Temporal Separation of AIA 131 Å and GOES 1-8 Å Peak Flux in Solar Flares

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Why Study Solar Flares?

- Flare radiation and escaping particles (CME's) can damage satellites and energy grids.
- Still many unknowns (including mechanism of energy transport)

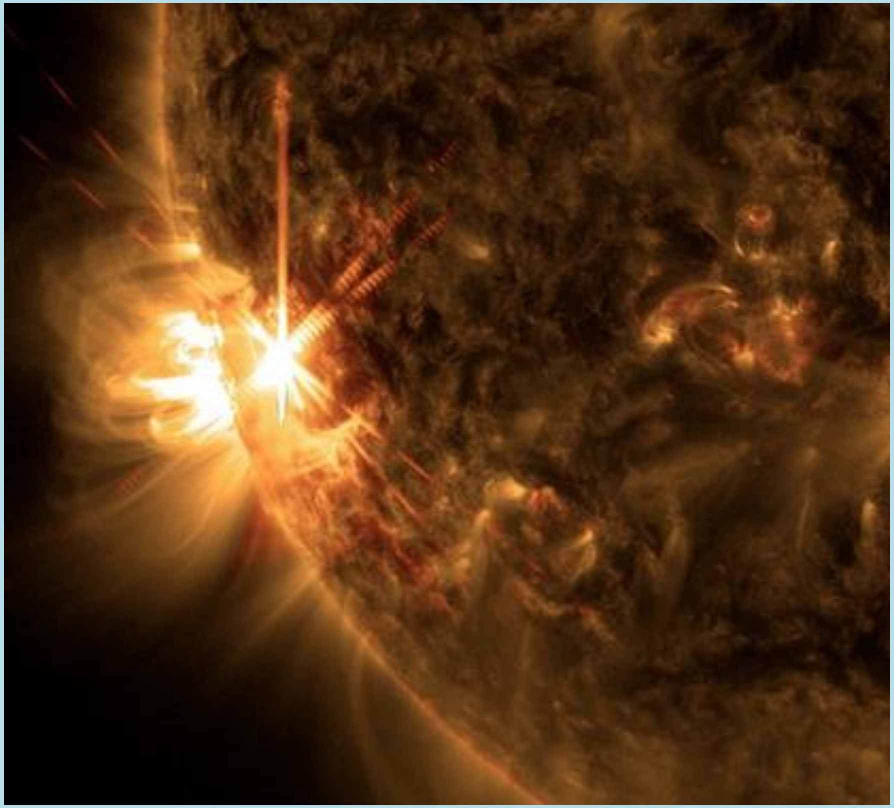


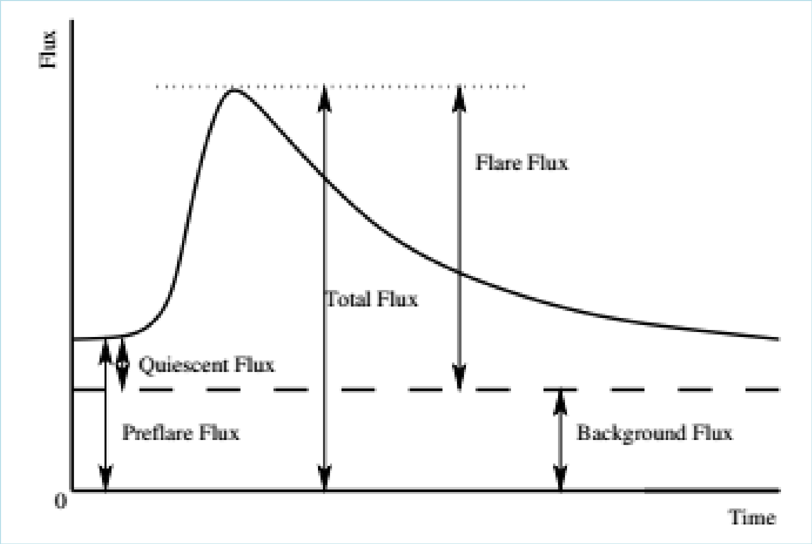
Image: SDO Gallery

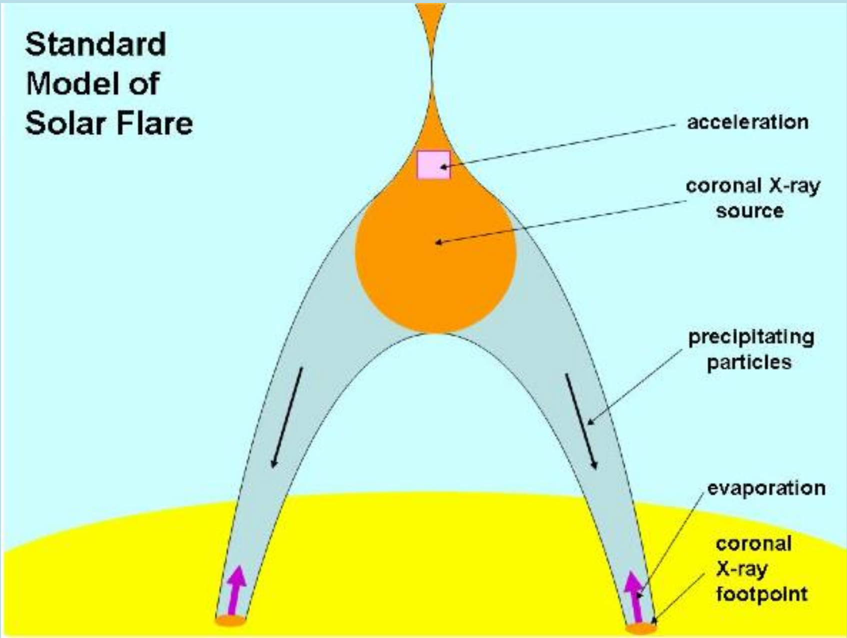
D.F. Ryan et al. APJ Supp. Ser. **202** (2012)

A.O Benz, Living Rev. Solar Phys. **5** (2008)

Main Flare Phases

- Impulsive Rise: EUV, SXR, HXR, Microwaves, Radio Wave Bursts, Hα
- Gradual Decay: EUV, SXR, Radio, Hα





A.O Benz, Living Rev. Solar Phys. **5** (2008)
Joshi et al. APJ **743** (2011)
E.R. Priest, Solar Phys. **86** (1983)

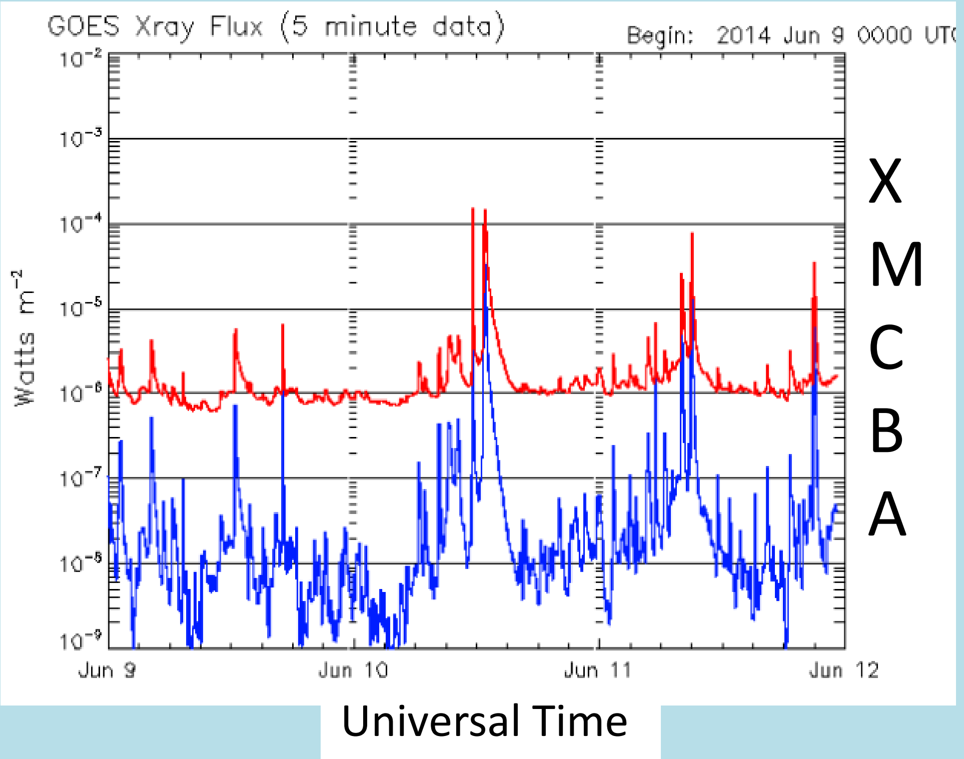
Project Motivation!

- We would like to better understand the energetic evolution of solar flares in general.
- SXR/EUV Flux Timing is not pinned down!

M.B. Dhanya and A. Bhardwaj, Astro Phys. and Space Sci Proc. (2010)

GOES-XRS and SDO-AIA Comparison

	XRS	AIA
Temporal Cadence	3 Seconds	12 Seconds
Relevant Passband	1-8 Å (SXR)	131 Å (EUV)
Relevant Temperature	~30 MK	~10 MK
Primary Use	Flare Classification	Thermal Evolution Analysis

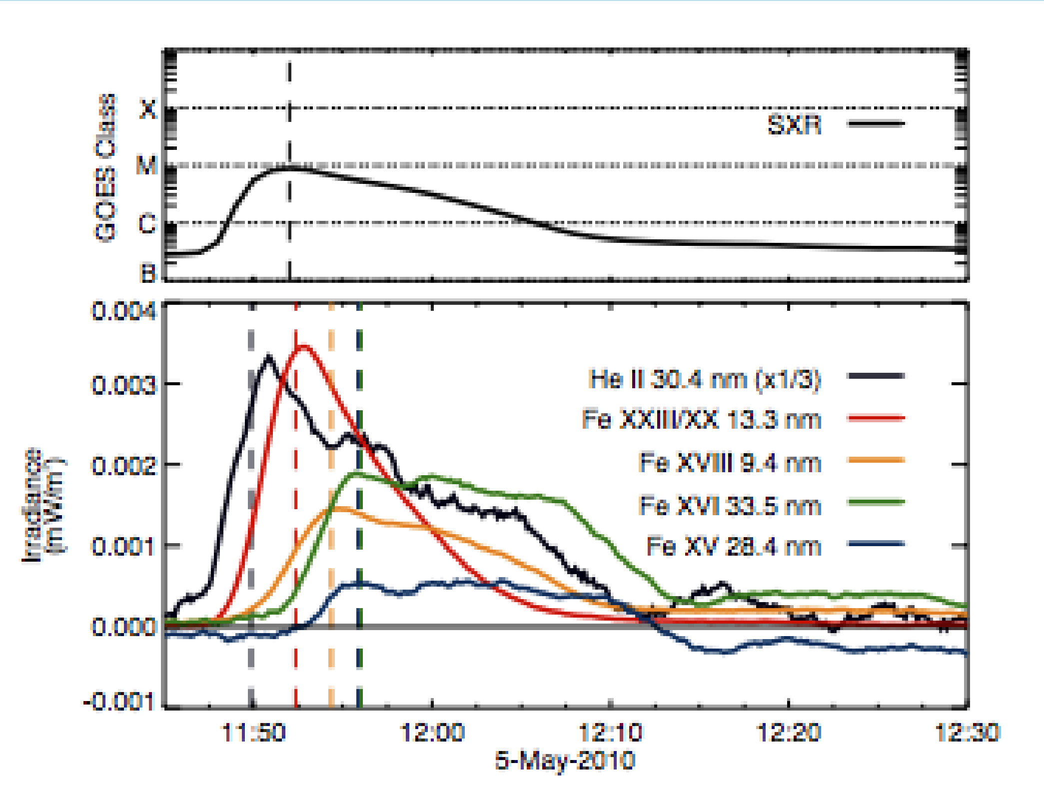


J.W. Brosius and G.D. Holman, A&A **540** (2012)
J.R. Lemen et al. Solar Phys **275** (2012)

Image: SolarMonitor.org

Initial Expectations

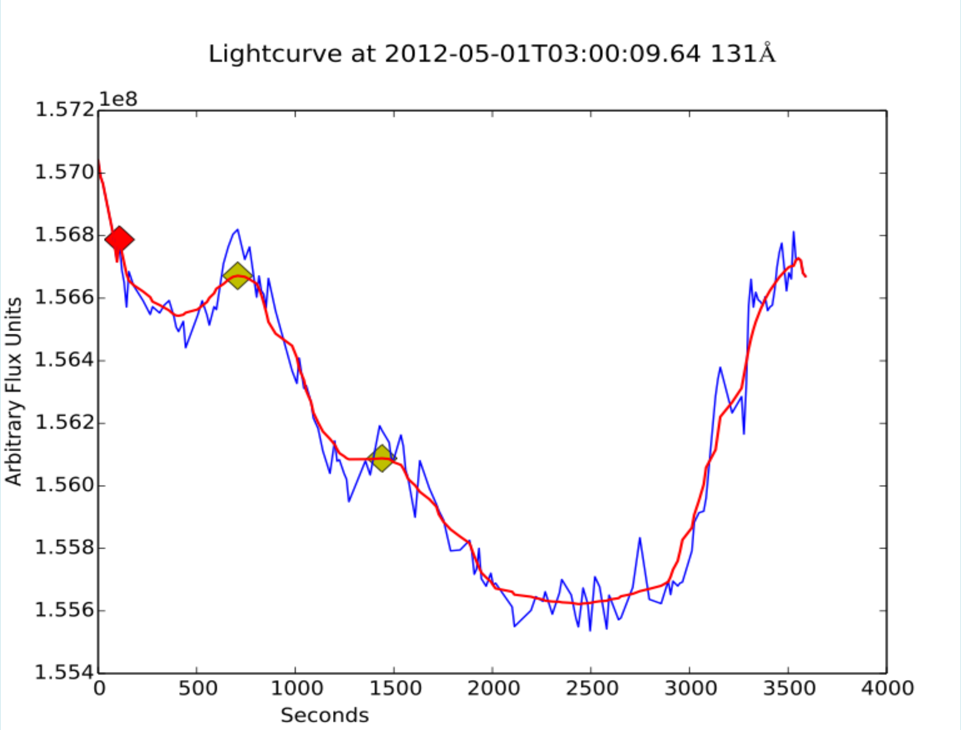
- The standard flare model leads us to expect to first see a peak in the hot SXR flux.
- As time goes on, we would expect cooling of the plasma, resulting in a later peak in the EUV.

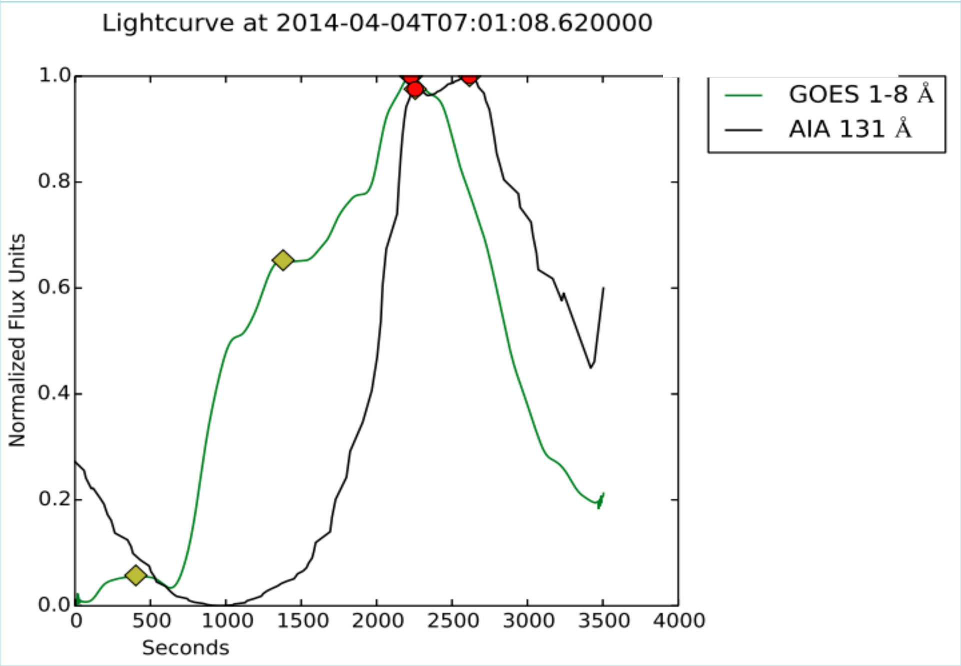


R. A. Hock et al. arXiv Preprint (2012)

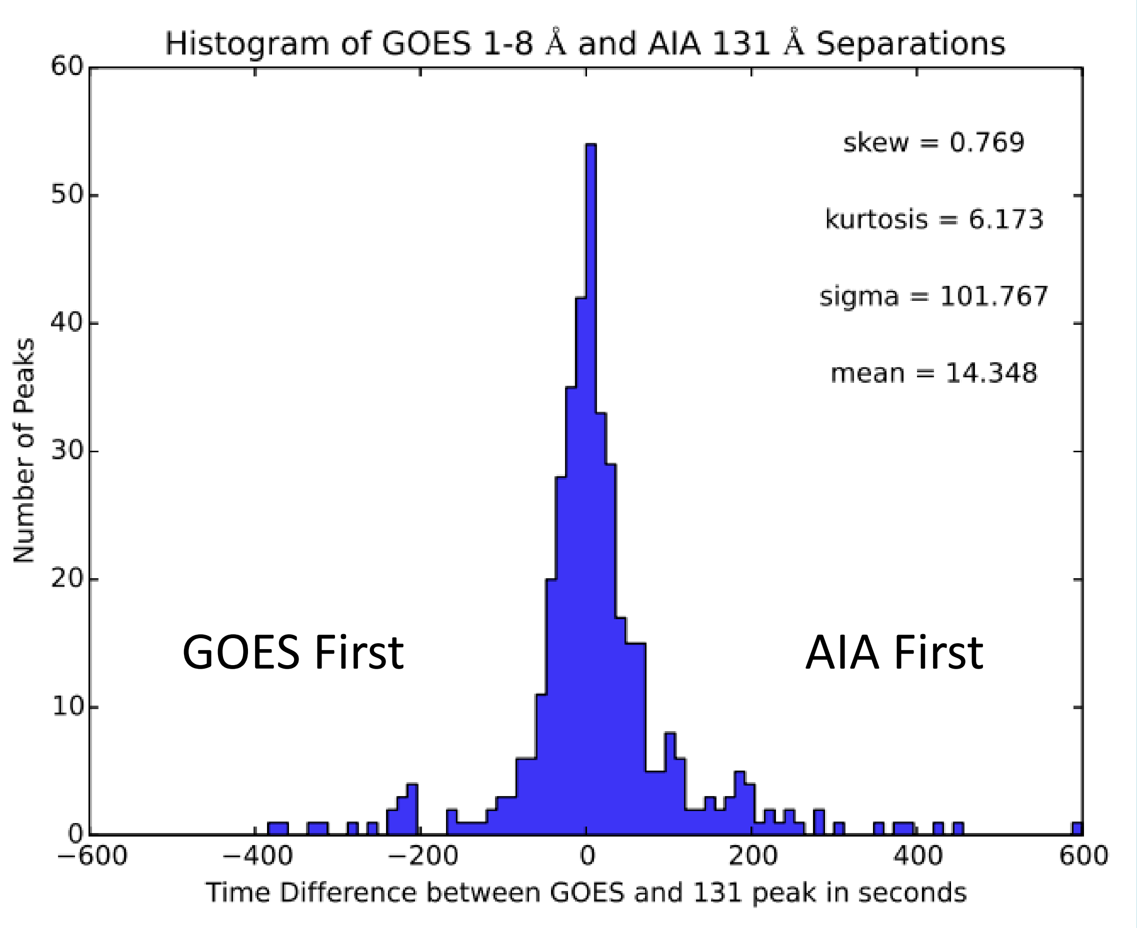
My Work

- Events selected by Flare Detective Module
- My Python program first creates lightcurves for AIA and GOES data
- Data Smoothing
- Peak Time Comparison
- Use difference in AIA/GOES peak time to populate histograms



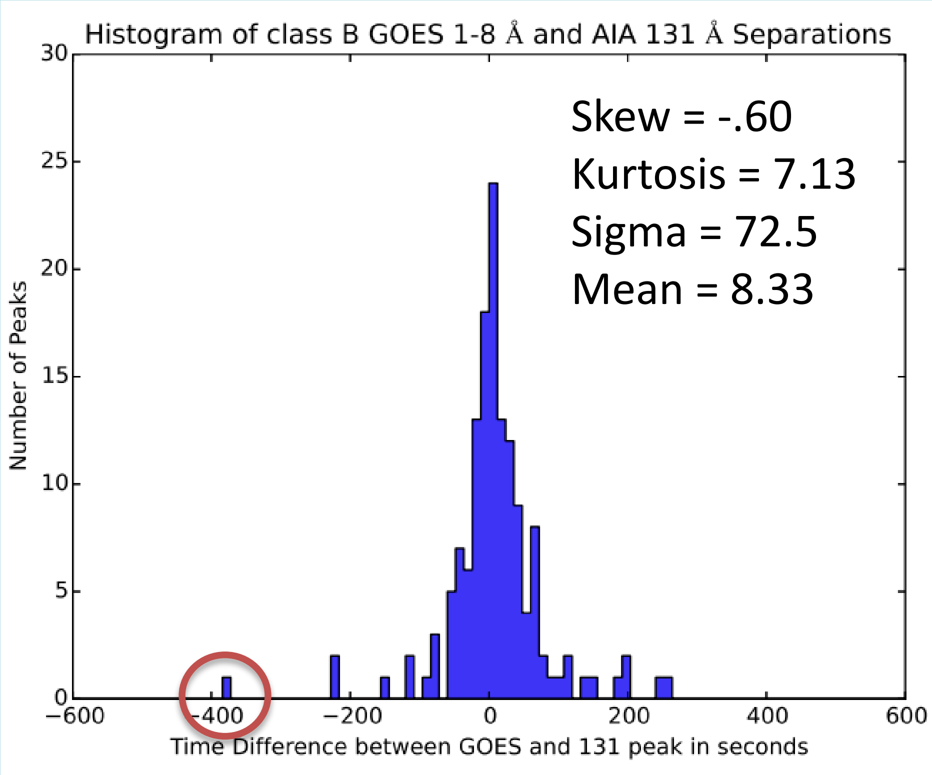


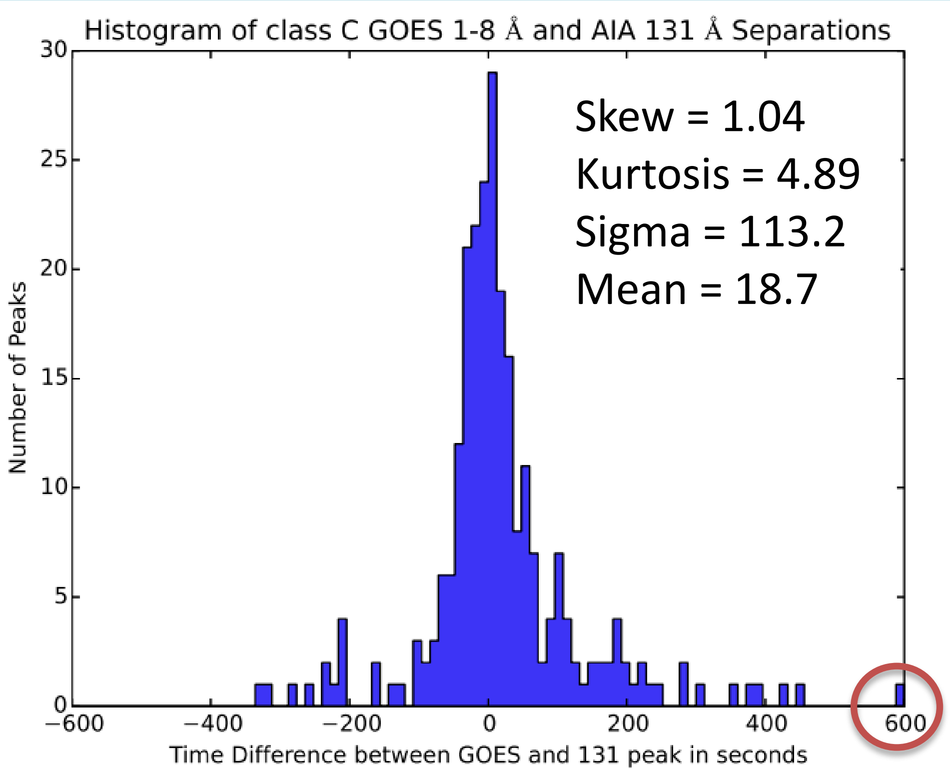
Main Results



- 400 total events mostly from first 7 months of 2014 and some from 2012
- 142 B class, 250 C class, 8 M class
- 224 Positive Events
- 176 Negative Events
- Slight statistical skew towards AIA peaking first!

Histograms by GOES Class





B class

Without outlier:

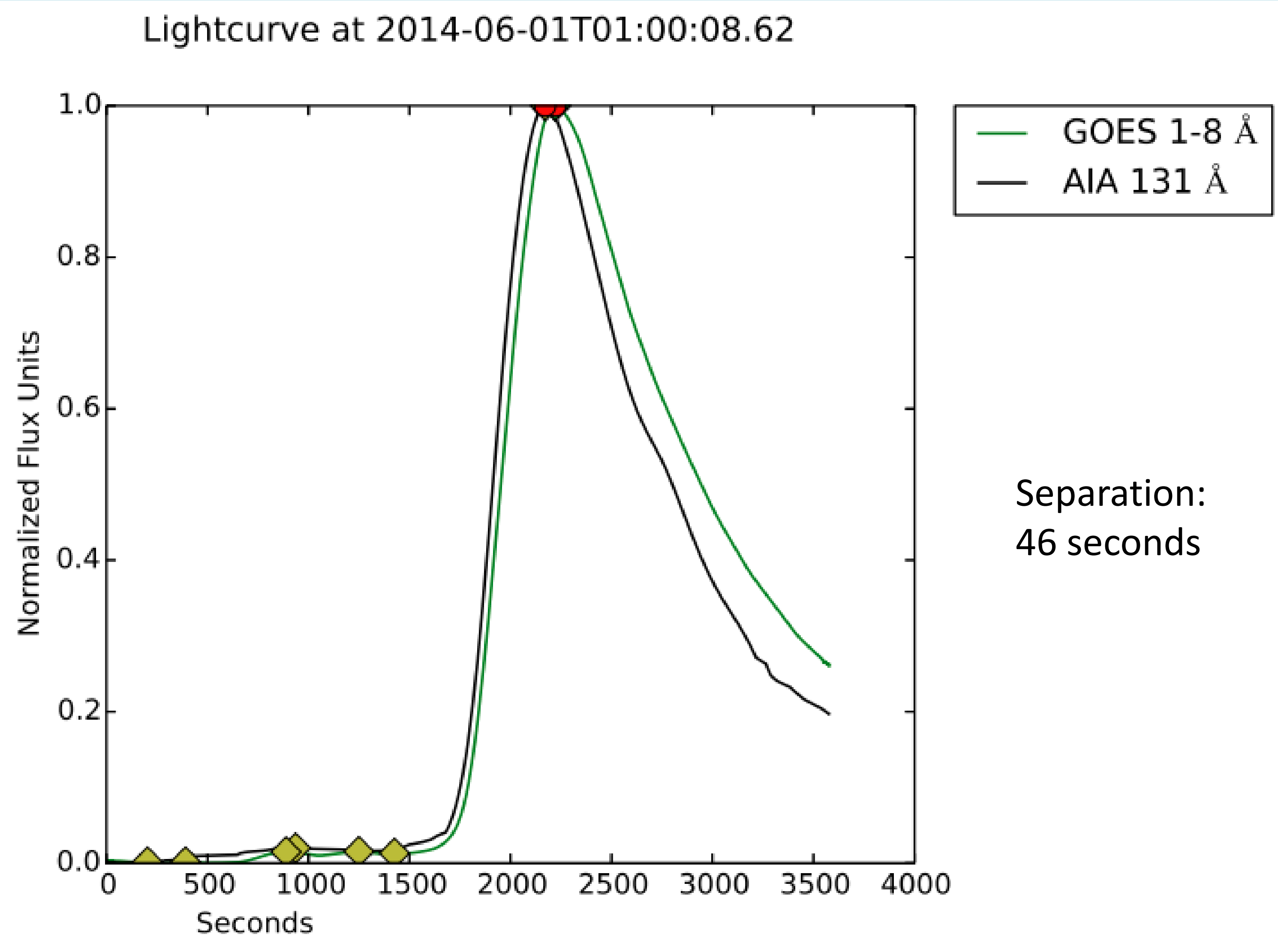
skew = .45 ; kurtosis = 4.2
sigma = 65.2 ; mean = 11.0

C class

Without outlier:

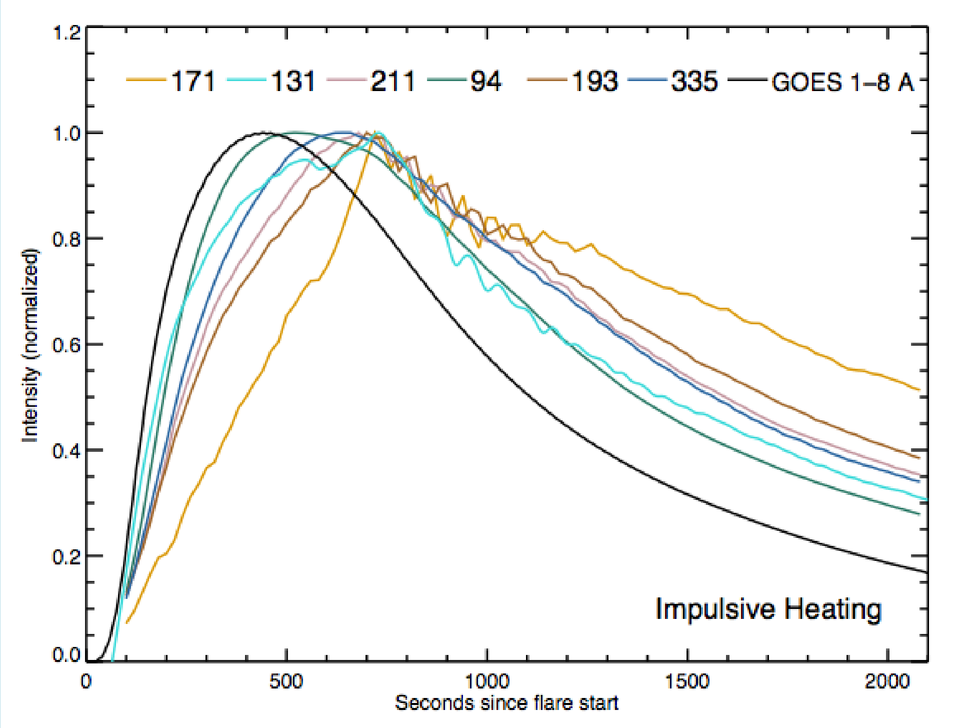
skew = .68 ; kurtosis = 3.6
sigma = 107.4 ; mean = 16.4

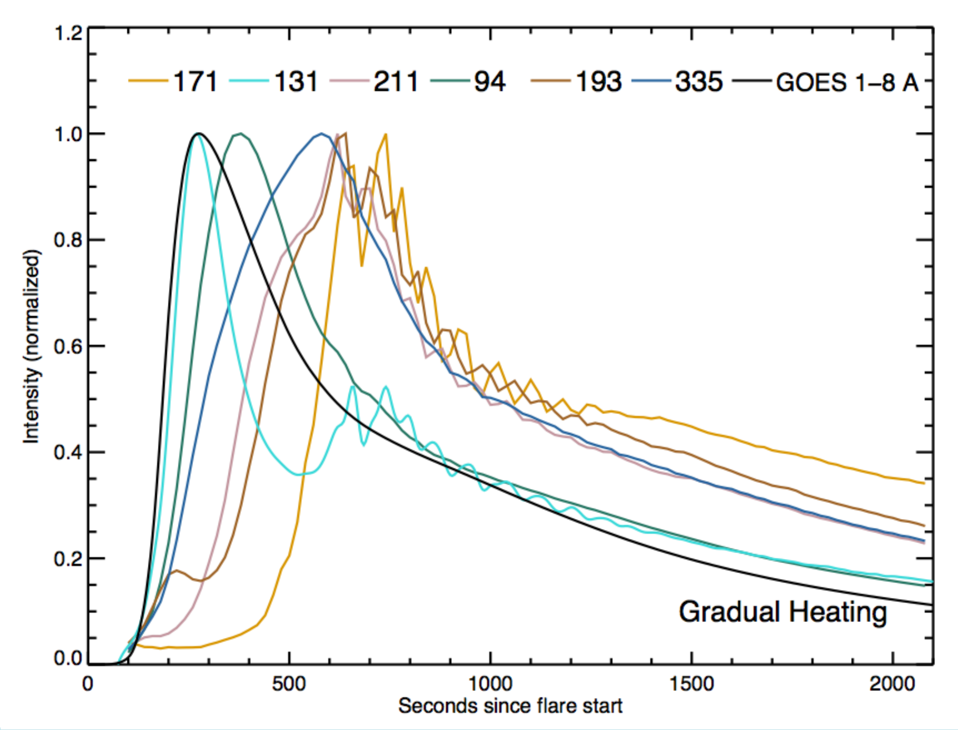
Classic Flare Profile: Sanity Check



Separation:
46 seconds

Possible Solution



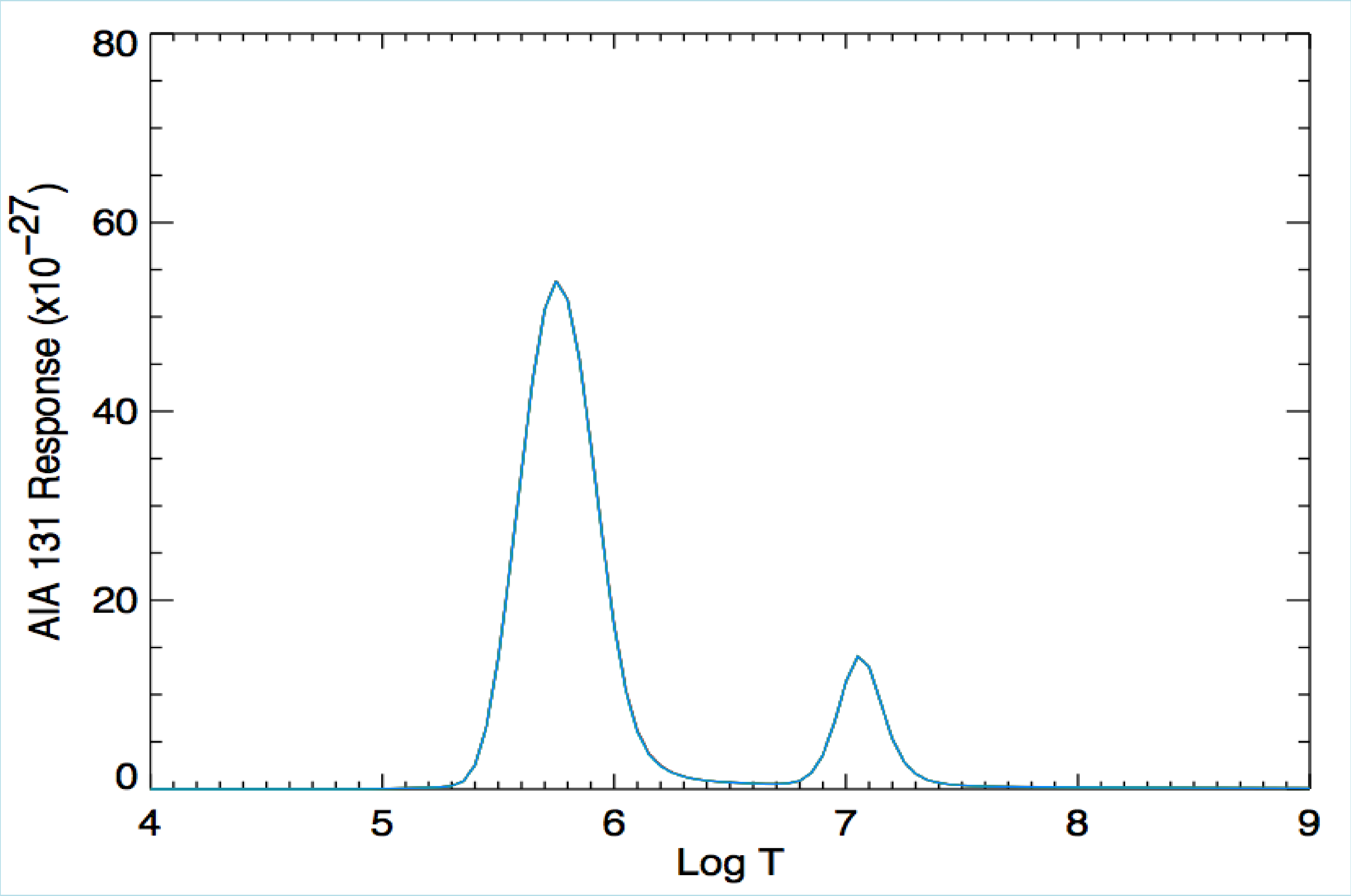


Impulsive: 40 second heating window

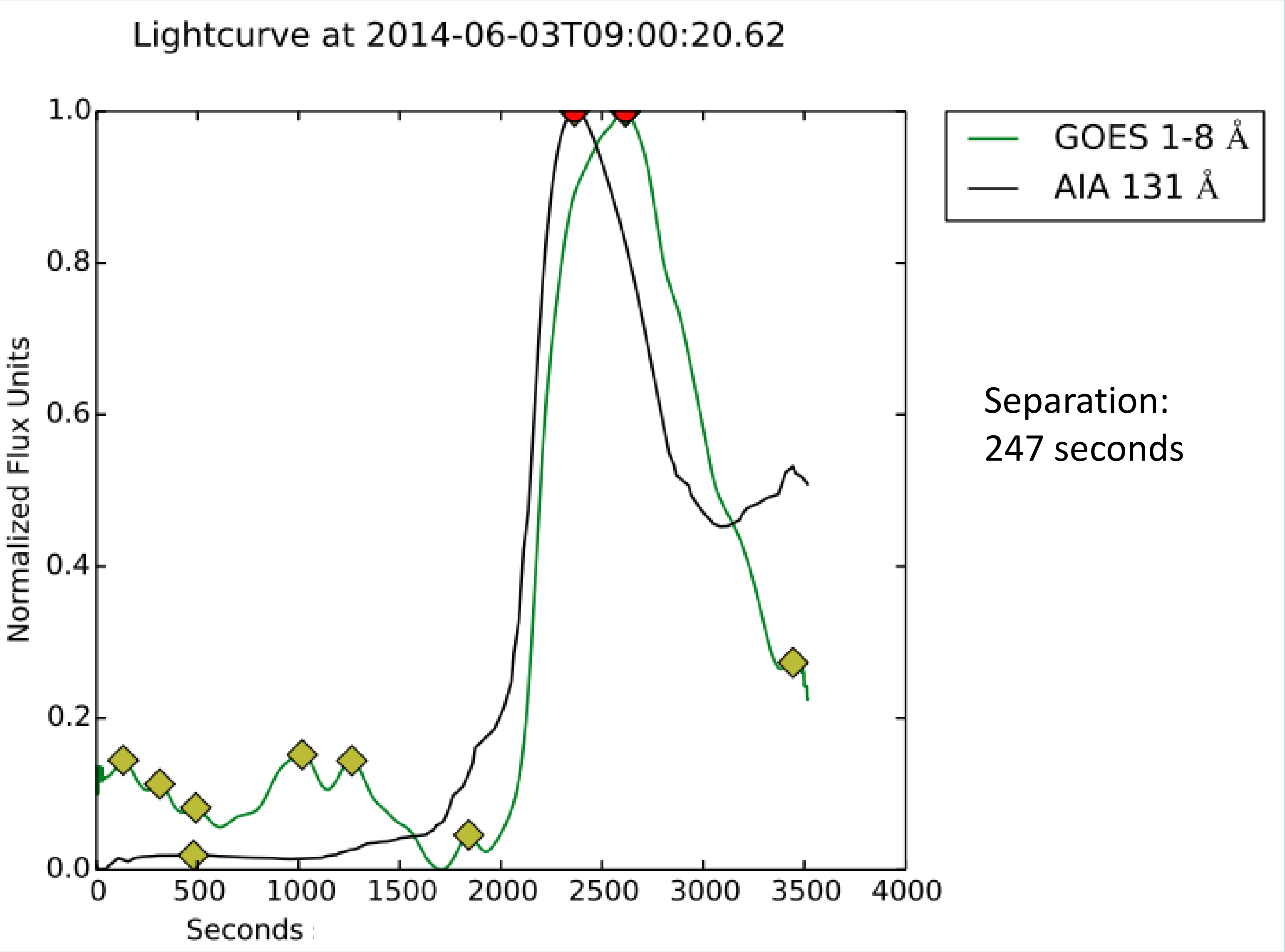
Gradual: 200 second heating window

131 Å peaks 5 seconds before GOES

AIA 131 Å Temperature Response

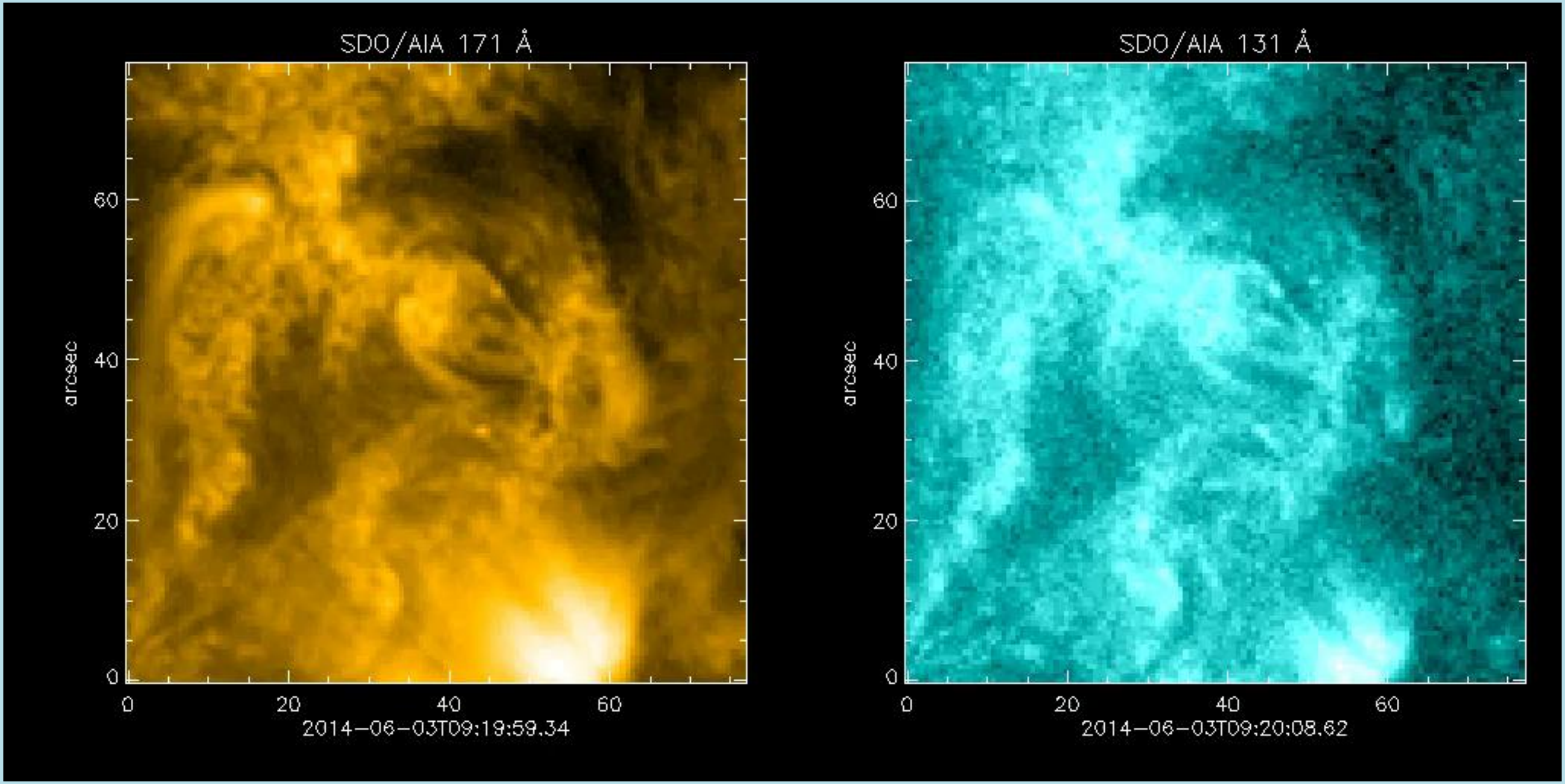


Possible Early Hot 131 Å Emission



Separation:
247 seconds

Hot or Cold 131 Å?



Review

- Both B and C flares tend to have 131 Å peak first (possibly a result of gradual energy deposition)
- C flares have a broader distribution than B flares.
- C flares have a greater variety of possible magnetic configurations, allowing for more variability in the rate of energy deposition.

Extensions

- Run my program on more AIA channels for each event.
- More channels could help us narrow down whether we are seeing hot or cold emission in the 131 Å.
- Use GOES catalogue to narrow down spatial uncertainties.
- Use XRT data when available.

Acknowledgements

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