SDO EVE:
Utility in Space Weather Operations

SDO EVE Spaced Weather Workshop
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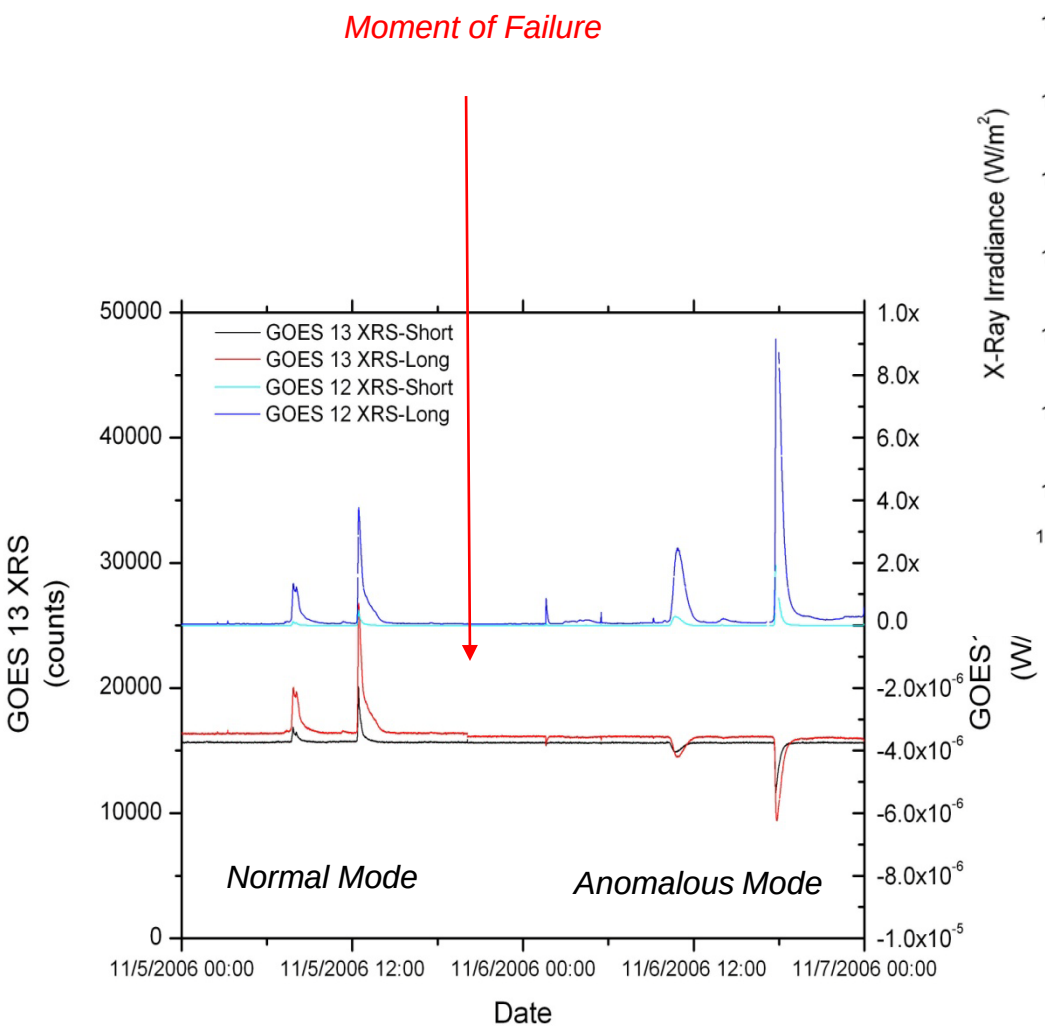
Outline

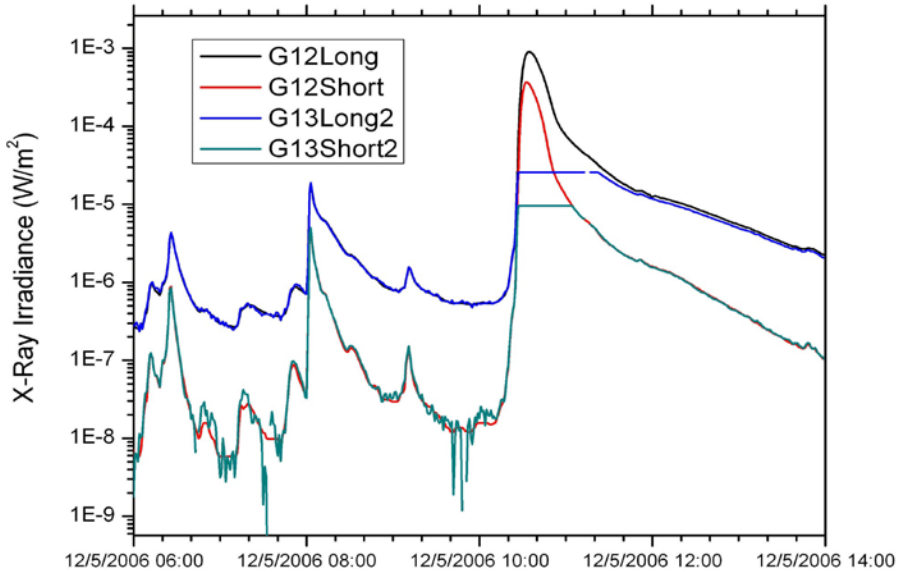
- Backup for XRS
- Calibration and trending for GOES EUVS
- Backup for EUVS
- Development of new products for EUVS

Some GOES XRS History

- NOAA has been flying X-Ray Sensors (XRS) continuously since 1978
  - XRS measures 0.05-0.4 nm and 0.1-0.8 nm band passes
  - XRS is the standard for flare monitoring
  - XRS is the most important data set in the Forecast Office
  - XRS is the sole input for the Radio Blackout Space Weather Scale
- When the program went from spinning to three-axis stabilized, the XRS sensor became more sensitive
  - XRS A (short channel) was 18% brighter
  - XRS B (long channel) was 42% brighter
  - <u>We currently apply a correction so the current data is incorrect.</u>
- Within one year both the GOES 11 and GOES 12 XRS pointing platforms failed.
  - The XRS's work fine… they just don't see the sun
- Six months after GOES 13 launched, the XRS went into an "anomalous mode"
  - Normal mode, it works fine
  - Anomalous mode, it has reverse sensitivity.
  - It switches between modes ~~~~seasonally

GOES 13 XRS Anomaly





The Current XRS Status

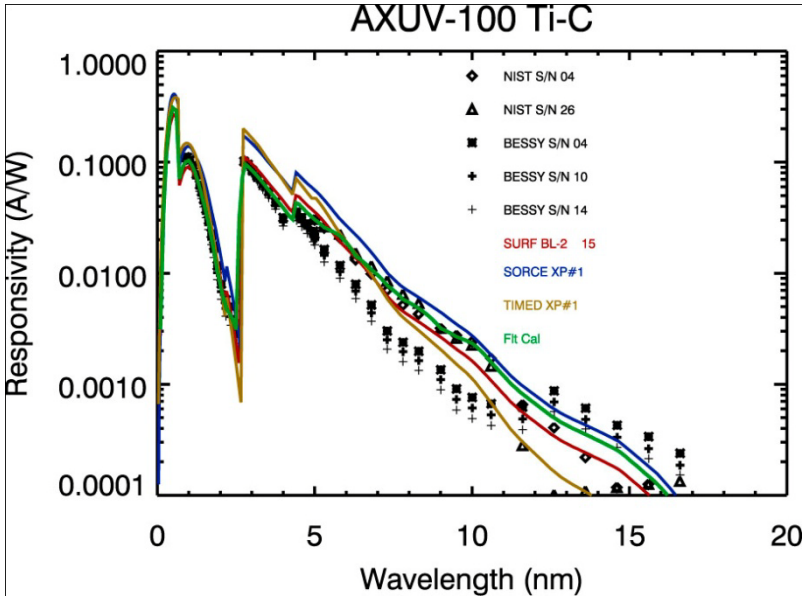
- GOES 10 has been turned off
- GOES 12 is no longer operational
- Currently there are four GOES satellites in operations/testing:
  - GOES-11 (135W): XRS unusable (sensor working but pointing platform is not)
  - GOES-13 (75W): XRS (and SXI) are not pointed at the sun
  - GOES-14 (95W): Operating for space weather sensors only. To be turned off (stored) in late October 2010
  - GOES-15 (105W): Just finished the Post Launch Test. Operating for Space Weather sensors only. To be left for space weather observations after 1 November SXI Issue)
  - GOES-R: Launch 2015, Operational ????
- So we are about to go to a single string for XRS (GOES 15 only)
  - Gaps for eclipses (GOES 15 is too close for full coverage)
  - Potential for longer outage for system failures… on-orbit failures, antennas, ground systems, etc…

SDO Solution

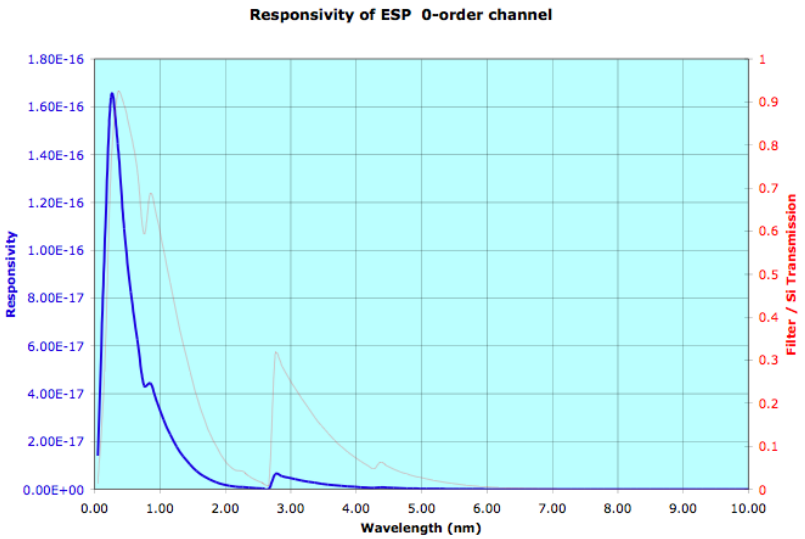
- **SDO EVE ESP sensor has two channels (one similar to SORCE XPS) that can provide XRS proxy data.**
  - ESP central order: 0.1-7 nm (1/4-sec cadence)
  - SAM: 0.1-7 nm (10-sec cadence)
- **While EVE ESP does not measure the exact bandpasses of XRS, what is measured will correlate well with XRS**

Bandpasses of These Instruments

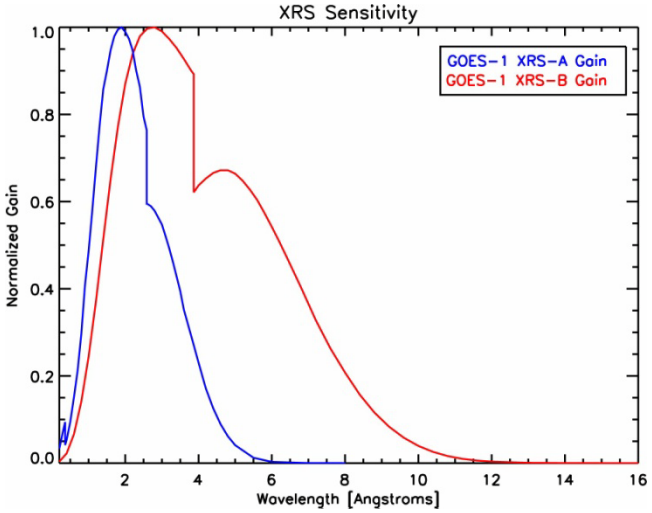
TIMED/SORCE XPS#1



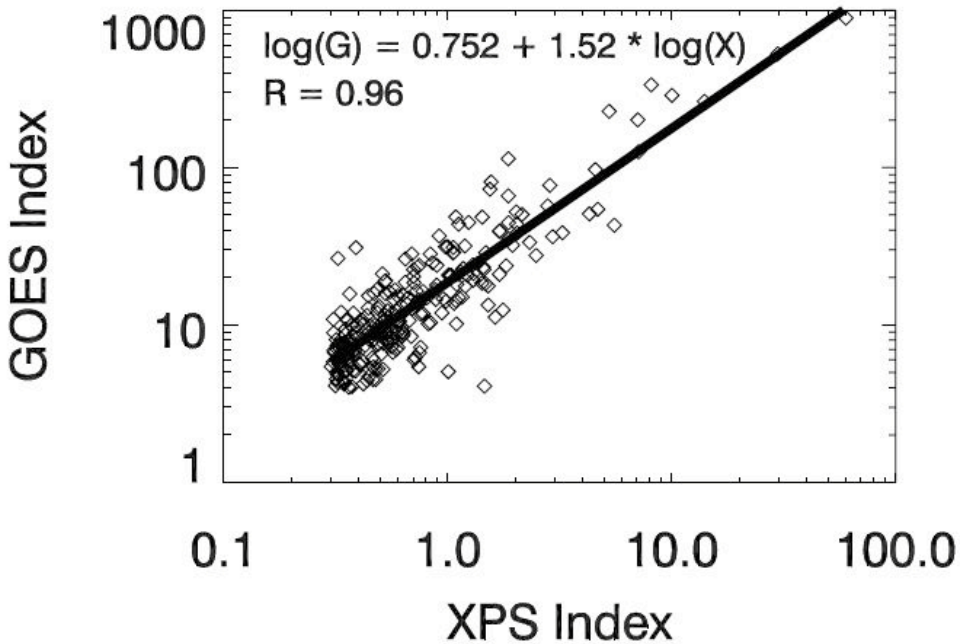
ESP Central Order



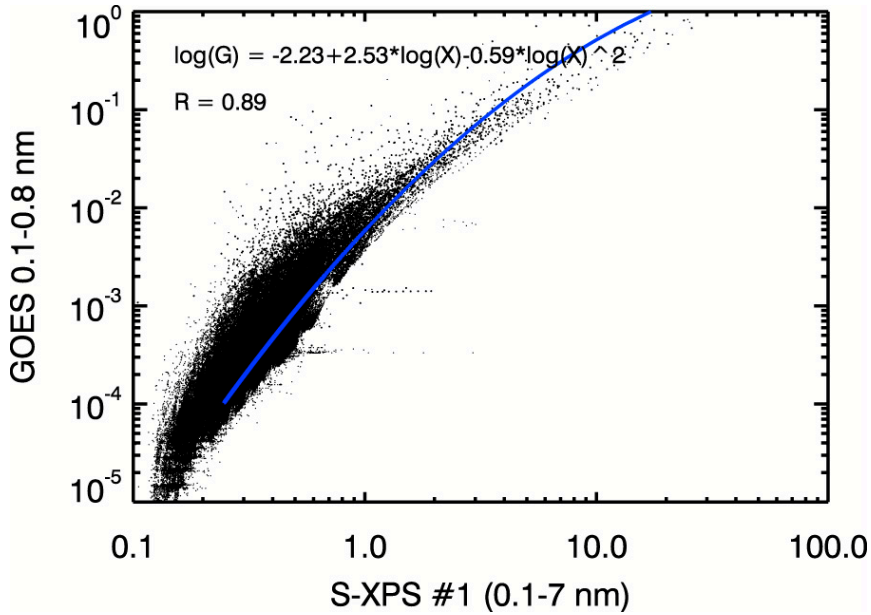
XRS A & B



TIMED and SORCE XPS and GOES XRS Correlation



TIMED-SEE XPS, flare data only. Fit is linear (on log-log scale)

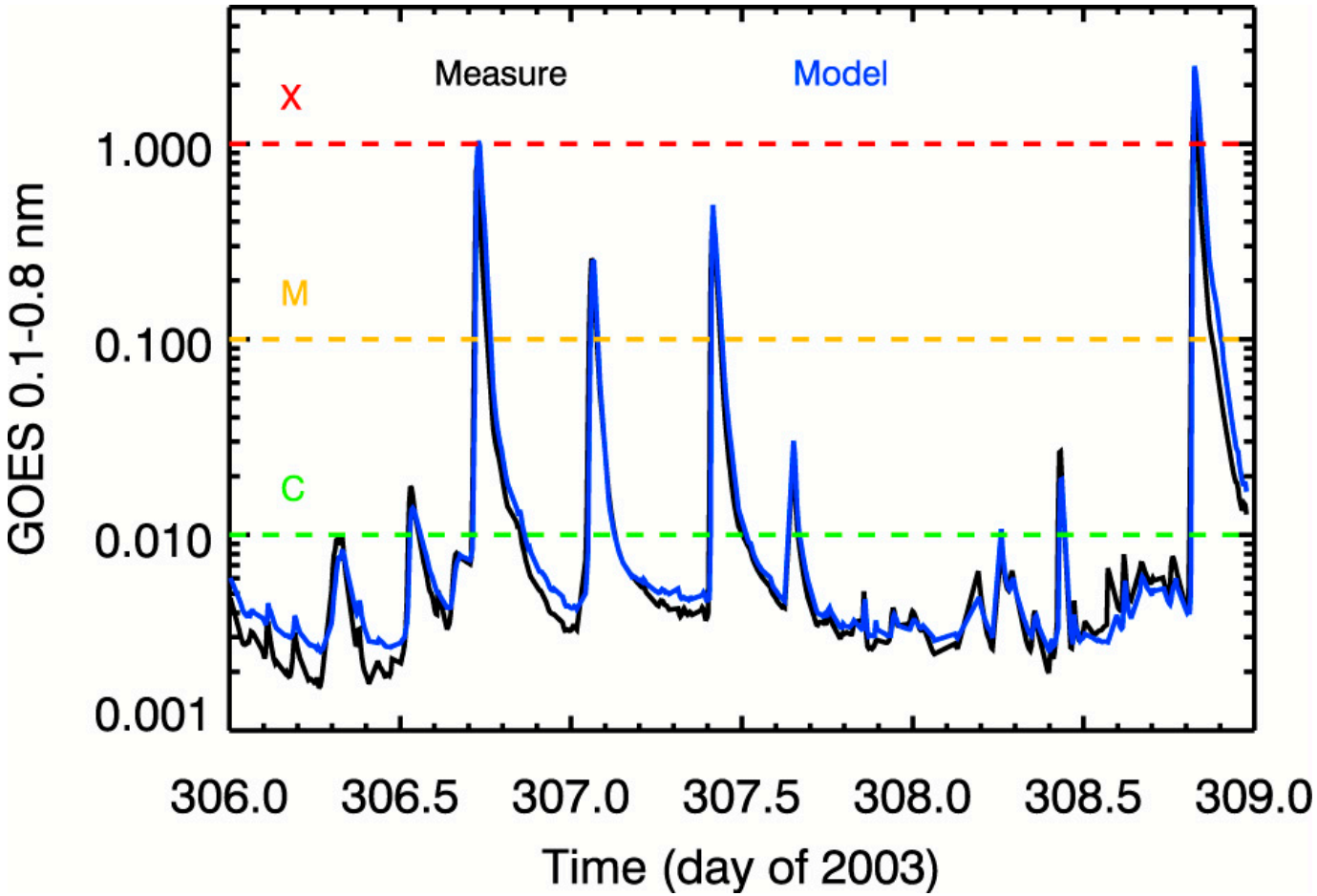


SORCE XPS, all irradiance data (not just flares). Fit is non-linear (on log-log scale).

- TIMED-XPS and SORCE-XPS Diode 1 Index are nearly identical to EVE ESP Central Order measturement (0.1-7 nm).
- Flares how high correlation with XRS 0.1-0.8 nm on log-log scale. (During flares 0.1-7 nm dominated by short λs.)

How Useful is the XPS to GOES fit?

Black Curve: GOES XRS .1-.8 nm channel
Blue Curve: Proxy based on SORCE XPS



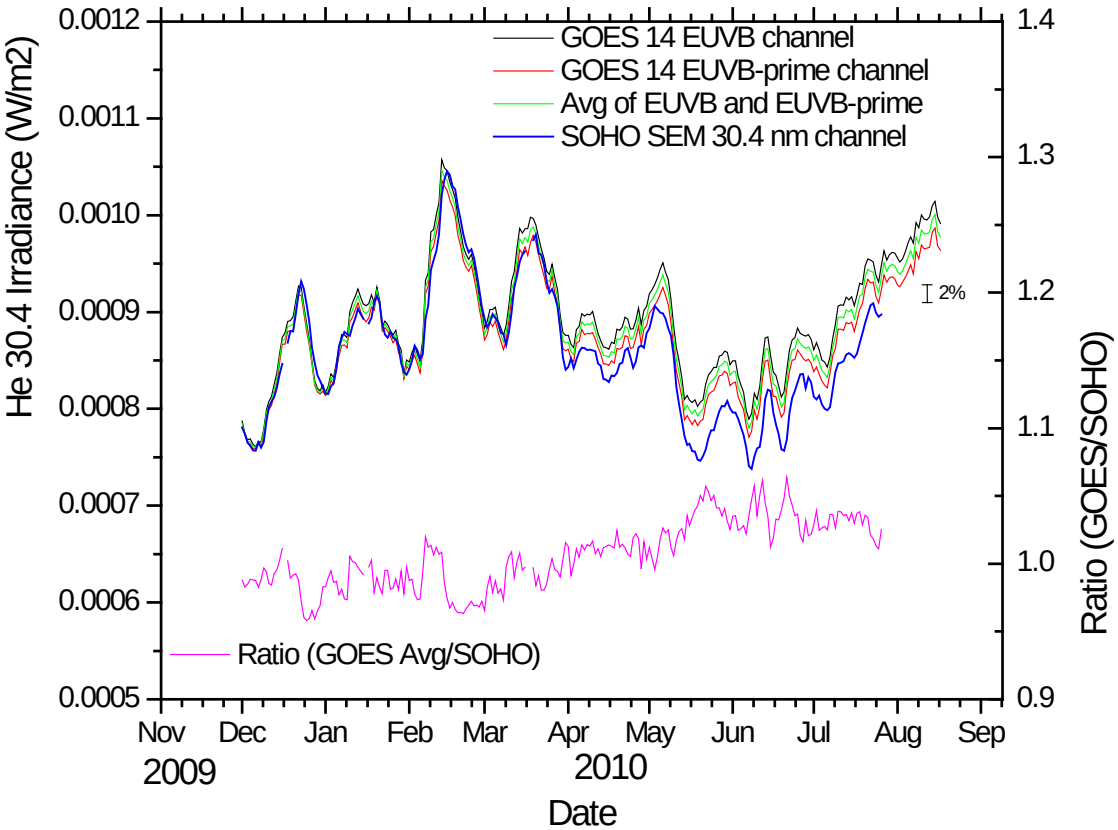
EUVS Validation

- GOES 14 EUVS
  - Operational Dec 2009
  - Three (useful) channels
    - EUVA 5-17 nm
    - EUVB 26-34 nm
    - EUVE 118-122 nm
  - Continuous @ 10 second cadence
  - To be turned off in a few weeks
- GOES 15 EUVS
  - Has just finished PLT
  - Will become operational in November

GOES 14 EUVB Increases Sensitivity

- Comparing GOES 14 EUV B channel with the SOHO SEM 30.4 nm channel
  - Similar band-passes
  - Similar design
- SOHO SEM has been operating since 1996
  - Several rocket flights provide calibration and tracking of long-term degradation
- Assuming that the SOHO SEM is well calibrated and that degradation has been accounted for…
  - GOES 14 EUVB channel has increased in sensitivity by nearly 4% over the course of the last 8 months.
    - EUVB is up by ~5%
    - EUVB-prime is up by ~3%

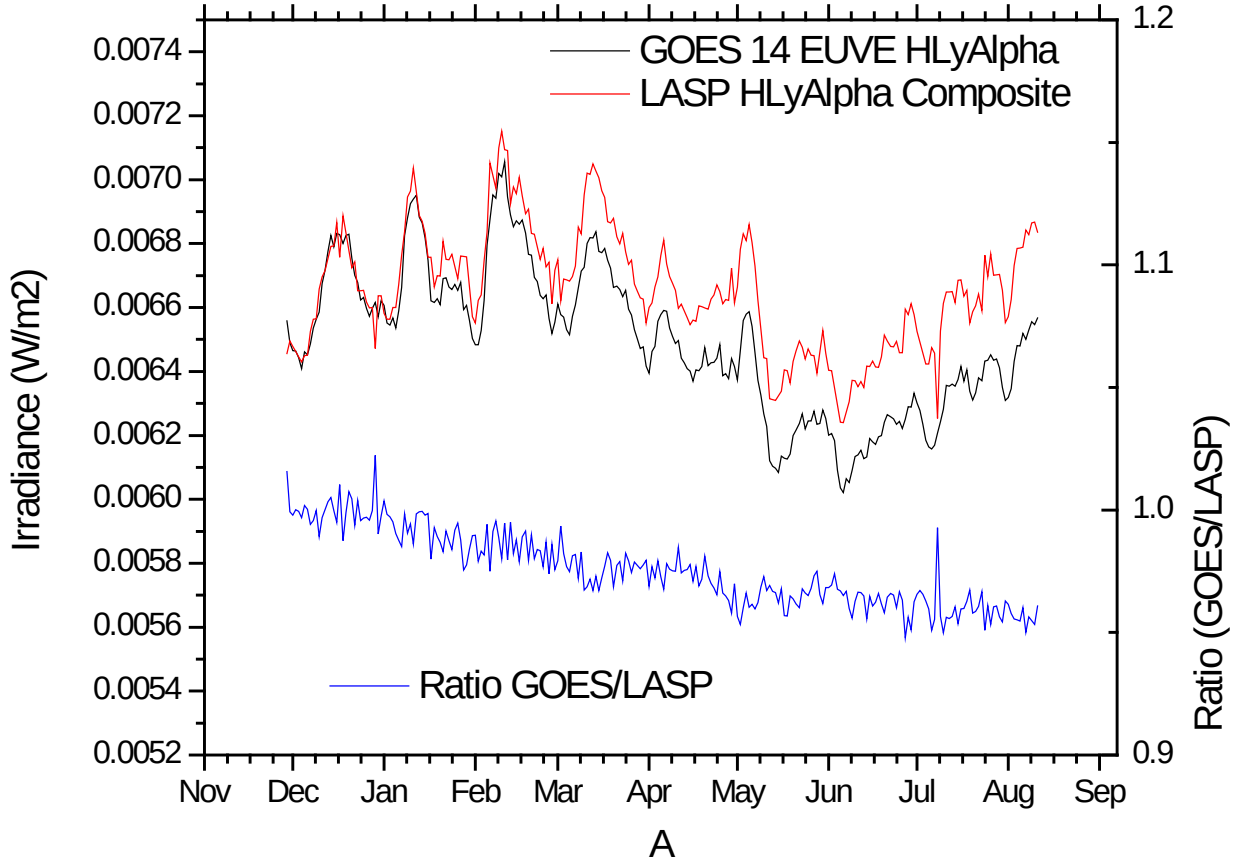
Daily averages of the GOES 14 EUVB and EUVB-prime channels and SOHO SEM 1st order 304 channel along with the ratio of the two



EUVE Degradation

- Comparing GOES 14 EUV E channel with the LASP Lyman Alpha (121 nm) Composite
  - different band-passes
    - GOES Wide
    - LASP Narrow
- LASP Composite has been extended back to 1947 with data and proxies
  - Several rocket flights provide calibration and tracking of long-term degradation
- Assuming that the LASP Composite is well calibrated and that degradation has been accounted for…
  - GOES 14 EUVE channel has dropped in sensitivity by nearly ~ 4.3% over the course of the last 8 months.

Daily averages of the GOES 14 EUVE H Lym. Alph. channel and the LASP H Lym. Alph. composite along with the ratio of the two



Backup for the EUVS

- Need to develop a bandpass proxy for the three EUVS channels
- Fill data gaps

- Explore an empirical model of EUV spectrum from GOES three (or five) channels.

Summary: EVE Data in Operations

- ESP Backs up for the XRS
- MEGS A detrends GOES EUVS A and B
- ESP Lyman Alpha detrends EUVS E
- MEGS A and ESP can backup GOES EUVS
- EVE spectra can help produce better EUVS products