# SSIAMESE

## Progress on the Lyman-α Composite

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SIST Meeting
8 - 9 May 2018

# LASP Lyman-α composite: construction

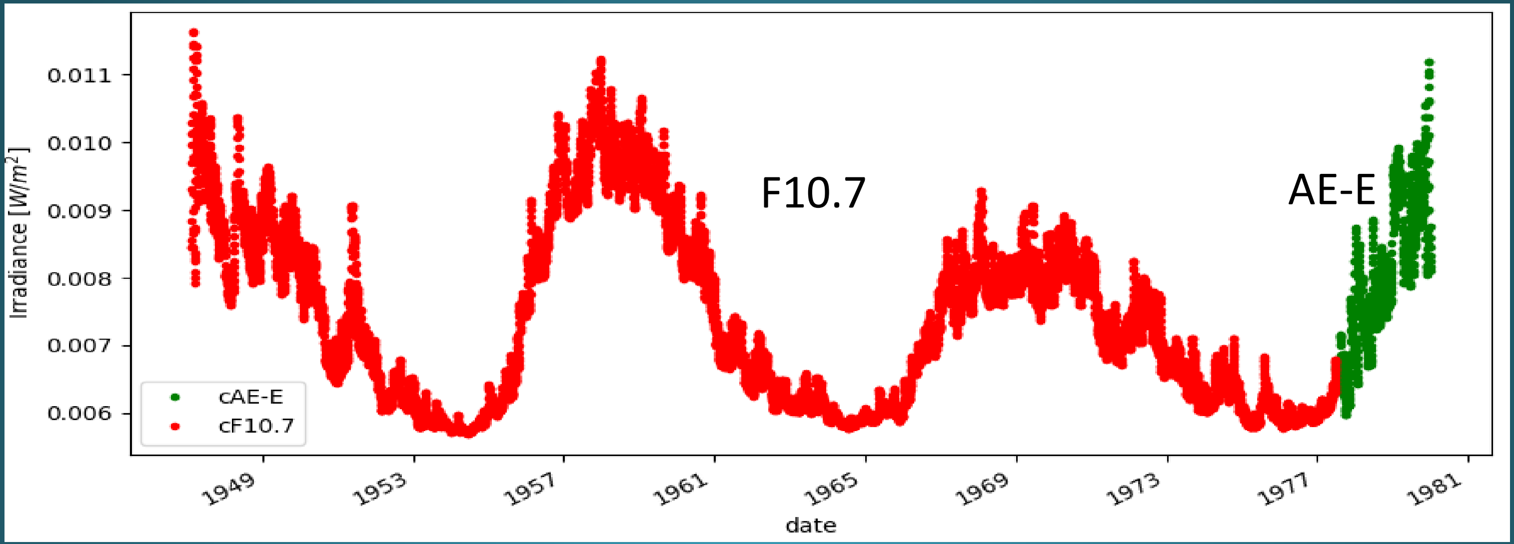
- Woods, Tobiska, Rottman, Worden (2000) "Improved solar Lyman-α irradiance modeling from 1947 through 1999 based on UARS observations", JGR.
- Scaled to average of UARS SOLSTICE and SUSIM.
- Approximate uncertainties of Lyman-α:
  - AE-E 30%, SME 40%
  - UARS SOLSTICE 5%, SORCE SOLSTICE 4%
- Proxies used:

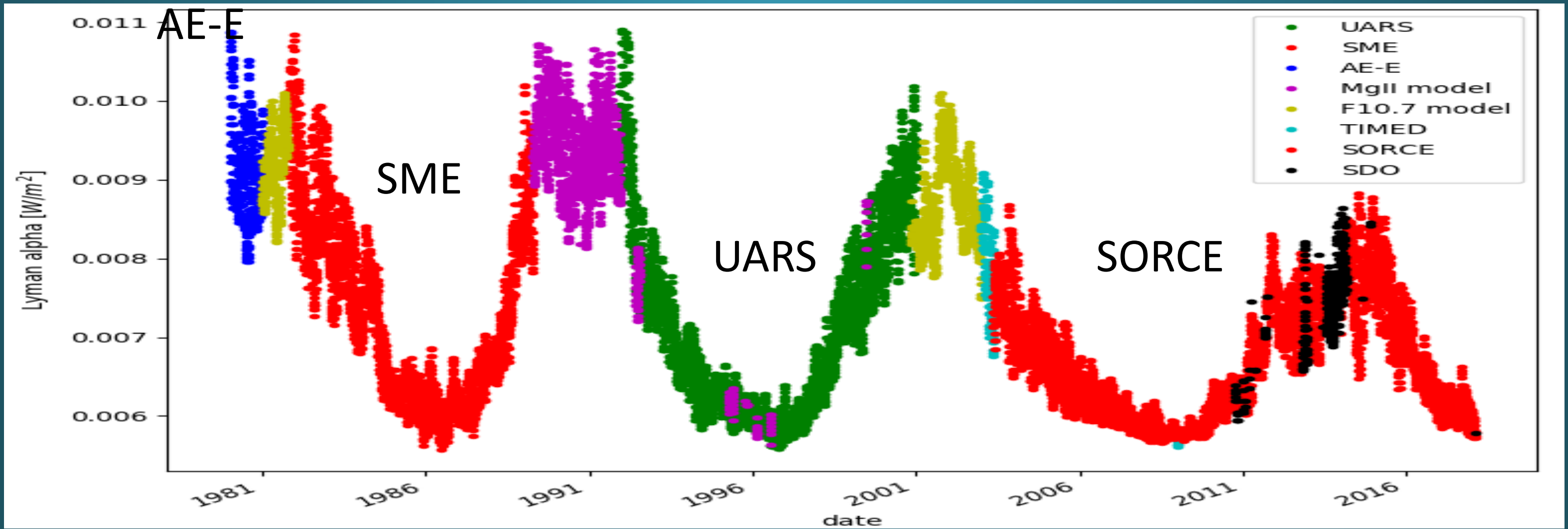
$$\text{Lyman-}\alpha\ (\text{Mg II}) = a + b\cdot Mg_{81} + c \cdot (Mg - Mg_{81})$$

$$\text{Lyman-}\alpha\ (\text{F10.7}) = a + b\cdot \sqrt{F10}_{81} + c \cdot (\sqrt{F10} - \sqrt{F10}_{81})$$

- Expanded to include SEE, EVE, and SORCE SOLSTICE (with daily rebuilds of that data).

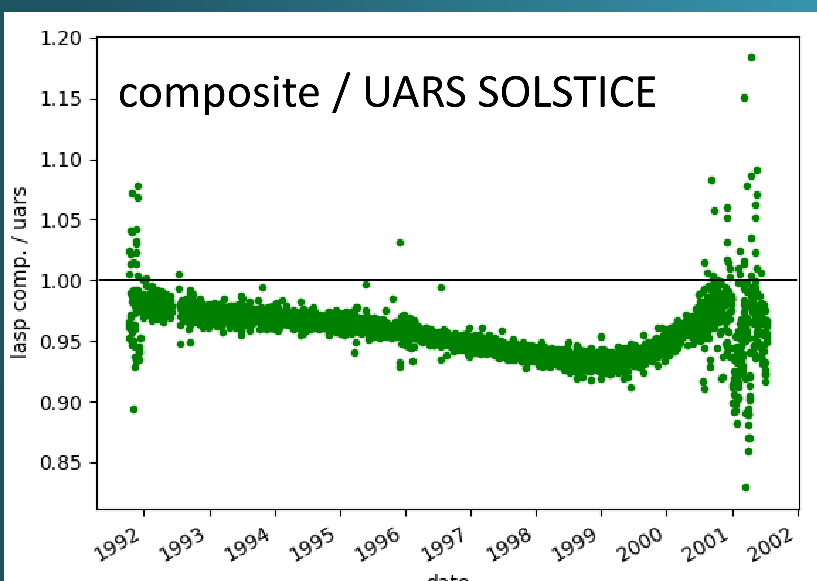
# LASP Lyman-alpha composite

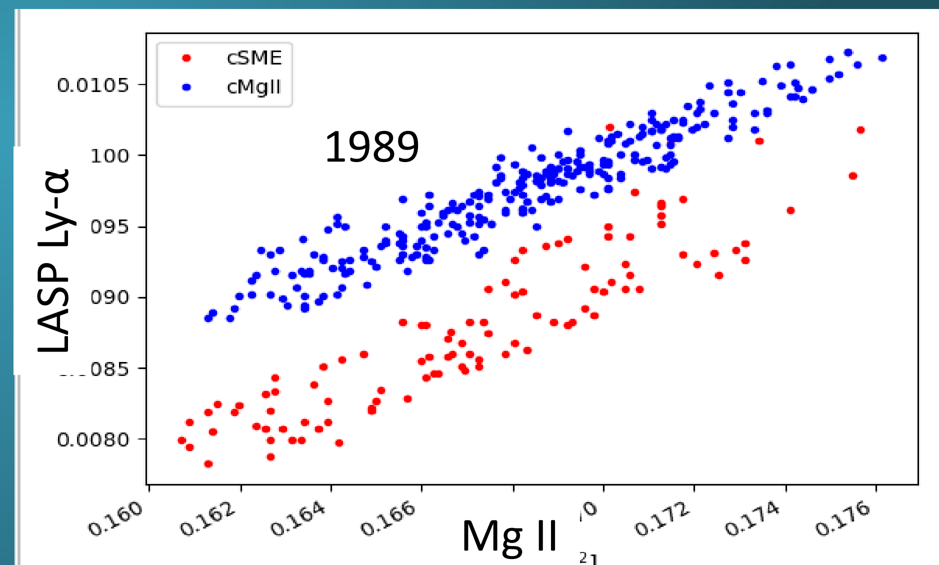


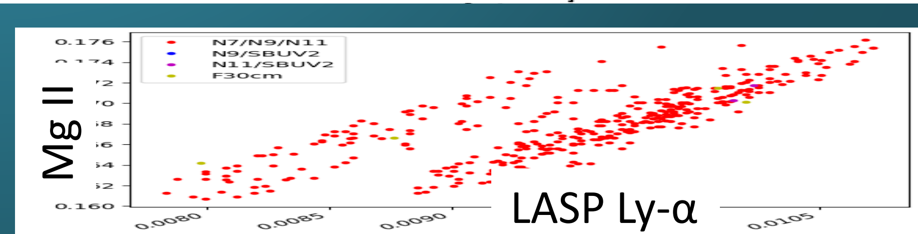



# Why update the Ly-a composite?  Examples

- Jumps as data source switches.
  - 1989 switch from SME to the Mg proxy model.
  - 1992 switch from the Mg proxy model to UARS SOLSTICE.
- SORCE SOLSTICE is scaled by ~0.96.



# What is needed for a new composite?

CREATE PROXIES

- Proxies are used as gap fillers and transfer function.
- Select data sets.
- Select function(s) for fits
- Select time period(s) for fits - full mission, rising/falling periods

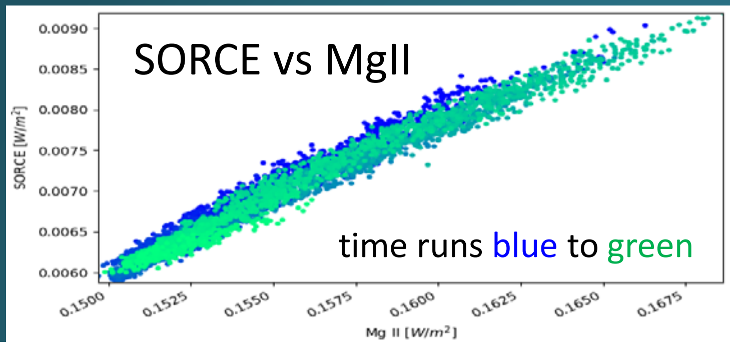
CREATE COMPOSITE

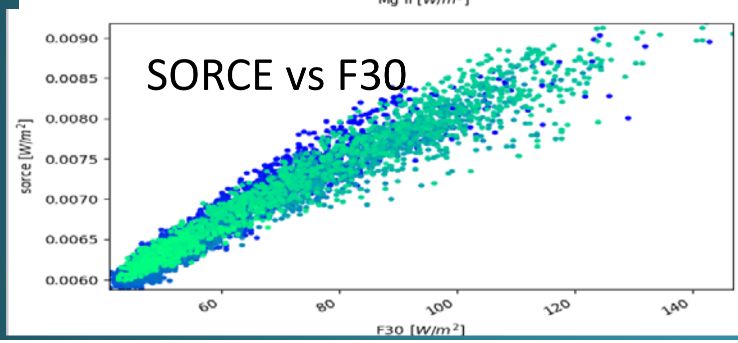
- Select data set or proxies for each time period.
- Select which data sets get scaled.

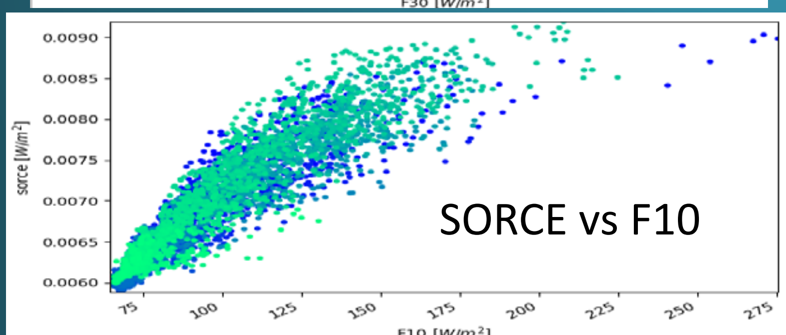
DIFFERENCES IN CONSTRUCTION FROM ORIGINAL

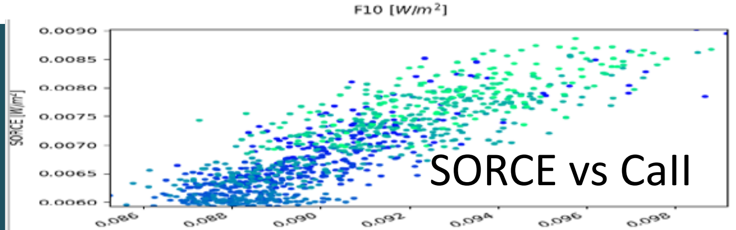
- No 3 day smoothing.
- Exclude short data sets.
- Use Bremen Mg II composite.

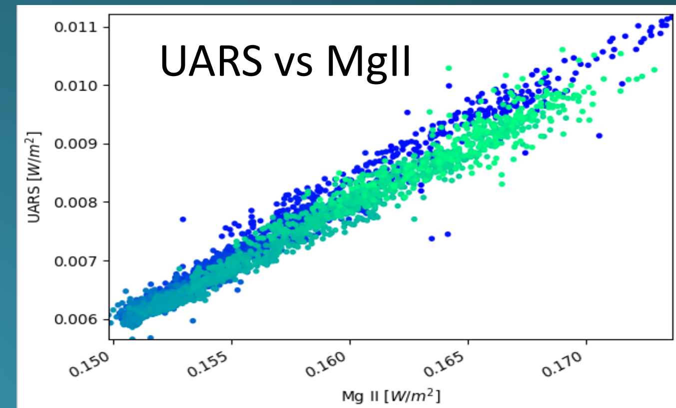
# Meet some potential proxies

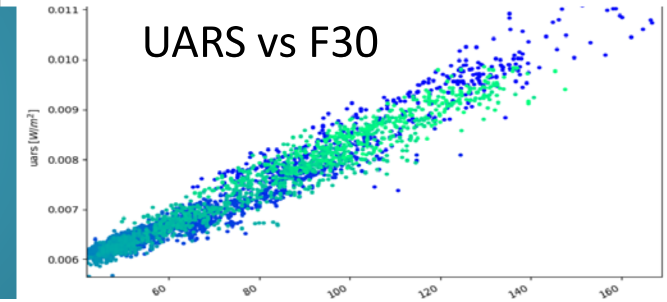


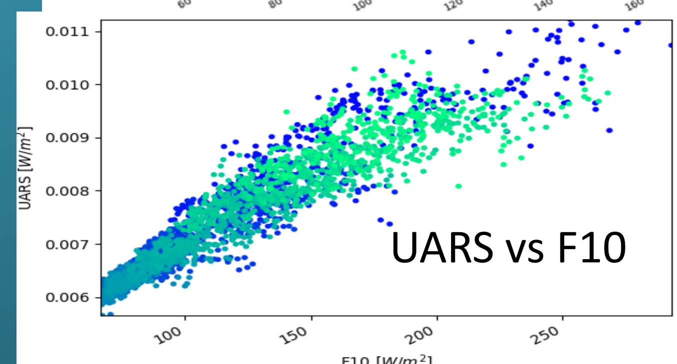



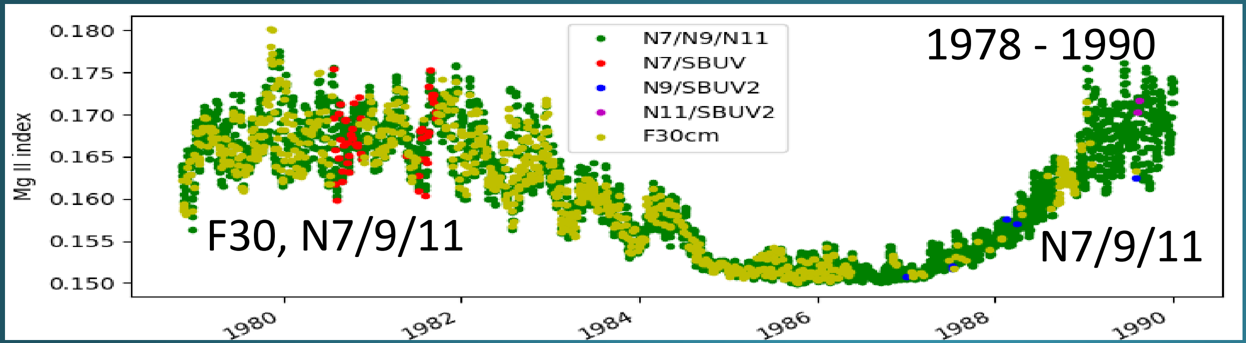



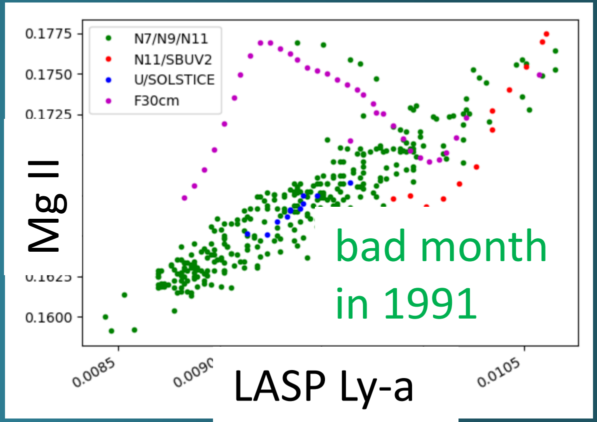



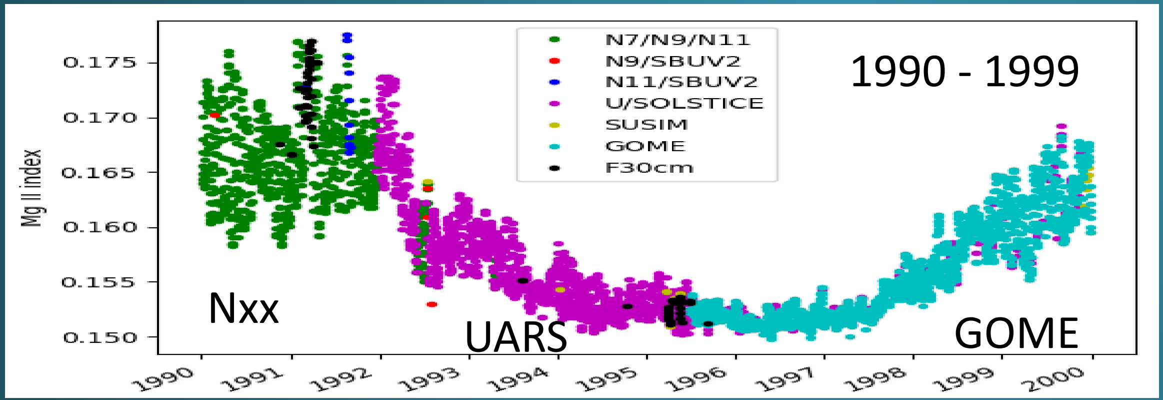



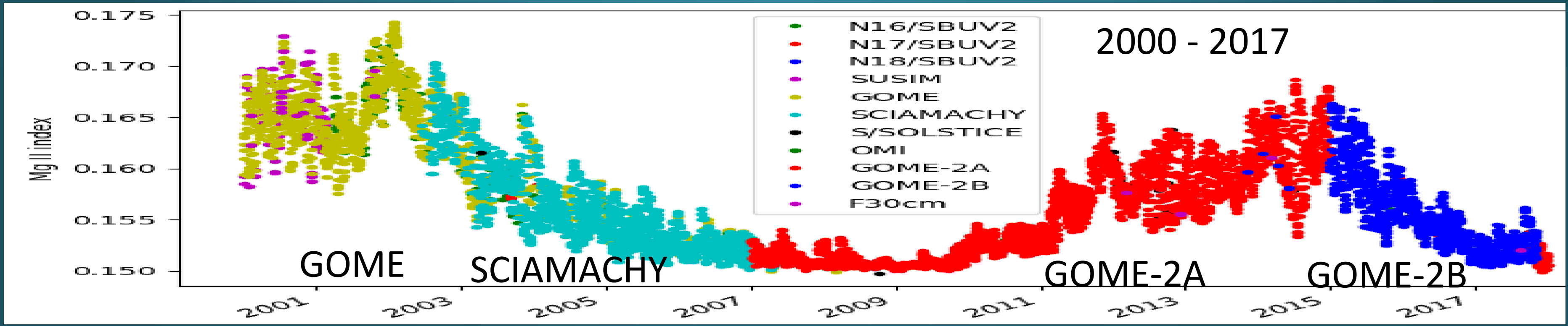



# Bremen Mg II composite



# Some possible proxy functions

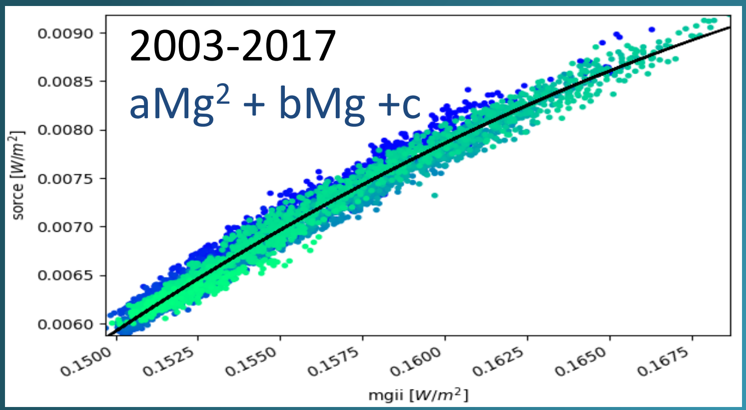
| | | |
|---|---|---|
| **Components** | Ly a | core: transition region, wings: chromospheric |
| | Mg II, Ca II | chromospheric |
| | F30, F10 | various |

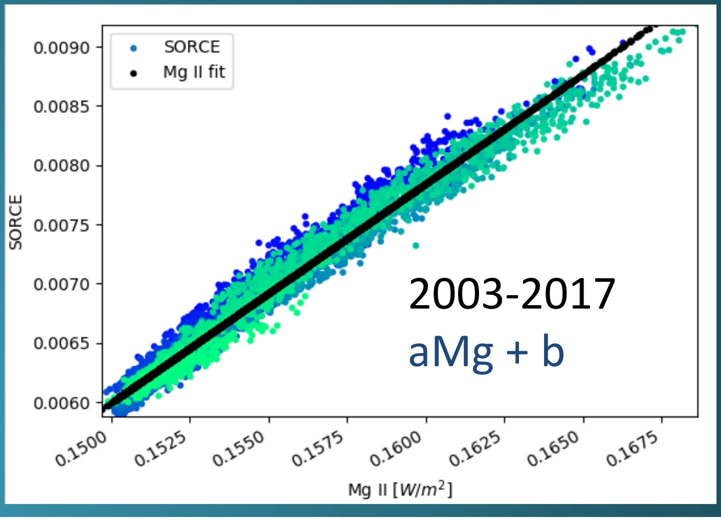
**Functions**

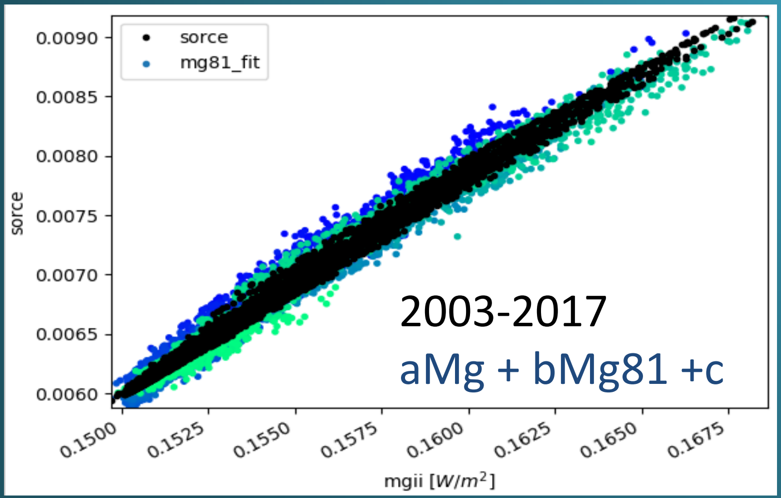
$$\text{Lyman-}\alpha = a \cdot Mg + b$$
$$= a \cdot Mg^2 + b \cdot Mg + c$$
$$= a + b \cdot Mg81 + c \cdot (Mg - Mg81)$$
$$= a \cdot F30 + c$$
$$= a \cdot F30 + b \cdot Mg + c$$
$$= a \cdot Ca + b \cdot Mg + c$$

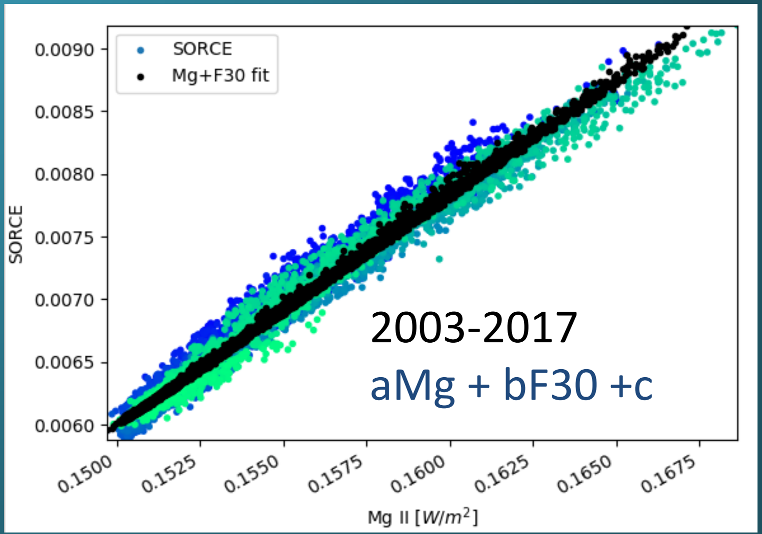
**Time Periods** full SORCE or UARS, GOME 2A, rising/ falling, ...

# Fits to SORCE SOLSTICE



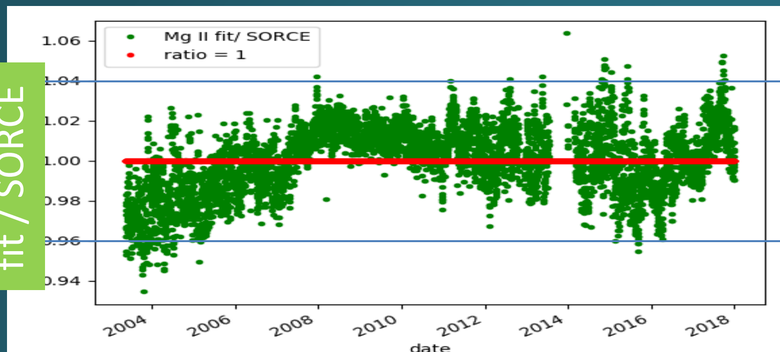
# Statistics of fits to SORCE SOLSTICE

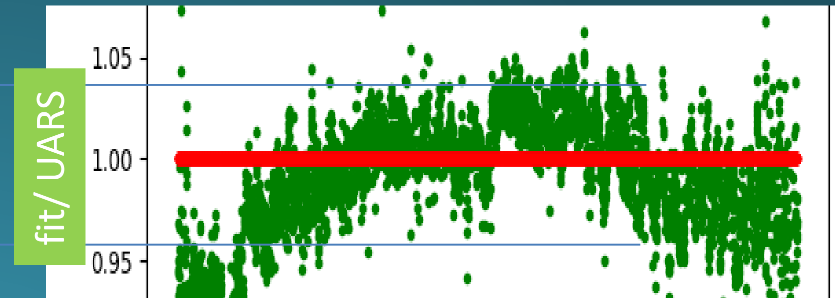
- Pearson correlation coefficient (r) and standard dev are similar.
- Shifted model in Woods et al.(2000) had an s.d. of 2.3%.

| years | proxy fit | Standard deviation for fit | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | $a \cdot Mg^2 + b \cdot Mg + c$ | $a + b \cdot Mg81 + c \cdot (Mg - Mg81)$ | $a + b \cdot MgII$ | $a + b \cdot MgII + c \cdot F30$ | $a \cdot F30 + c$ | $a \cdot Ca\ II + c$ | $a + b \cdot MgII + c \cdot CaII$ |
| 2003 - 17 | same | 1.6% | 1.6% | 1.8% | 1.7% | 2.7% | 5.3% | 1.7% |
| 2003 - 12 | same | 1.7% | 1.6% | 1.7% | 1.7% | | | |
| 2013 - 17 | 2003 - 12 | 1.5% | 1.6% | | | | | |

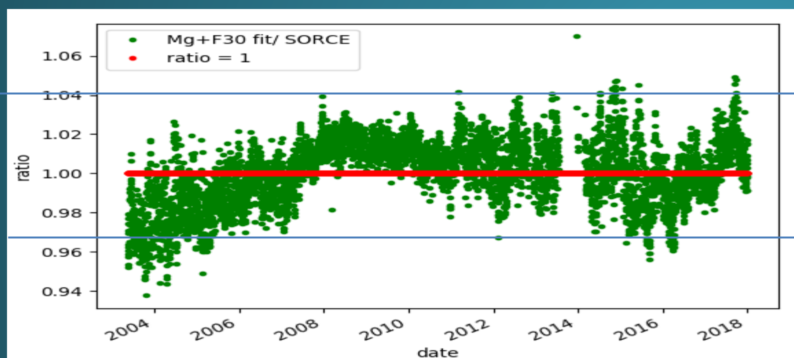
# Fits to SORCE SOLSTICE

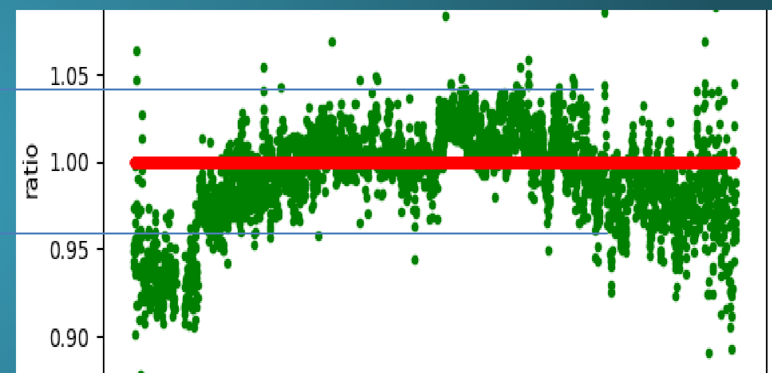
a · Mg + b



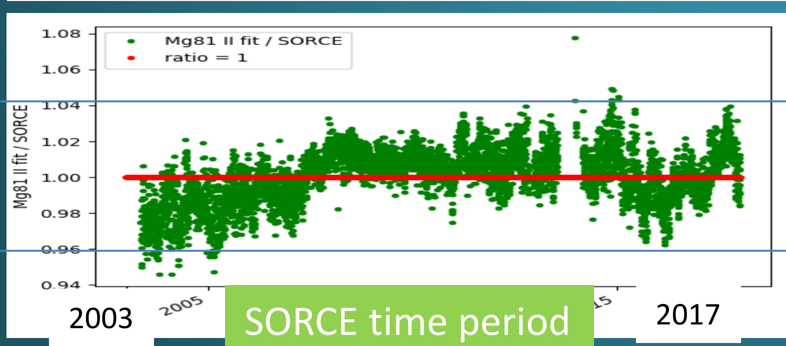



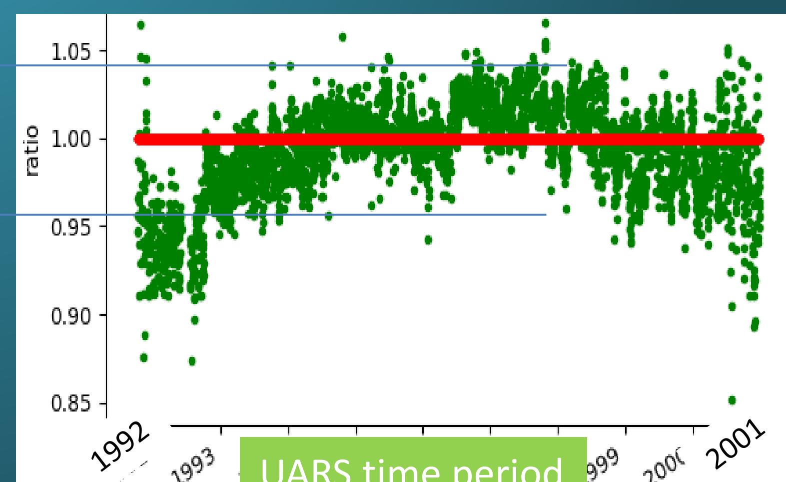

a · Mg + b · F30 + c




a · Mg81 + b · Mg +c



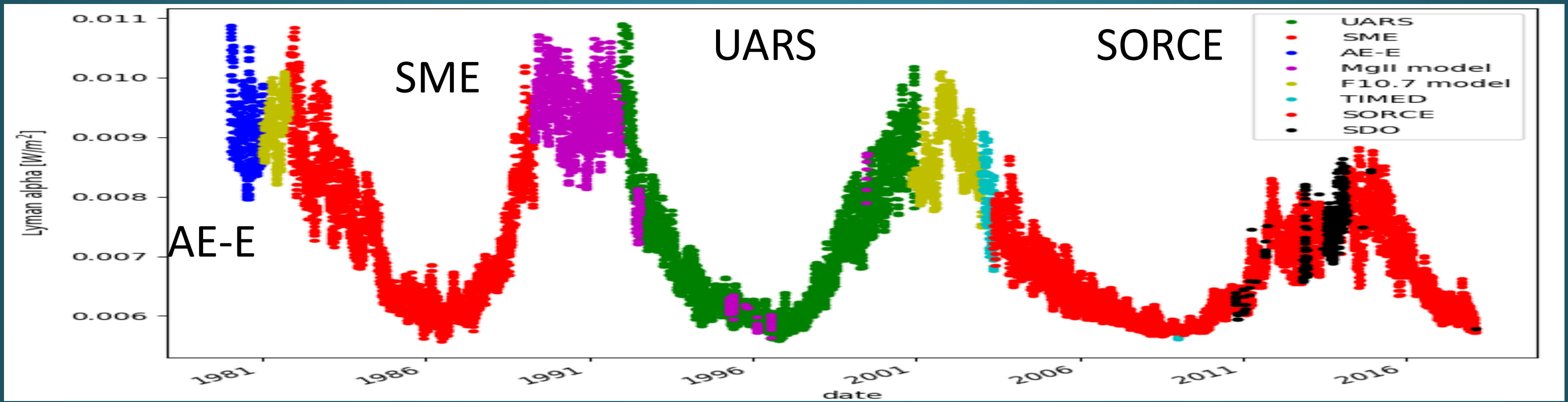



# Build new composite

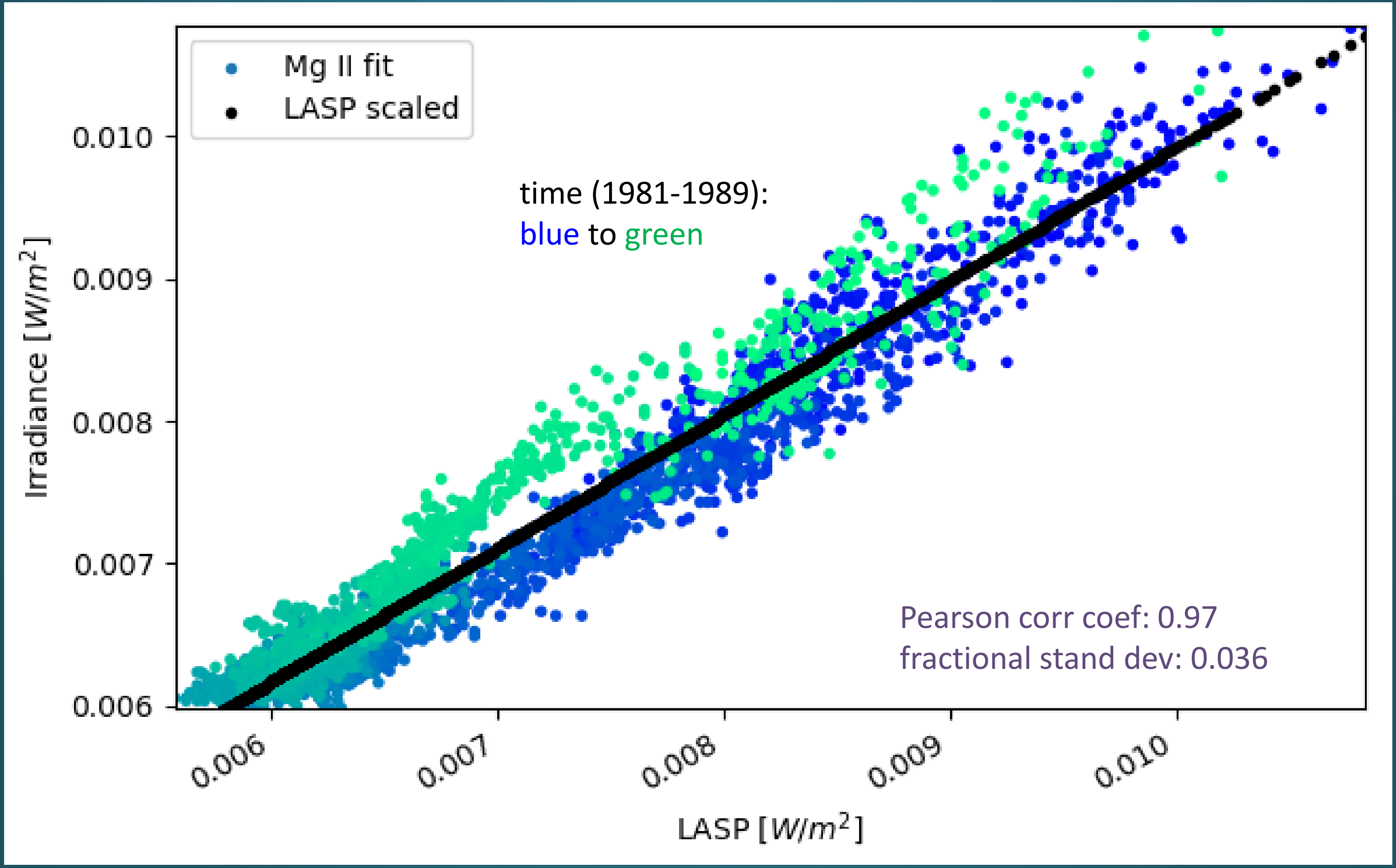
**Lyman-alpha**
- 2003 - 2018 SORCE SOLSTICE
- 1993 - 2000 UARS SOLSTICE

**Proxy to fill in data gaps**
- 1989 - 2018 Mg II scaled to SORCE
- 1991 F30 scaled to SORCE

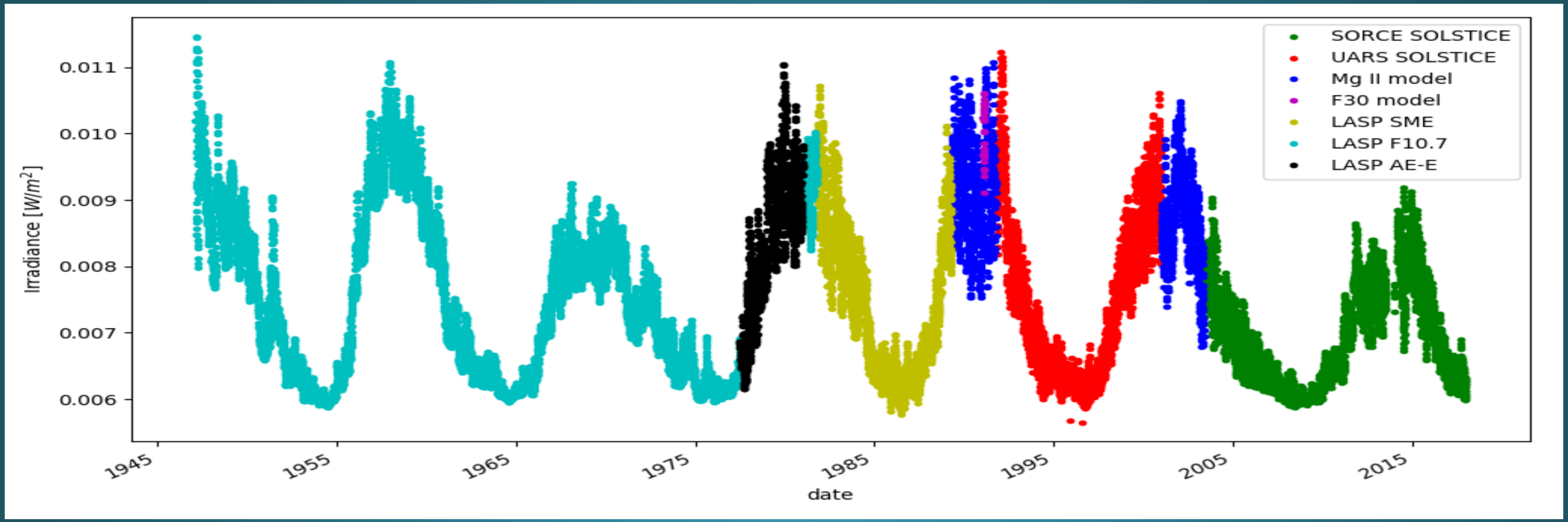
**Scaled LASP Lyman-alpha composite**
- 1947 - 1989 LASP composite scaled to Mg II model over SME period (1982 - 1989)

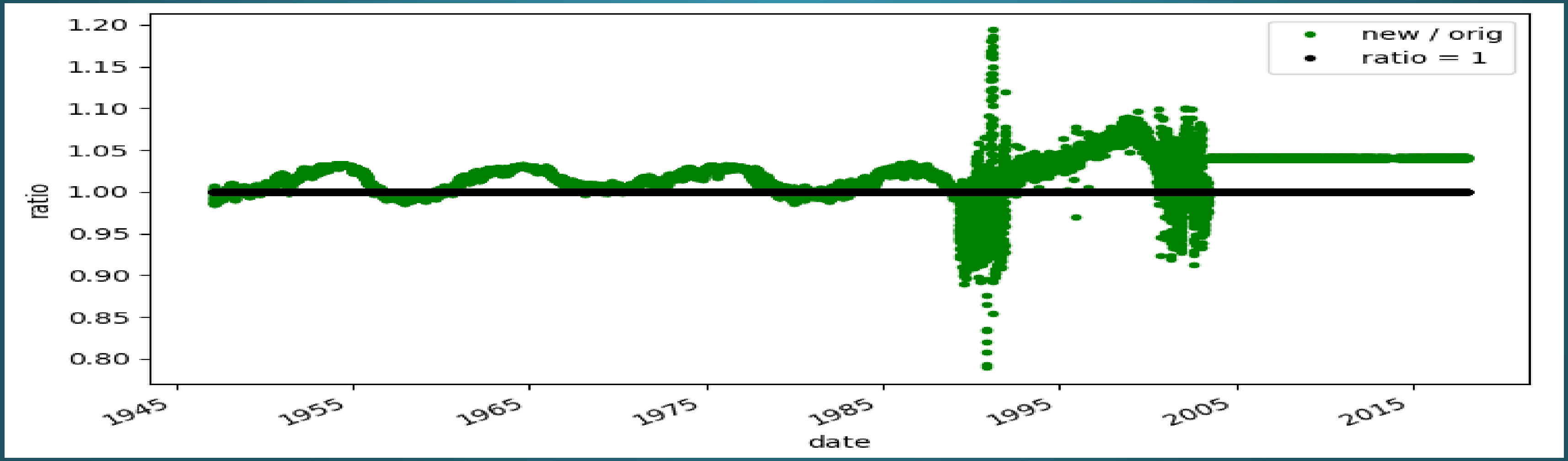


# Fit of LASP composite during SME period to Mg II proxy

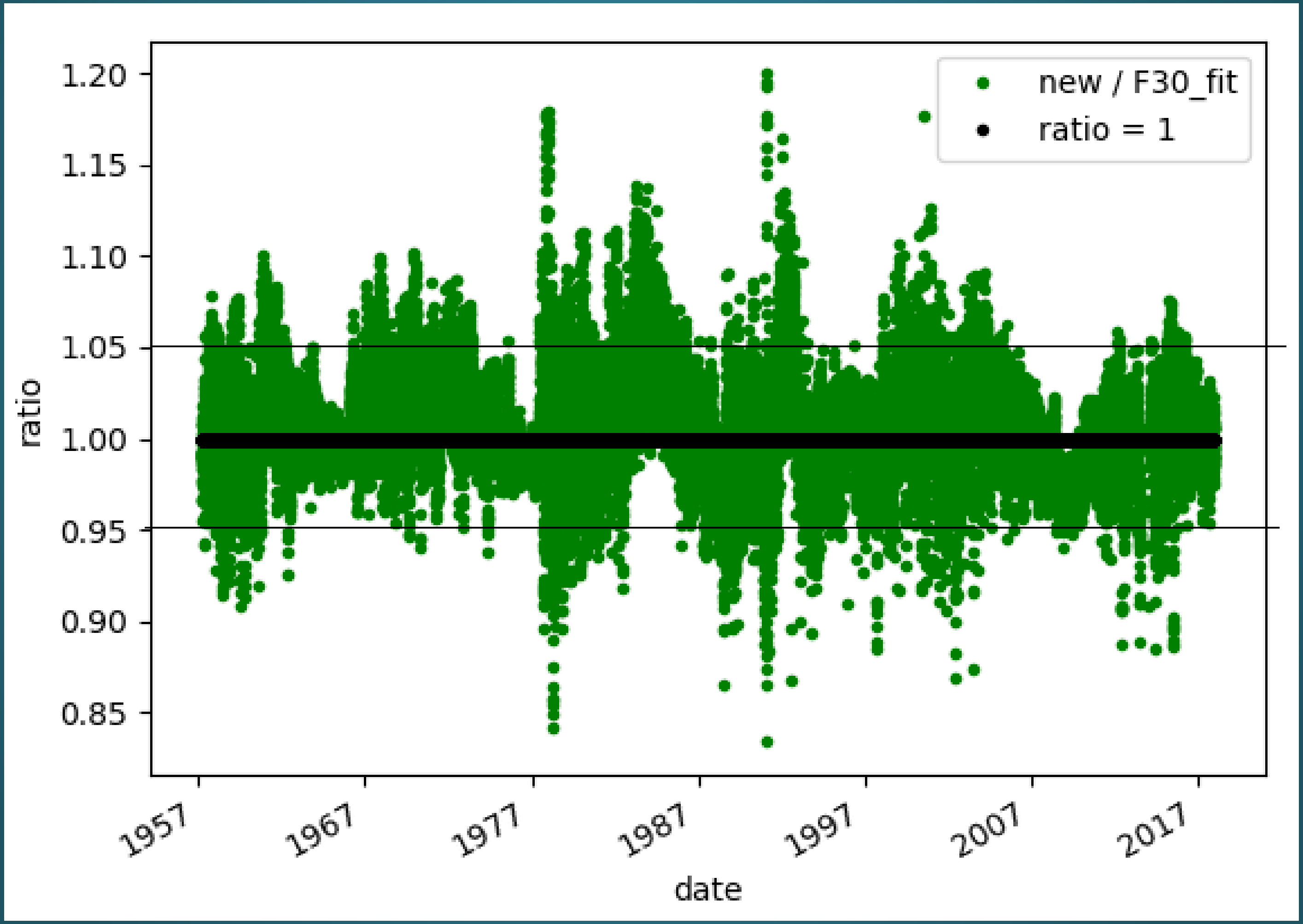


# New Lyman-α Composite



# New Lyman-α composite vs F30 proxy



# Future Efforts

- Adjust composite with any revisions to SME.
- June 18 LASP calibration rocket.
- Adjust composite with any revisions to UARS or SORCE.
- Scale UARS SOLSTICE to SORCE SOLSTICE?
- Add GOES-R series Lyman-α to composite.
- Switch to SSIAMESE Mg II composite.
- Quantify uncertainties.

# backup


OH, HI; I'M HERE FROM THE INTERNET.
WHAT ARE YOU DOING!?
GLUING CAPTIONS TO YOUR CATS.
RRRR

# Data sets

composite_lyman_alpha.csv
  description: LASP Lyman-alpha daily composite
  source: http://lasp.colorado.edu/lisird/data/composite_lyman_alpha/
  other format options: txt, json
  data range: 1947-02-14 to 2018-02-02
  cadence: daily
  adjustments: scaled to 1AU
  download date: 2018-02-03
  version: 3

composite_mg_index.csv
  description: LASP Mg II daily composite
  source: http://lasp.colorado.edu/lisird/data/composite_mg_index/
  data range: 1978-11-06 to 2013-07-15
  adjustments:
  download date: 2018-2-3
  version: 13

sorce_ssi_l3.csv
  description: SORCE SOLSTICE daily Lyman-alpha 1 nm band
  source: http://lasp.colorado.edu/lisird/data/sorce_ssi_l3/
    -- use 'displayed range to get just one wavelength'
  data range: 2003-05-14 to 2018-02-03
  note1: http://lasp.colorado.edu/home/sorce/data/
    -- Ly alone not available, potentially 1 min data
  download date: 2018-2-3
  adjustments:
  cadence: daily
  version: 15

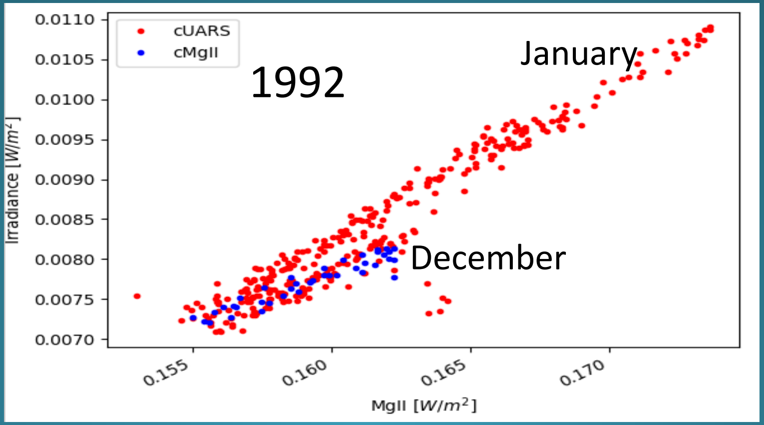
uars_solstice_ssi.csv
  description: 1 nm band around Ly-alpha
  source: http://lasp.colorado.edu/lisird/data/uars_solstice_ssi/
    -- use 'displayed range to get just one wavelength'
  data range: 1991-10-07 to 2001-07-16
  cadence: daily
  adjustments: adjusted to 1AU
  download date: 2018-2-3
  version: 18

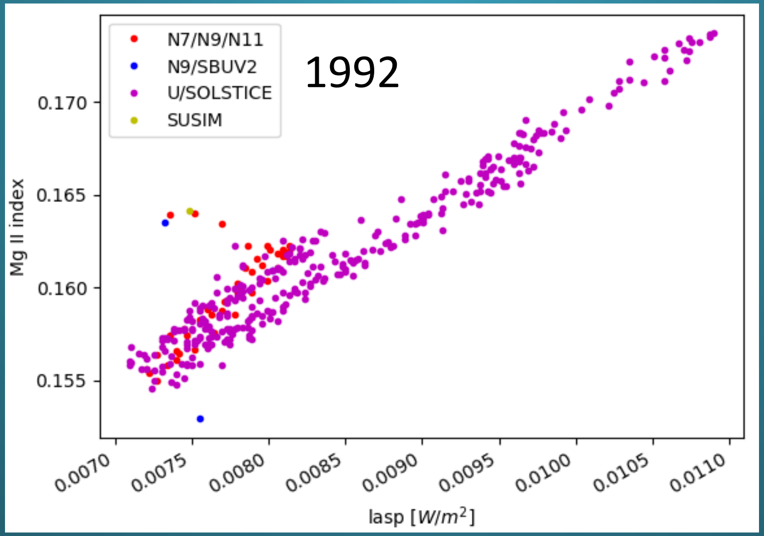
MgII_composite_Bremen.dat
  description: Bremen Mg II composite
  source: http://www.iup.uni-bremen.de/gome/gomemgii.html
  data range: late 1978 - 2018-2-3
  cadence: daily
  download date: 2018-2-3
  version: 5

radio_flux_adjusted_observation.txt
  description: various radio fluxes
  source: https://spaceweather.cls.fr/services/radioflux/
  data range: 1951-11-01 to 2018-04-03
  f30 start time: 1957-03-01
  cadence: daily
  download date: 2018-4-10
  adjustments: adjusted to 1AU
  notes: lots of info in header

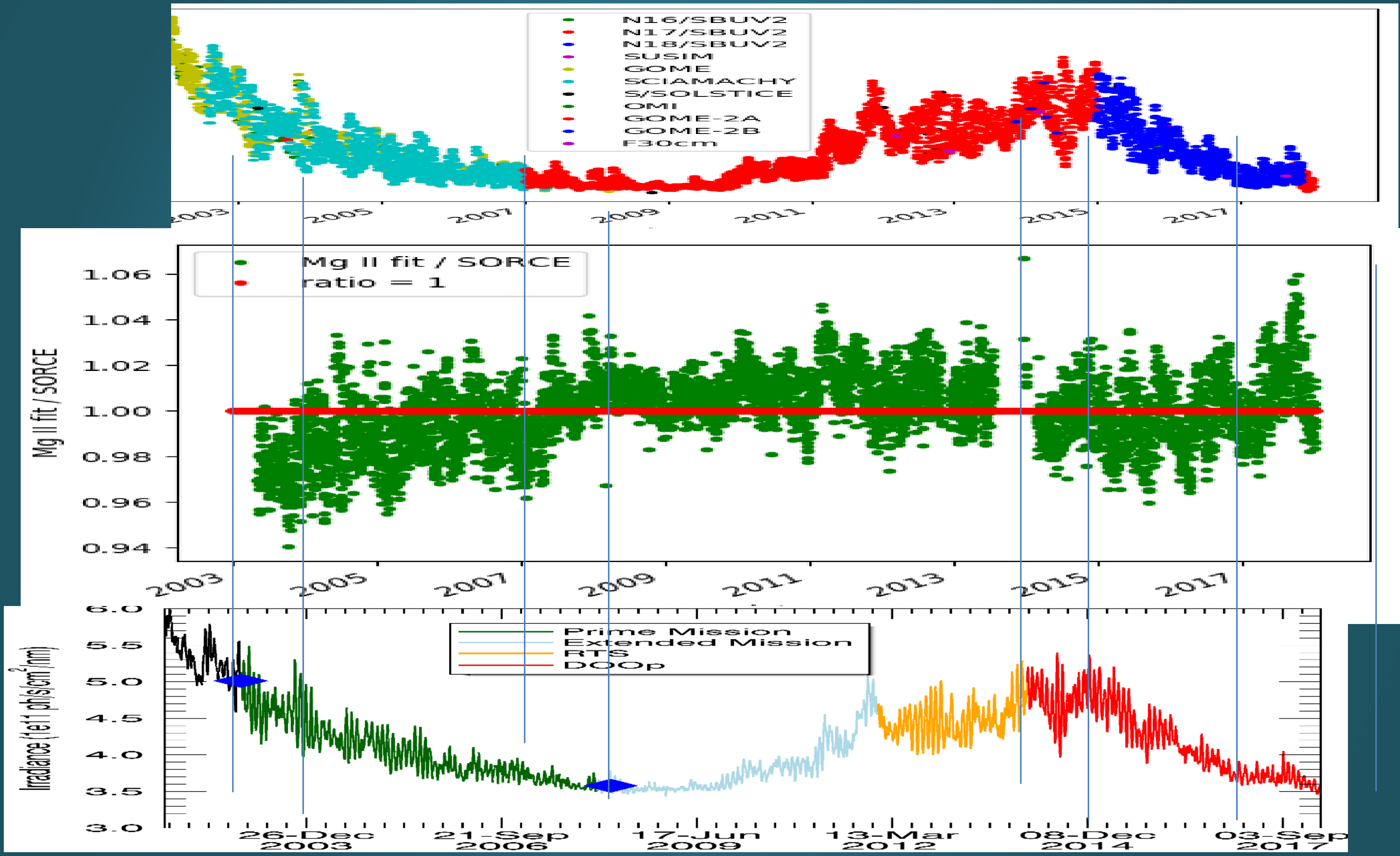
caII_k_1976_2015.csv
  description: CaII k data
  source: http://lasp.colorado.edu/lisird/data/cak/
  data range: 1976-11-20 to 2015-10-01
  cadence: daily
  download date: 2018-4-12
  notes: LASP site has link to SOLIS (ISS) instrument for other data
   Missing a lot of days.

# Example UARS trends



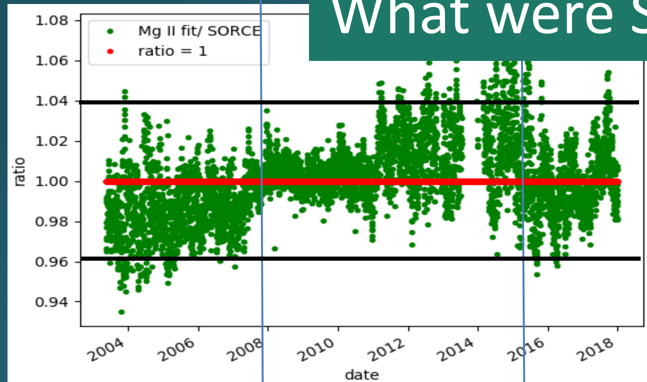



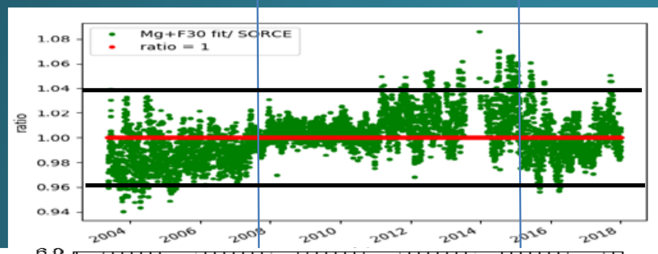
# What was SORCE doing?

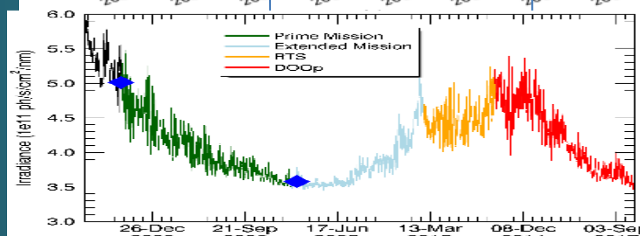


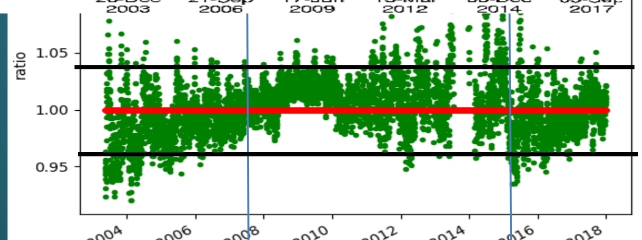
# What were SORCE and UARS doing?

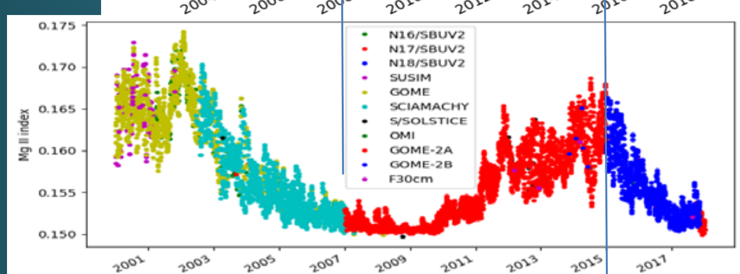
fits made for UARS 1993-2001

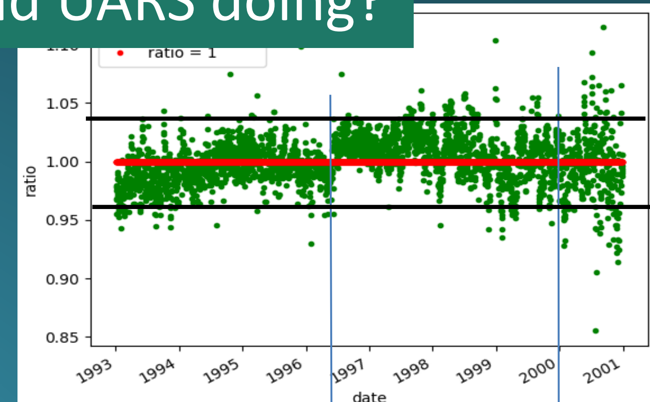


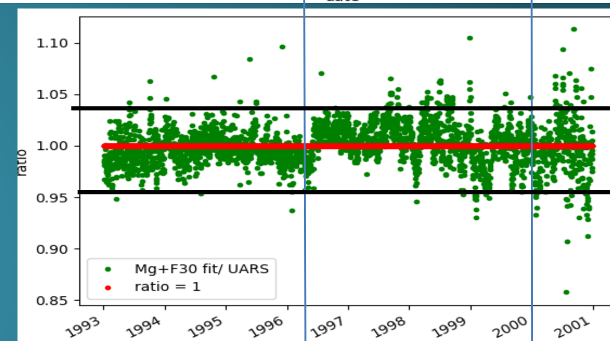



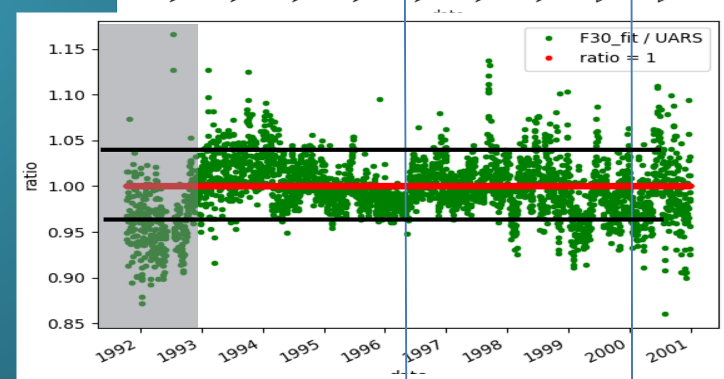



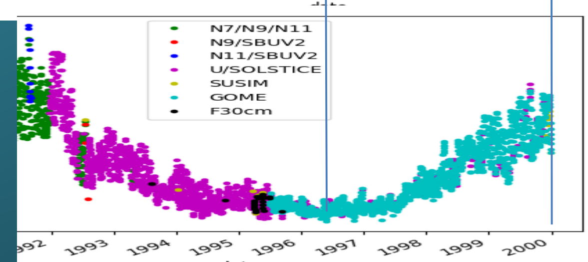



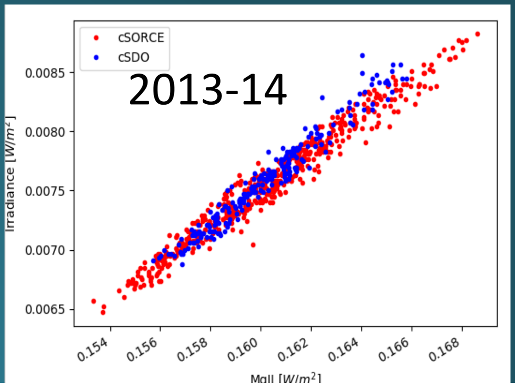



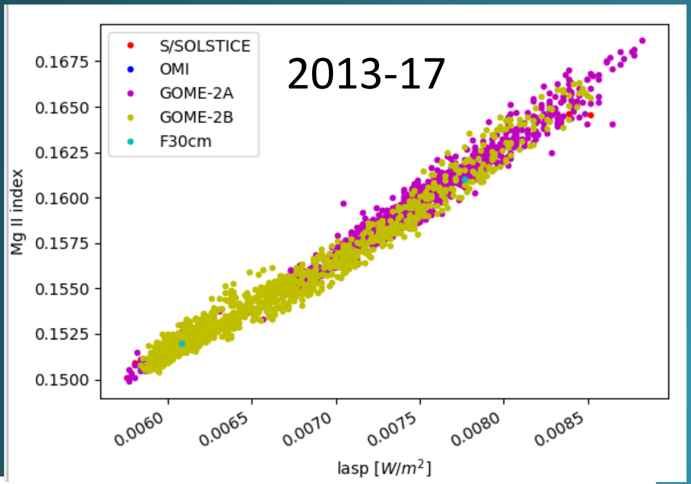



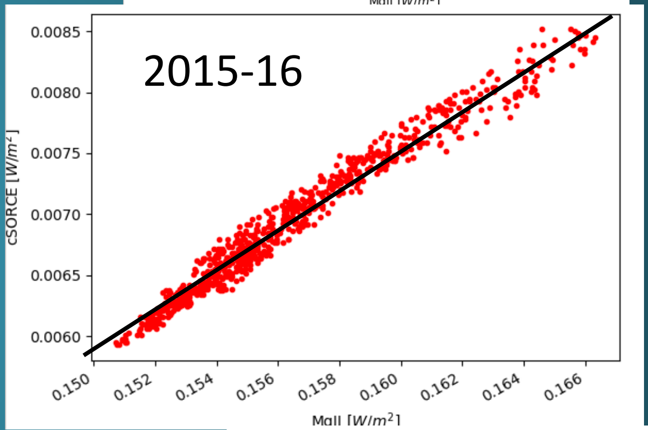



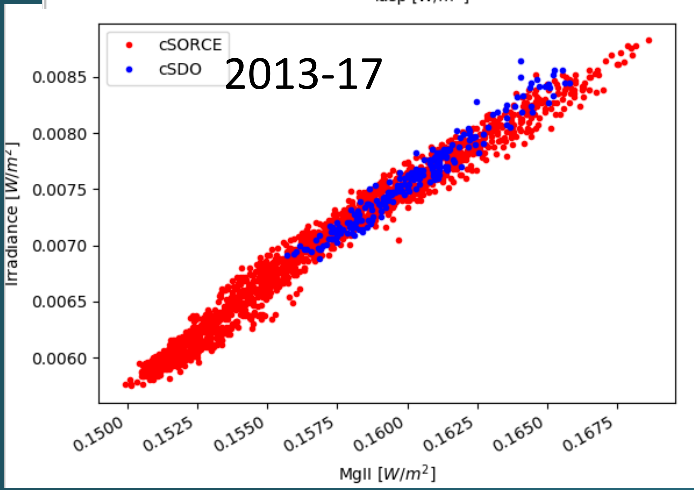



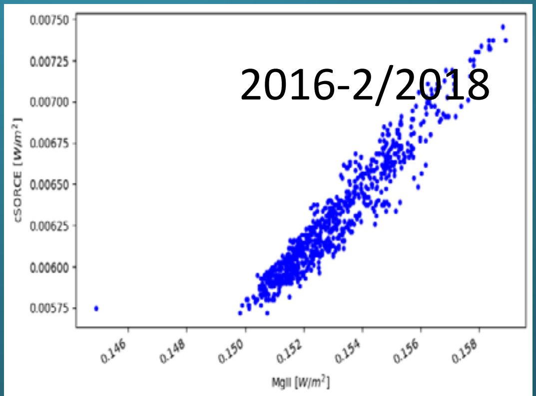
## MgII comparisons

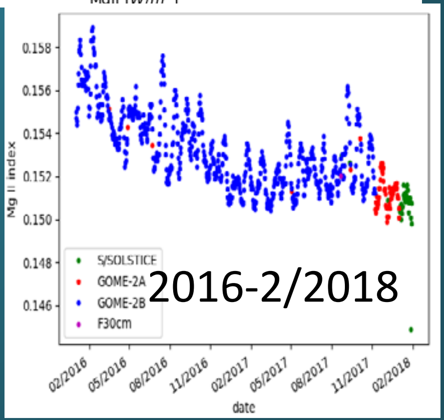


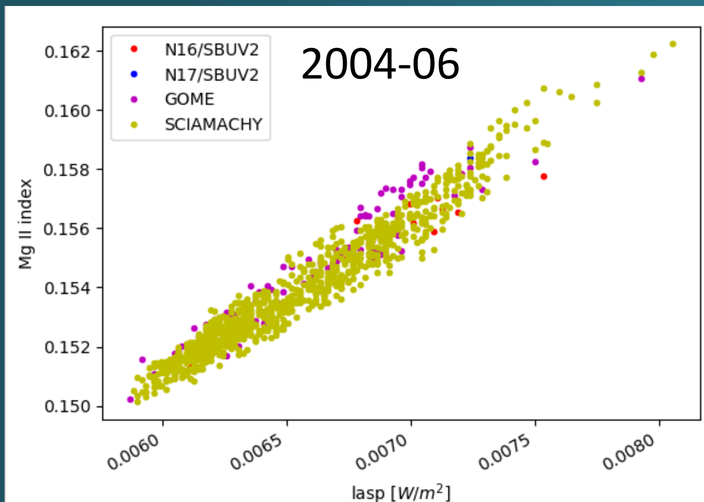



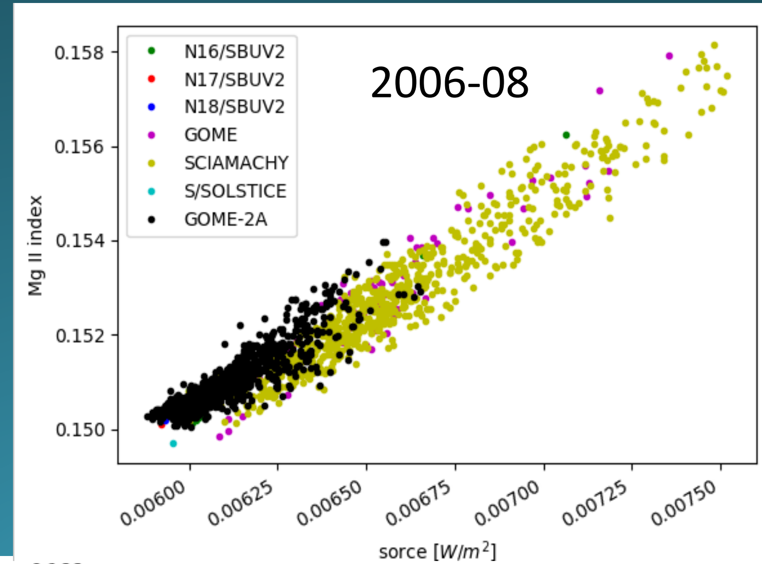



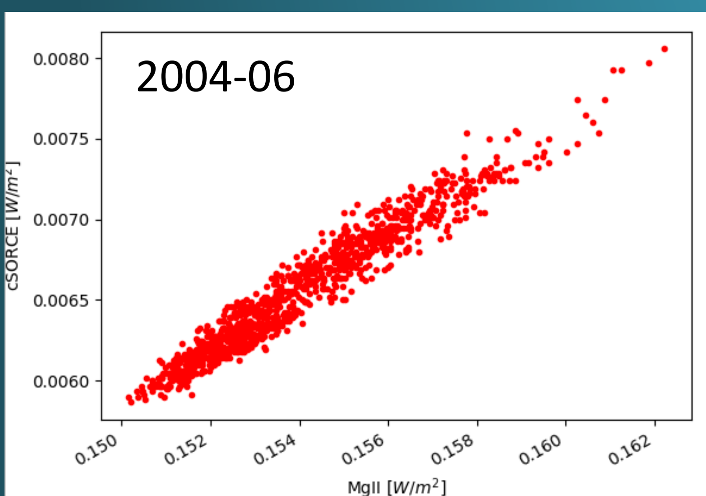



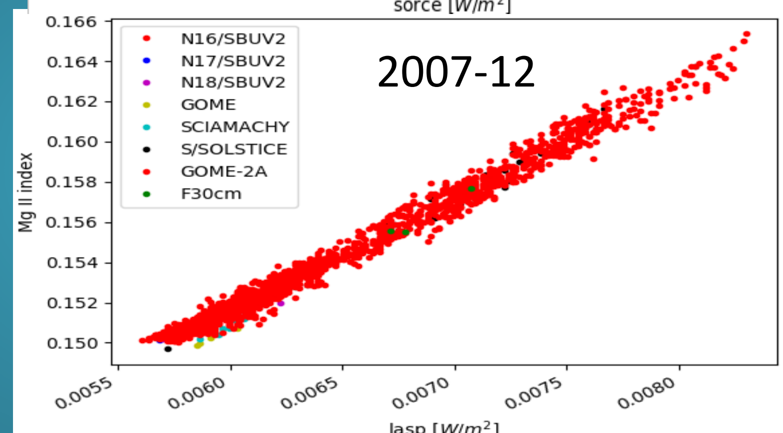



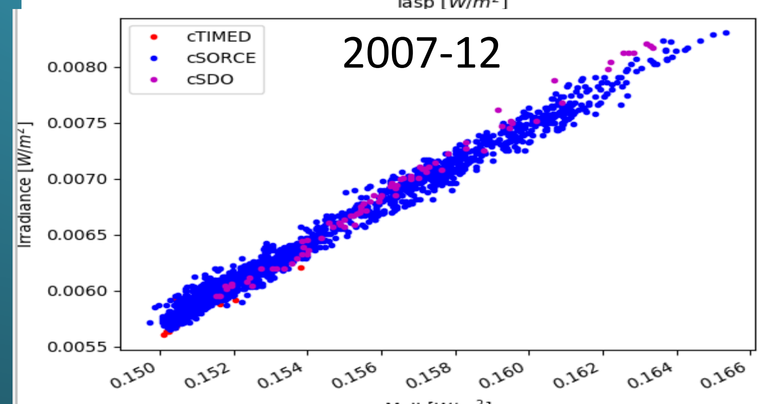
# Mg II comparisons



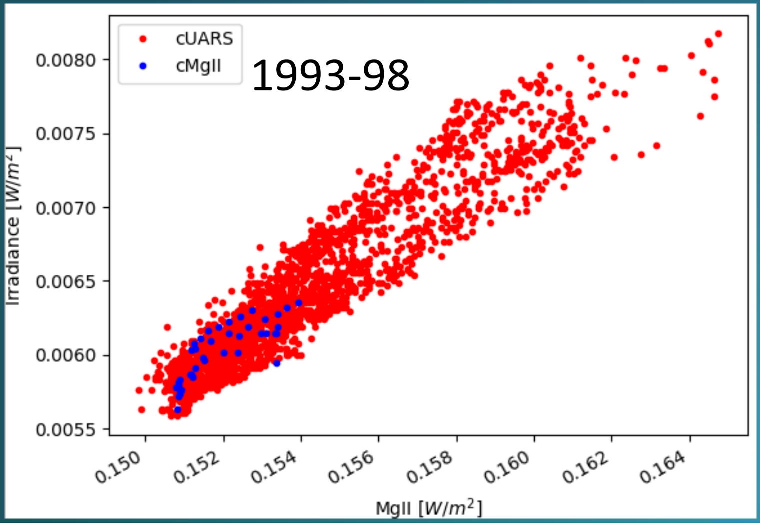



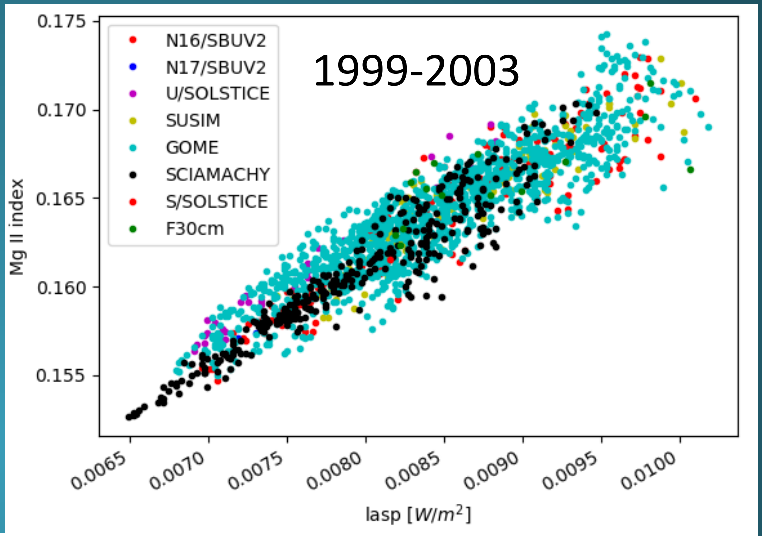



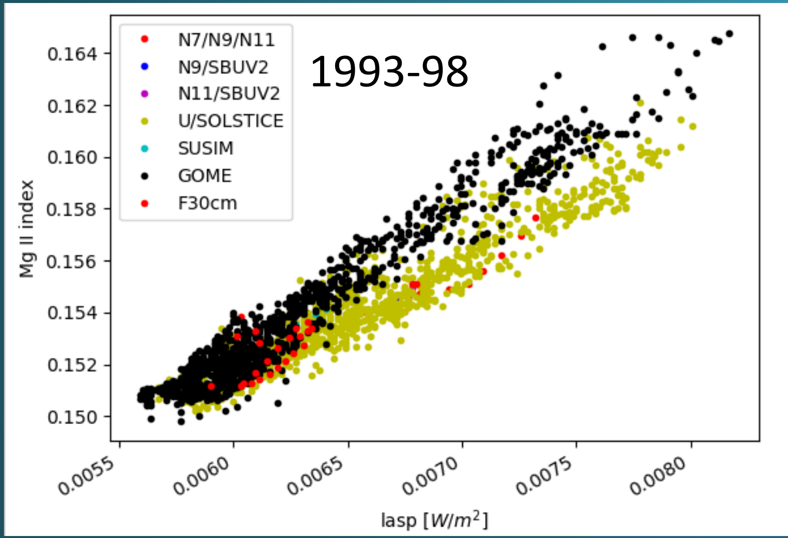



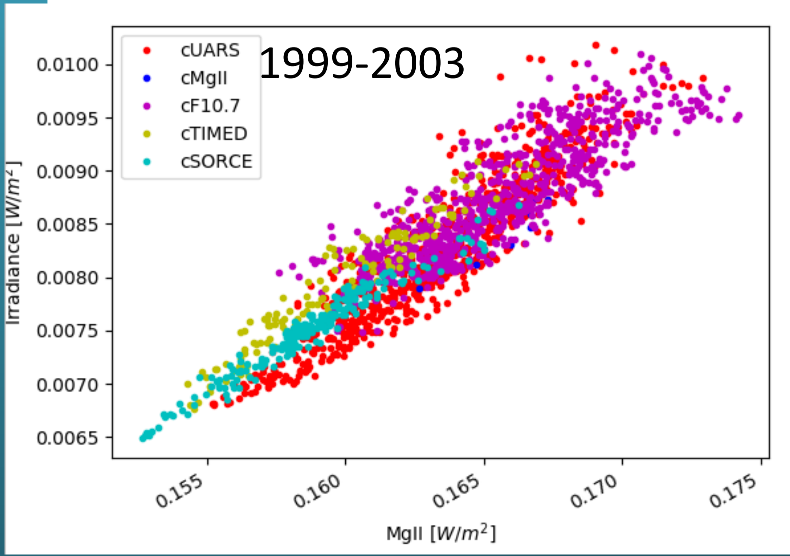
## Mg II comparisons

- 1993-99 - Mg II issue when switches from GOME to U/SOLSTICE or UARS decay?

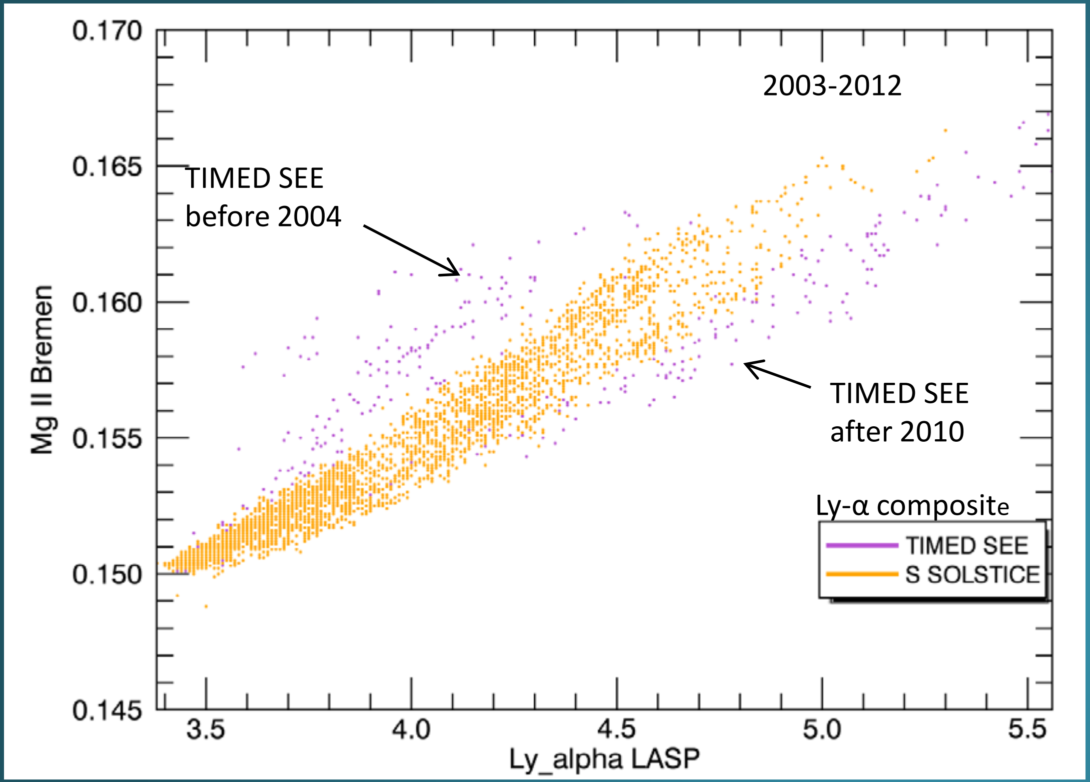


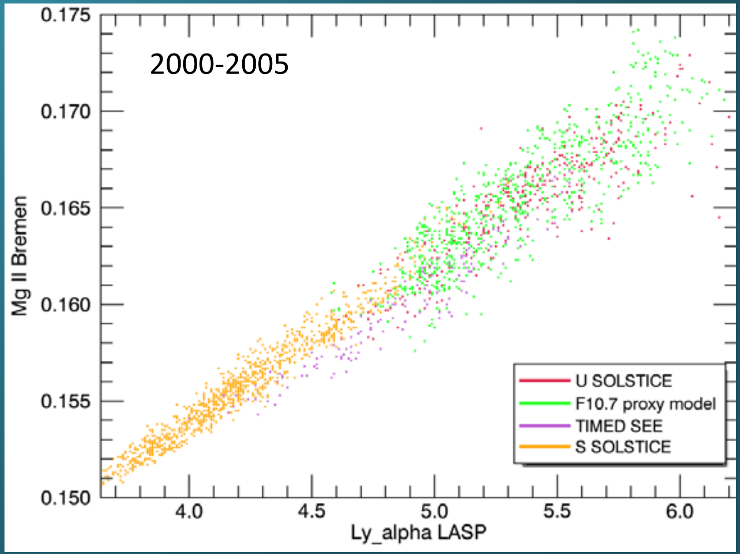



# 1. TIMED SEE has an offset and more scatter than SORCE SOLSTICE



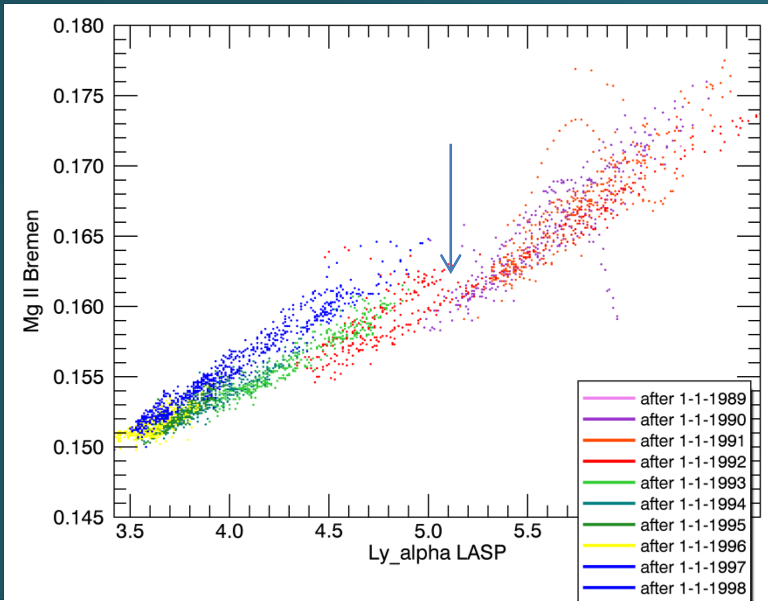

Need to reconsider scaling of TIMED SEE and then can recompare after SOLSTICE trend is fixed.

Plotting earlier times, we can see that the F10 Proxy Model also has more scatter than SORCE SOLSTICE, but since has no offset (and so doesn't need a correction.)

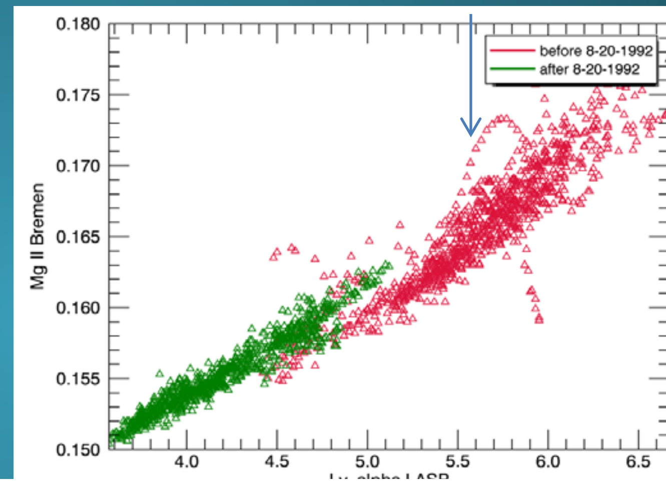


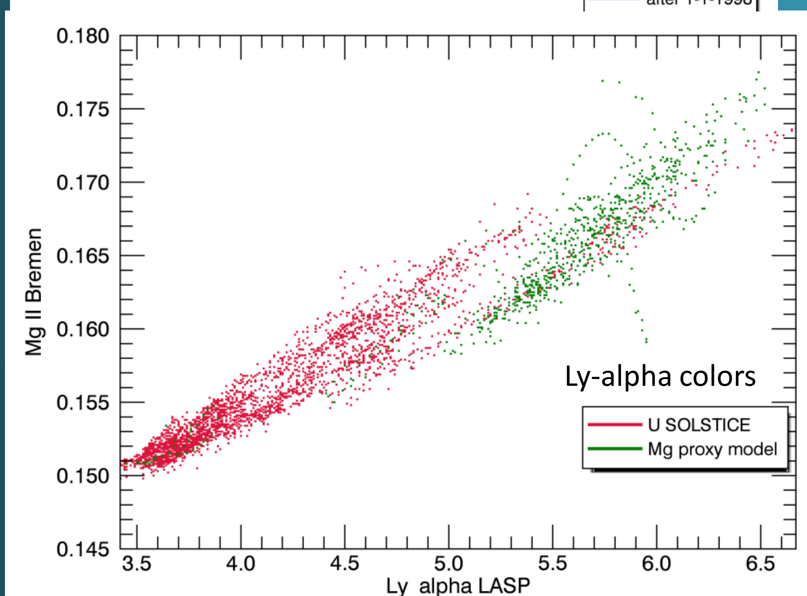
# 4. Jump in composite in 1992 when its source switches to UARS SOLSTICE. (1/2)

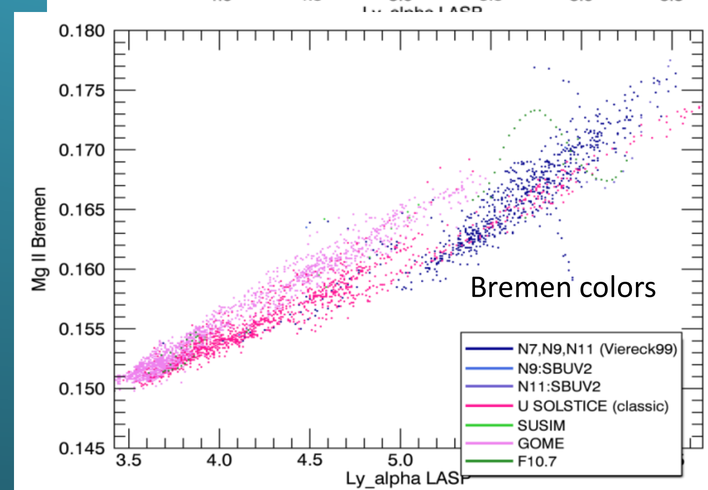
Reference level (scaling) done with average of SUSIM and SOLSTICE, but then only SOLSTICE was used in the composite. Need to look at SUSIM in later time period and see how it behaves relative to SOLSTICE. Suspect that offset has changed. Recompare after fix.



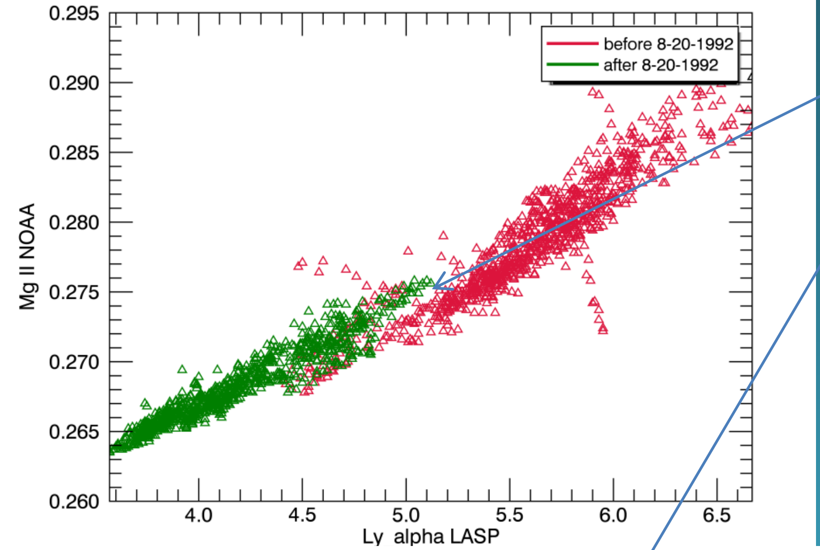

There is a jump in 1992. Are we seeing a jump in Lyman-α or the Bremen composite? Both depend on U SOLSTICE during this time period.



# 4. Jump in composite in 1992 when its source switches to UARS SOLSTICE. (2/2)




A comparison of the NOAA composite (which has different sources than Bremen) with Lyman-α shows the same jump in August, 1992.

However, when we plot with the colors indicating the source of the NOAA composite data, we see that the jump is not related to the different data sources.

So we conclude that there is a jump in the Lyman-α composite in August 1992.

Since the Bremen Mg II composite uses U SOLSTICE after 1992, we check if it is also impacted. However, when a comparison of Bremen Mg II with the NOAA Mg II shows no change except in noise levels.