Modeling 13.3 nm Fe XXIII flare lines

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Understanding the EUV spectrum

Understanding the entire EUV spectrum in high wavelength resolution and high time cadence is relevant to:

-Modeling the upper atmosphere

-Electronic communications

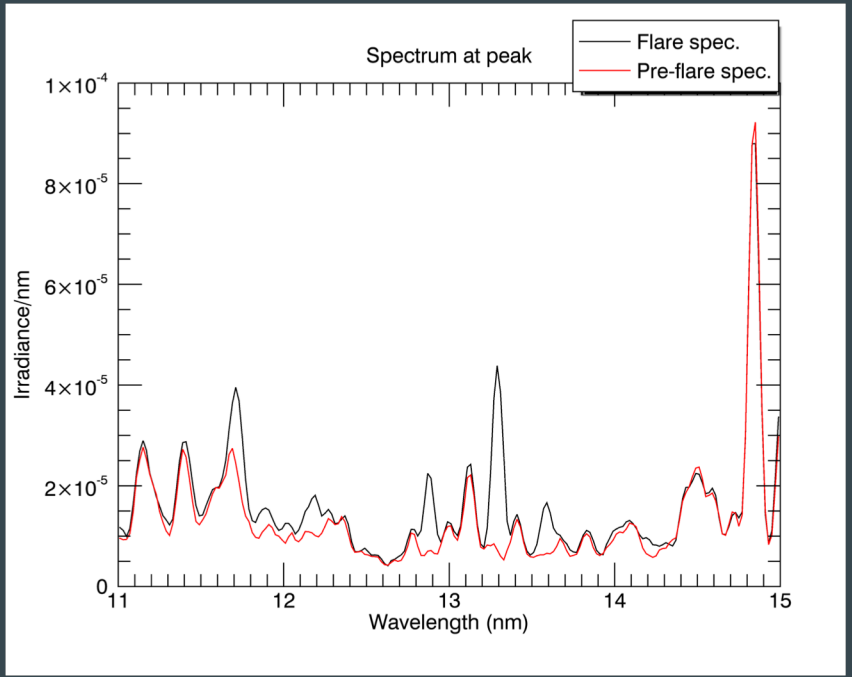
-Satellite navigation

MEGS-A EUV data

MEGS-A collected ~4 years of full spectrum EUV data before operations ceased

MEGS-A collects 6-37 nm

Can study MEGS-A to better understand future flare EUV emissions

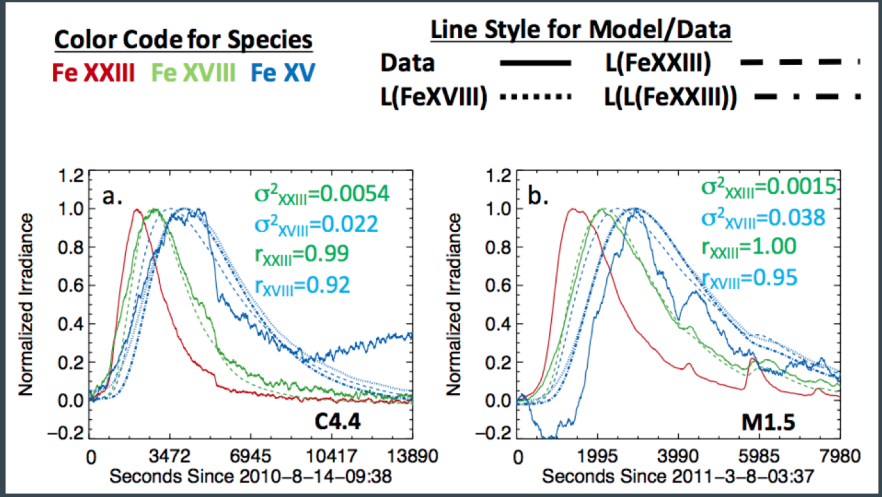


Producing flare EUV spectra

Future flares require a model for a full EUV study

We can use a single hot EUV flare line to model cooler EUV lines using analogue to RC low pass filter equation

Such a model requires an available line to use as an input to the model



Fe XXIII as a model input

Fe XXIII could fill the role of EUV model input

With end of MEGS-A, Fe XXIII data no longer collected

Require a proxy for Fe XXIII for use in modeling future flares

Finding an Fe XXIII proxy

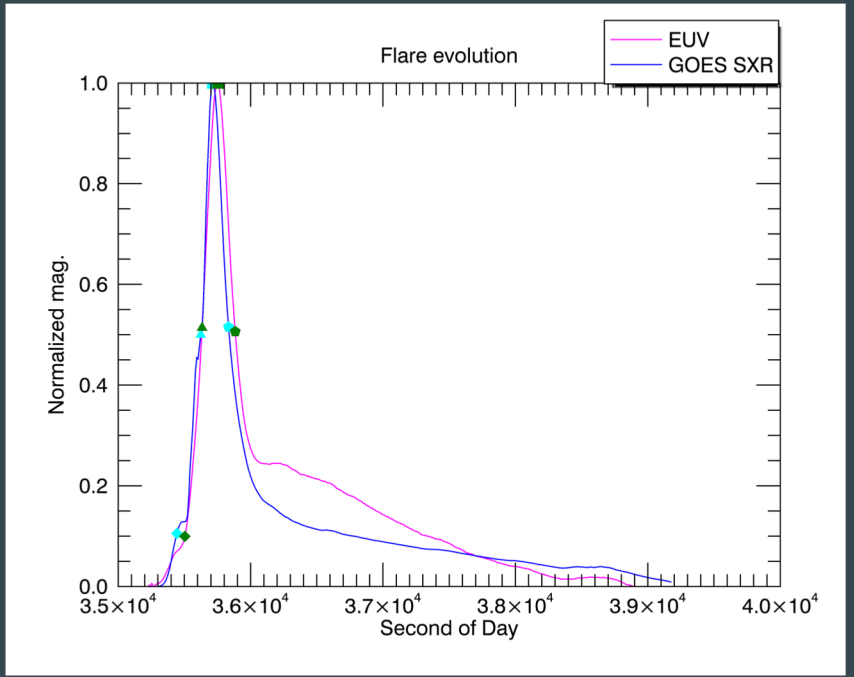
Need a data set gathered during MEGS-A that is still being gathered that can be compared to MEGS-A

The data set must provide a proxy to Fe XXIII

Only need timing as we focus on normalized curves

Prior observations suggest qualitative agreement between GOES 0.1-0.8 nm (SXR) and Fe XXIII

Need to quantitatively assess correlation between SXR and Fe XXIII



Studying SXR as an Fe XXIII proxy

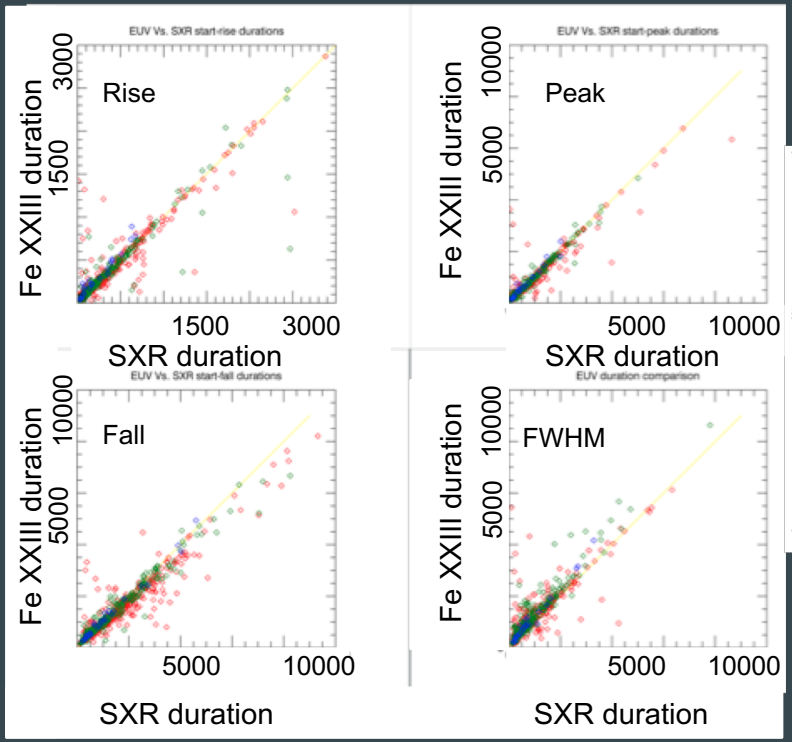
We study ~1195 C flares or larger:

-Define start, rise, peak and fall times for Fe XXIII line and for SXR line for each flare

-Use times to compare SXR and Fe XXIII timing and durations

-Generate statistical comparisons for all flares

Success of simple SXR proxy



	Fit slope	All flare fractional standard deviation	C flare fit slope	C flare fractional standard deviation	M flare fit slope	M flare fractional standard deviation	X flare fit slope	X flare fractional standard deviation
From SXR								
Rise	0.845	1.132	0.827	1.426	0.875	0.402	1.138	0.336
Peak	0.894	1.036	0.864	1.217	0.964	0.236	1.035	0.200
Fall	0.845	0.365	0.819	0.447	0.884	0.186	0.975	0.109
Duration	0.797	1.142	0.758	1.384	0.853	0.305	0.937	0.148

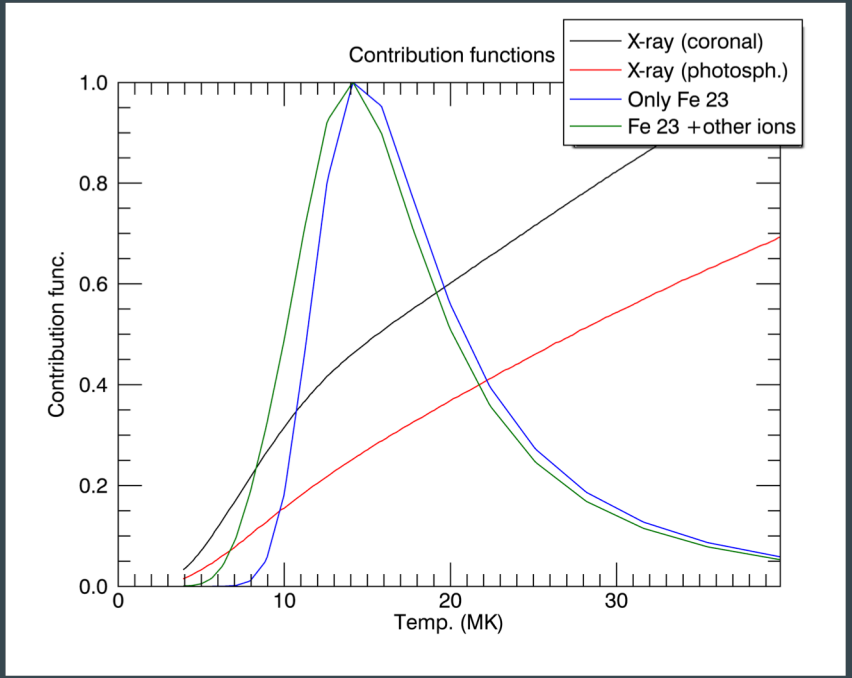
Why does SXR work?

Constructing a theory:

-Use theoretical contribution functions and GOES temp and emission measure (EM) data

- Use *White et al, 2005* for SXR contribution function

-Use CHIANTI for Fe XXIII contribution functions



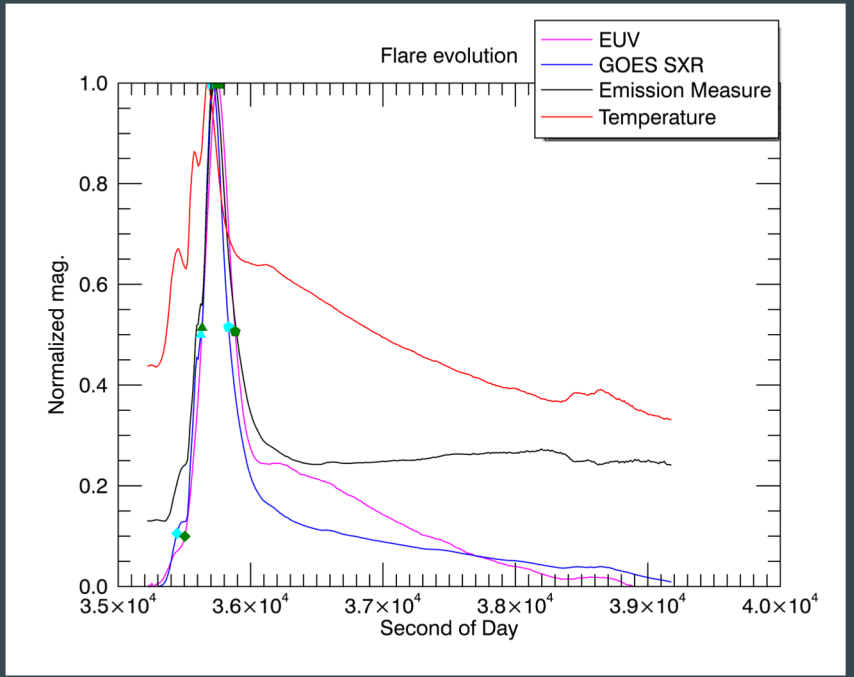
Temperature and emission measure (EM&T)

EM&T theory:

-Intensity$_t$ = EM$_t$* Contribution(Temp$_t$)

Temperature and emissions measure (EM) evolve during a flare

Both are derived from GOES data using a model

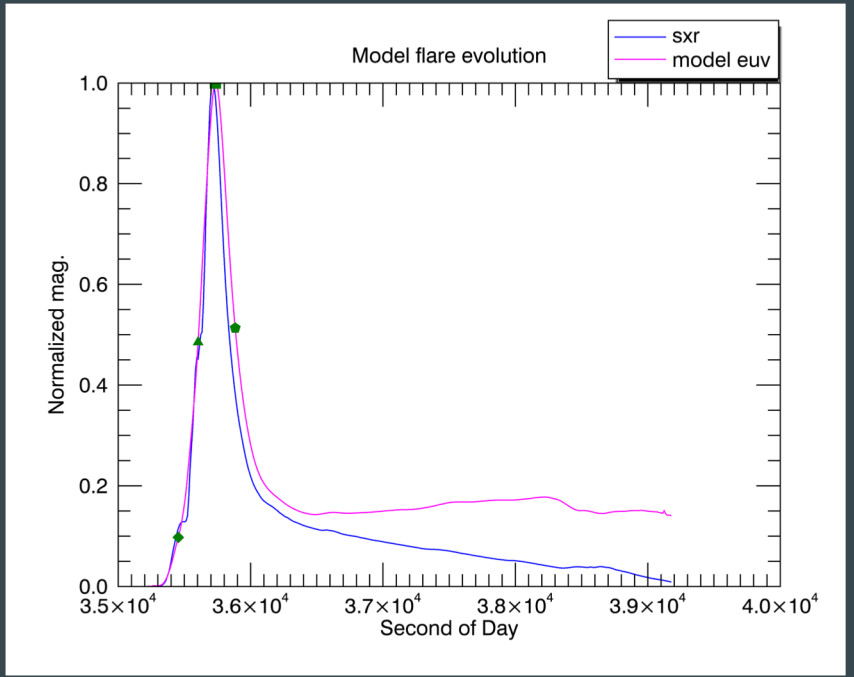


Studying EM&T as Fe XXIII proxy

We model the same 1195 flares:

-construct EM&T line for each flare

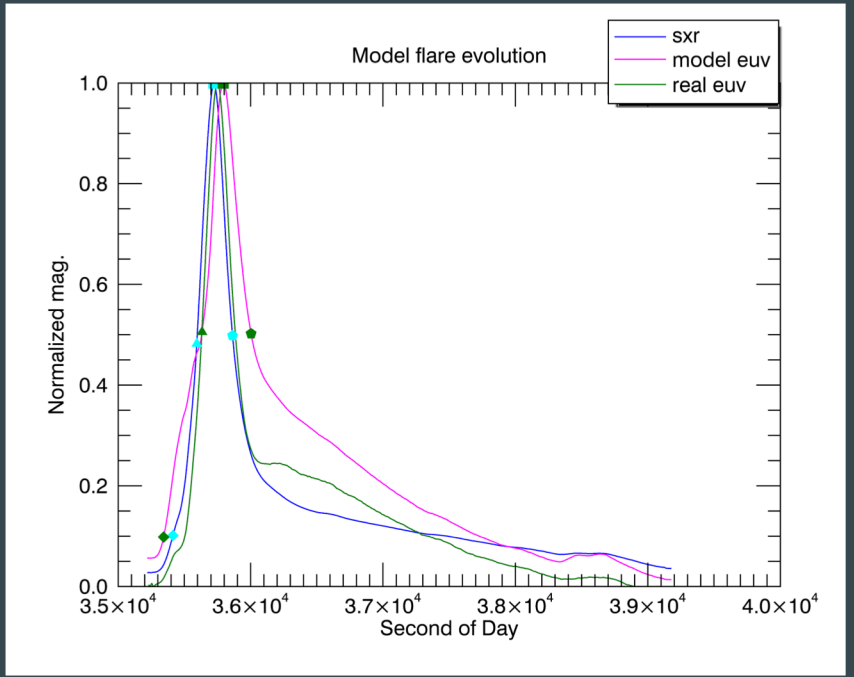
-same time selections, same statistics, but with EM&T line



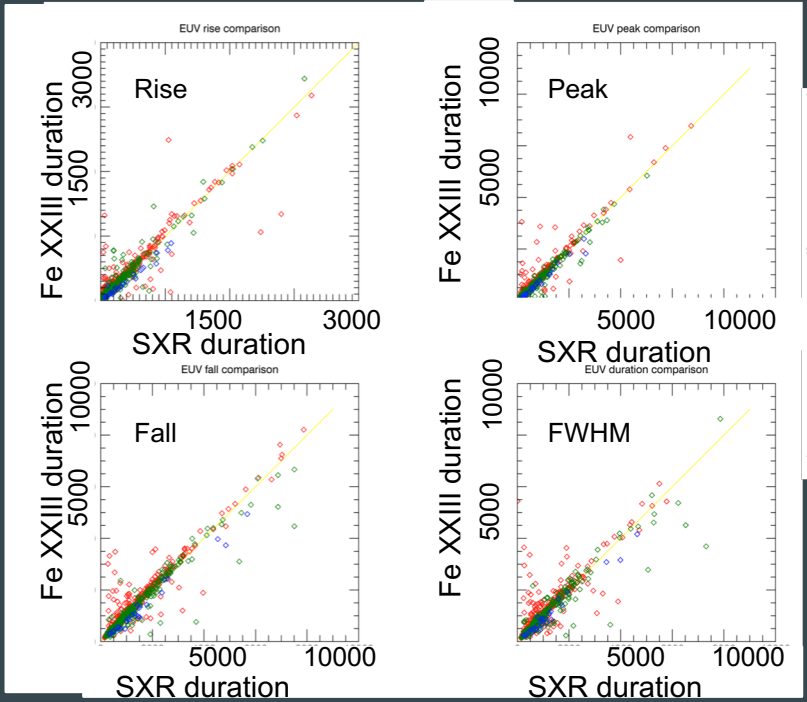
Comparing data and EM&T

EM&T shows qualitative agreement with Fe XXIII

-Lines disagree at some points, with some flares being easier to model



Success of EM&T



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From Model								
Rise	0.896	0.833	0.860	0.880	0.988	0.521	0.762	0.340
Peak	0.969	0.562	1.000	0.625	0.942	0.178	0.841	0.112
Fall	0.957	0.432	1.012	0.495	0.917	0.211	0.862	0.148
Duration	0.910	1.987	0.970	2.567	0.867	0.267	0.875	0.198

Comparison of statistics from both models

-Comparable SXR and EM&T standard deviations

-Timing variations exist between both model sand Fe XXIII

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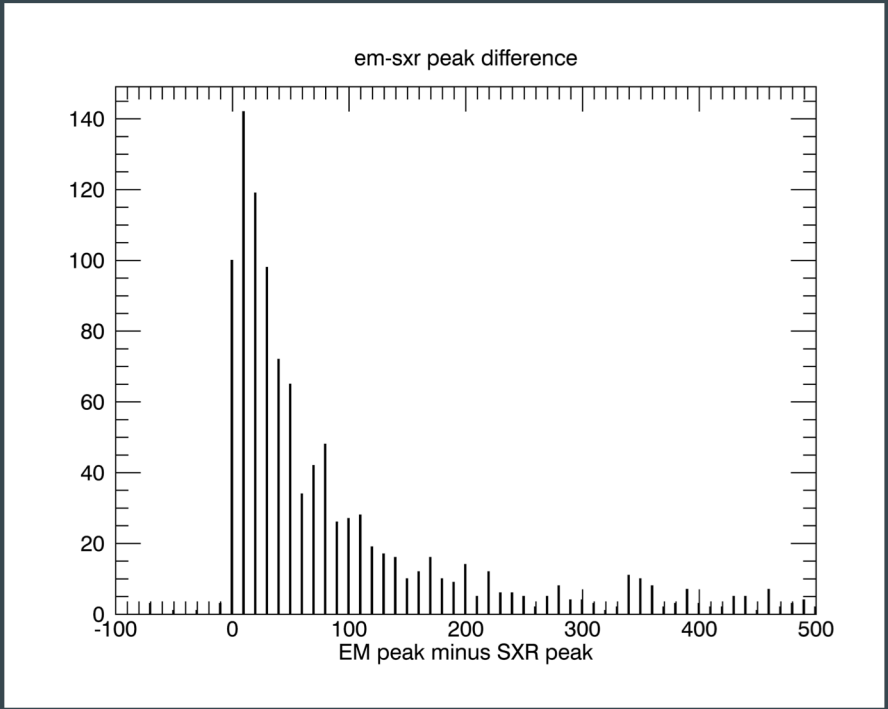
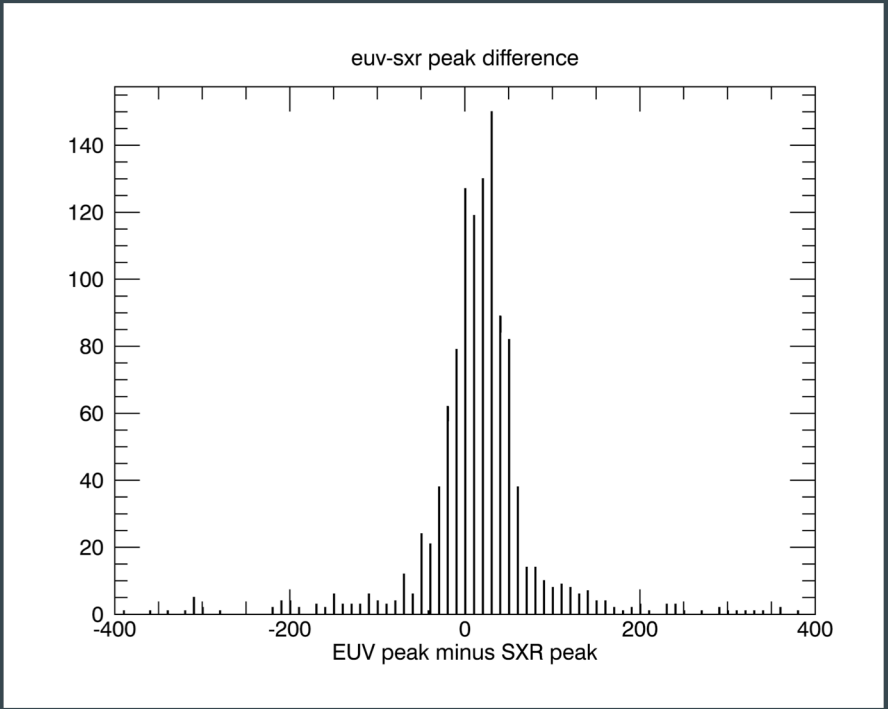
Model aspects and SXR agreement

Why does SXR show agreement?

Why is the EM&T imperfect?

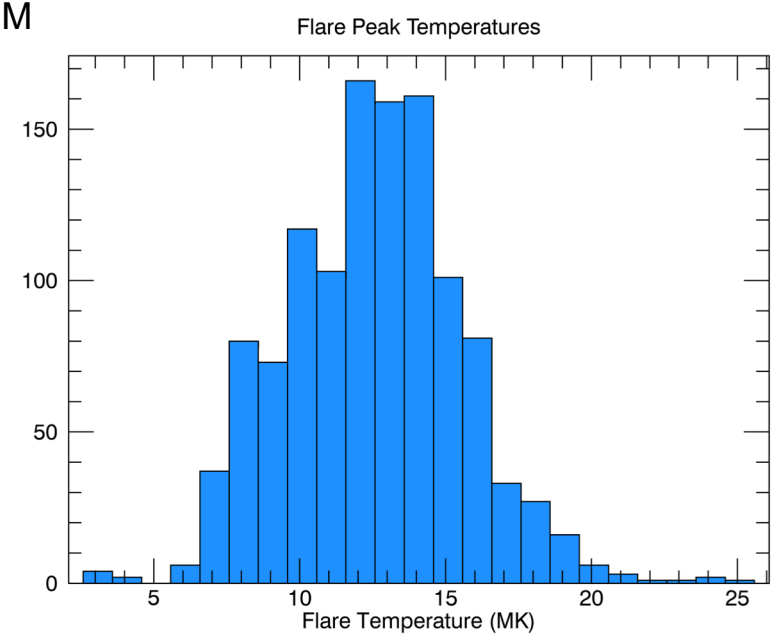
Peak timing


em-sxr peak difference
140
120
100
80
60
40
20
0
-100
0
100
200
300
400
500
EM peak minus SXR peak

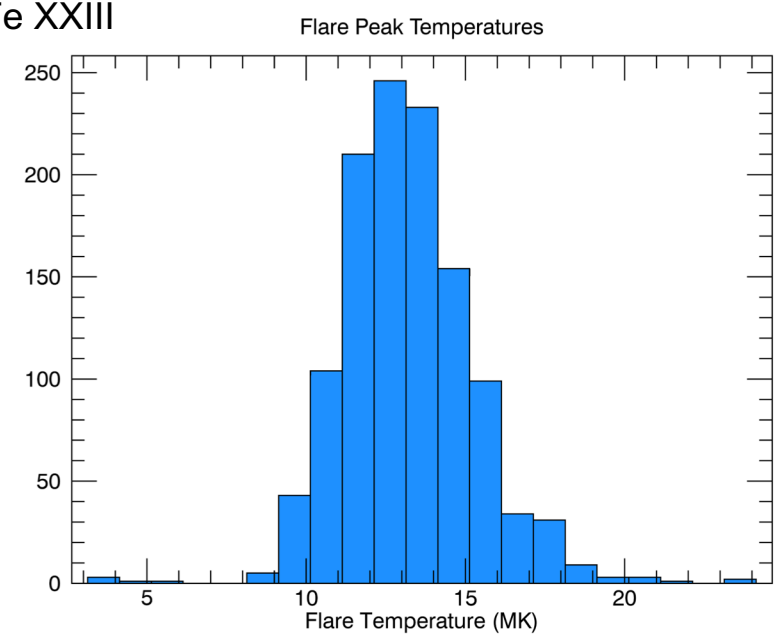

euv-sxr peak difference
140
120
100
80
60
40
20
0
-400
-200
0
200
400
EUV peak minus SXR peak

Temperature at peaks

EM



Fe XXIII



SXR and EM&T analysis

From histograms, Fe XXIII should peak with EM:

-EM peaks at peak Fe XXIII formation temperatures

-Fe XXIII peaks before or around EM

Disagreement potentially explained by errors in GOES temperature and EM estimates.

-GOES temperature and EM depend on both SXR and HXR channels

Model implementation

-Either EM&T or SXR could be used as a proxy for Fe XXIII, with EM&T offering some advantages

EM&T could be improved by exploring EM&T model parameters and investigating GOES temperature and EM models.

References

1. 1.Thiemann, E.M.B., F.G. Eparvier, and T.N. Woods. A Time Dependent Relation Between EUV Solar Flare Light-Curves from Lines with Differing Formation Temperatures. *Journal of Space Weather and Space Climate*
2. White, S.M., R.J. Thomas, and R.A. Schwartz. Updated Expressions for Determining Temperatures and Emission Measures from GOES Soft X-Ray Measurements. *Solar Physics,* **227**(2), 231-248, 2005