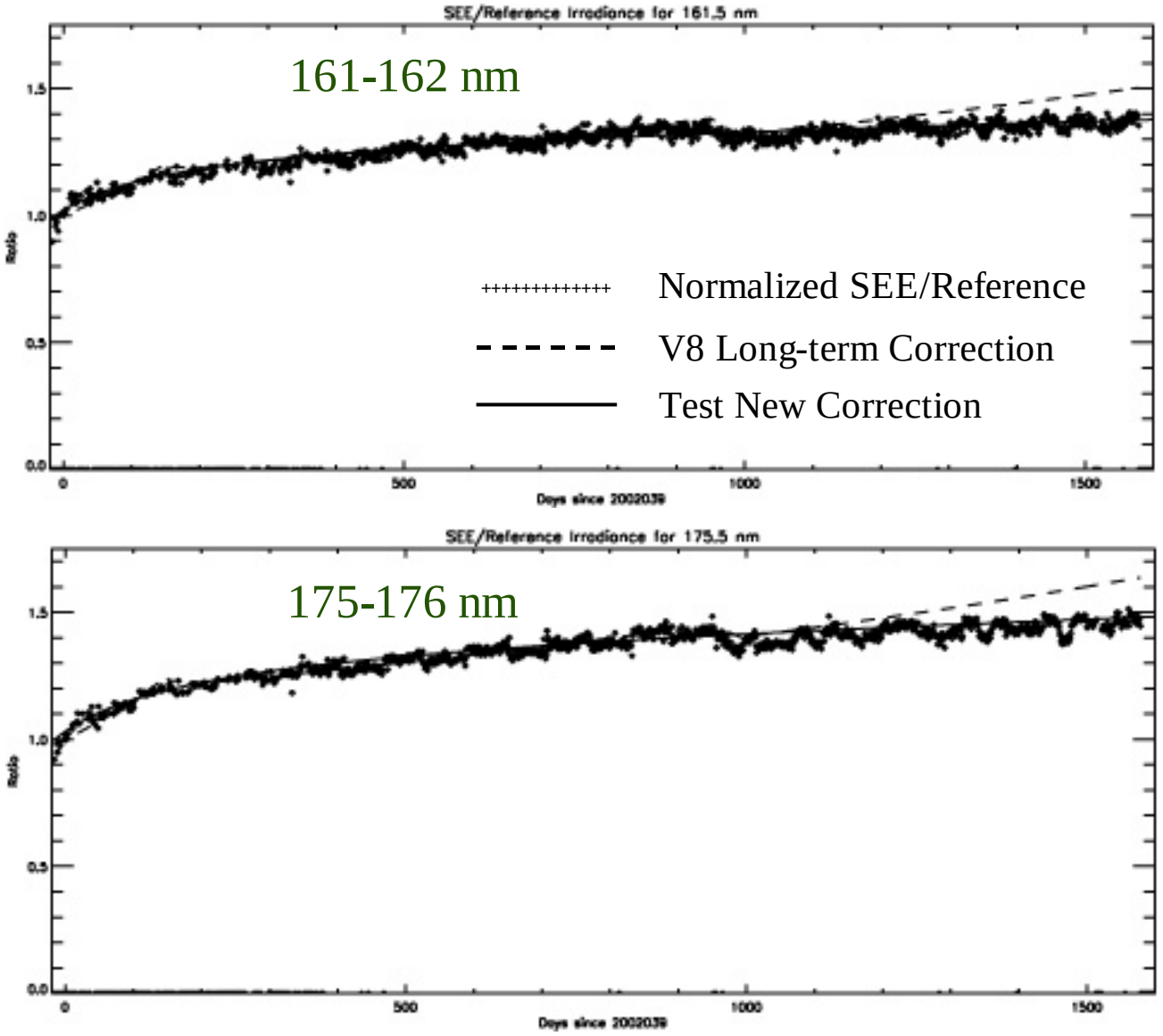
Some Normalized Comparisons (1)

New normalized composite reference time-series compared with un-corrected SEE data in 1-nm bins.

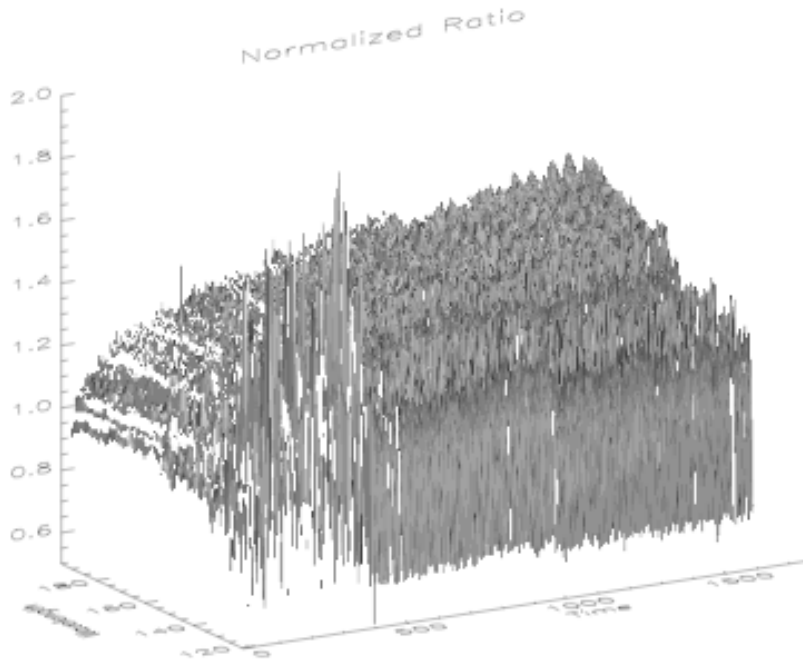


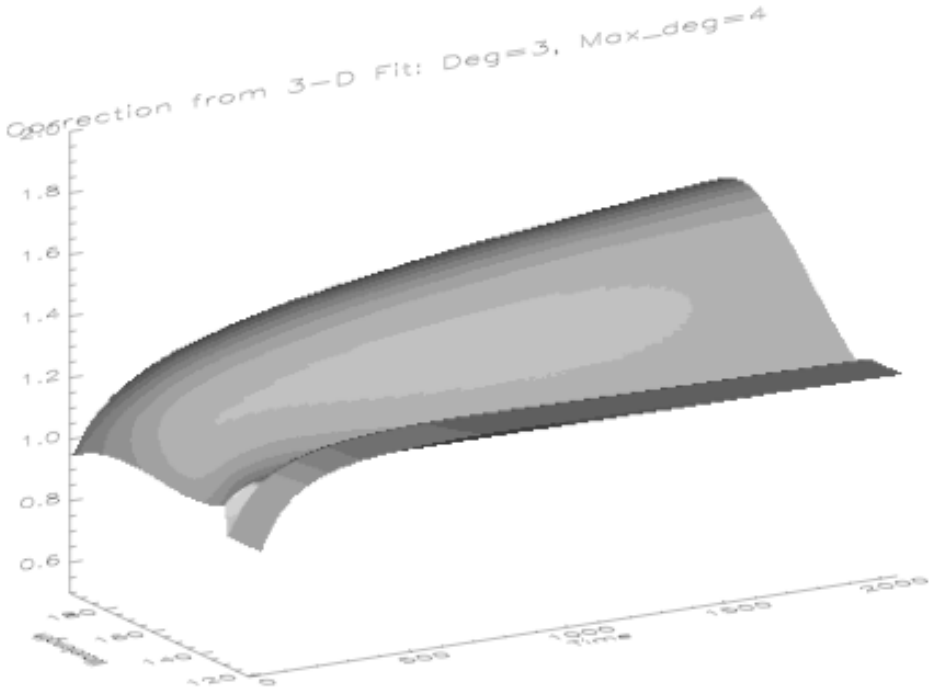
Some Comparisons (2)

Nearing Solar Minimum, the V8 fits are starting to overestimate the long-term change at some wavelengths.



Fitting the Long-term Correction





Discussion Points

- Are the chosen time and wavelength regions for the composite appropriate?
  - What combination of UARS and SORCE data is best?
- What wavelength/time binning for corrections?
  - 5-nm bins for fits are too large (sawtooth)
  - 1-nm bins will force SEE data to have the same spectral shape as composite reference
  - Should fits be smoothed in time? in wavelength?