GOES 13-15 EUV

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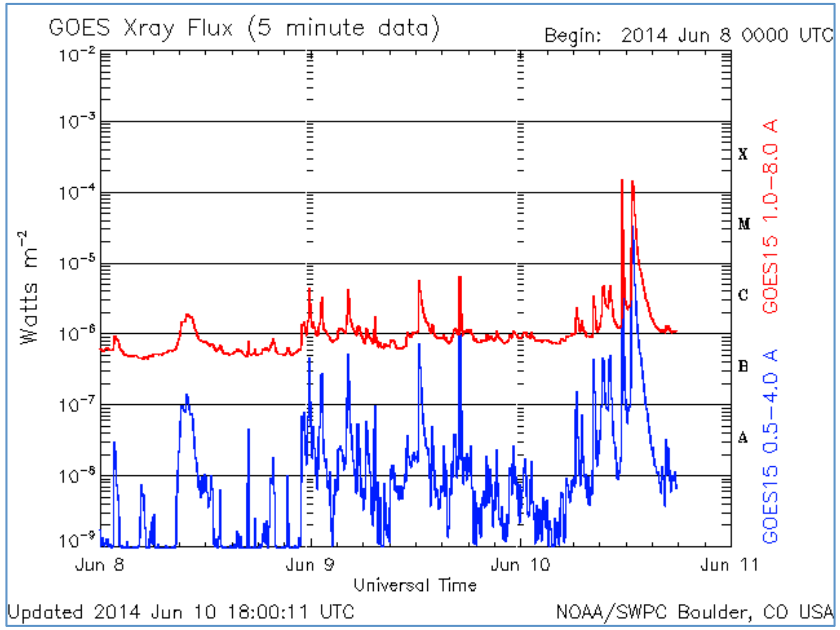
GOES Space Weather Sensors

GOES: Geostationary Operational Environmental Satellite

GOES 13-15 **XRS** 2 x-ray bands: A: 0.5-4 Å, B: 1-8 Å since 1972

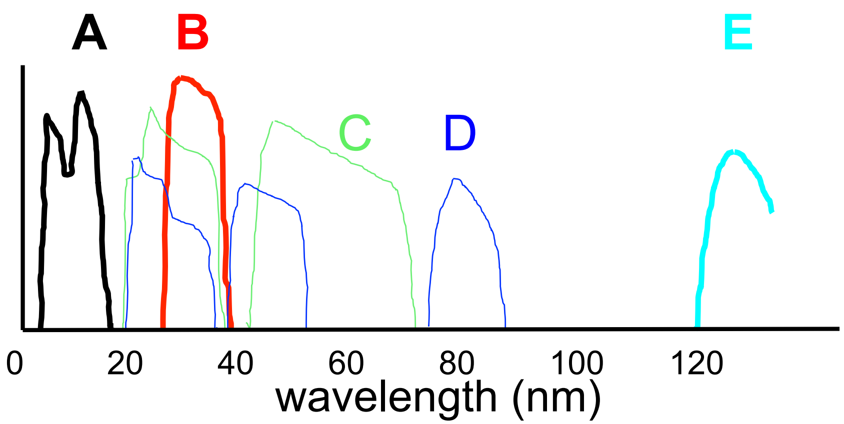
SXI x-ray imager, 3 channels: 0.6-6 nm

EUVS 5 EUV channels, bands: 5-127 nm

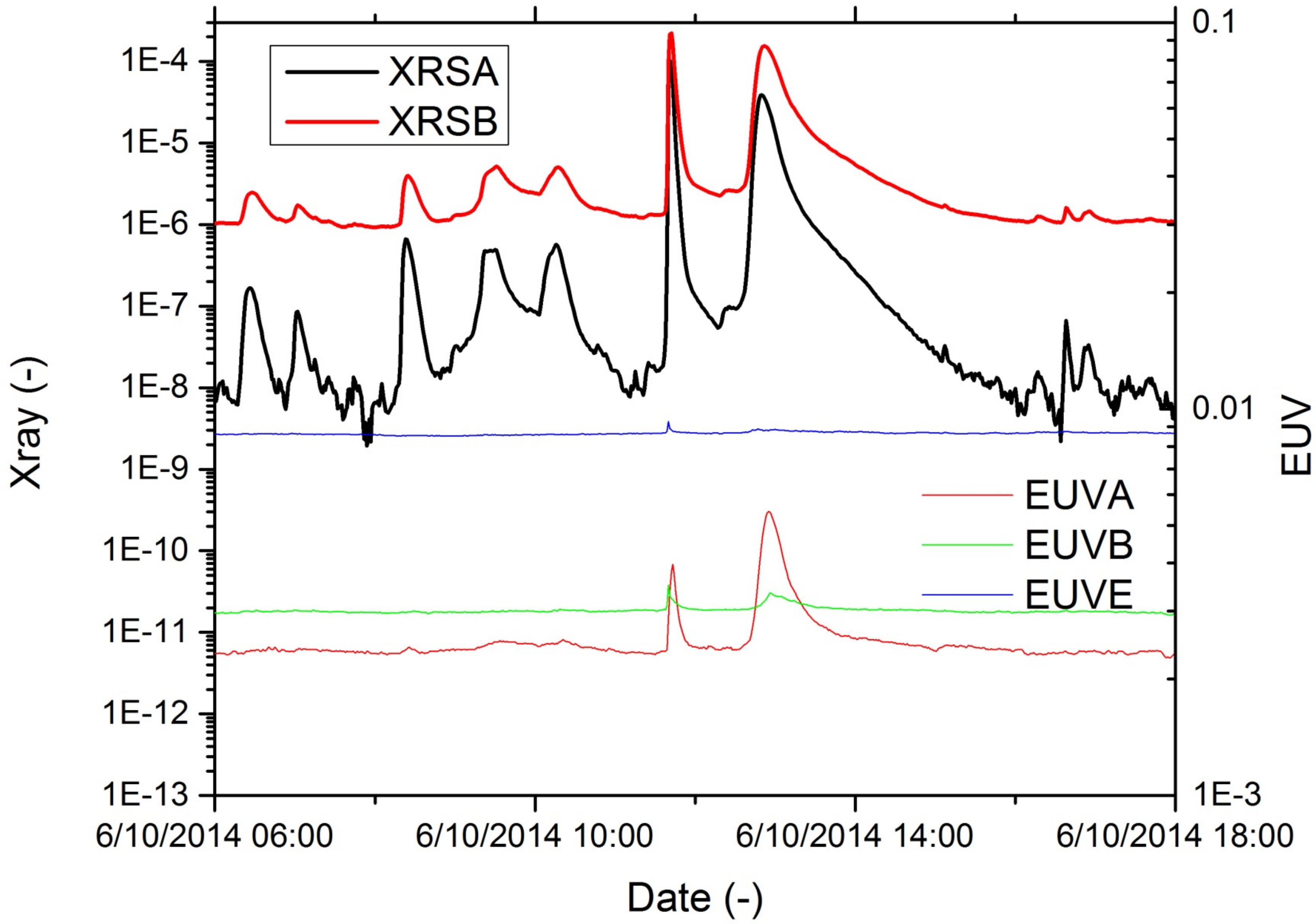


EUVS

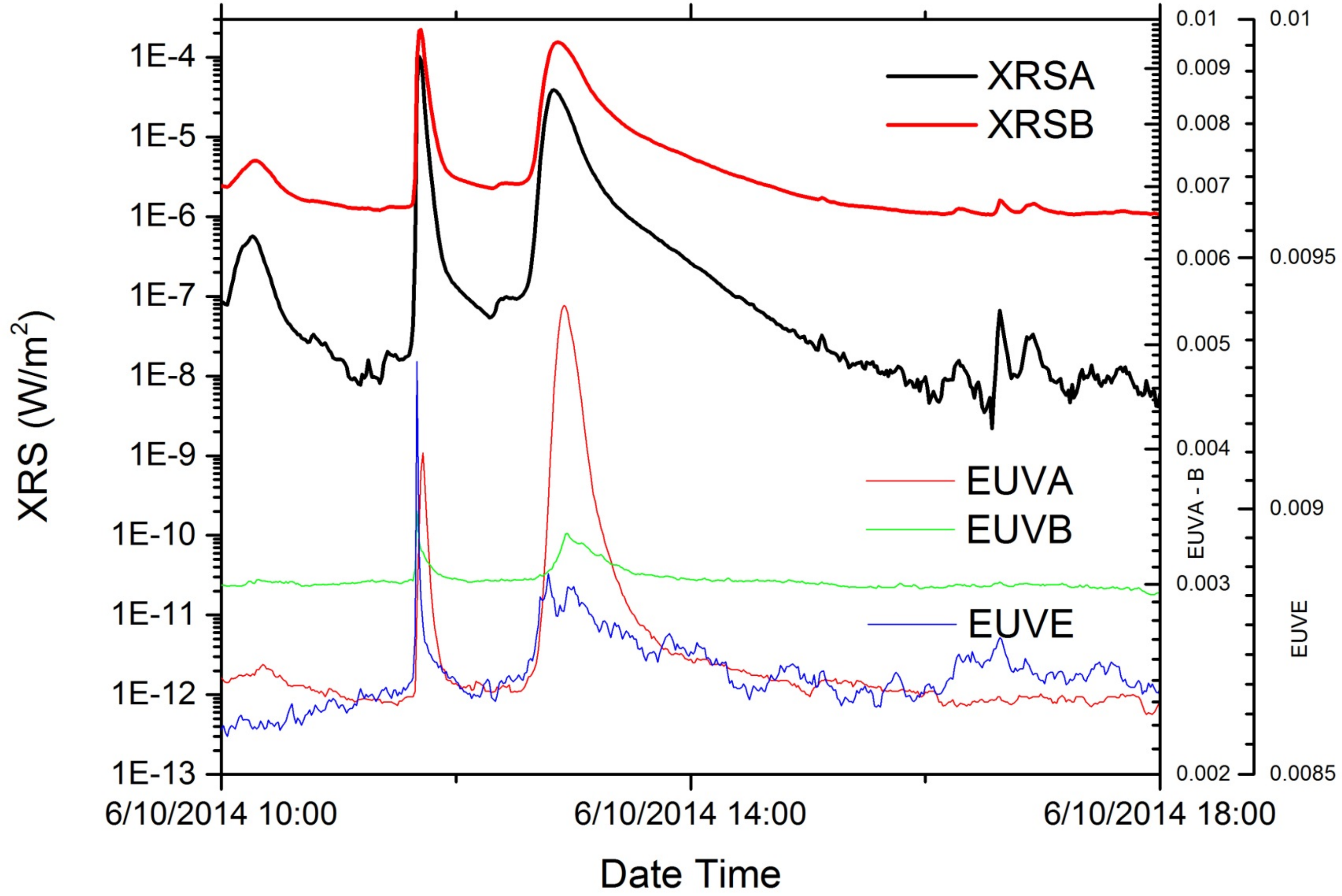
cadence:	10 s
latency requirement	3 s
uncertainty requirement:	15%



Flare irradiances from yesterday



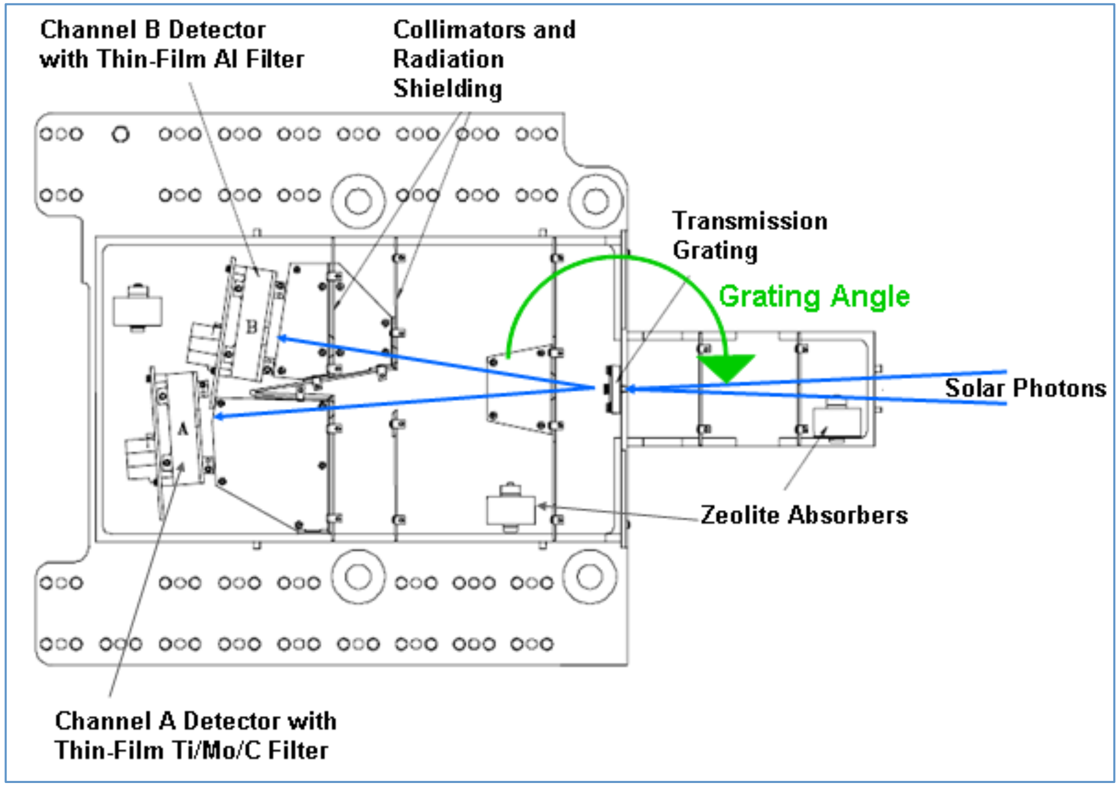
Evolution of flares from yesterday



GOES EUVS

Transmission grating spectrographs

- Panametrics → ATC
- shared gratings for A&B, C&D
- detector: silicon photodiodes (IRD)
- thin film filters on detector for A-D, free standing on E (Ly-α)
- no moving parts
- calibrations at the NRL Beam Line at Brookhaven (John Seeley)



GOES EUVS Data

GOES-13	2006-present
GOES-14	2009 - 2012
GOES-15	2010-present

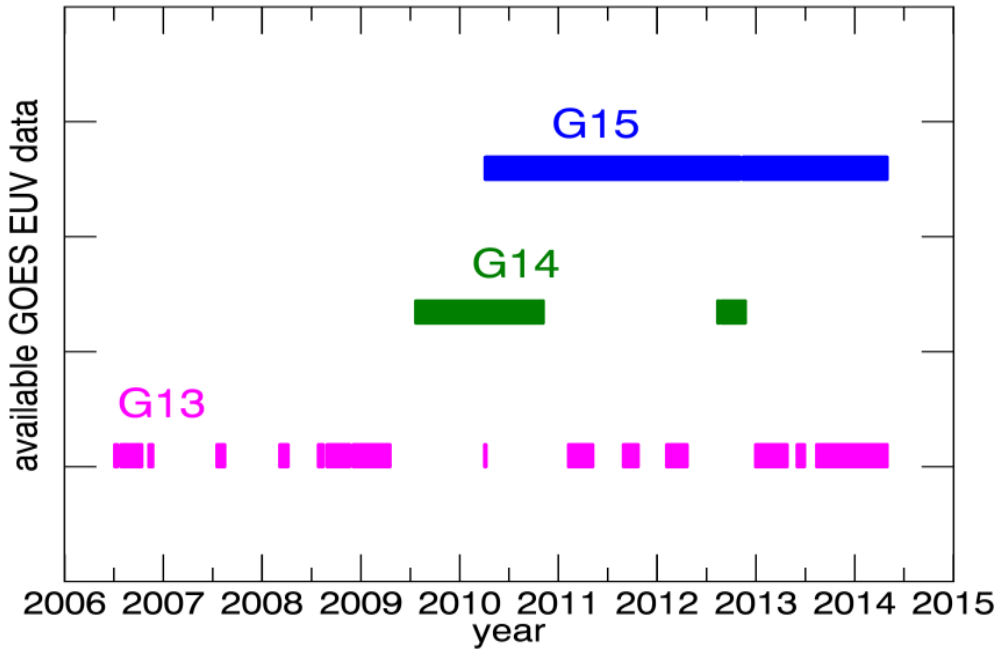
Calibrated data V2

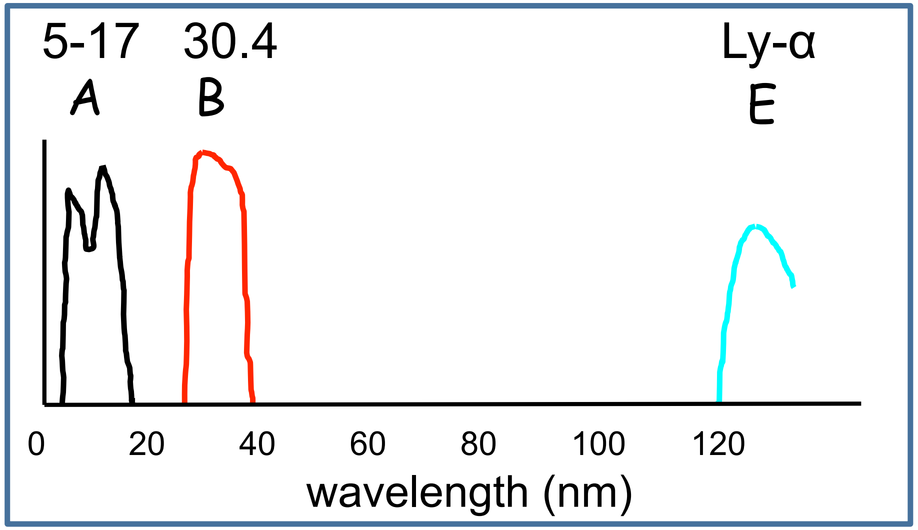
- daily averages
- 1 minute averages
- 10.2 s (available soon)
- channels A, B and E
- GOES14 also has A' and B'

Comparisons

- EVE V4 L3, SOHO SEM
- SORCE SOLSTICE

Documentation





GOES EUVS Calibrations

Conversion from measured counts to irradiance with:

$$J\ [W/m^2] = ((\text{Counts} - \text{Offset}) * \text{Gain} - \text{VisLight}) / \text{Calibration}$$

Gain [A/count]	pre-launch
VisLight [A]	" ", visible light contamination
Offset [counts]	counts when satellite off pointed
Calibration [A/(W/m^2)]	function of wavelength and bandpass requires spectrum, response function

Channels A and B are calibrated without any scaling. *Independent.*

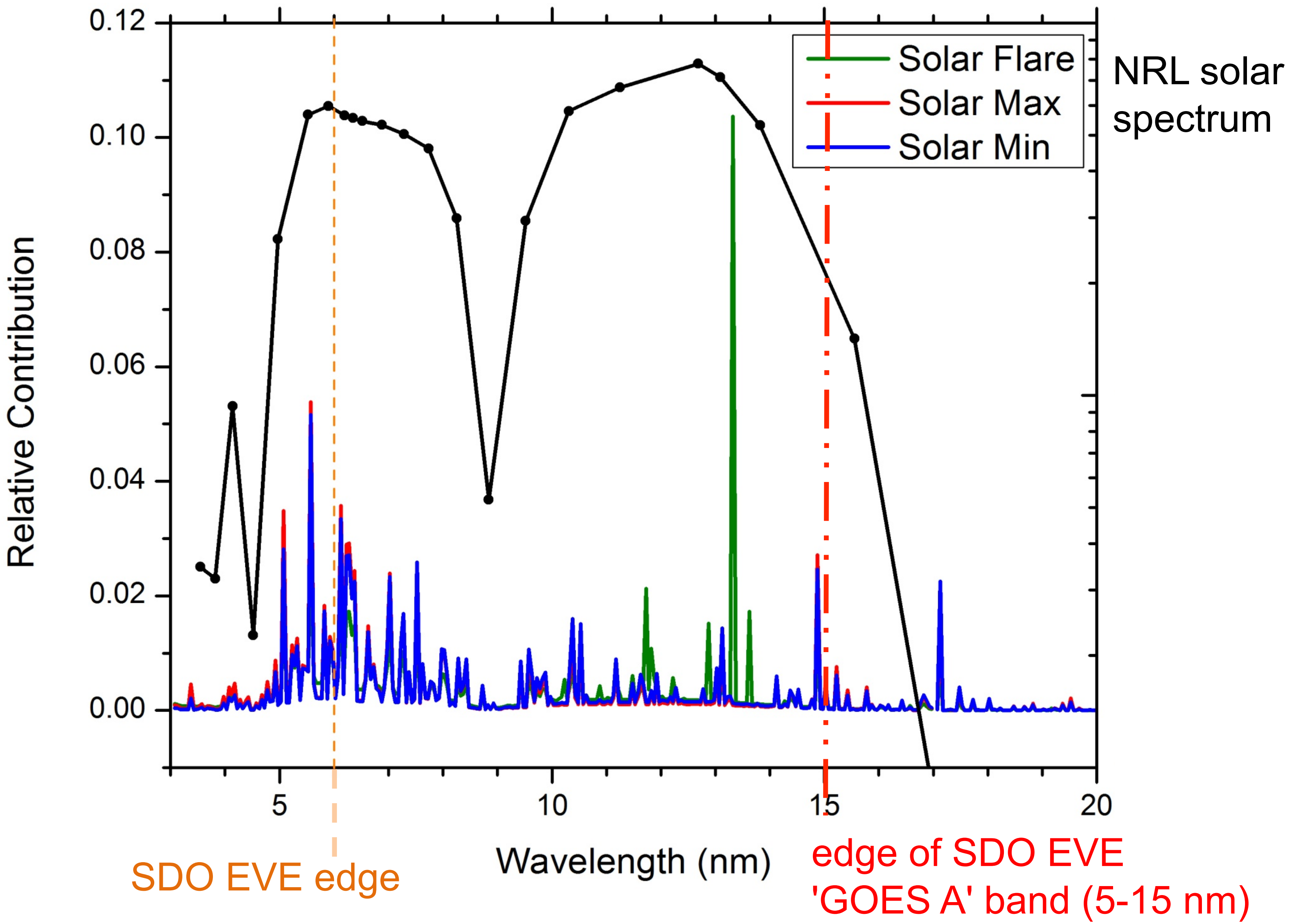
V2 has revised Offset and Calibration factors. Corrected for heater noise on ChA.

Data impacted by eclipses, offpointing, calibrations, and geocoronal absorption.

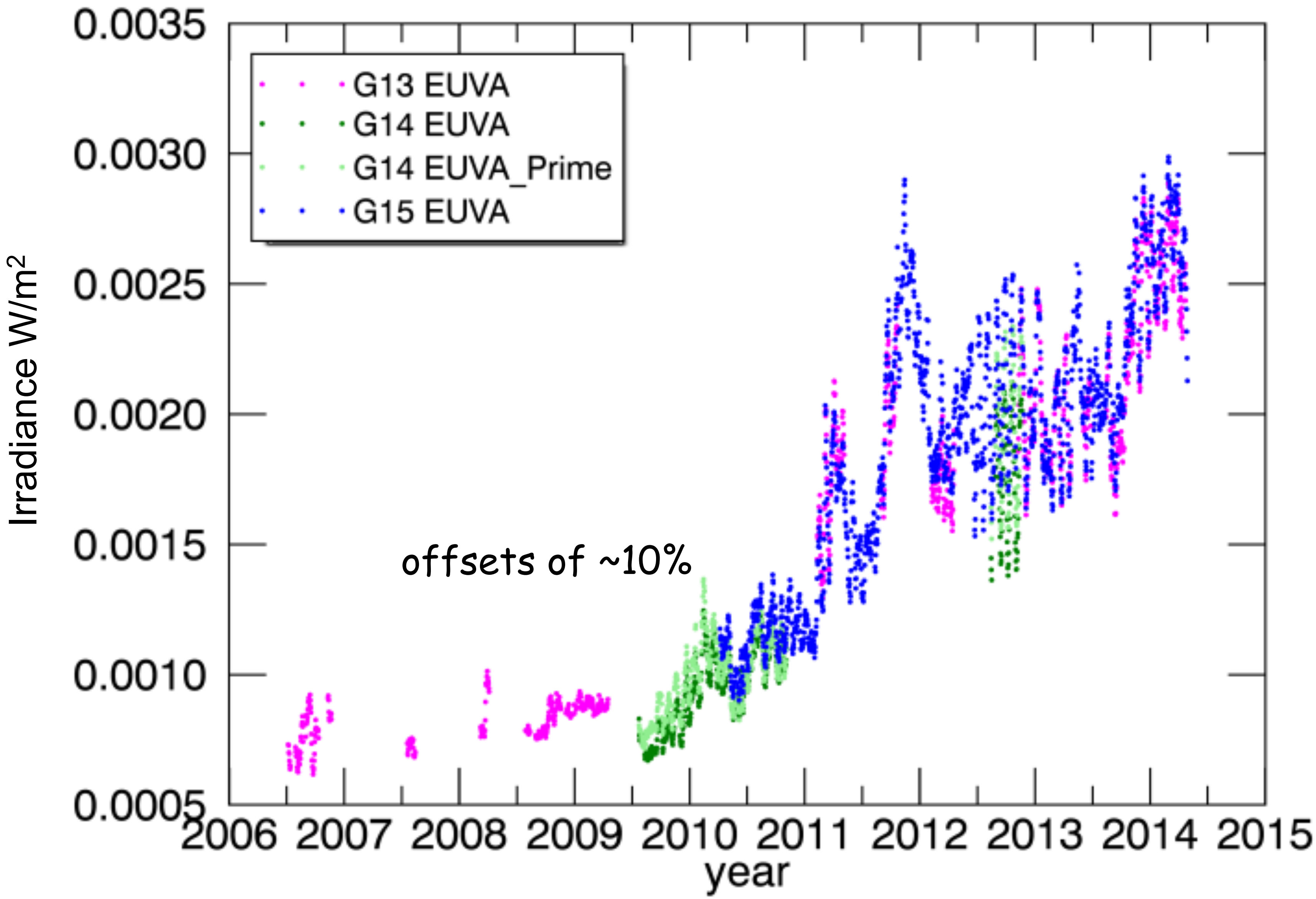
Assume quiet Sun spectrum (NRL or WHI).

Comparisons with other instruments apply factor to account for fraction of bandpass.

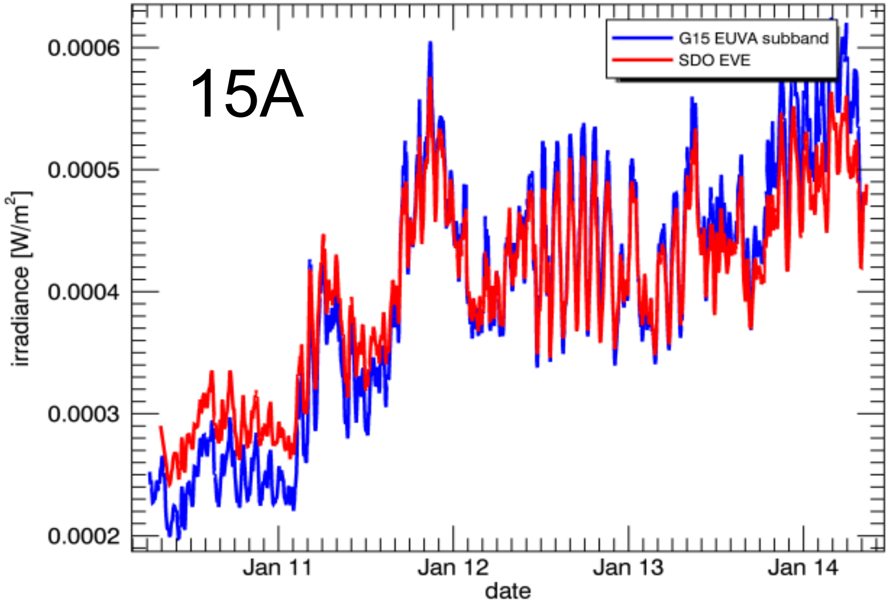
GOES EUV-A Bandpass

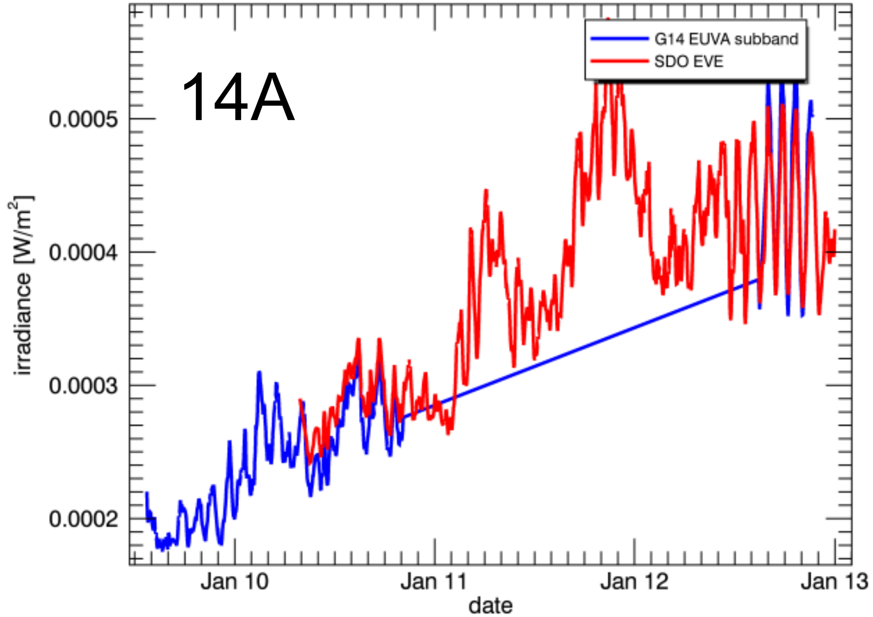


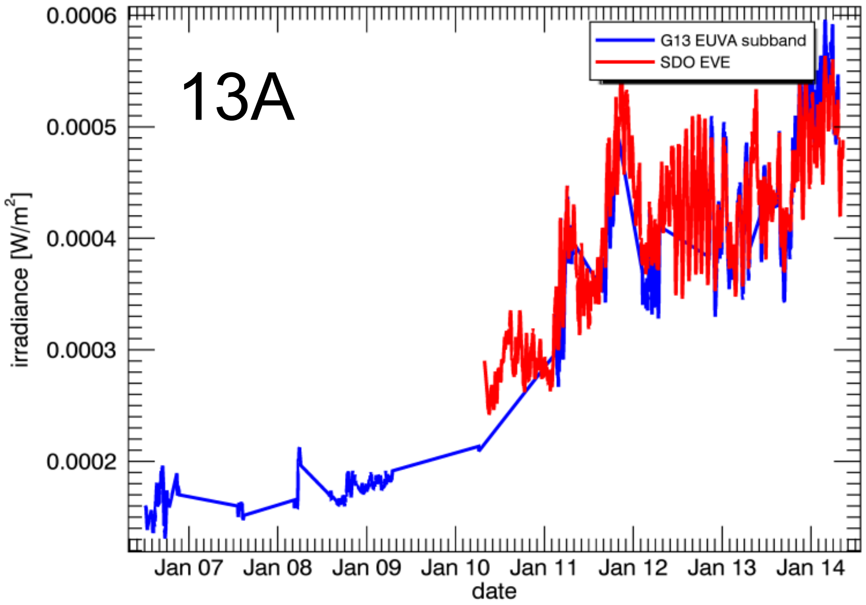
GOES EUV-A Irradiances

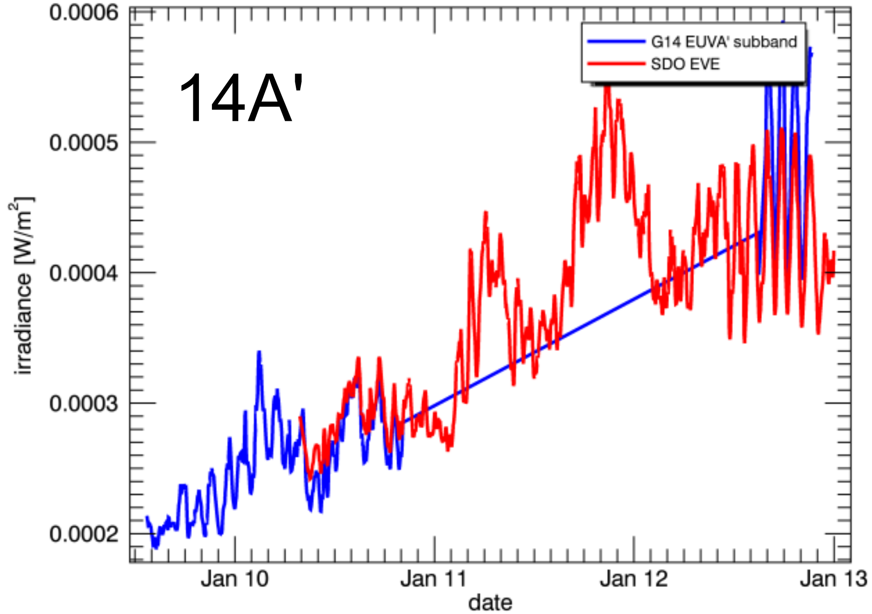


GOES A and EVE 'GOES-A band'

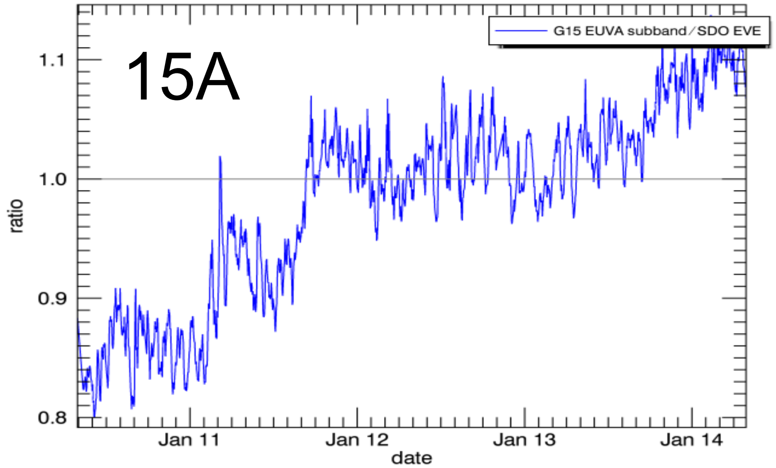


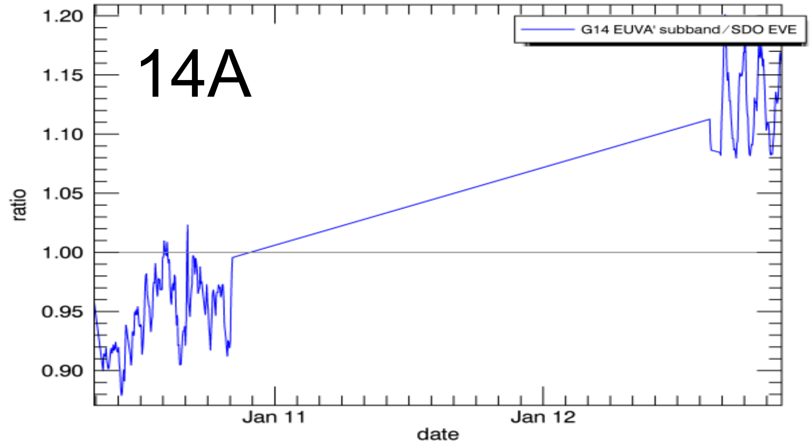


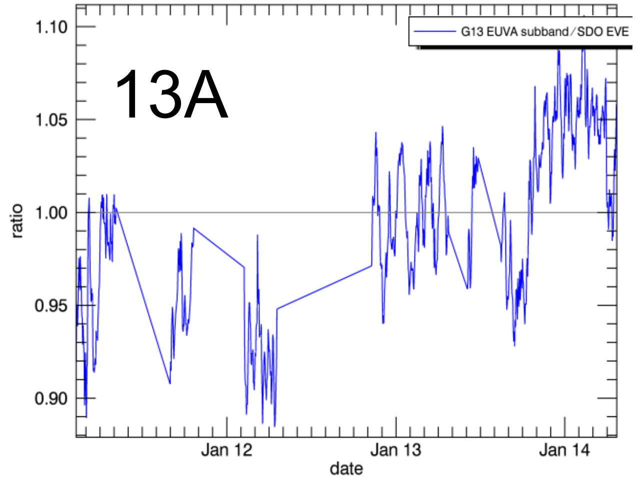


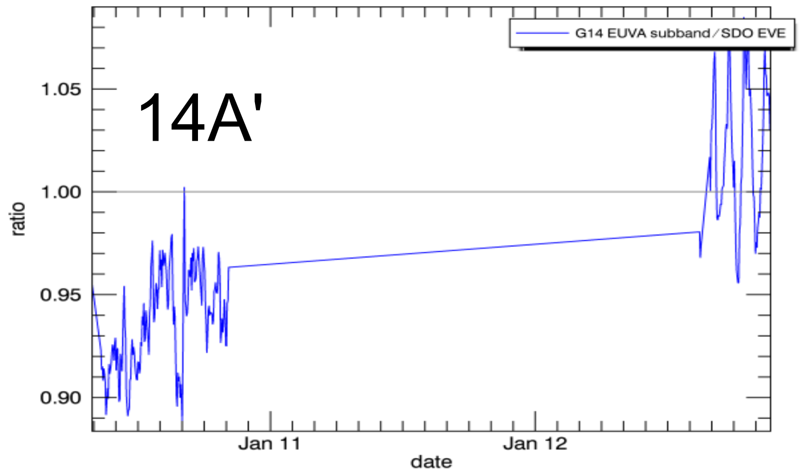


Channel A Ratios: GOES/EVE



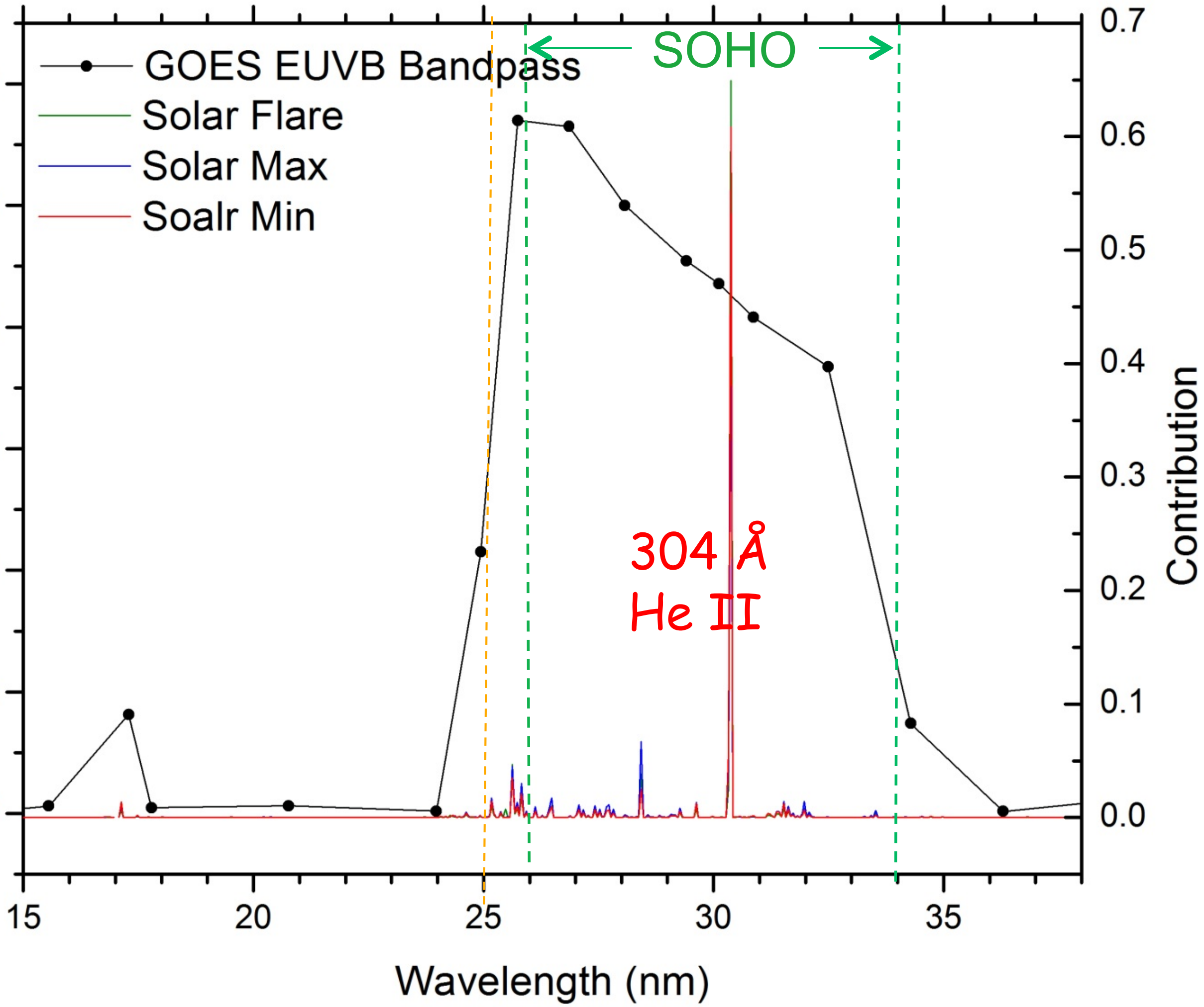






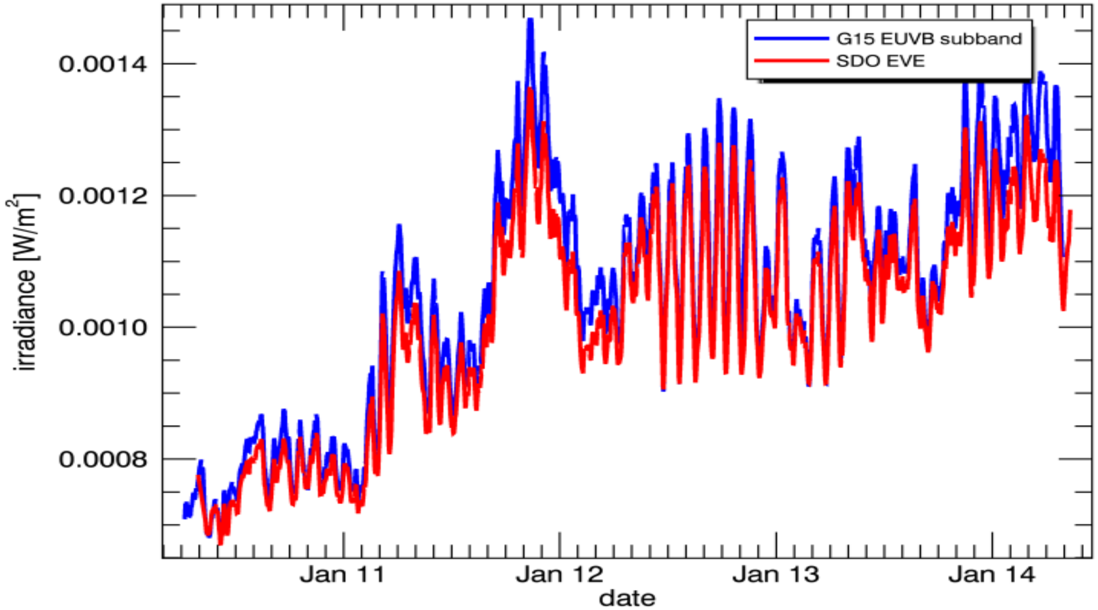
Channel A has a trend relative to EVE.
Discrepancies of 10% between channels, notably 14 A and A'.
A has smaller signal than other channels.

GOES EUV-B

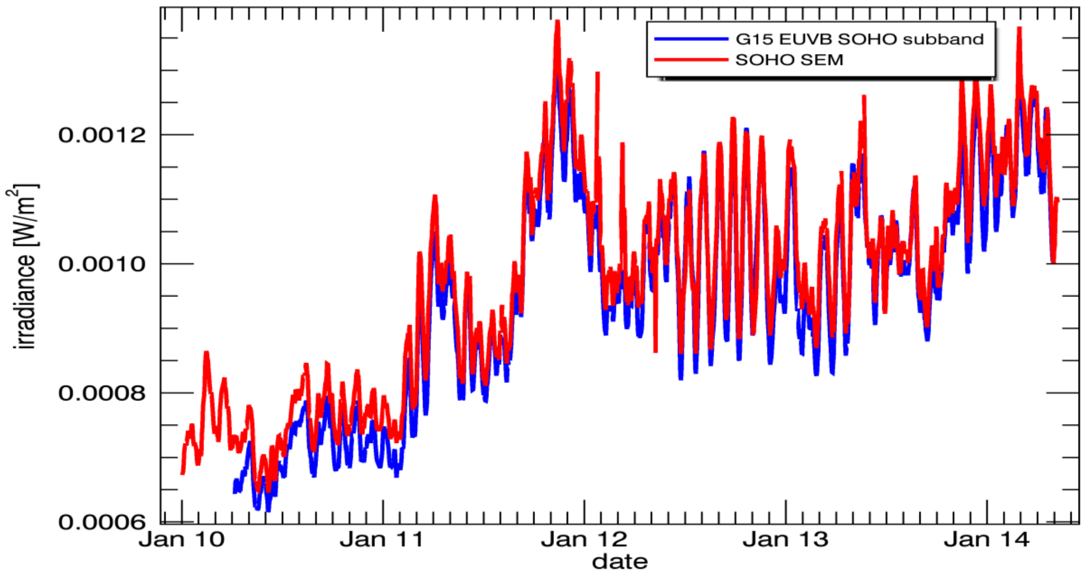


Comparisons
SDO EVE "GOES-B" (25-34 nm), SOHO SEM (26-34 nm)

GOES EUV-B



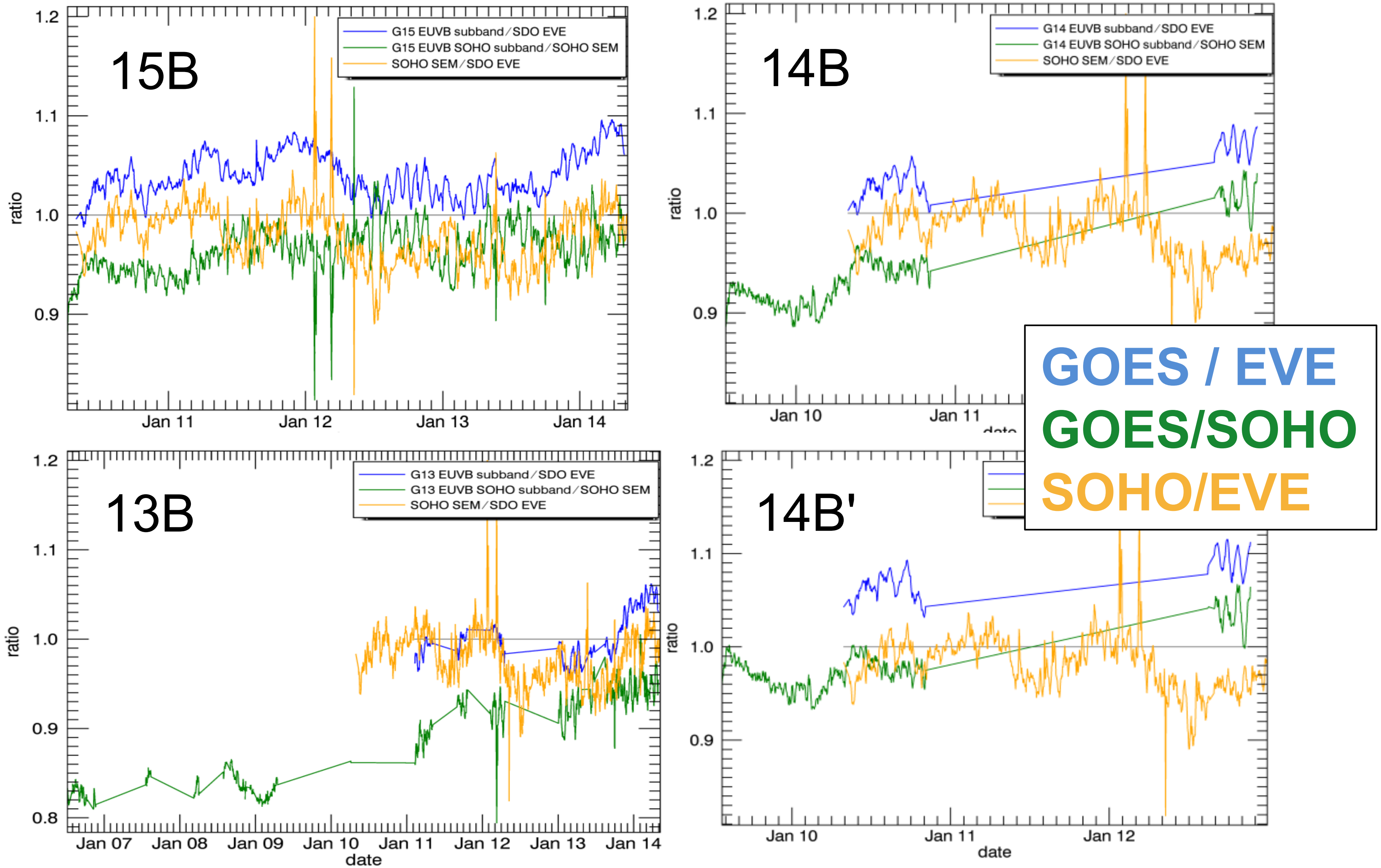
GOES 15
SDO EVE



GOES 15
SOHO SEM

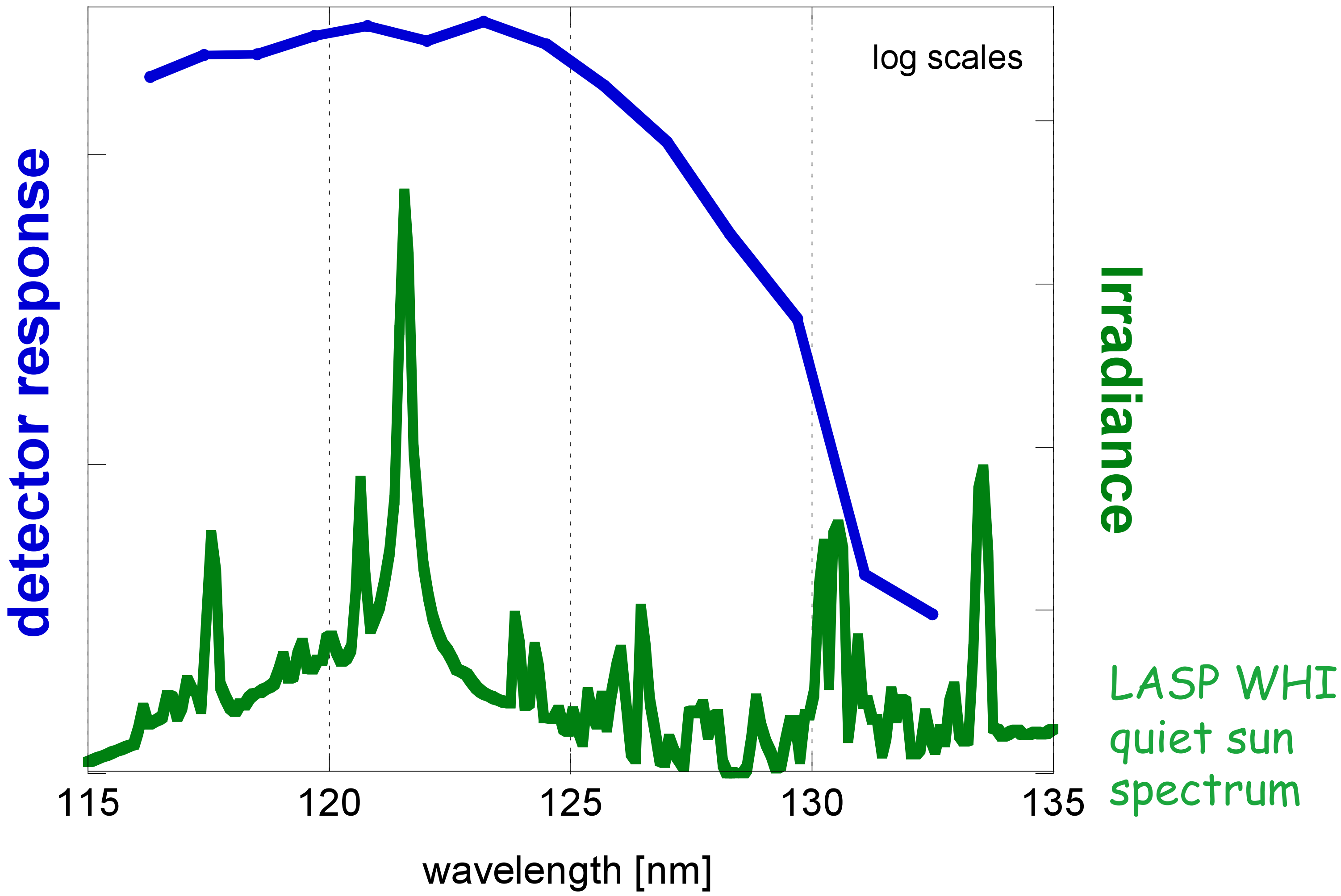
offsets of ~5-10%

Irradiance Ratios for Channel B

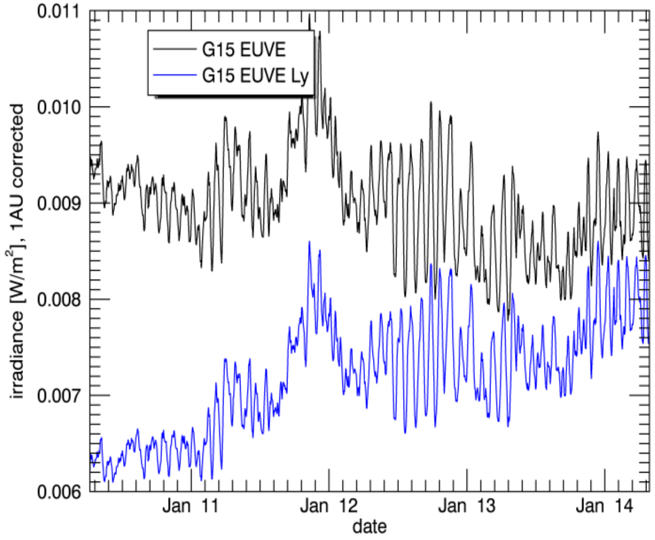


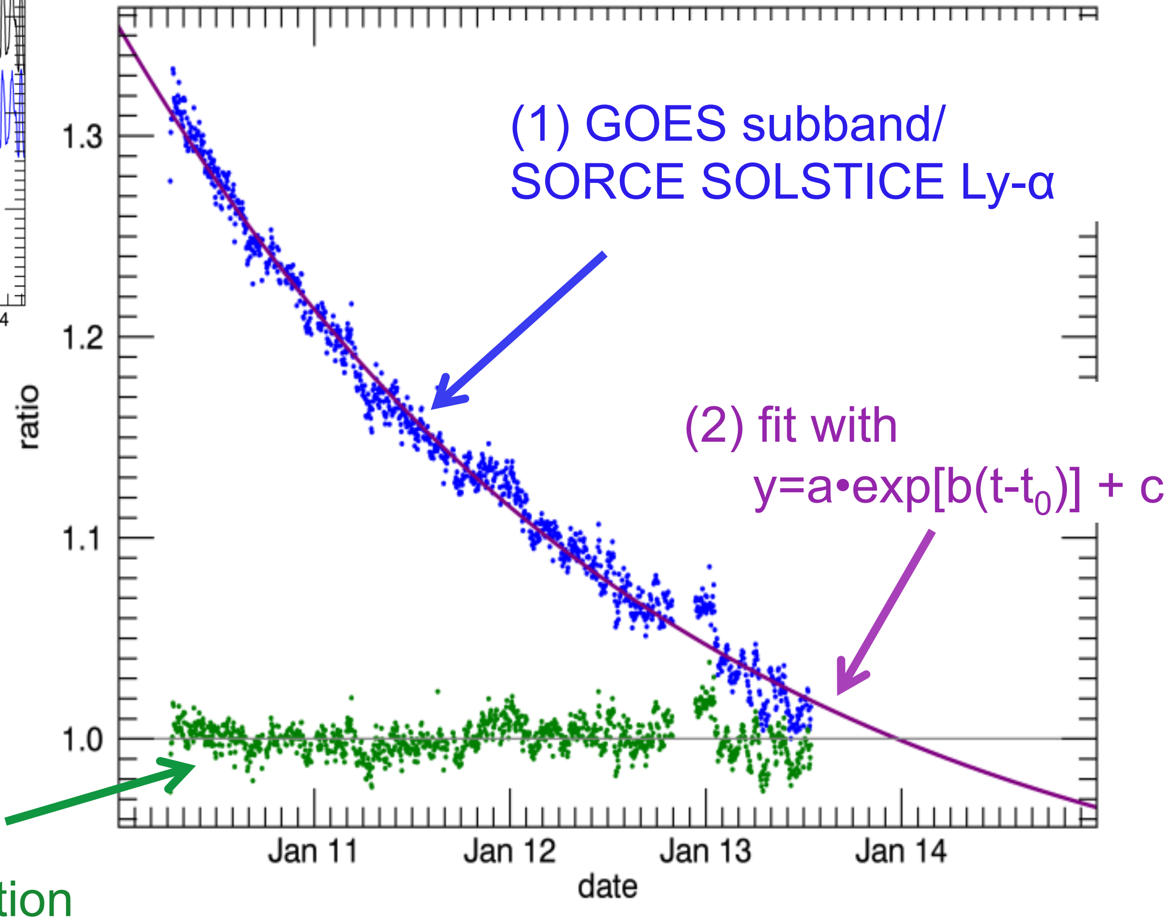
Channel B discrepancies <±10% except for early GOES 13.

GOES EUV-E (Lyman α, 121 nm)

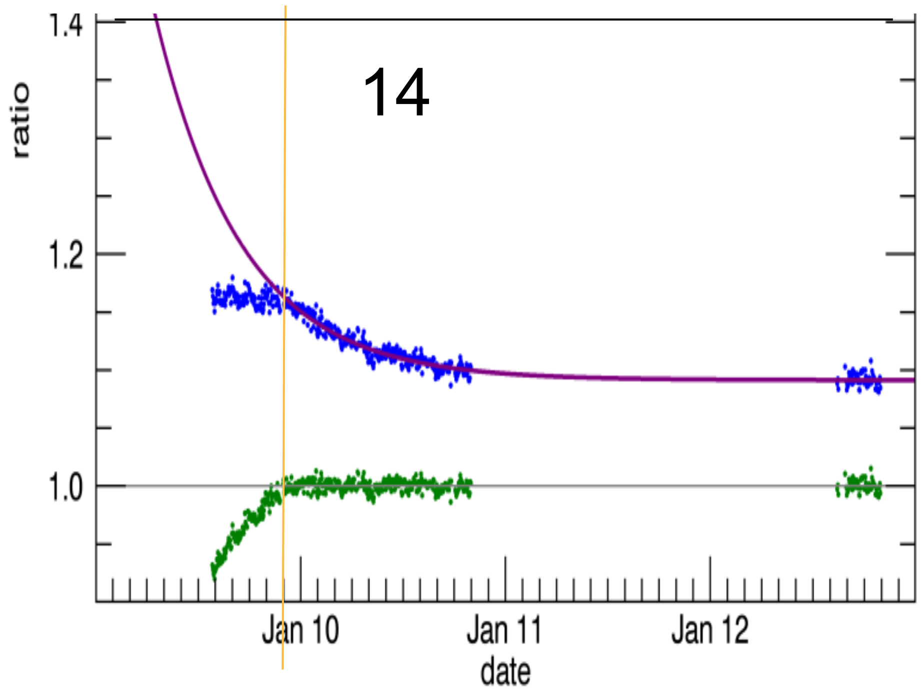


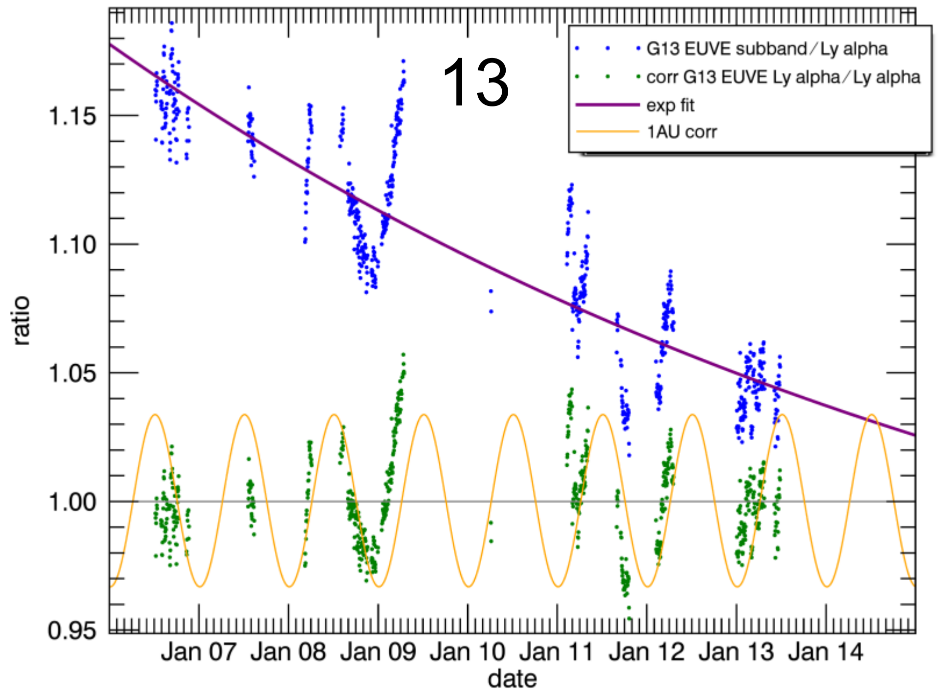
GOES EUV-E (Lyman α, 121 nm)





GOES EUV-E





	noise relative to SOLSTICE	after: 1 year	2 years	5 years
GOES13	systematic ±5% (after fix ±2% ??)	3%	5%	10%
GOES14	±2%	6%	7%	7%
GOES15	±2%	13%	22%	35%

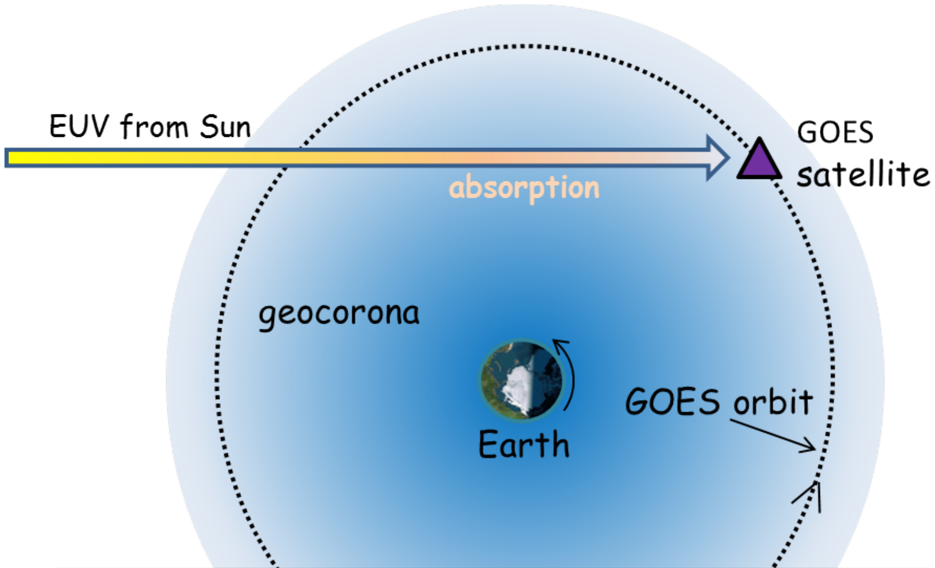
Channel E offsets <±2% for GOES15 and most of GOES14.
Need to resolve issues with GOES13.

Geocoronal H density from Lyman-α

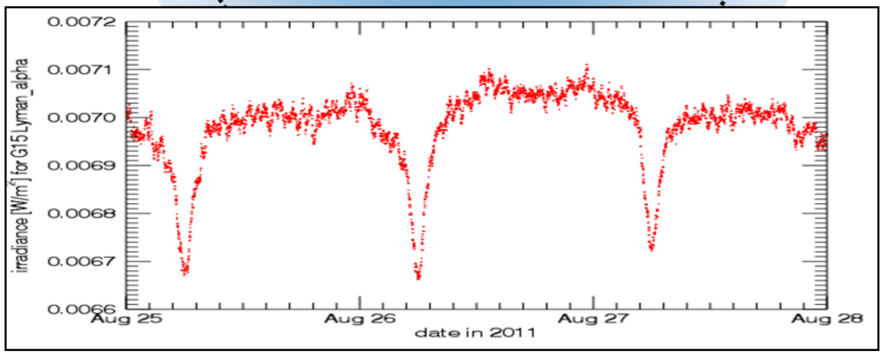
Geocorona: H cloud from 500-10,000+ km.

At equinoxes, absorption dips

- roughly 6%.
- last 3 hours per day.
- cause 1% change in daily avgs.



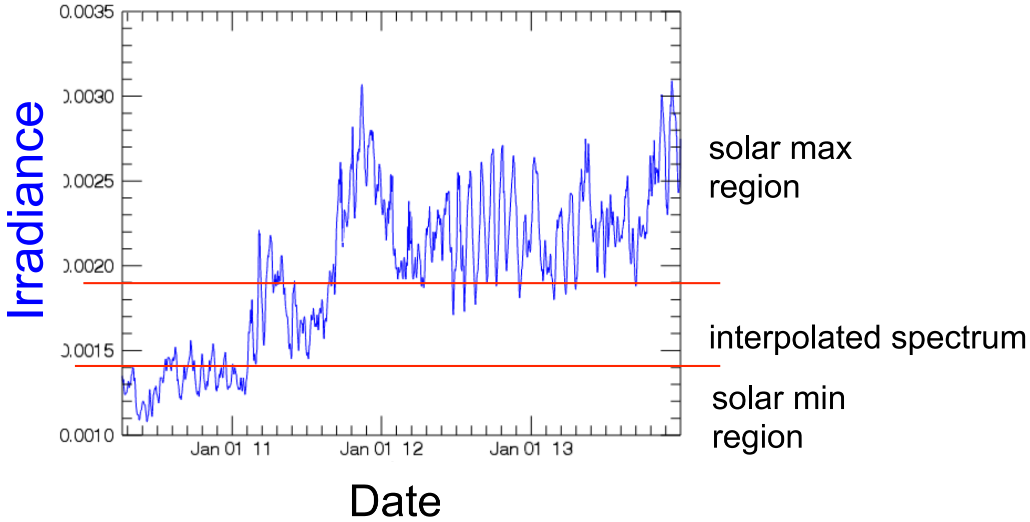
- Determine H density distribution.
- Useful for
  - upper atmospheric models (exospheric H expected to rise with tropospheric methane)
  - ring current models (decay due to charge exchange with geocoronal H)
  - satellite drag models

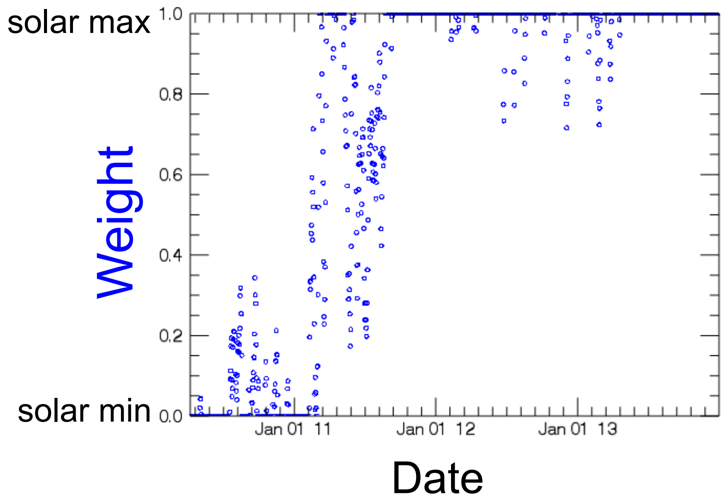


Does a variable solar spectrum improve comparisons? (1/2)

Weighted reference spectrum

- Set irradiance thresholds for pure solar min or max ref spectra.
- Interpolate in between.

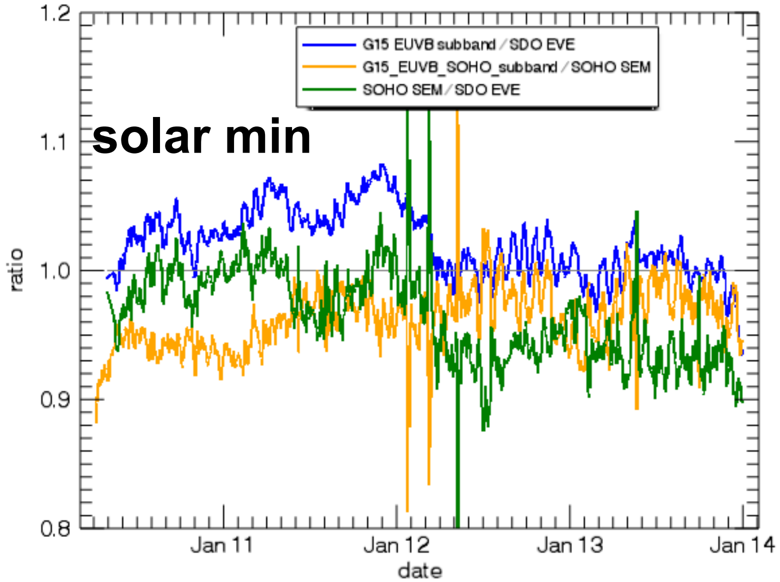




Does a variable solar spectrum improve comparisons? (2/2)

Results from a weight reference spectrum

- ChA vs EVE - negligible
- ChB vs EVE – negligible
- ChB vs SOHO – better

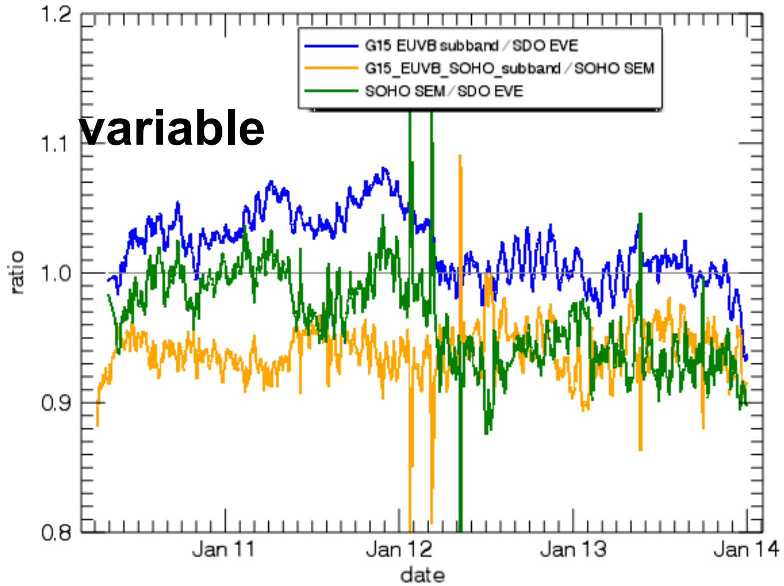


Explanation

- Conversion factor (A→W):
  ∑(irrad*detector_response) / ∑ irrad

- Comparisons use subband factor:
  ∑ irrad_over_subband/∑irrad

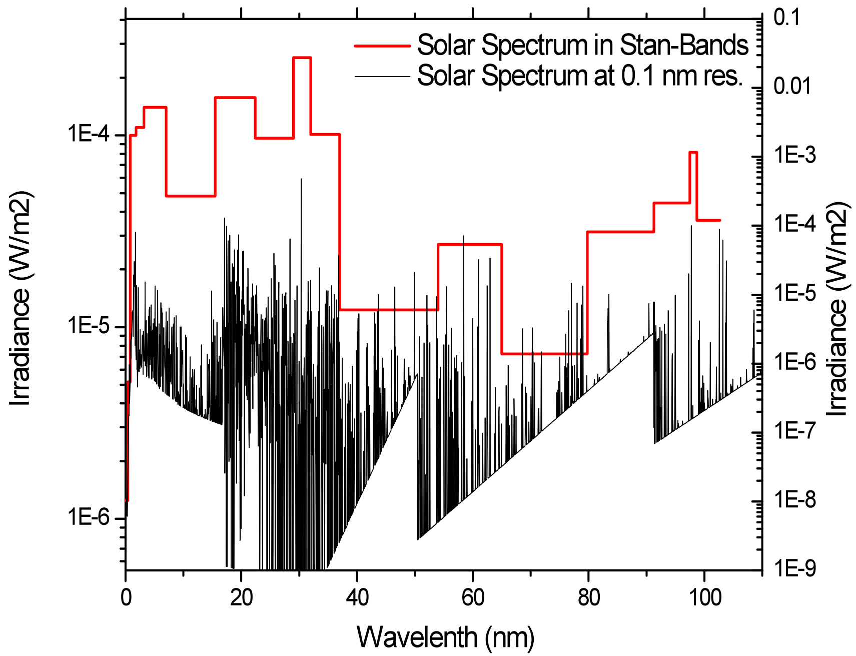
- Full band irradiance may increase by 10% at higher activity, but sometimes cancelled by increased subband factor.

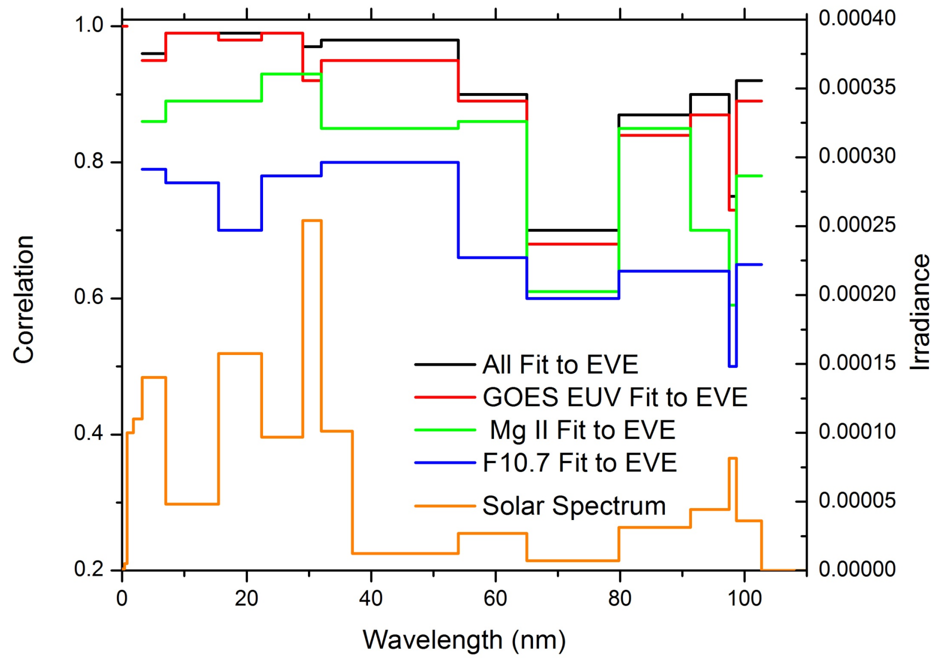


EUV Irradiance Proxy Model: "Stan" Bands

(Viereck) Use the GOES data, F10 and Mg II, to reproduce the SDO EVE data in the Stan-band wavelengths (Solomon and Qian). Similar to FISM and how GOES-R EUVS.

$SB(daily) = C_0 + C_1 * MgII + C_2 * MgII\_smooth + C_3 * F10.7 + C_4 * XRS\_Short + C_5 * XRS\_Long + C_6 * EUVA + C_7 * EUVB + C_8 * EUVC + C_9 * EUVD + C_{10} * EUVE$





Daily proxy works well.

1 minute proxy still being improved. Does not use Mg II or F10.7.

Further work

- Consider other reference spectra.
- Define more accurate bands for comparisons with other instruments.
- GOES13 Lyman-α: Resolve seasonal fluctuations and scale factor. Determine cause of degradation.
- How should we apply reference spectra that vary with solar activity? Especially to look at flares.
- Create flags for years prior to 2010.
- Geocoronal absorption dip – flag 1 min data, exclude dips in daily avg
- Derive uncertainties for the data.
- Combine GOES 14 duplicate A and B channels.
- Process Channels C and D on GOES 13 and 15.
- Create composite with data from all three satellites.
- Automate file creation.

How to minimize degradation risks

- Duplicate filters/channels when possible.
- Launch multiple satellites... one every few years, to update cals.
- Rocket underflights.
- Don't use multi-layer filters (Acton Labs Lyman-α).
- Produce flags for when satellite is doing calibrations, etc.
- Provide access to housekeeping data such as temperatures.
- Make sure housekeeping data has adequate resolution.
- Ensure that other instruments do not impact neighbors.
- Require that instrument take measurements at least every 6 months.