

Hot X-ray onsets of solar flares

Paulo Simões

paulo@craam.mackenzie.br

CRAAM/Mackenzie (Brazil)

Hugh Hudson (Glasgow/Berkeley)

Lyndsay Fletcher (Glasgow/Oslo)

Laura Hayes (DIAS)

Iain Hannah (Glasgow)

Hot X-ray onsets of solar flares

Hudson et al.

MNRAS, v. 501-1, Feb 2021

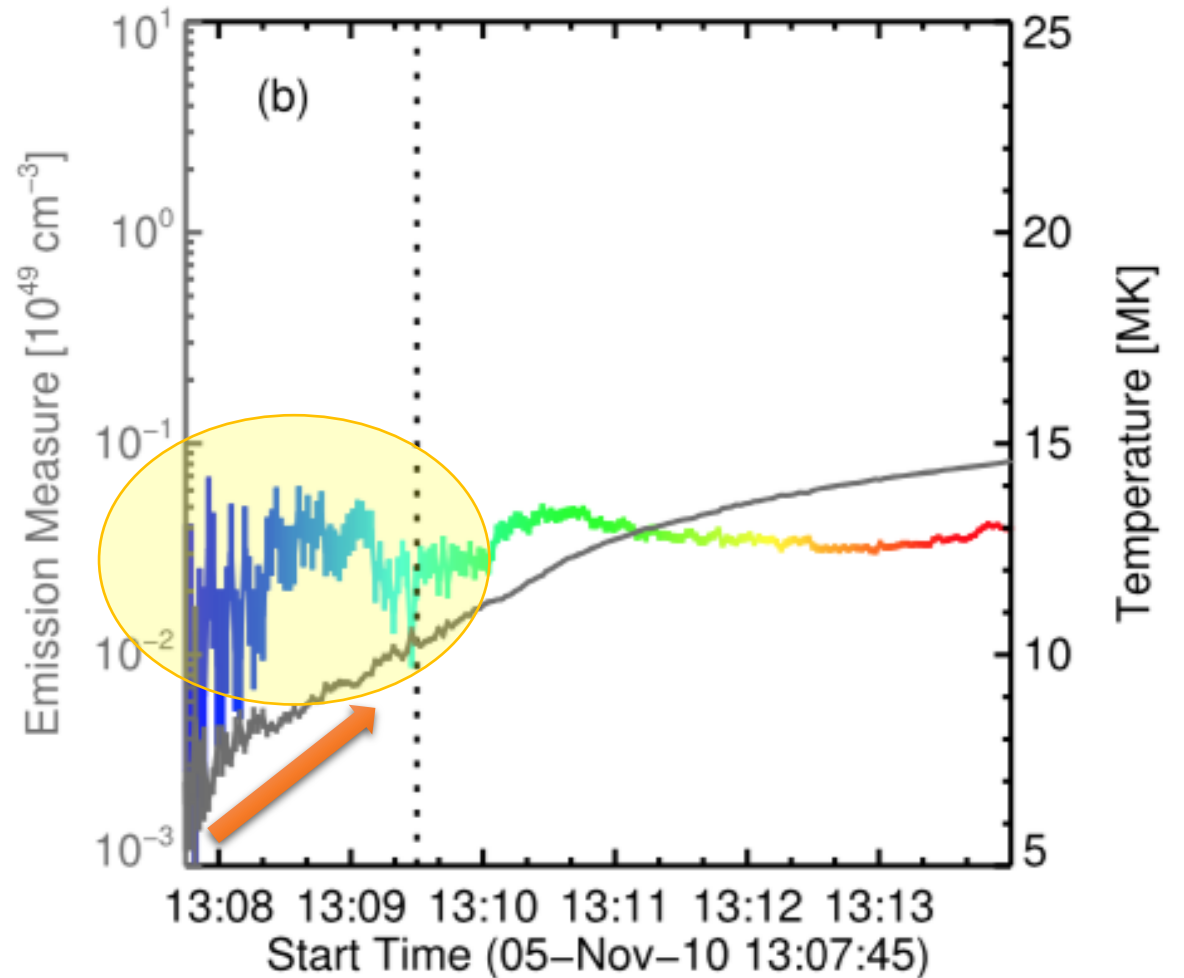
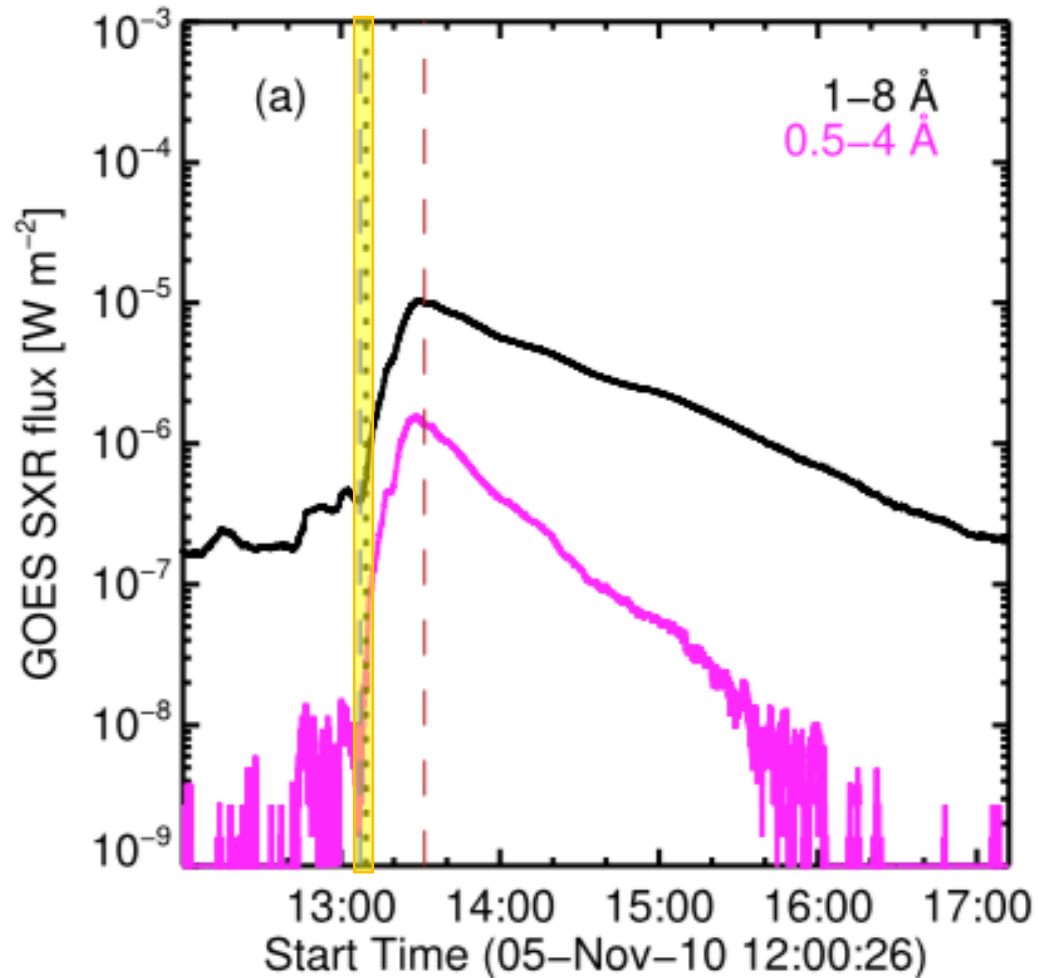
<https://doi.org/10.1093/mnras/staa3664>

arXiv:2007.05310

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



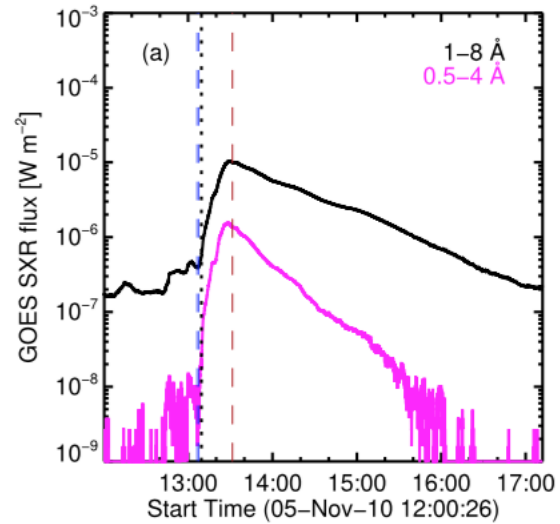
GOES Temperatures: first detection at 10-15 MK

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

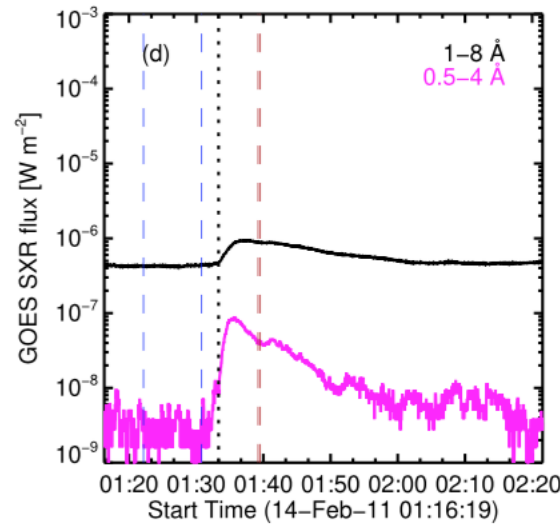
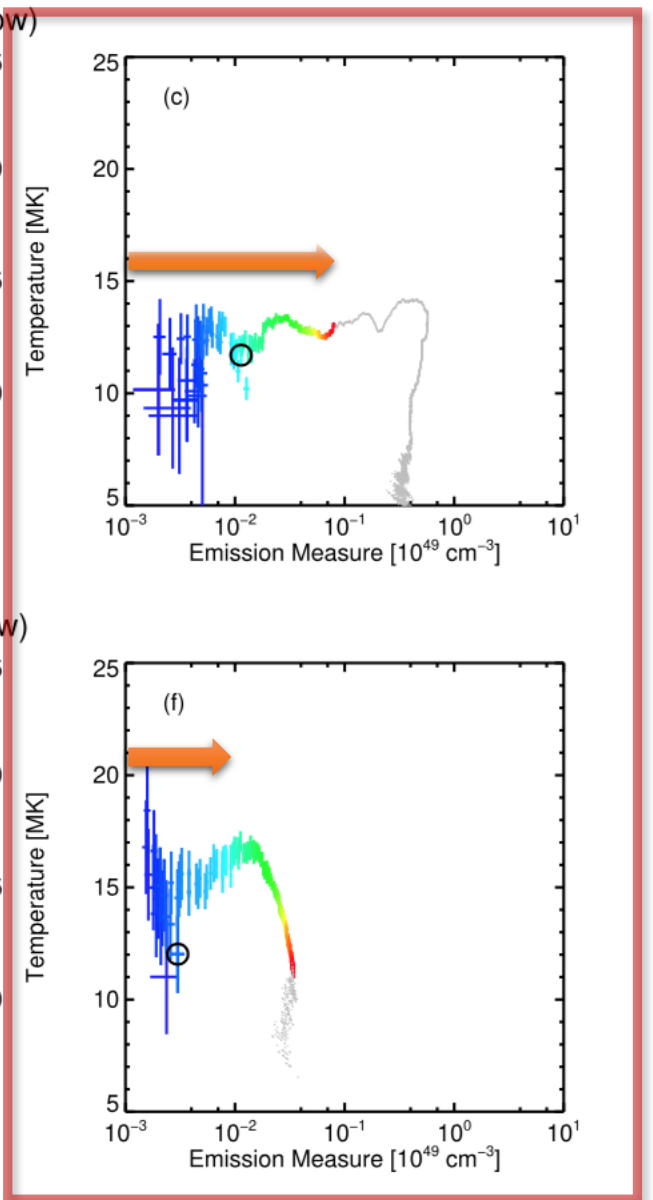
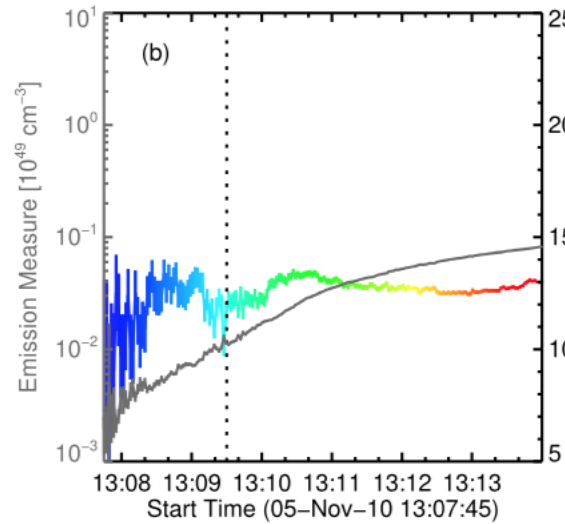
Weak & Slow
SOL2011-02-14T01:37
B9.4

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

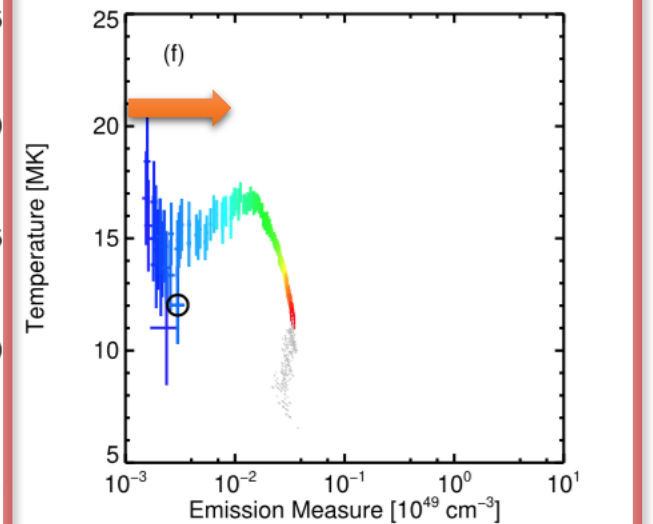
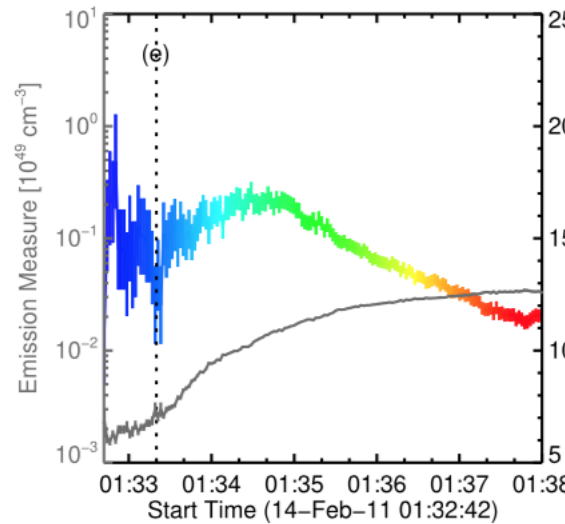
Strong & Fast
SOL2014-01-07T10:13
M7.3



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



SOL2011-02-14T01:37 B9.4 (weak & slow)



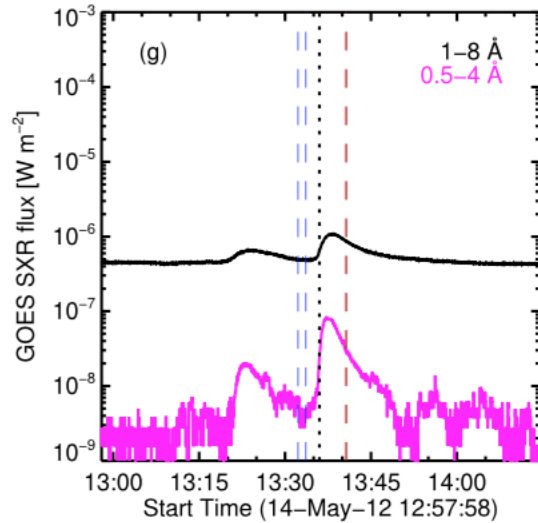
GOES Temperatures: first detection at 10-15 MK

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

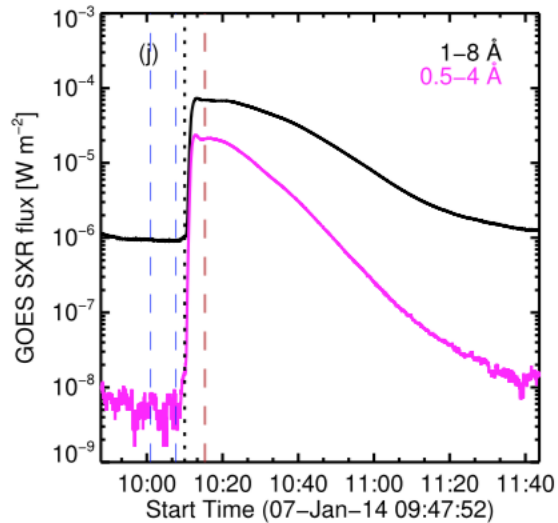
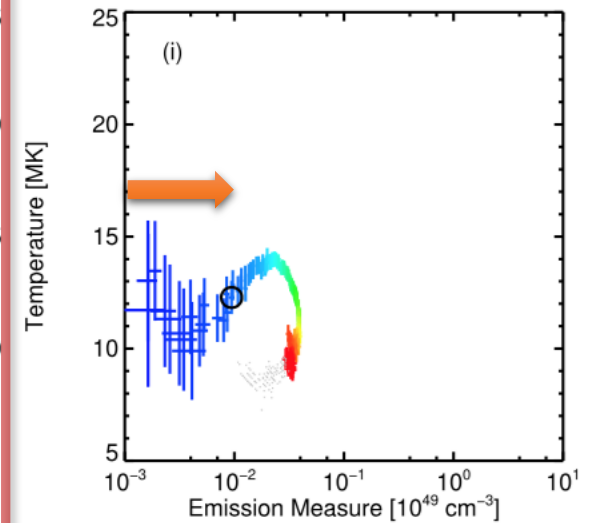
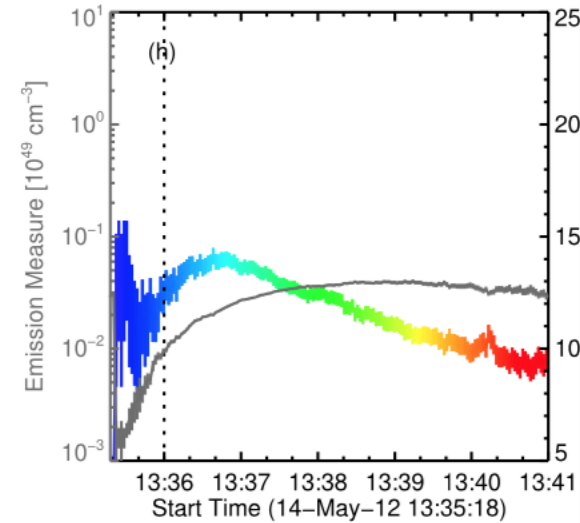
Weak & Slow
SOL2011-02-14T01:37
B9.4

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

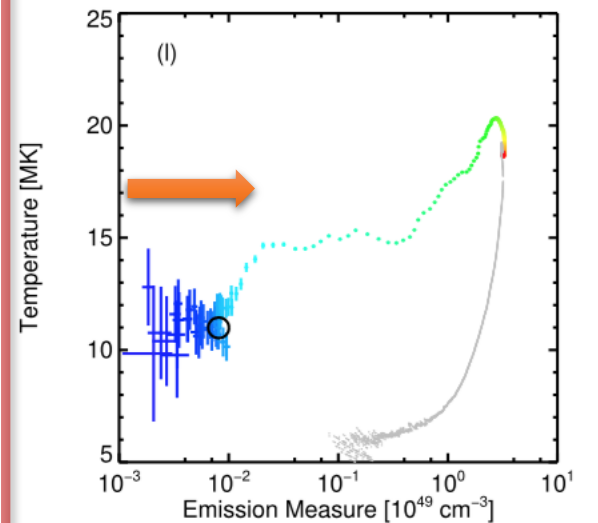
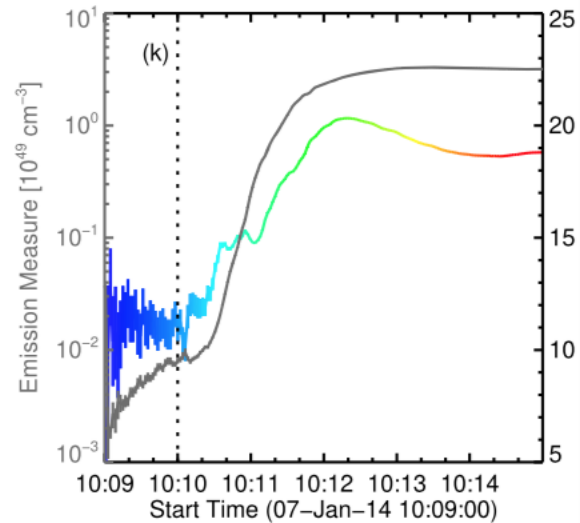
Strong & Fast
SOL2014-01-07T10:13
M7.3



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



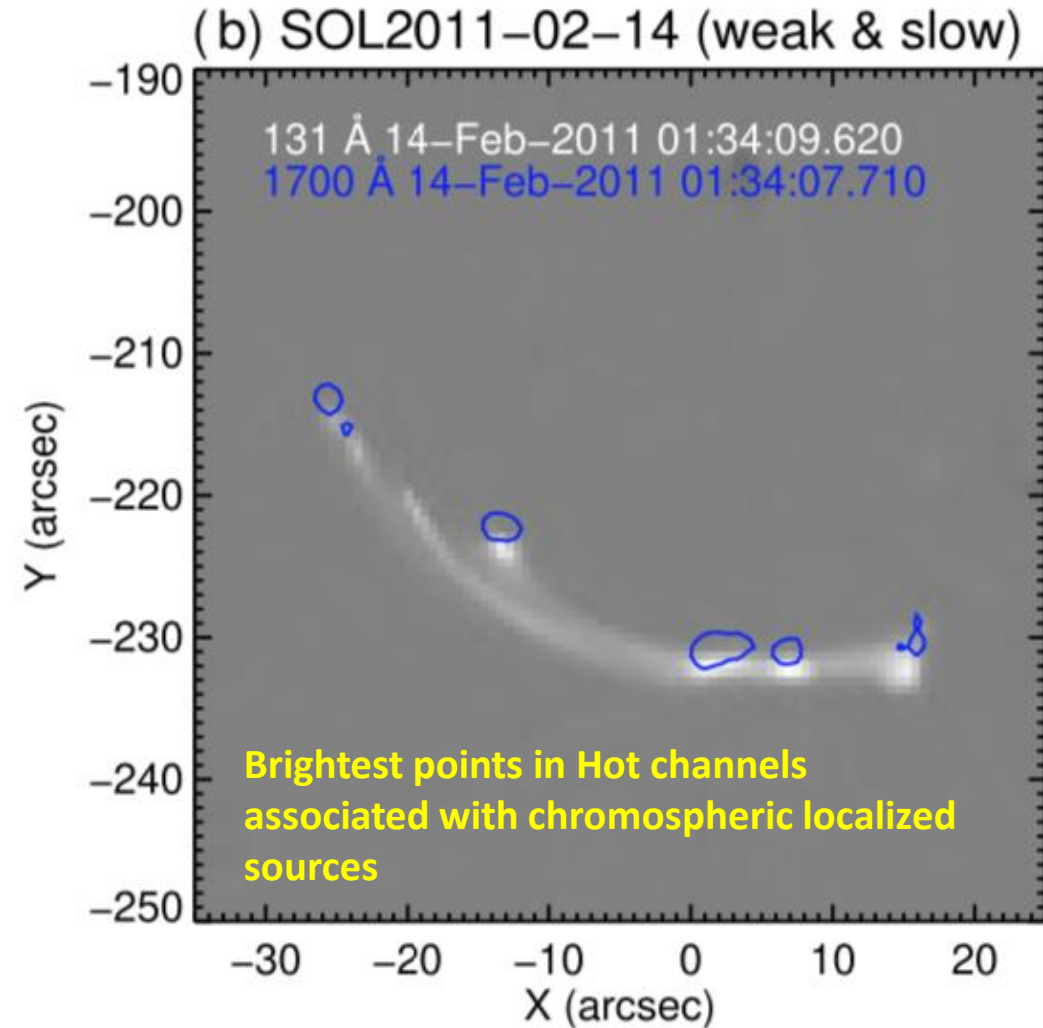
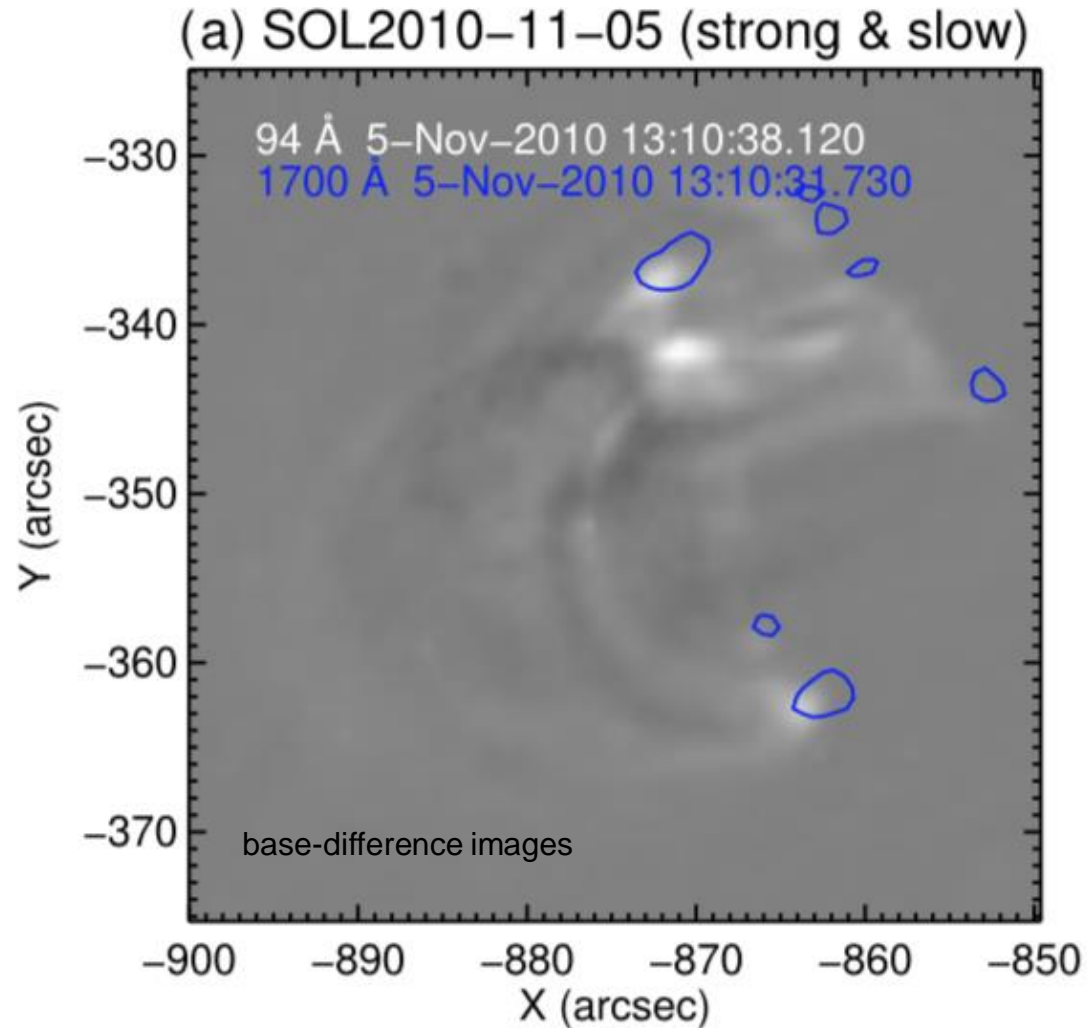
SOL2014-01-07T10:13 M7.3 (strong & fast)



Sources of the Hot Onset: AIA imaging (1)

Hot emission: 94 \AA (Fe XVIII/XX, 8-10 MK) and 131 \AA (Fe XXI/XXIII, $\sim 12 \text{ MK}$) (e.g. O'Dwyer et al. 2010)

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

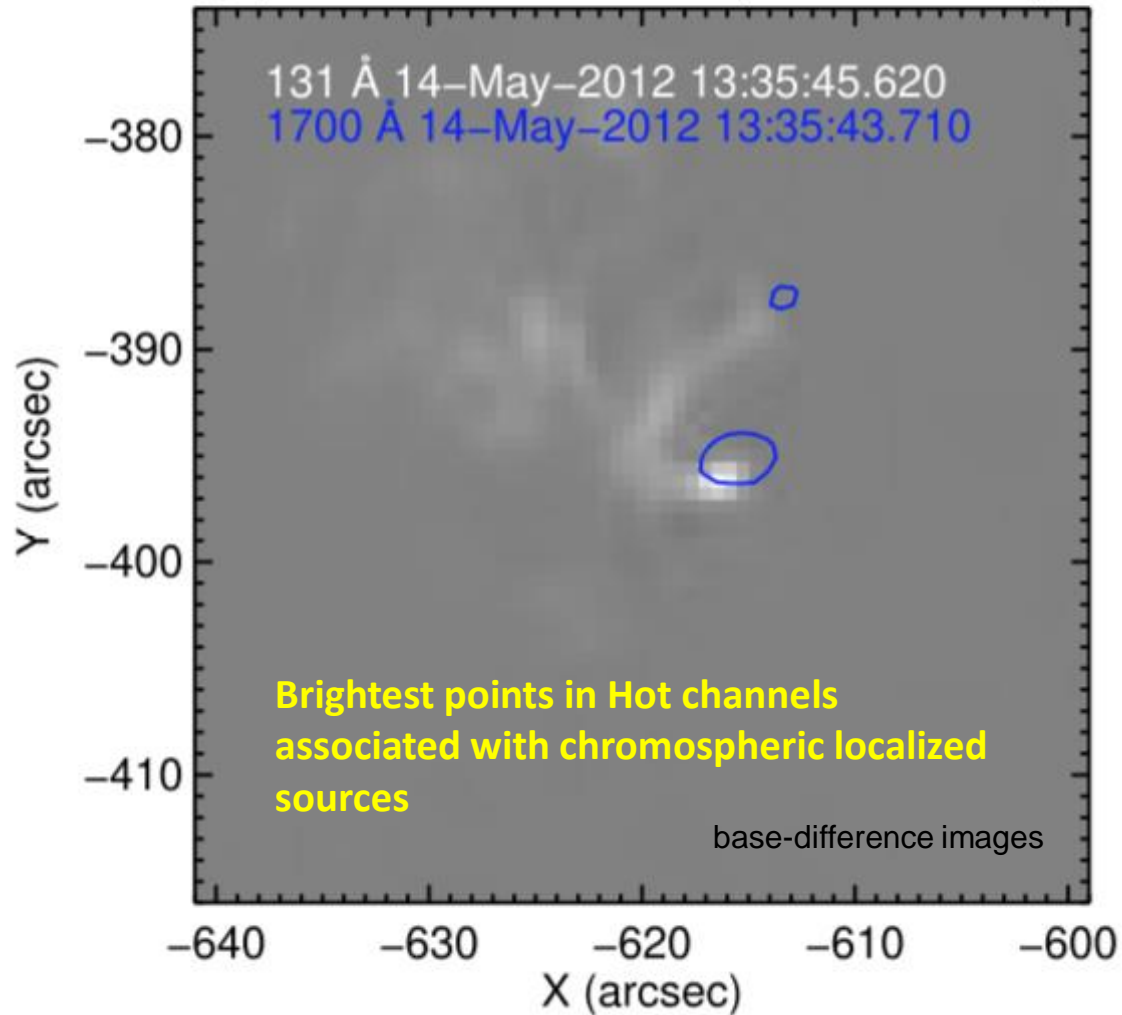


Sources of the Hot Onset: AIA imaging (2)

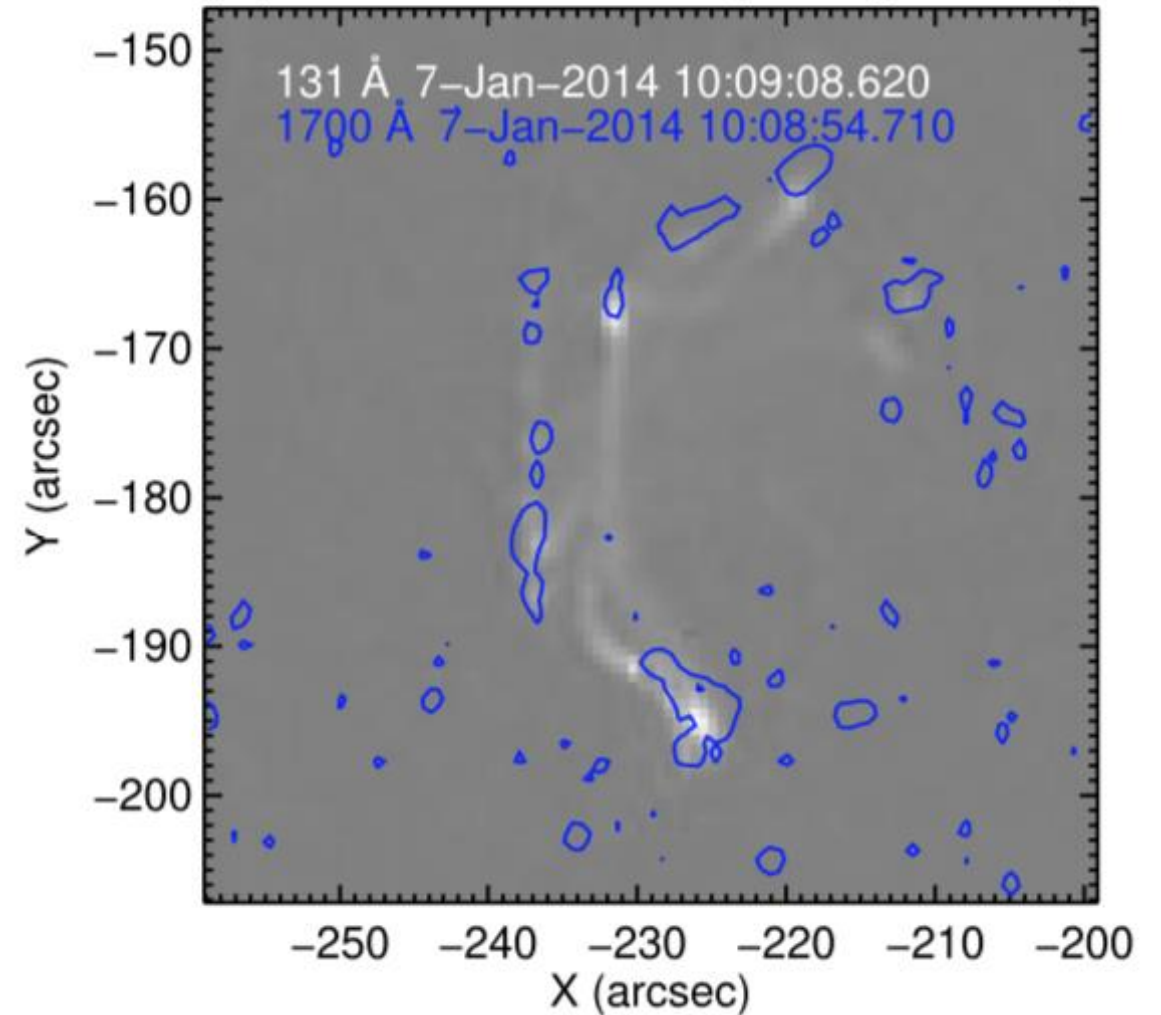
Hot emission: 94 \AA (Fe XVIII/XX, 8-10 MK) and 131 \AA (Fe XXI/XXIII, $\sim 12 \text{ MK}$) (e.g. O'Dwyer et al. 2010)

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

(c) SOL2012-05-14 (weak & fast)

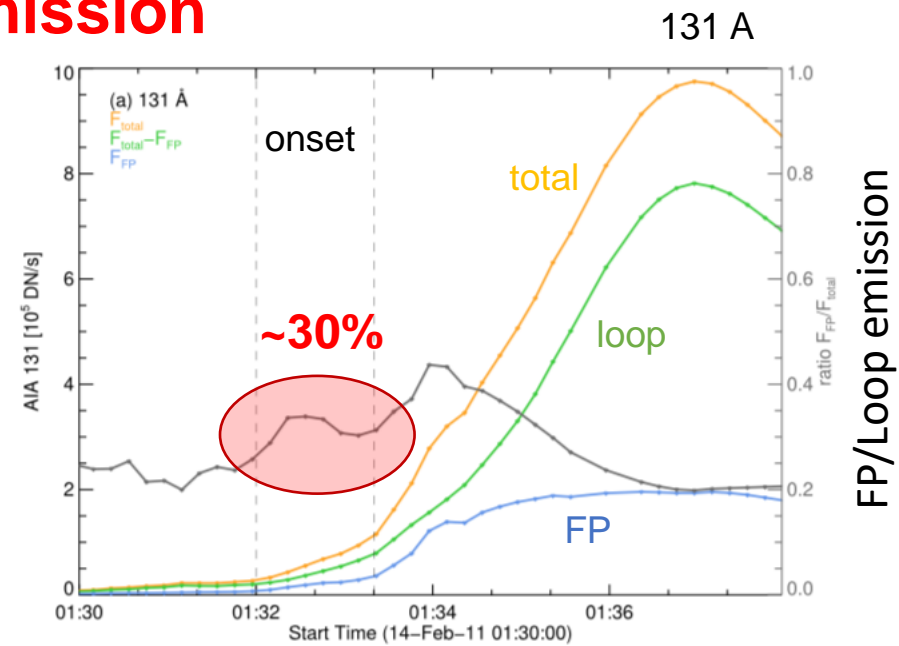
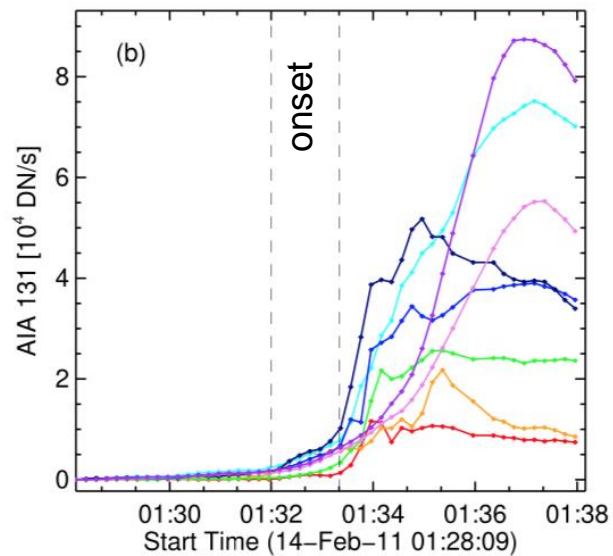
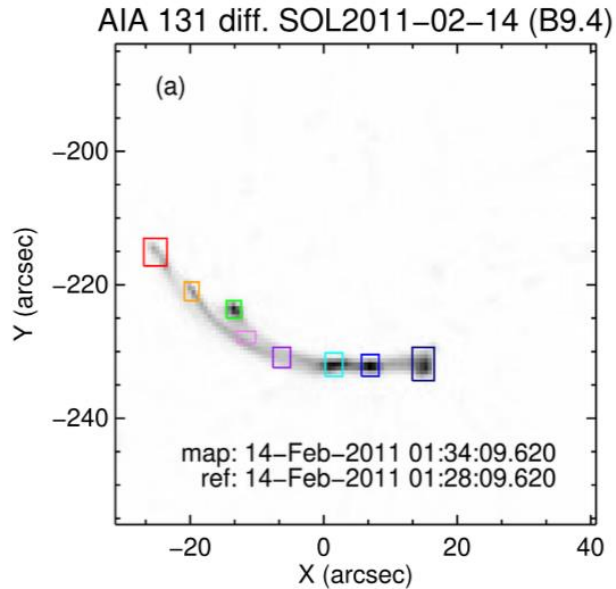


(d) SOL2014-01-07 (strong & fast)

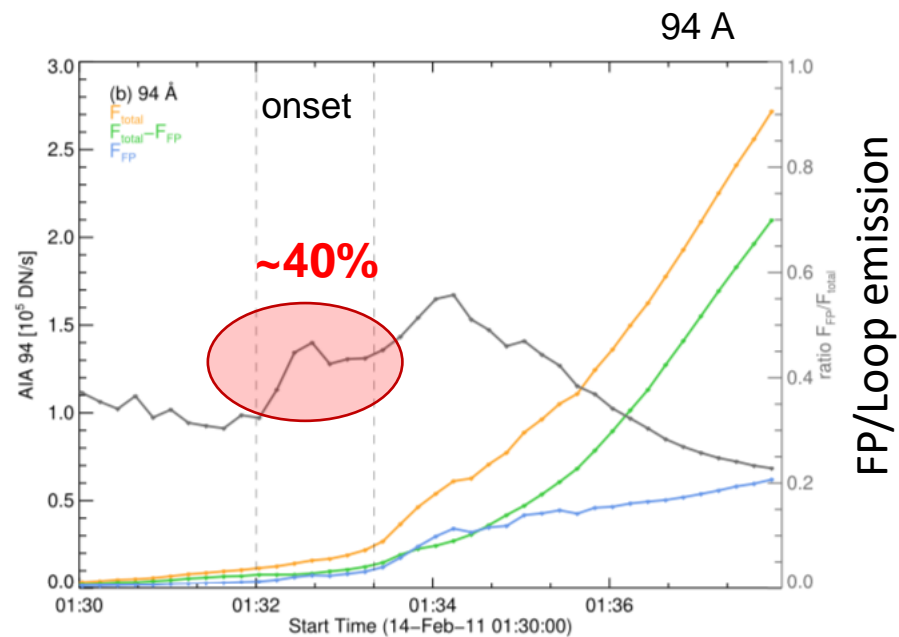
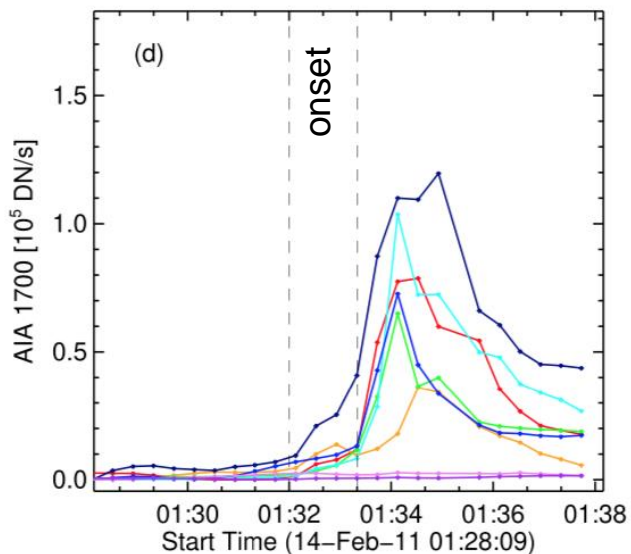
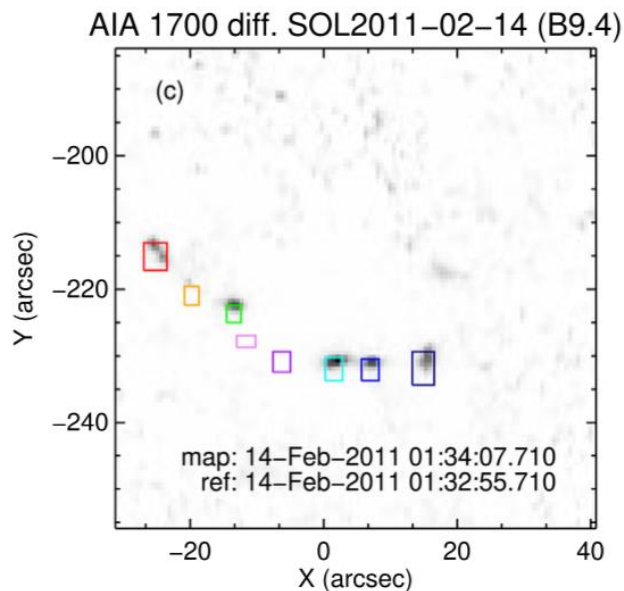


Sources of the Hot Onset: Loop vs. footpoint emission

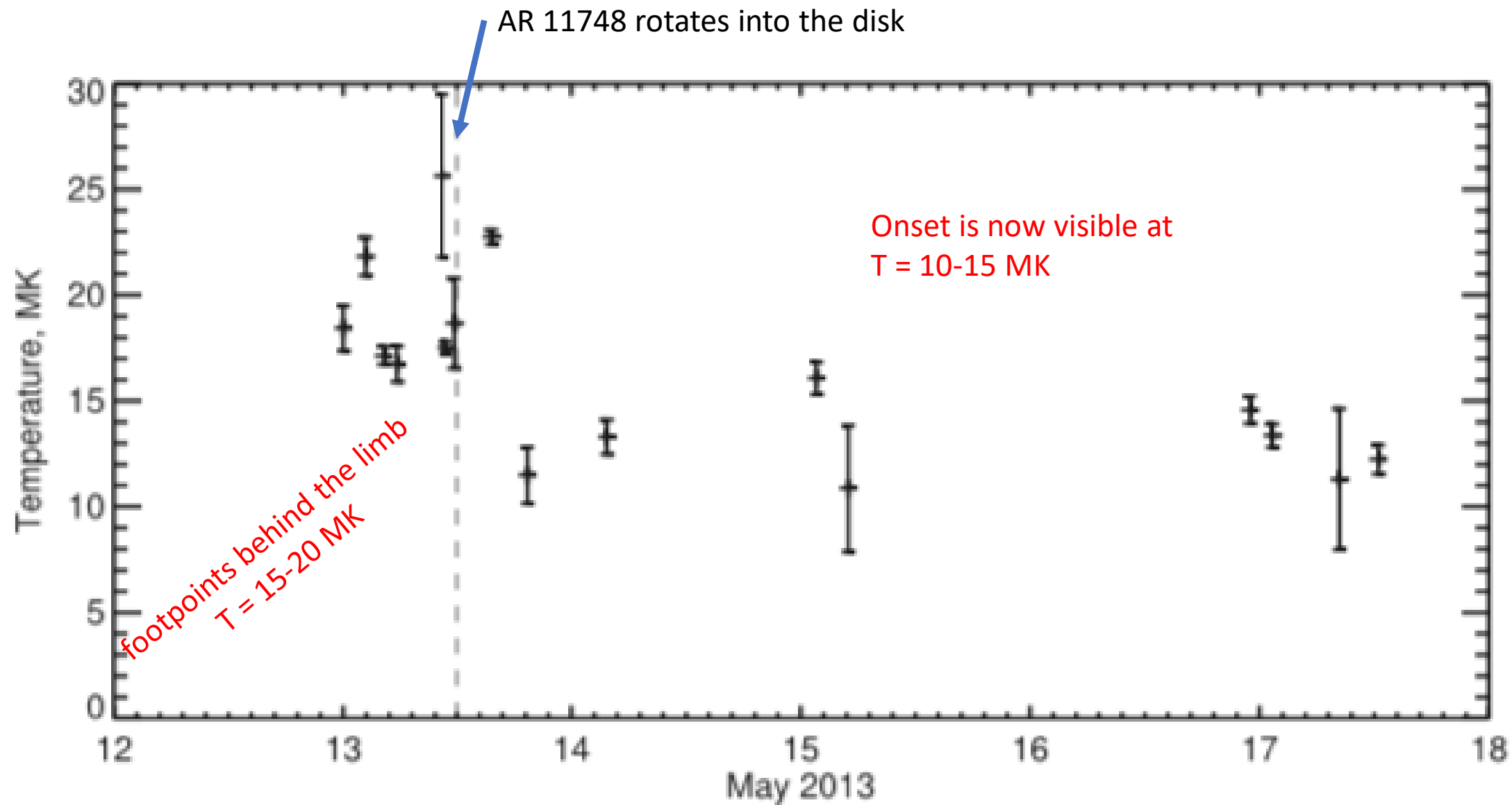
131 Å



1700 Å



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 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

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

Poster by Hugh Hudson: GOES-R data

More details:

Hot X-ray onsets of solar flares

Hudson et al.

MNRAS, v. 501-1, Feb 2021

<https://doi.org/10.1093/mnras/staa3664>

arXiv:2007.05310

Contacts:

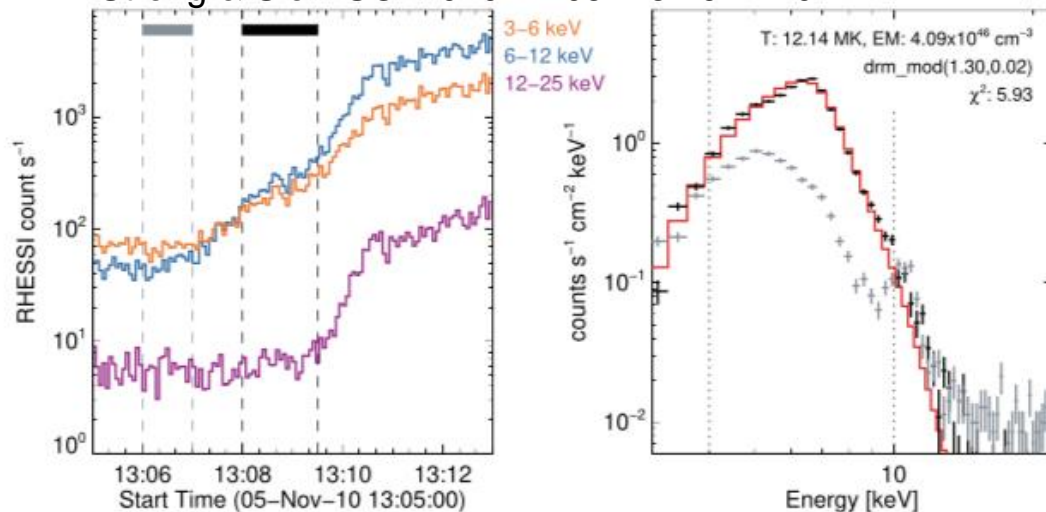
hugh.hudson@glasgow.ac.uk

paulo@craam.mackenzie.br

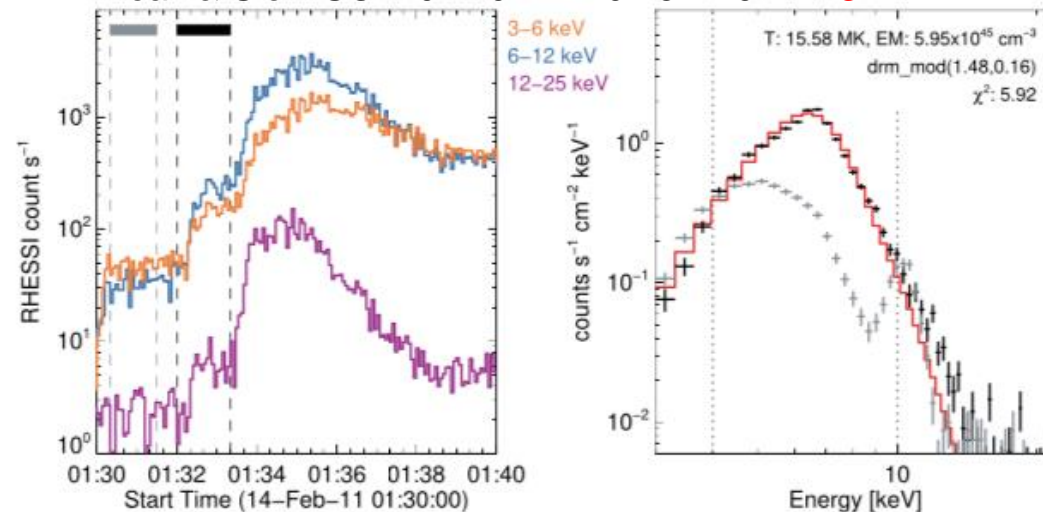
Verification: RHESSI Temperatures

background time
onset time

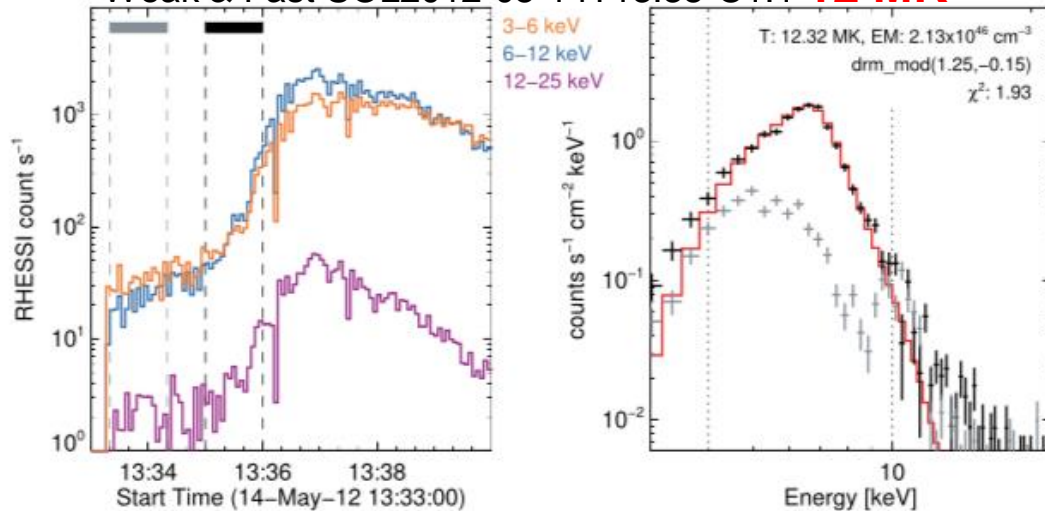
Strong & Slow SOL2010-11-05T13:29 M1.0: **12 MK**



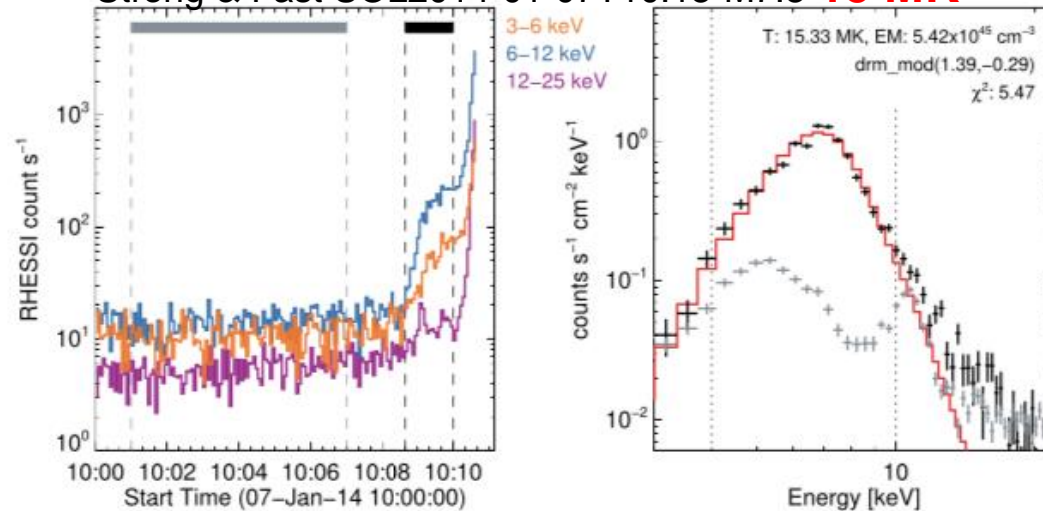
Weak & Slow SOL2011-02-14T01:37 B9.4: **16 MK**



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

