



# Hot X-ray onsets of solar flares

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*Hot X-ray onsets of solar flares*

*Hudson et al. 2021*

*MNRAS, v. 501-1, Feb 2021*

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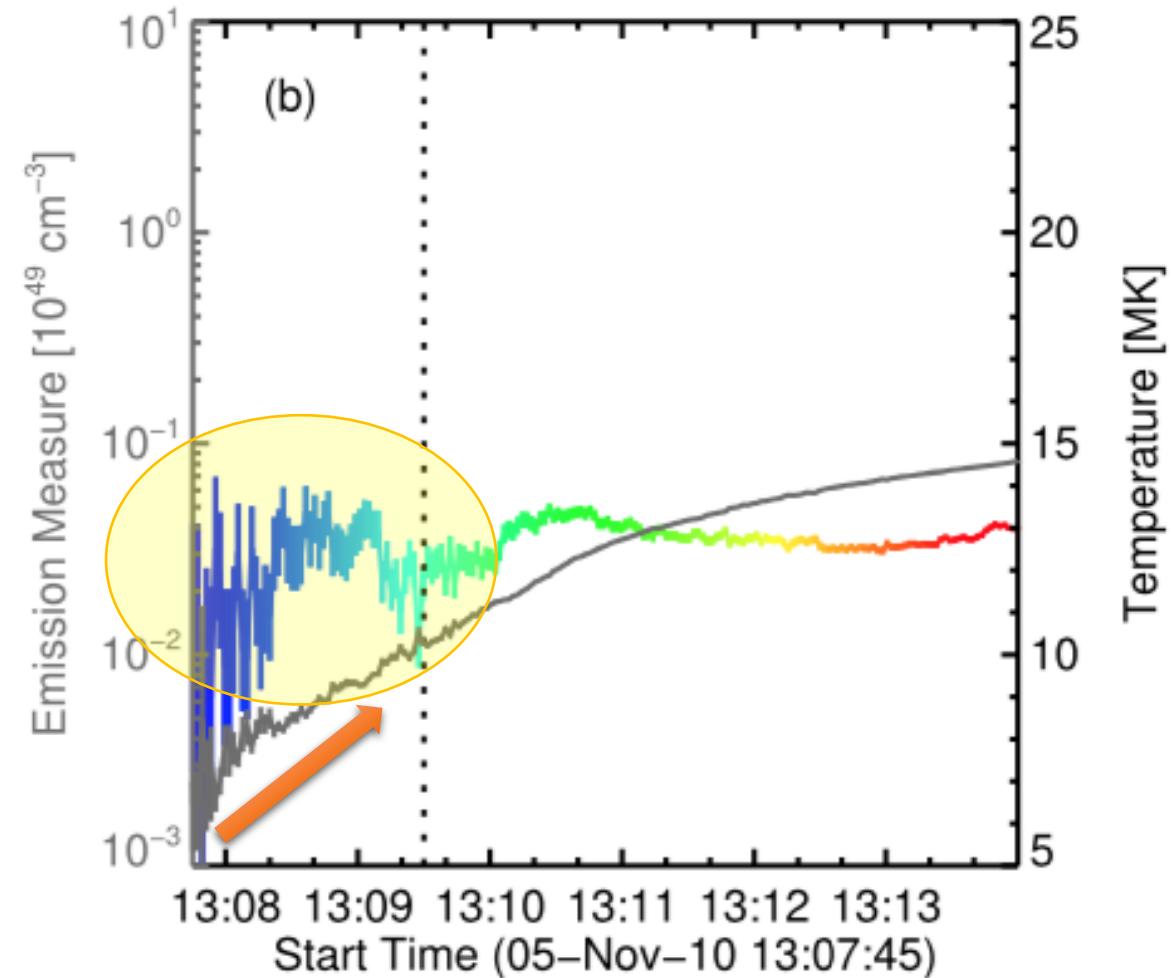
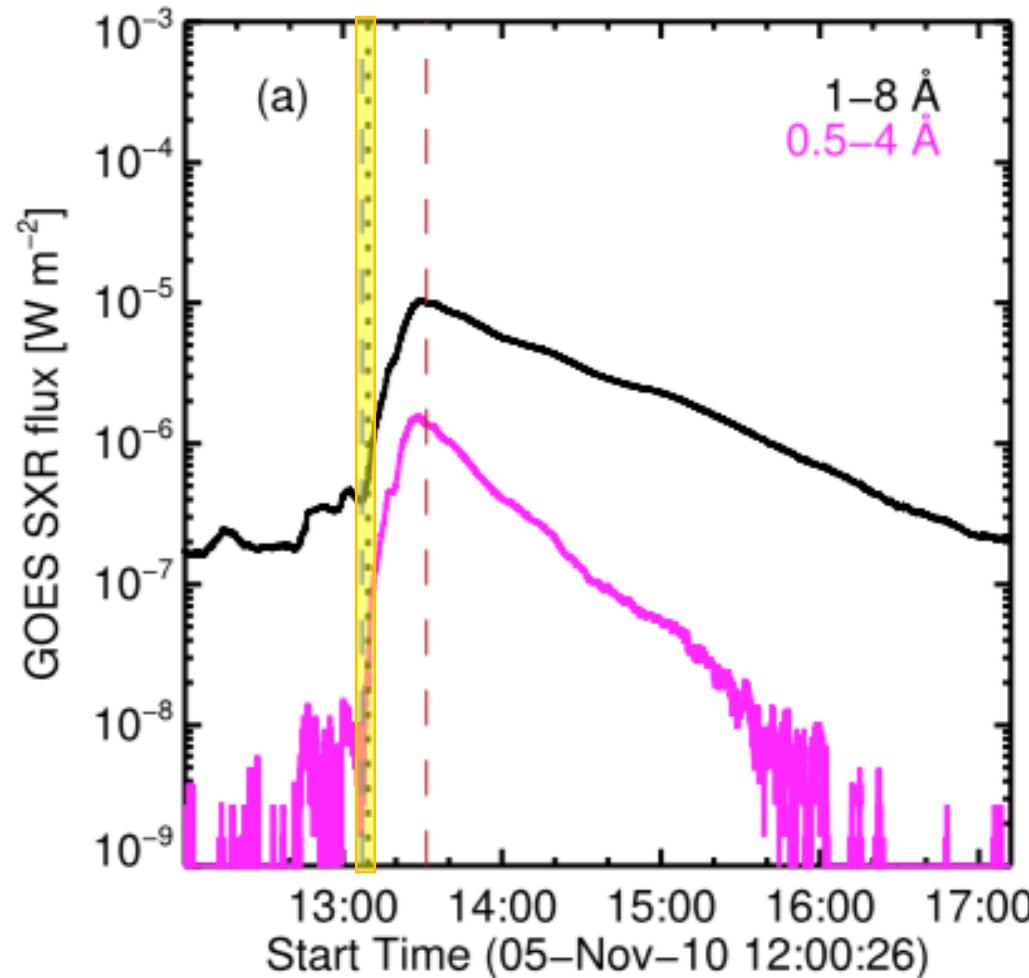
arXiv:2007.05310

RHESSI workshop 2021  
July 2021

# What is the Hot Onset?

initial temperature values measured from a flare: **10-15 MK**

EM starts low (log EM 46) **increasing 10-fold** during this onset



# GOES Temperatures: first detection at 10-15 MK

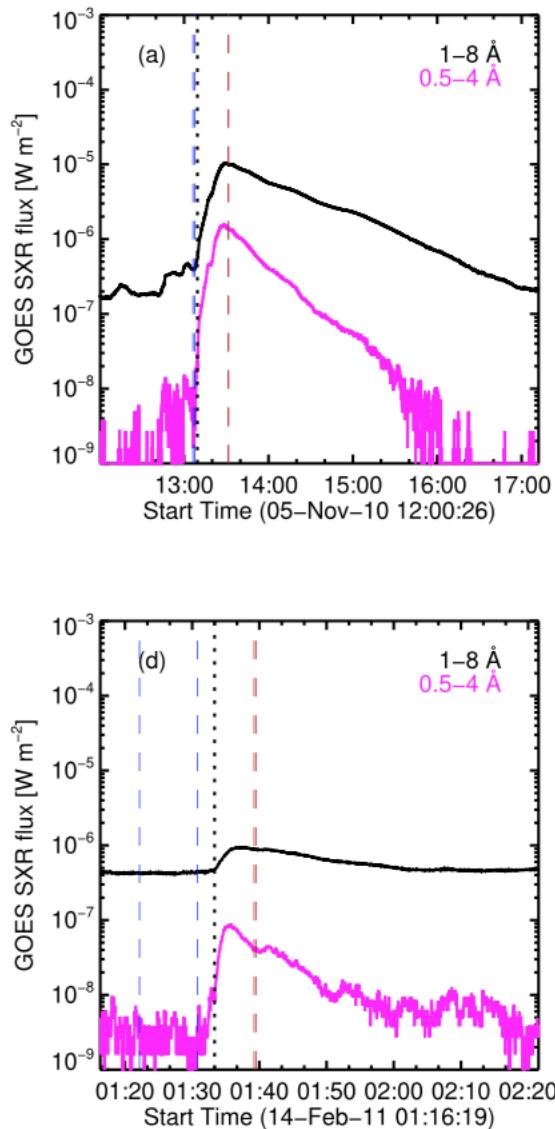
Sample: 4 events

Strong & Slow  
SOL2010-11-05T13:29  
M1.0

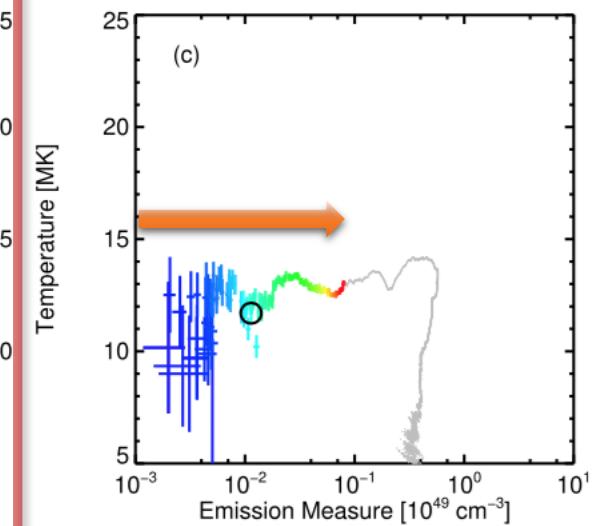
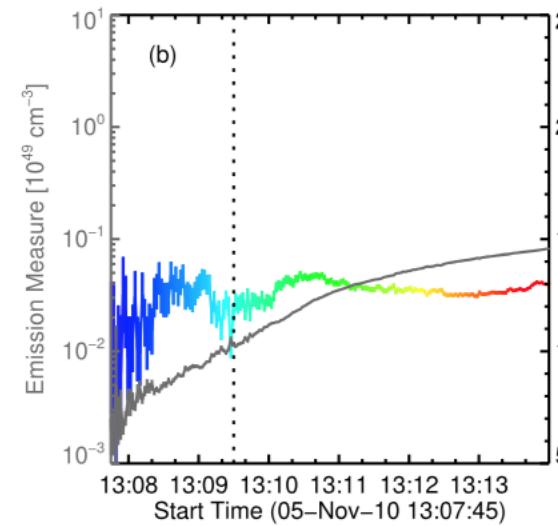
Weak & Slow  
SOL2011-02-14T01:37  
B9.4

Weak & Fast  
SOL2012-05-14T13:38  
C1.1

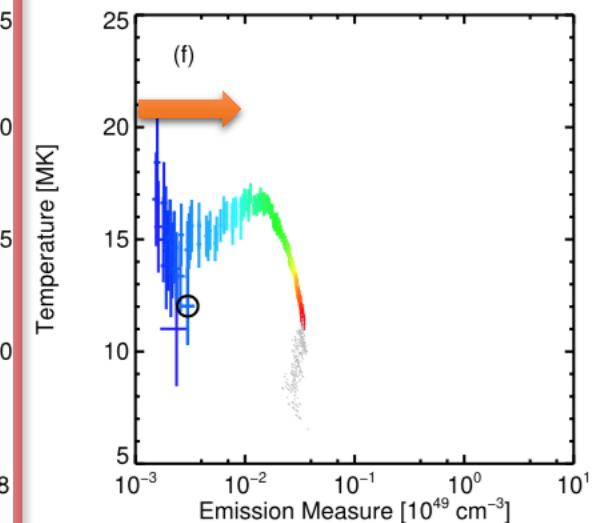
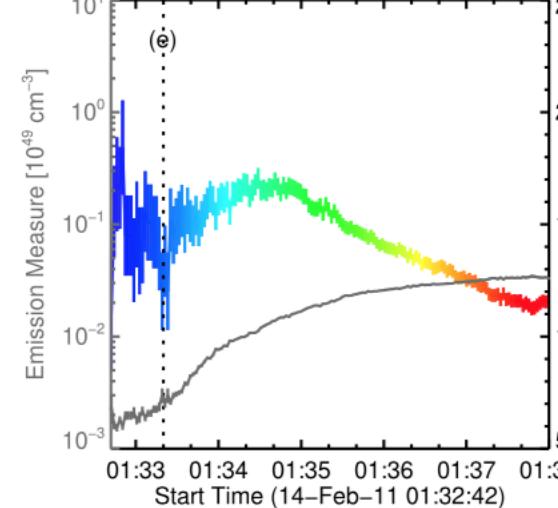
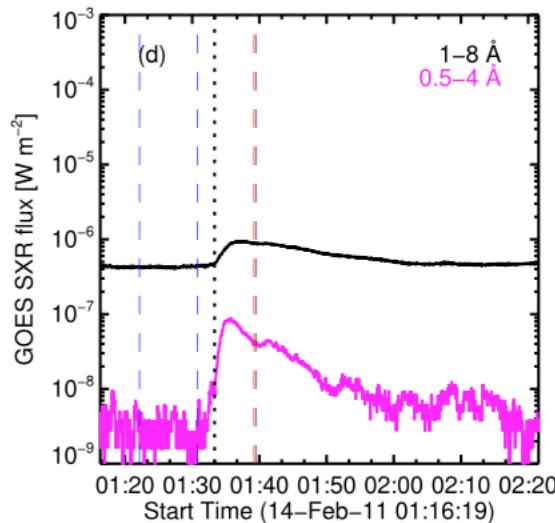
Strong & Fast  
SOL2014-01-07T10:13  
M7.3



SOL2010-11-05T13:29 M1.0 (strong & slow)



SOL2010-11-05T13:29 M1.0 (strong & slow)



# GOES Temperatures: first detection at 10-15 MK

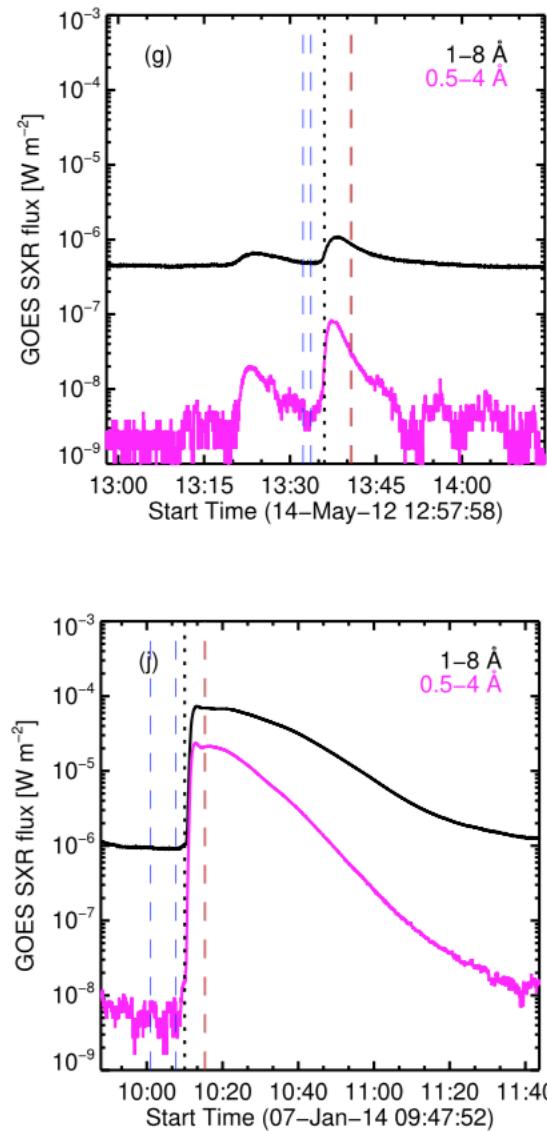
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Strong & Slow  
SOL2010-11-05T13:29  
M1.0

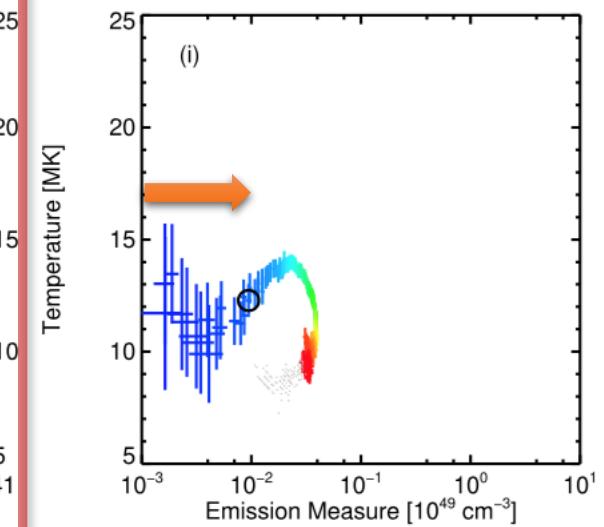
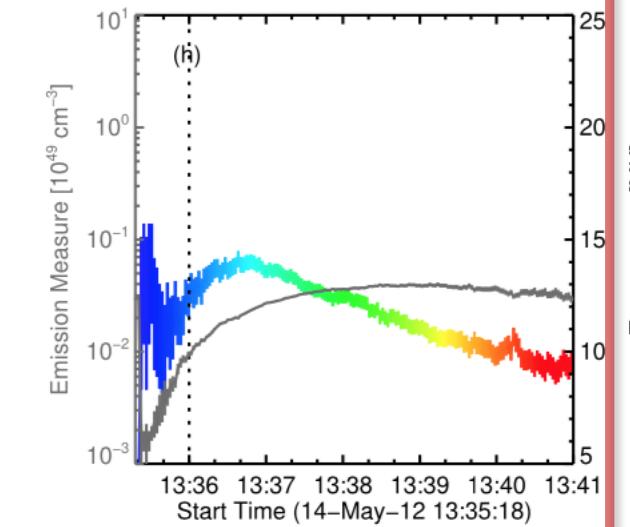
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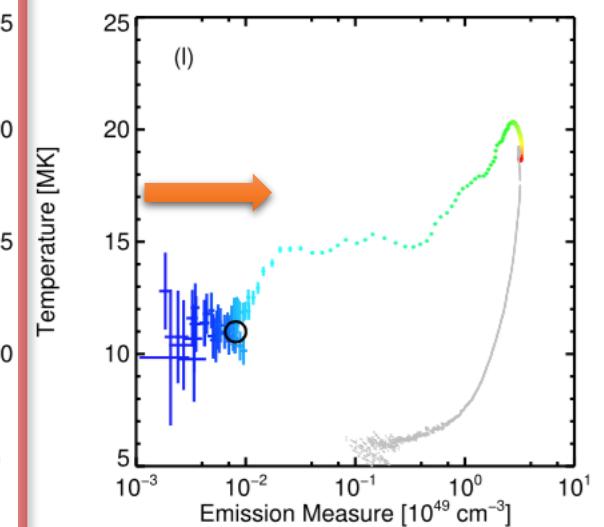
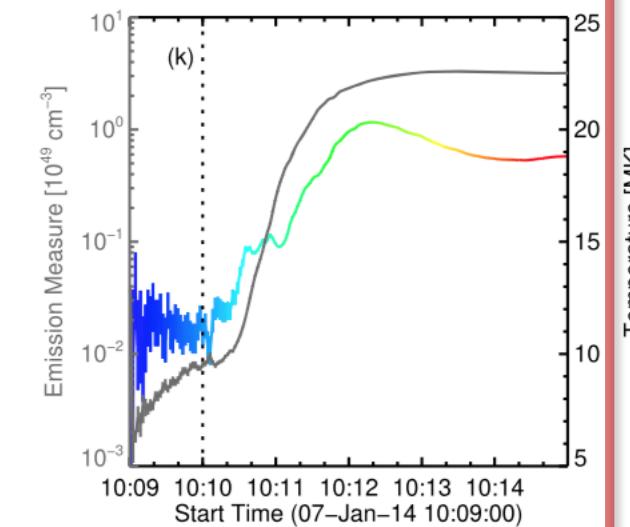
Strong & Fast  
SOL2014-01-07T10:13  
M7.3



SOL2012-05-14T13:38 C1.1 (weak & fast)



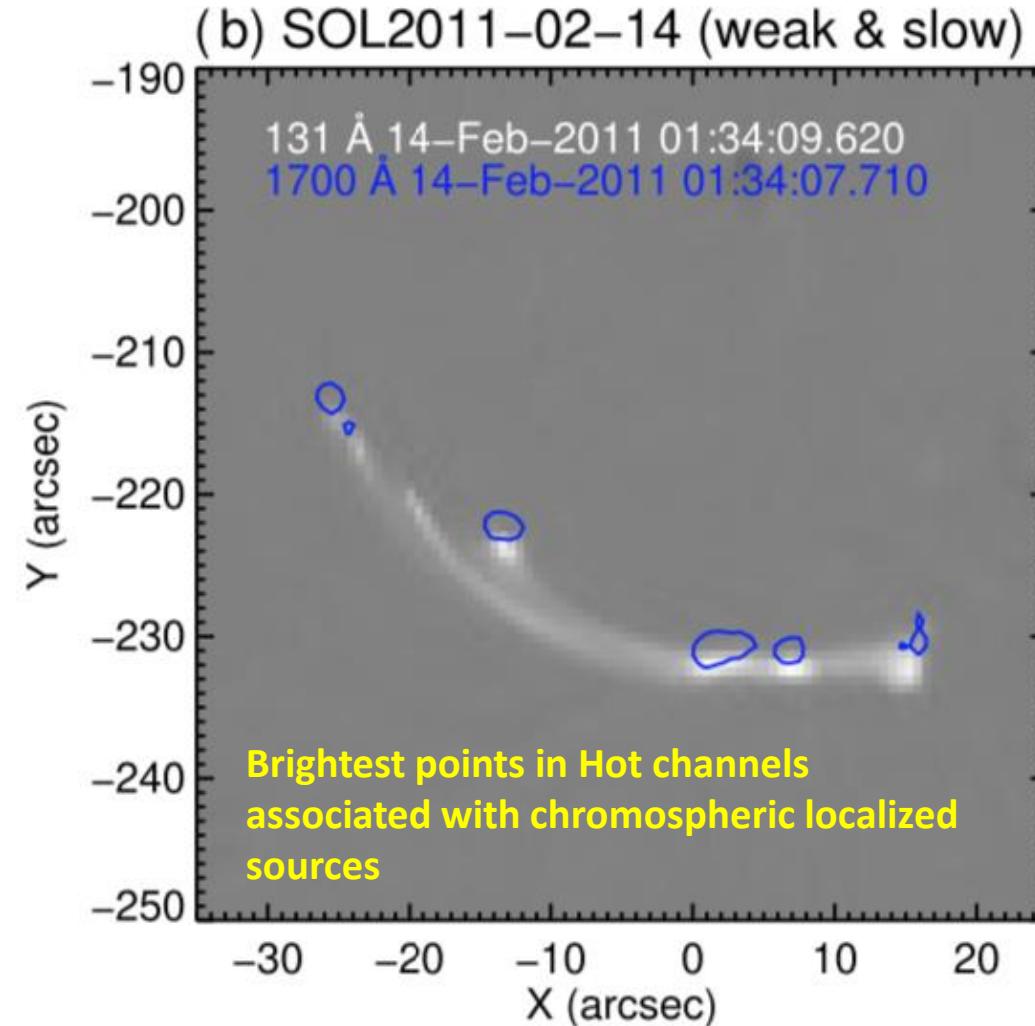
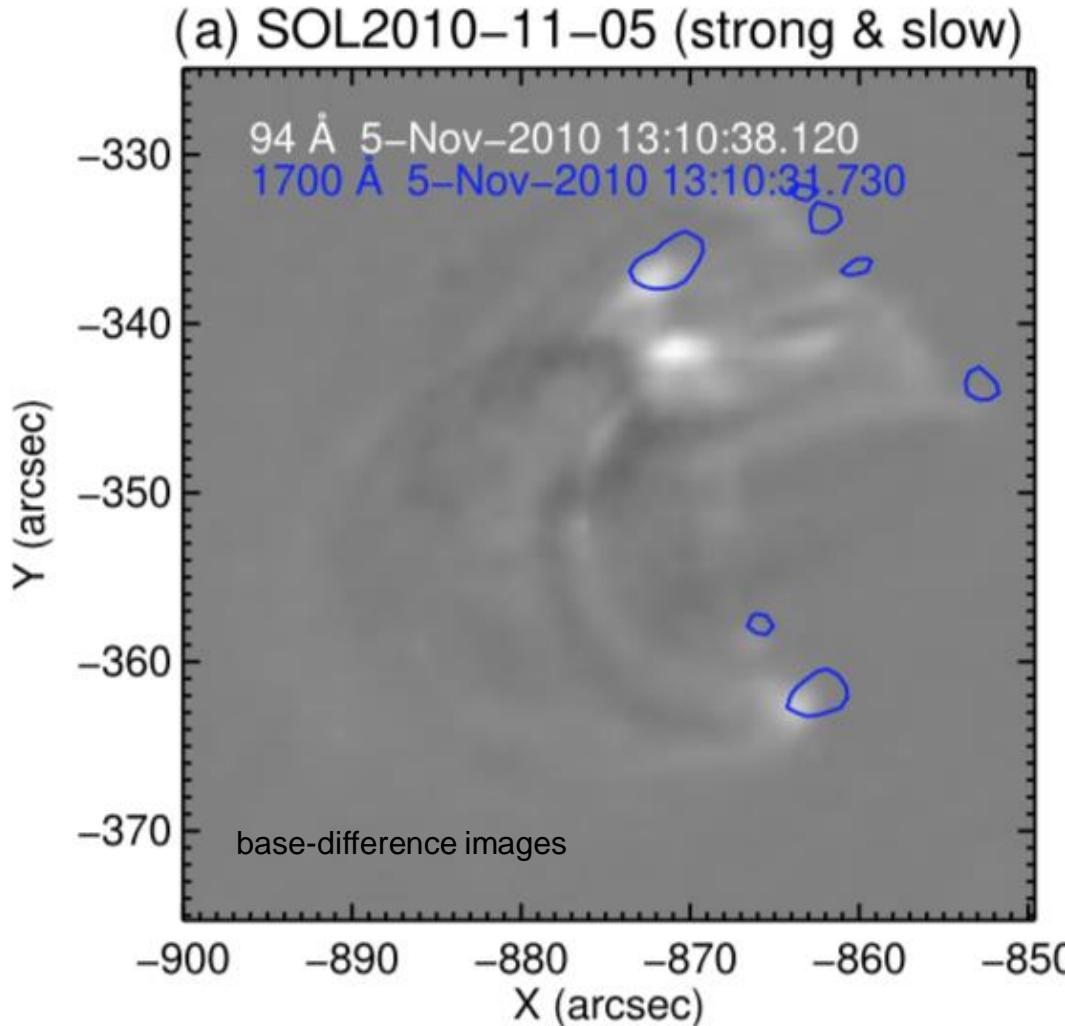
SOL2014-01-07T10:13 M7.3 (strong & fast)



# Sources of the Hot Onset: AIA imaging (1)

Hot emission: 94 Å (Fe XVIII/XX, 8-10 MK) and 131 Å (Fe XXI/XXIII, ~12 MK) (e.g. O'Dwyer et al. 2010)

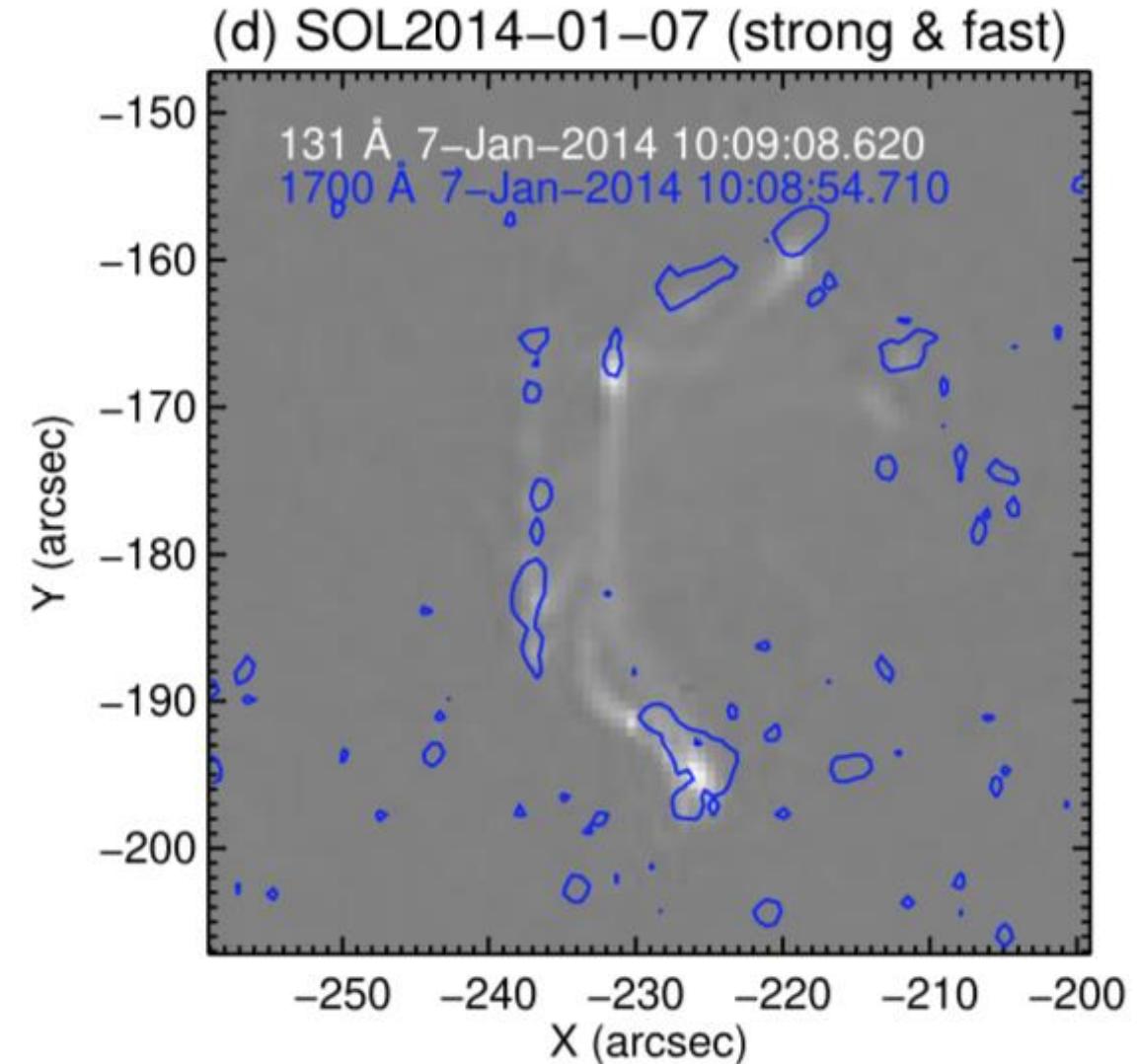
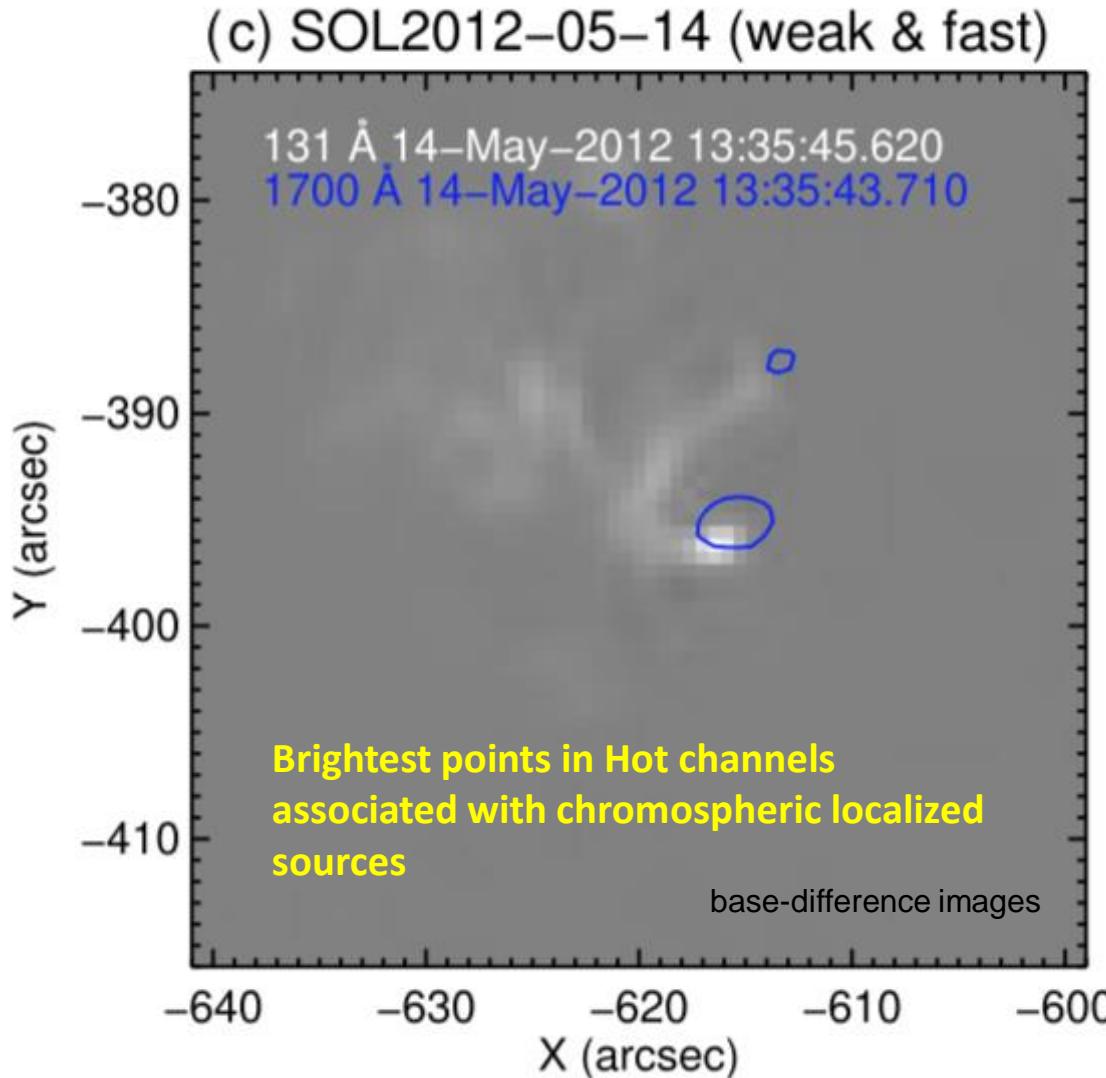
Chromospheric emission: 1700 Å (C I, He II, Al II +lines, ~ $10^{4.5}$  K) (Simões et al. 2019)



## Sources of the Hot Onset: AIA imaging (2)

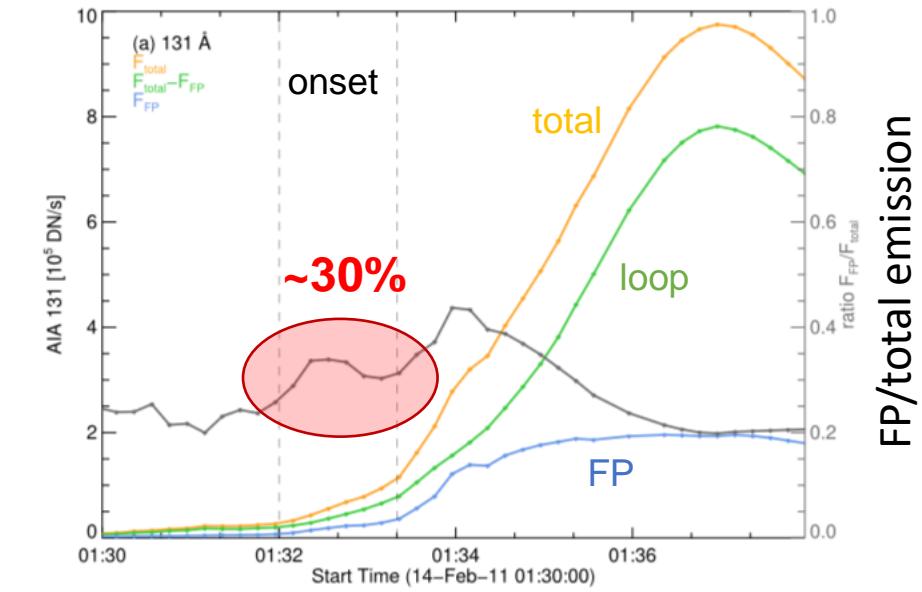
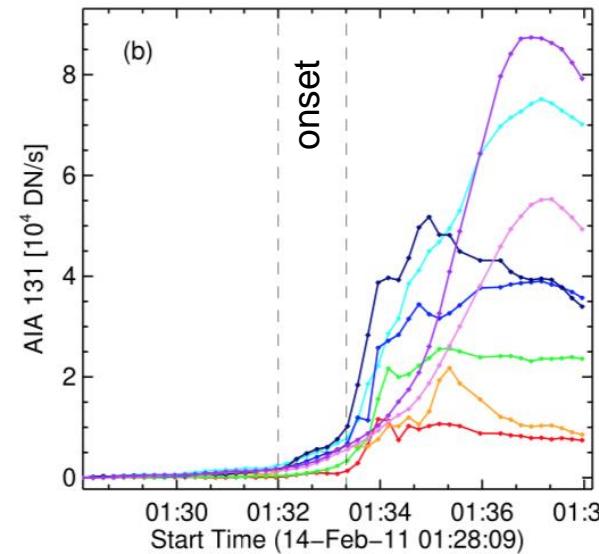
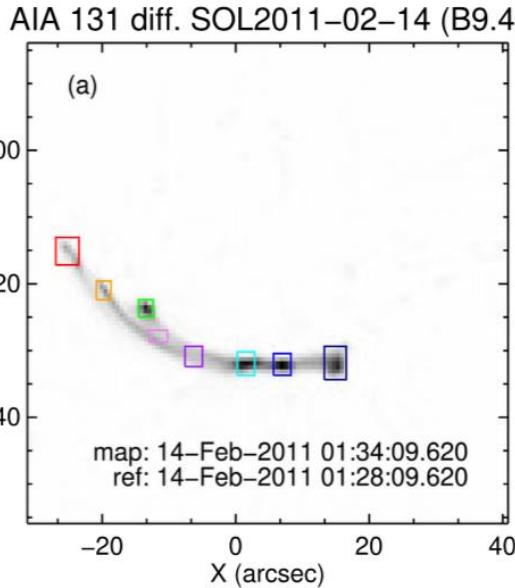
Hot emission: 94 Å (Fe XVIII/XX, 8-10 MK) and 131 Å (Fe XXI/XXIII, ~12 MK) (e.g. O'Dwyer et al. 2010)

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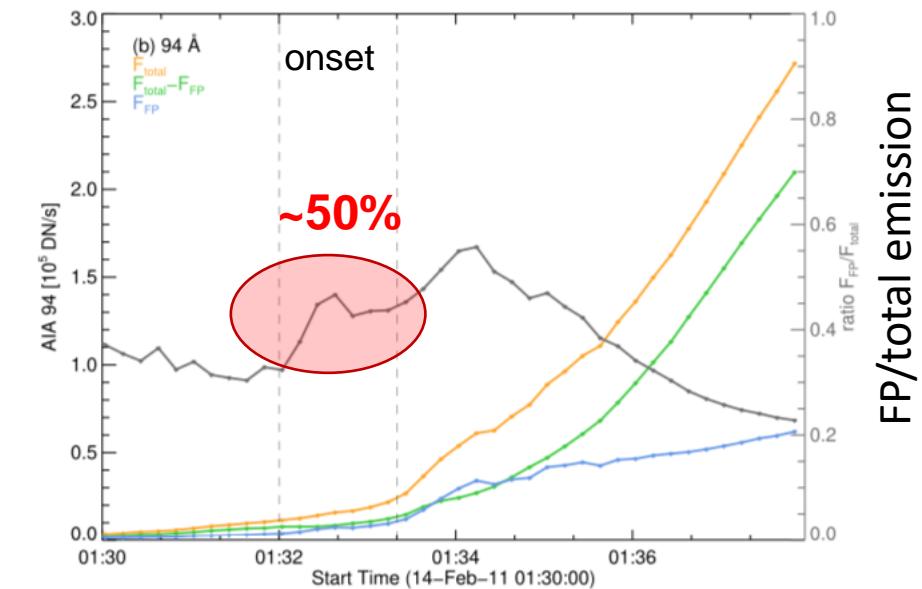
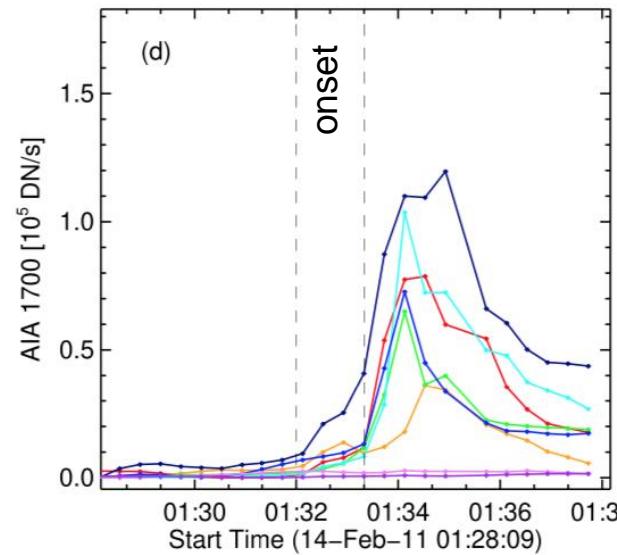
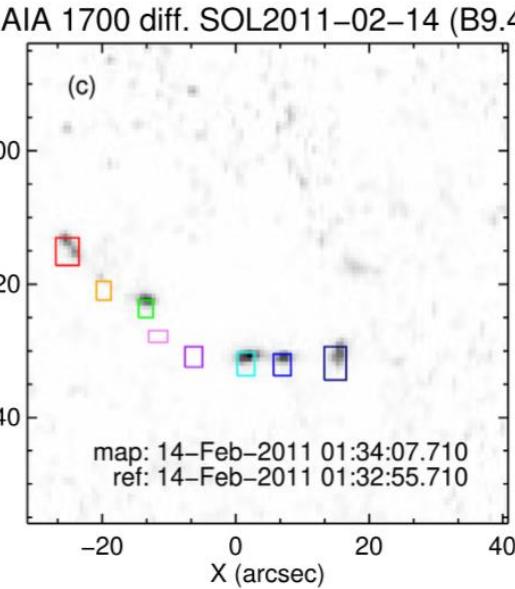
# Sources of the Hot Onset: Loop vs. footpoint emission

131 A



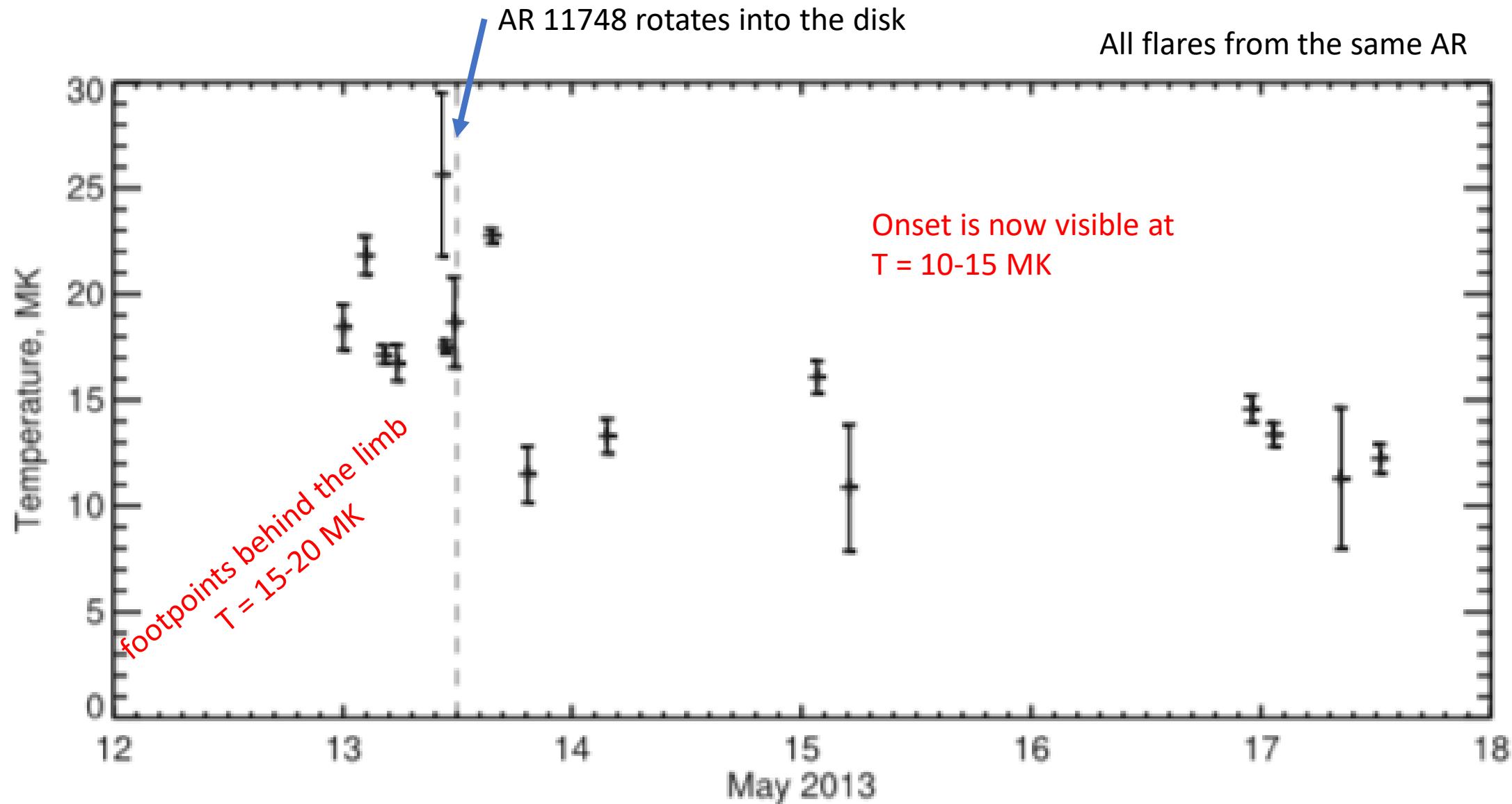
94 A

1700 A



FP/total emission

# Verification: limb-occulted flares





## Summary

GOES temperatures start at 10-15 MK

B to M classes

Onset temperatures confirmed with RHESSI data

Very small amounts of plasma:  $\log EM \sim 46$  to  $47 \text{ cm}^{-3}$

SDO/AIA imaging: localized near footpoint regions & low-lying faint loops

**Flare models? Regulated 10-15 MK while EM increases 10-fold**

**Ubiquitous? Are there hints to flare magnitude here?**

## Future work

Alasdair Wilson (Glasgow): DEMograms (temperature analysis via AIA-DEM)

Douglas Silva (CRAAM/Mackenzie): statistical analysis of GOES temperatures

**More details:**

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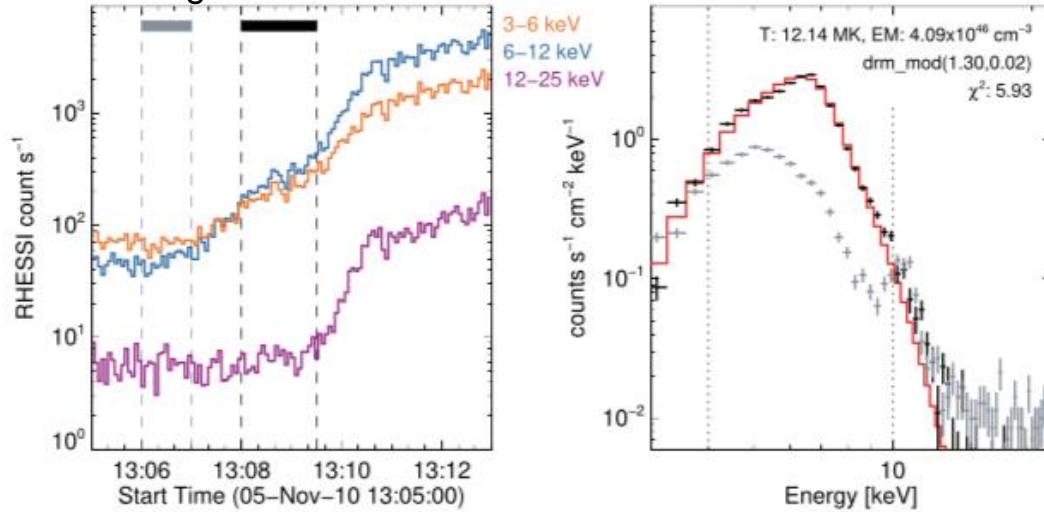
paulo@craam.mackenzie.br

## EXTRA SLIDES

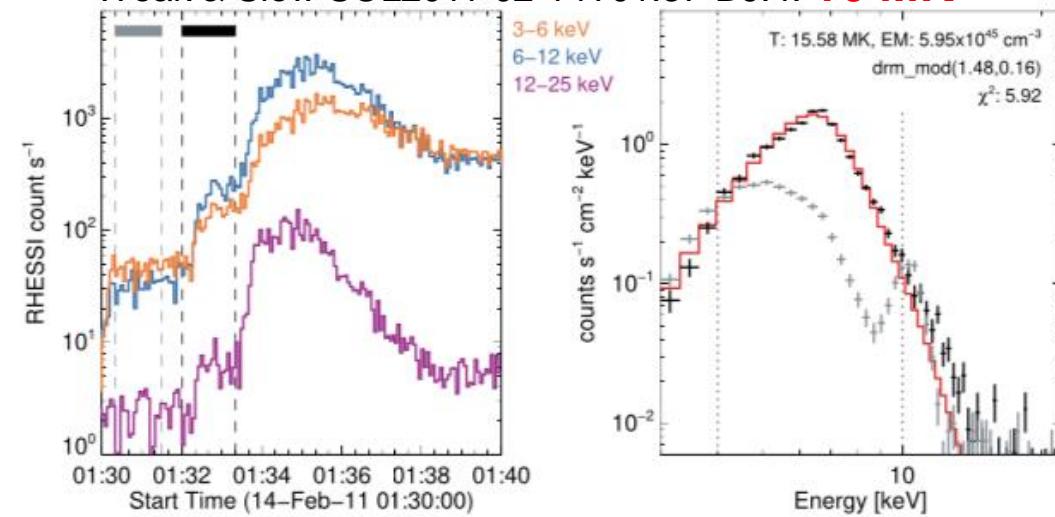
# Verification: RHESSI Temperatures

background time  
onset time

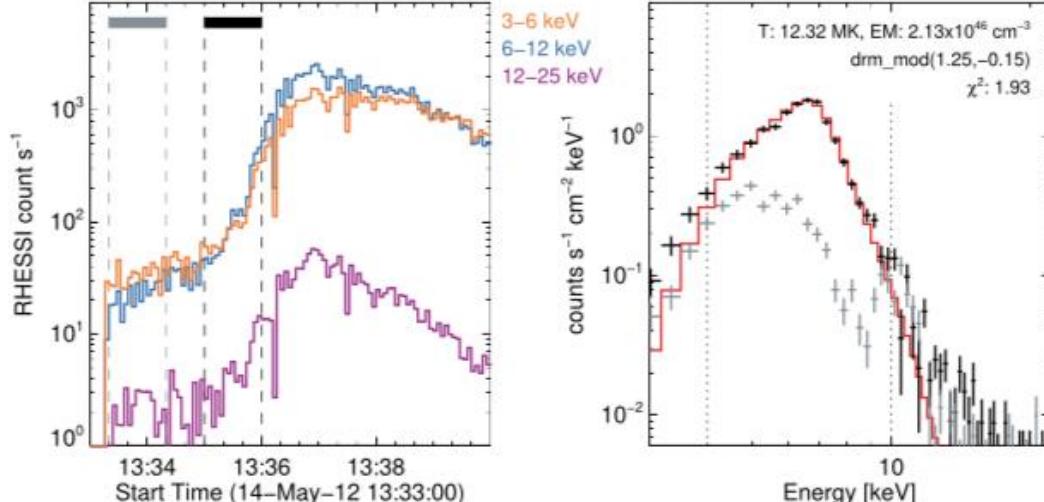
Strong & Slow SOL2010-11-05T13:29 M1.0: **12 MK**



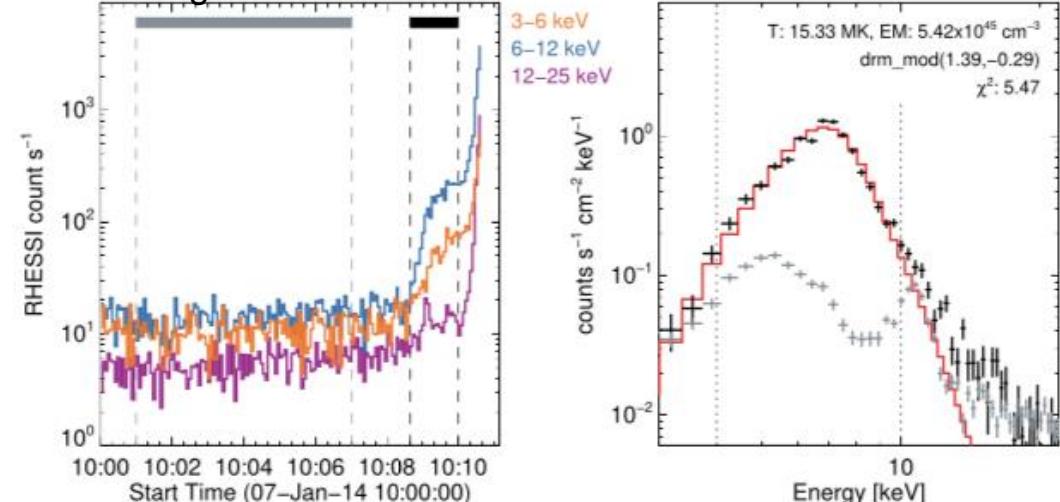
Weak & Slow SOL2011-02-14T01:37 B9.4: **16 MK**



Weak & Fast SOL2012-05-14T13:38 C1.1 **12 MK**



Strong & Fast SOL2014-01-07T10:13 M7.3 **15 MK**



# GOES Temperatures: background (pre-flare) subtraction

background subtraction can be tricky but it does not affect the determination onset temperature too much

