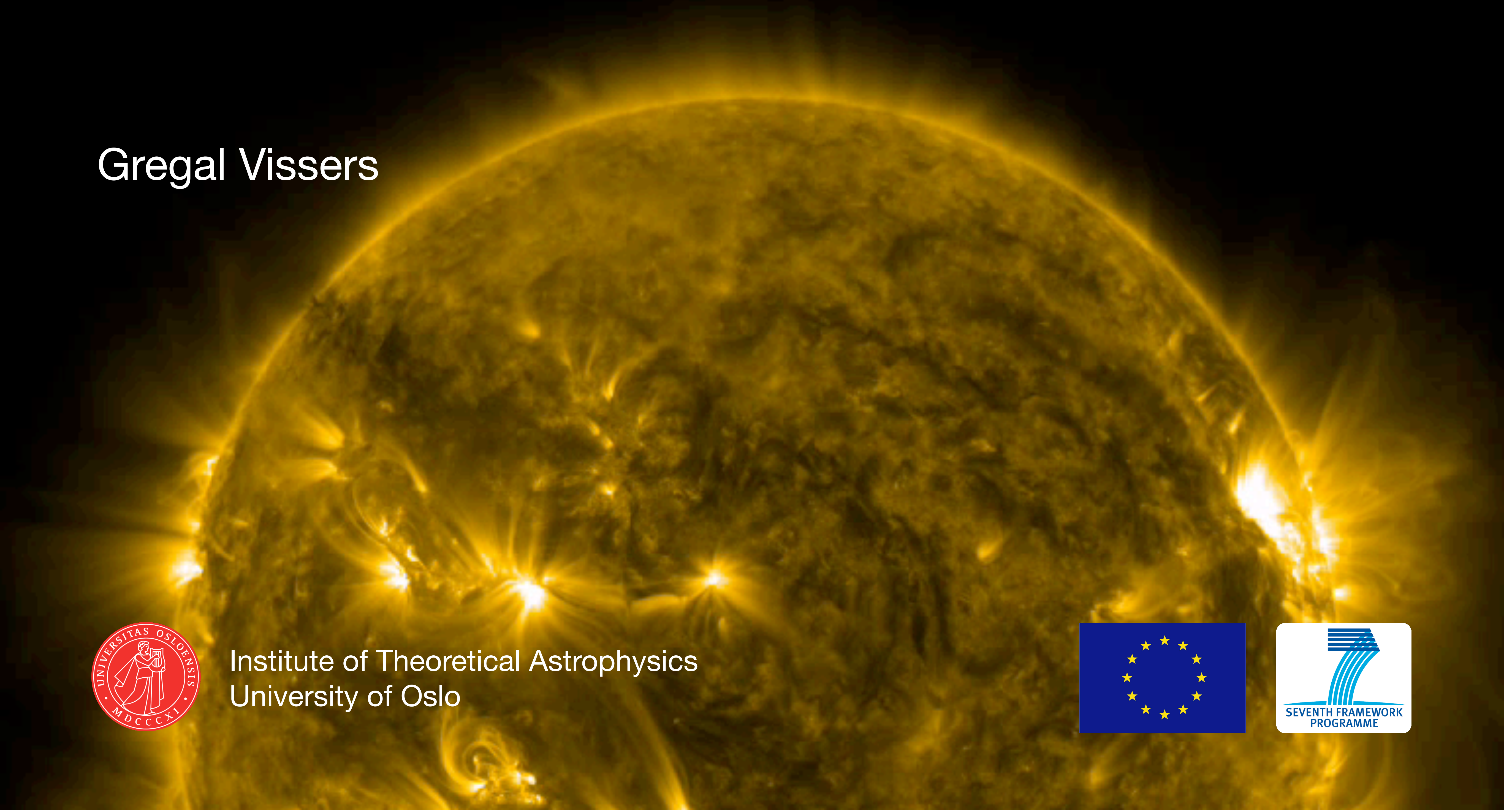
Observations of thermally unstable loops

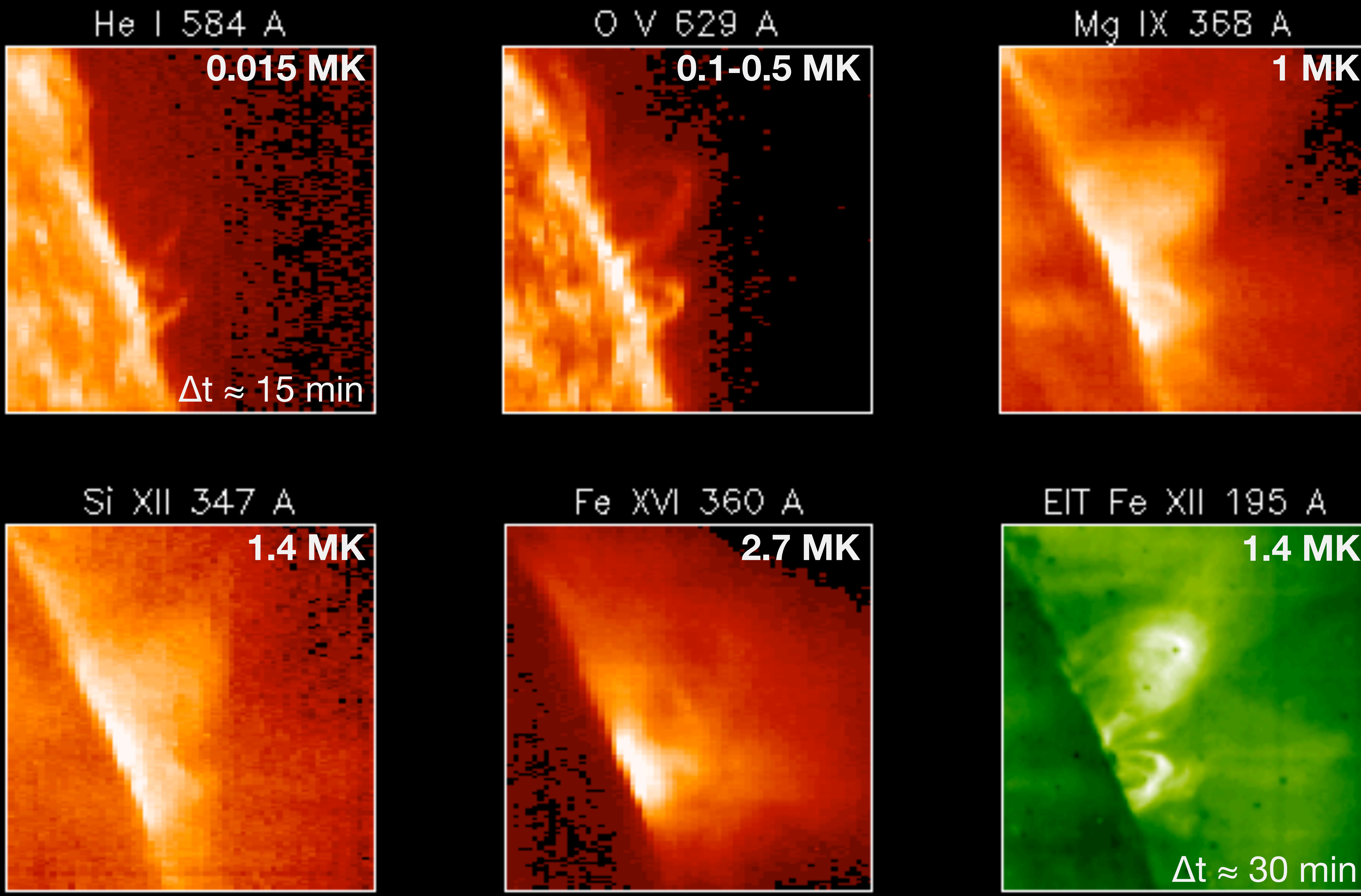
An overview of observed (E)UV variations associated with coronal rain



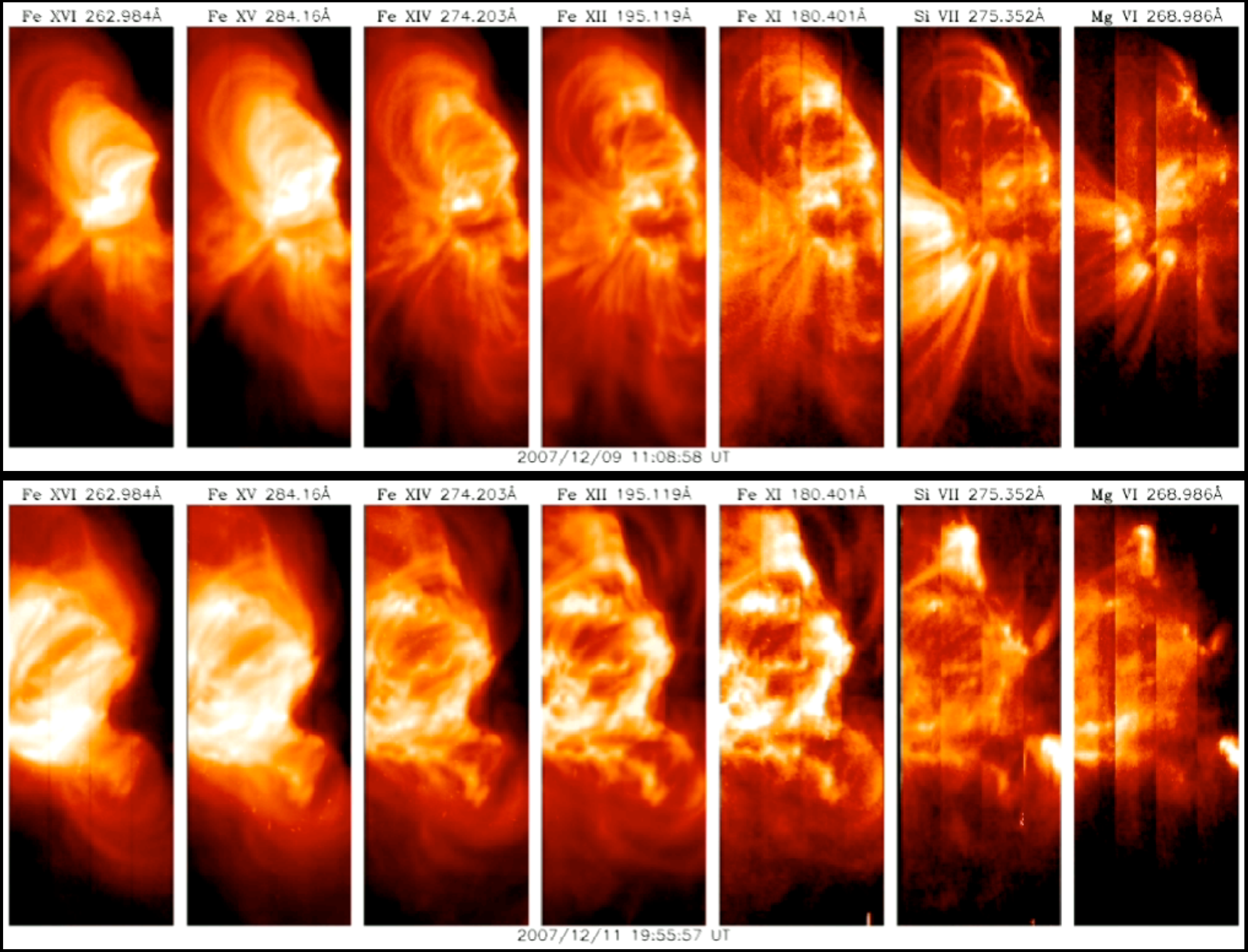
Gregal Vissers

Institute of Theoretical Astrophysics
University of Oslo

SOHO shows cool active region loops with substantial time variability

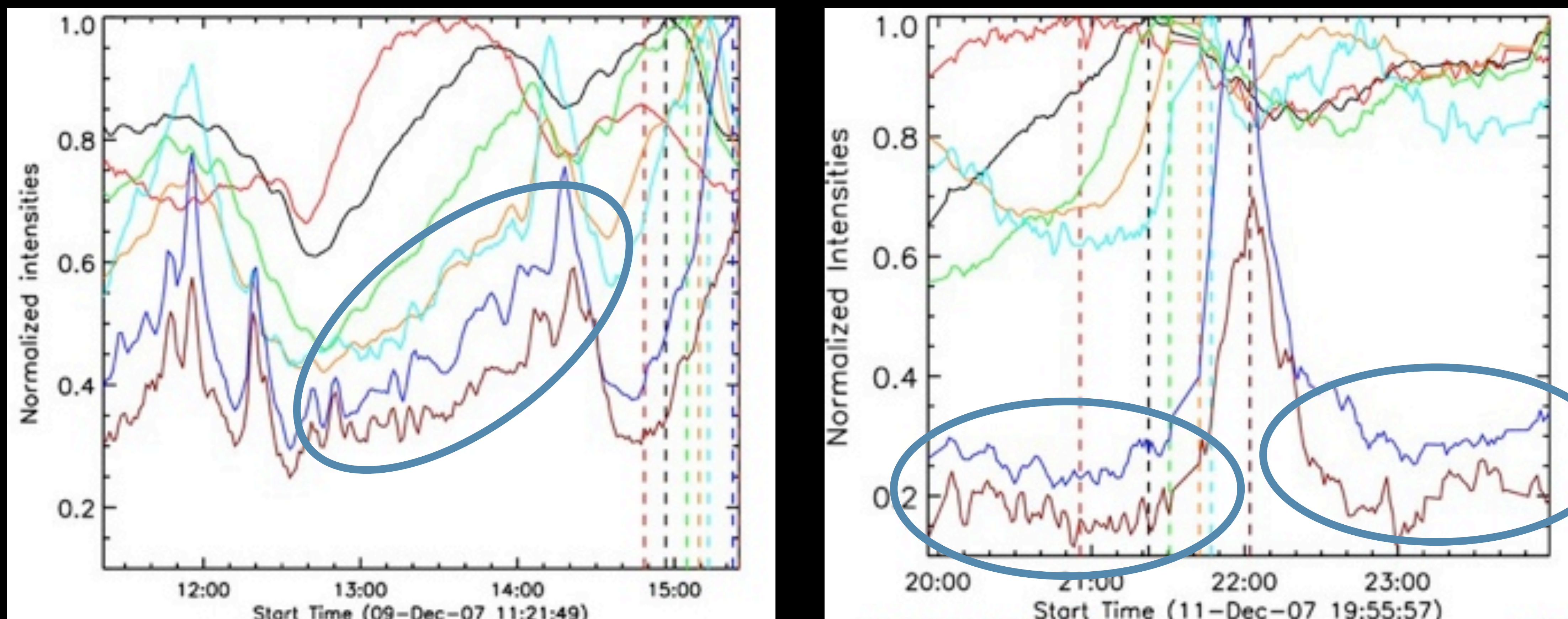


Kjeldseth-Moe & Brekke (1998): SOHO CDS and EIT, 14 September 1997



Ugarte-Urra et al. (2009)

Lightcurves show clear intensity variations, on shorter timescales for cooler lines



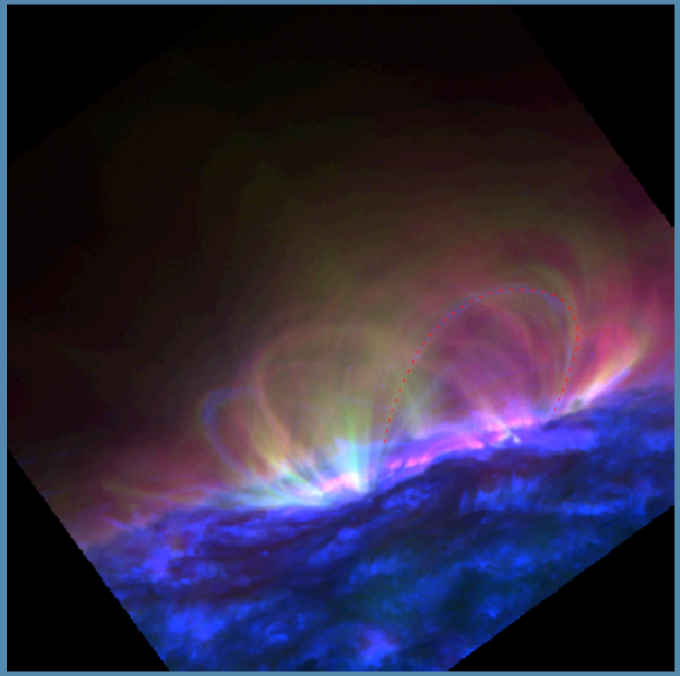
Ugarte-Urra et al. (2009)

These variations have regularly been associated with thermal non-equilibrium

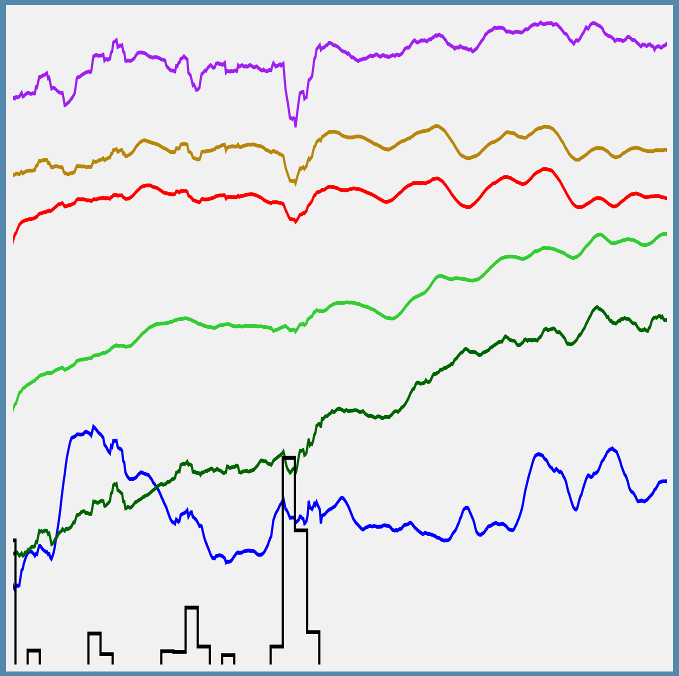
What are the relevant time scales?

To what extent are the instabilities complete?

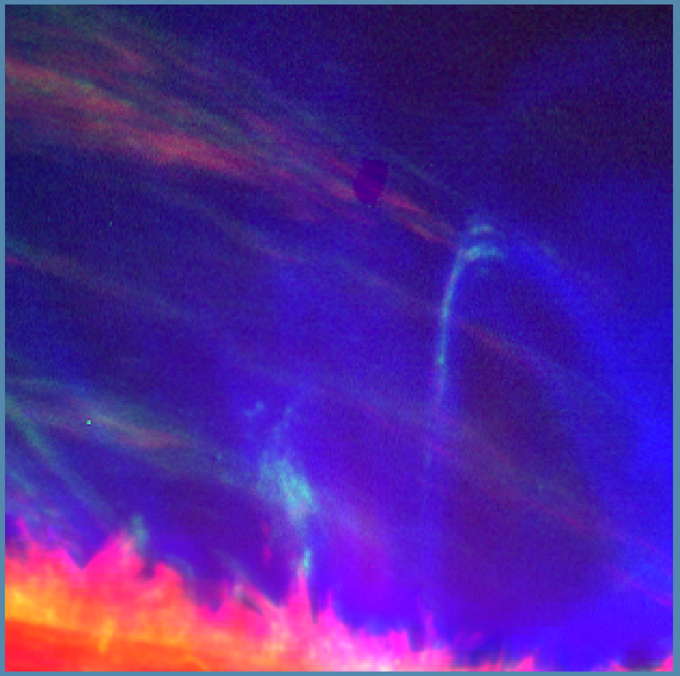
Cooling progression



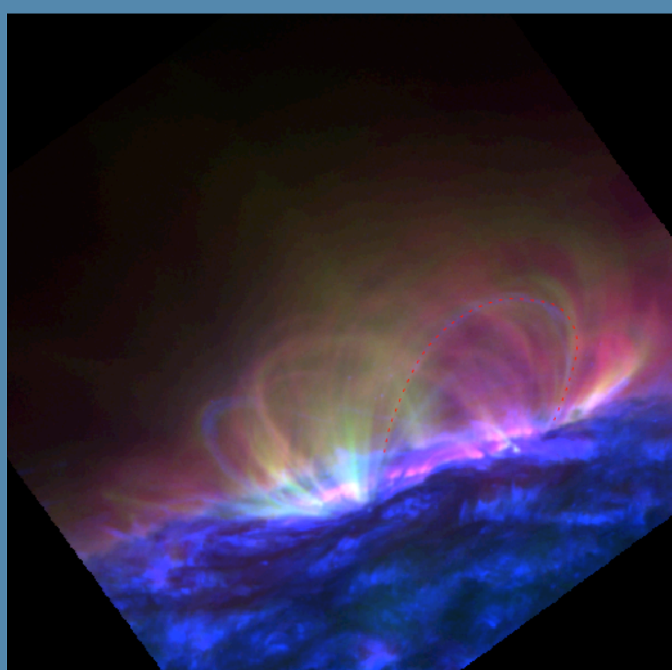
(E)UV dimming



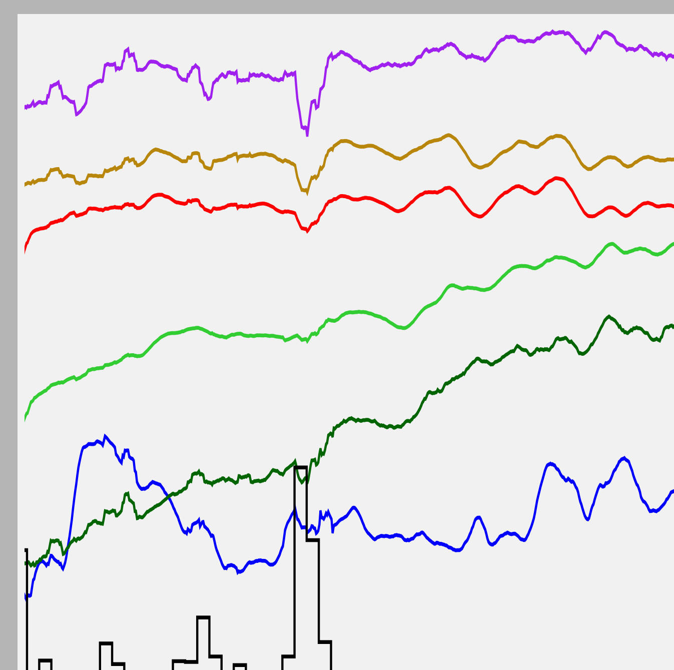
Multi-thermal coronal rain



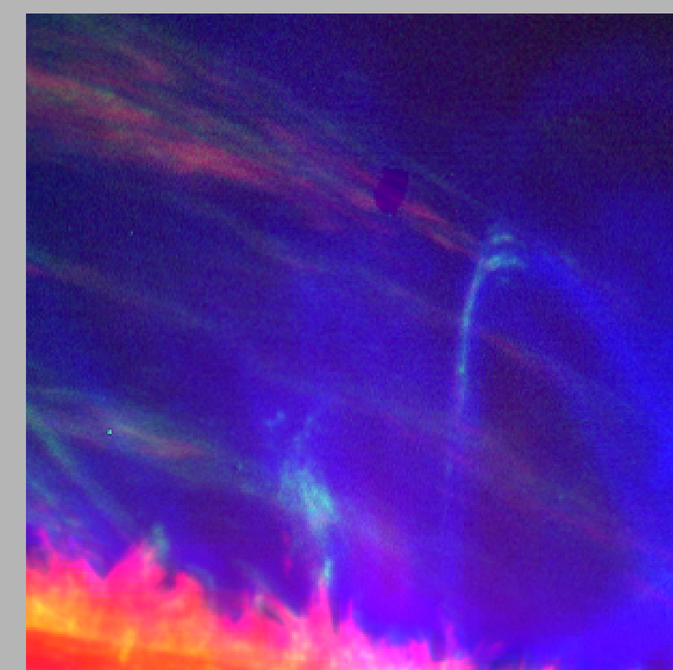
Cooling progression



(E)UV dimming

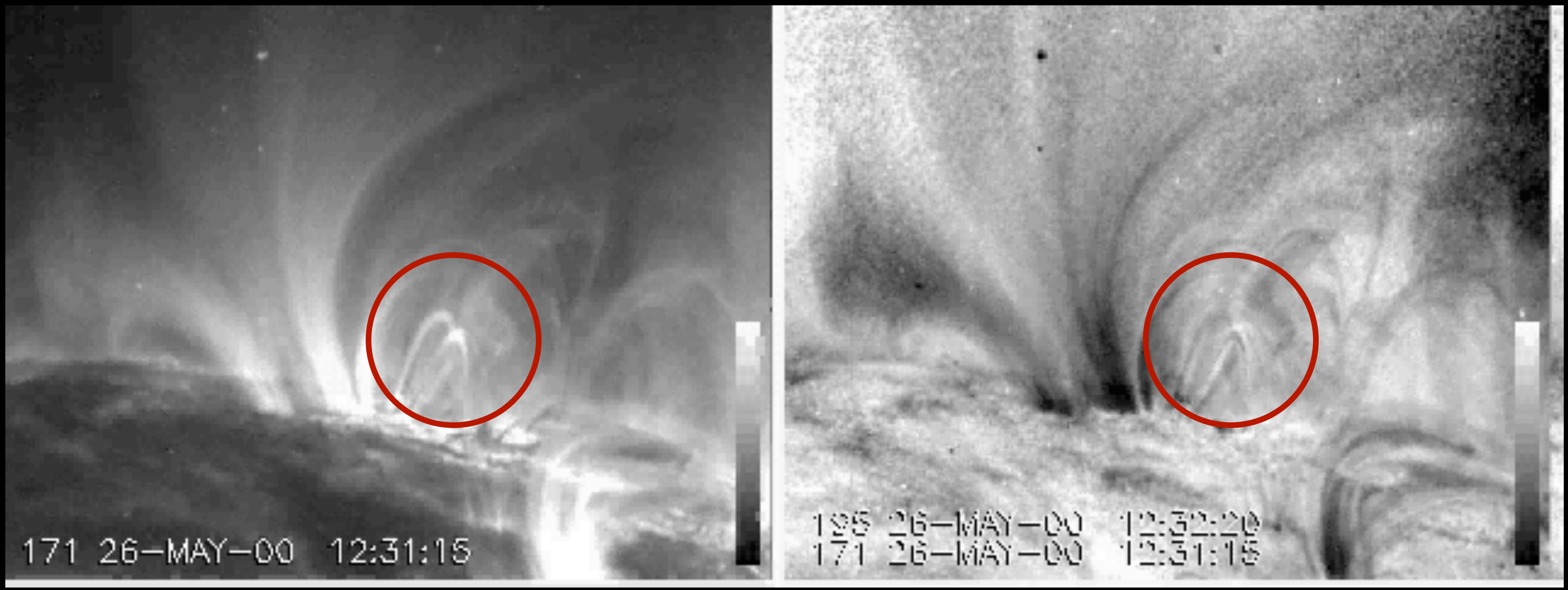


Multi-thermal coronal rain

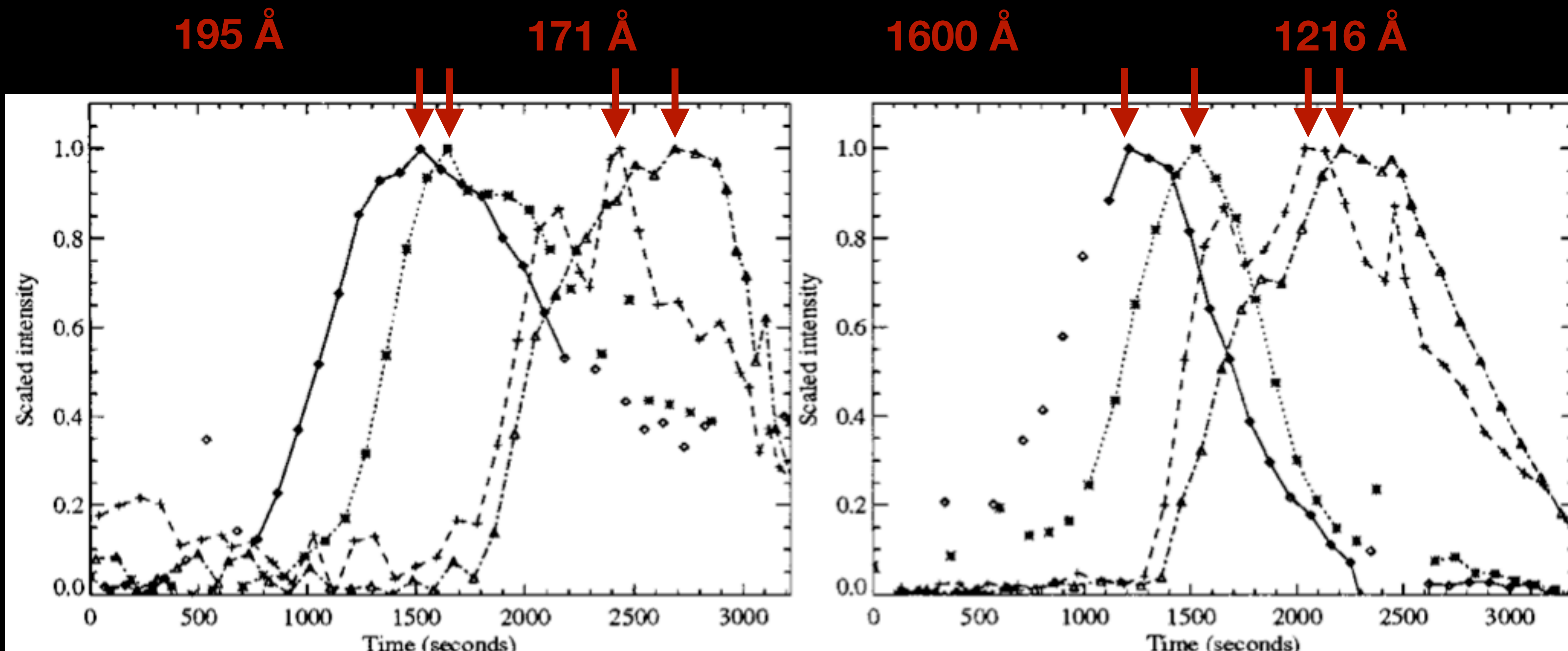


Clear cooling progression is observed in TRACE channels

Schrijver (2001)

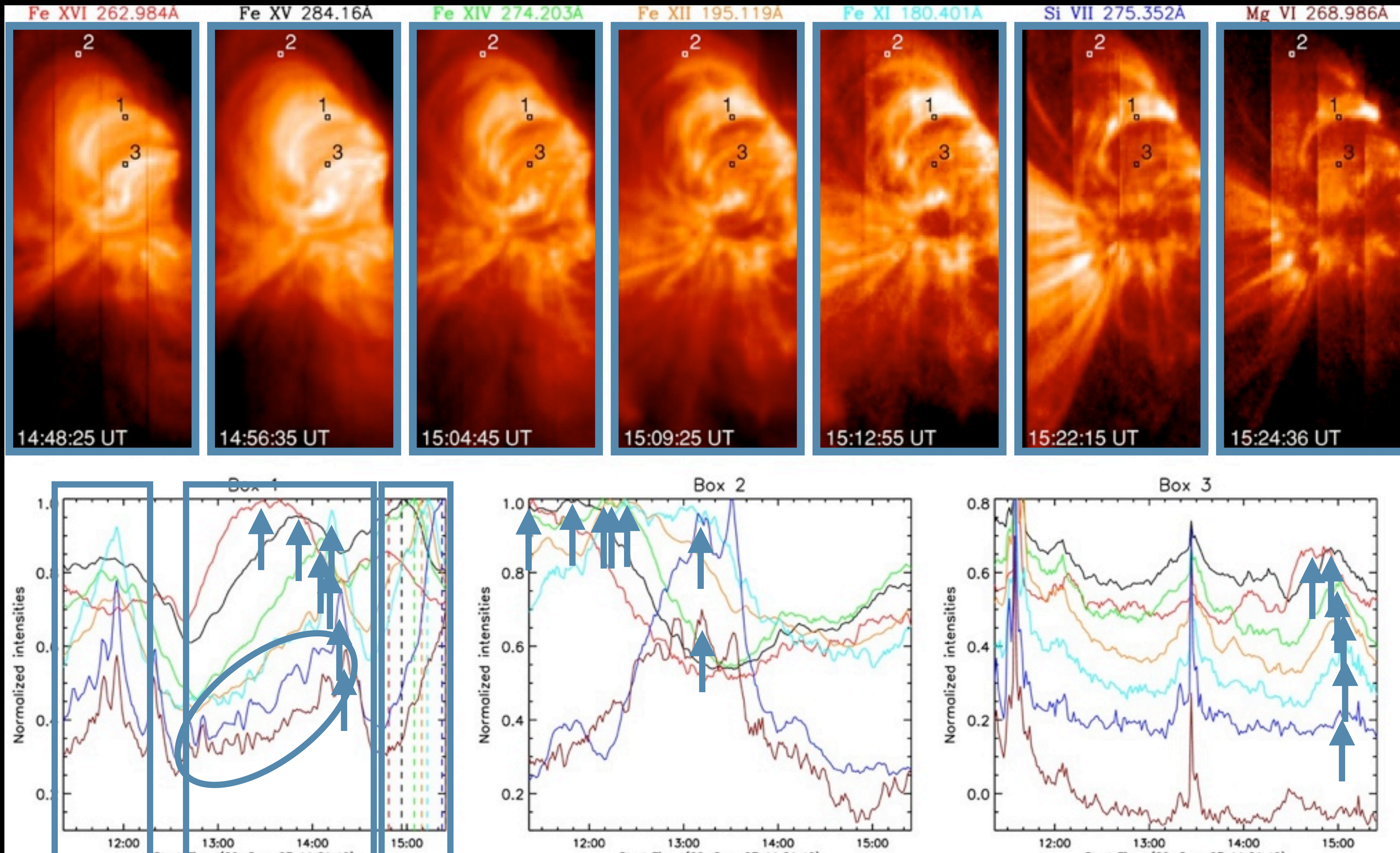


Lightcurves of hotter lines tend to peak first, followed by progressively cooler ones

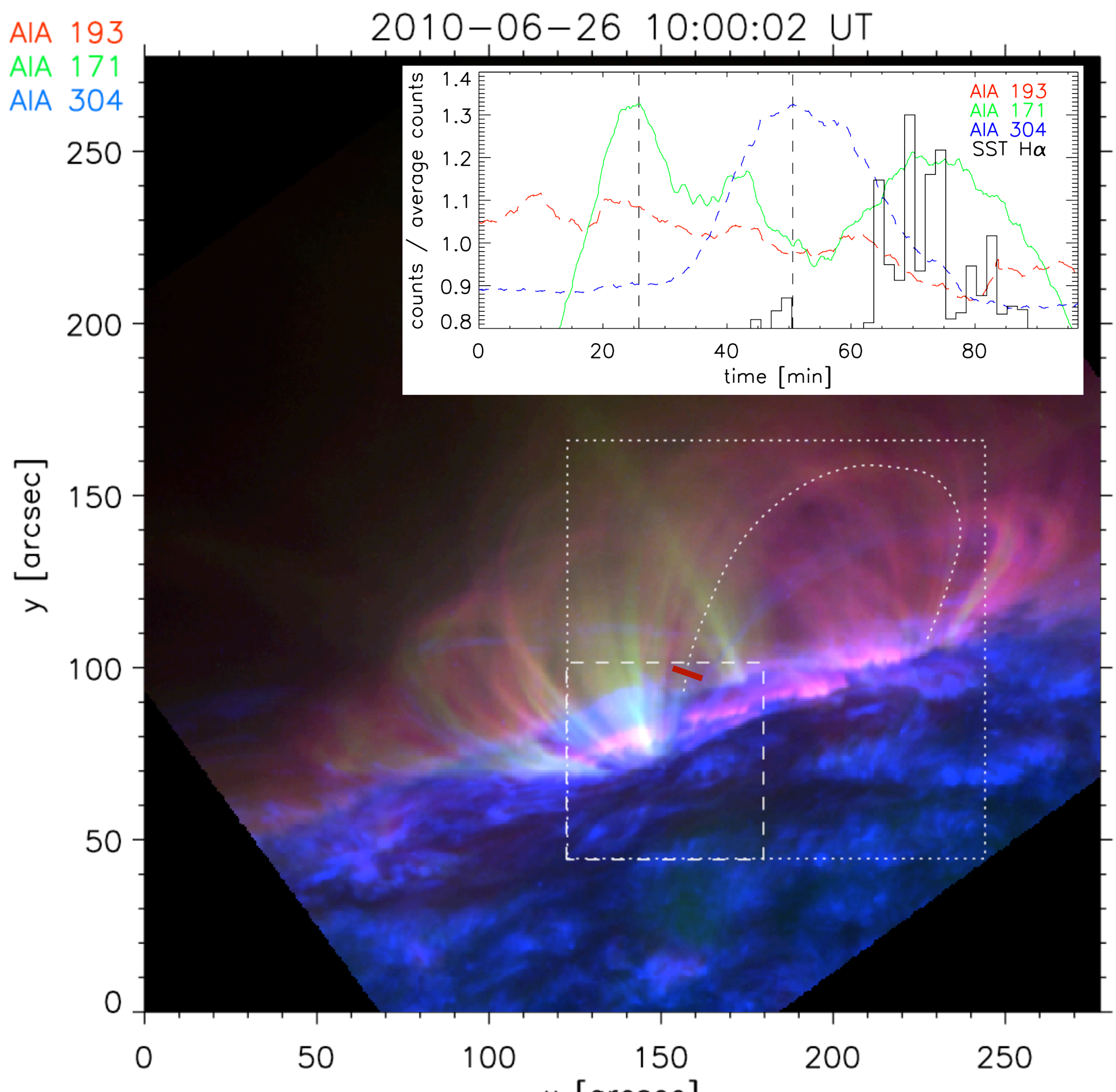


Schrijver (2001)

Coronal loops show recurring episodes of sequential brightening

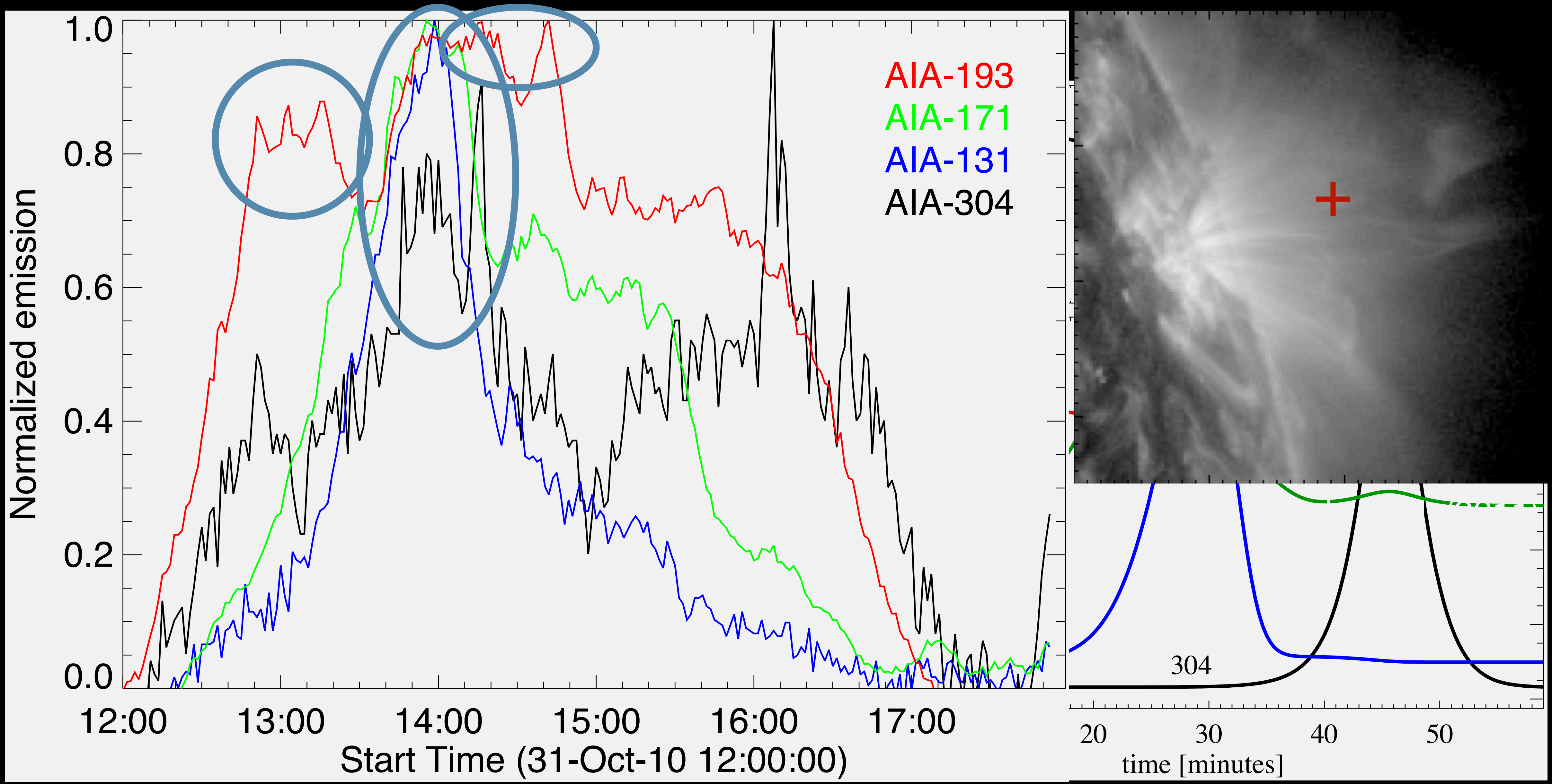


Ugarte-Urra et al. (2009)

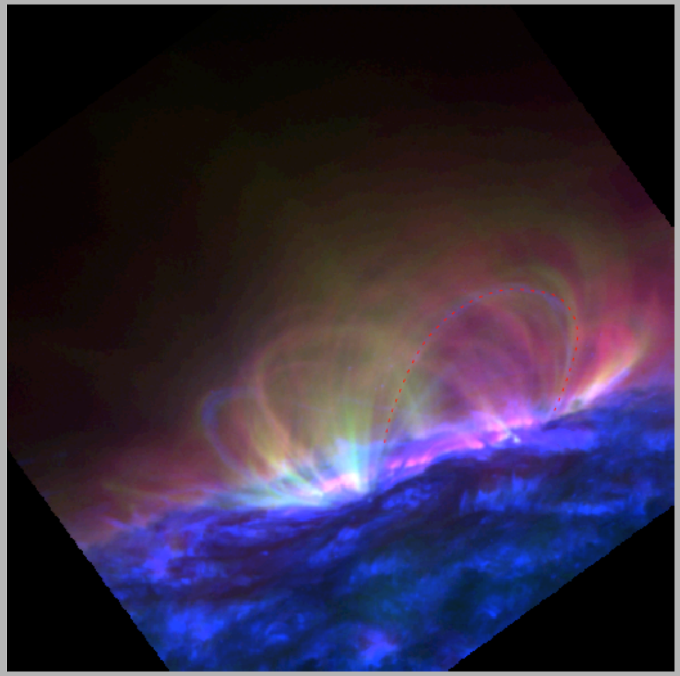


Antolin et al. (2015, submitted)

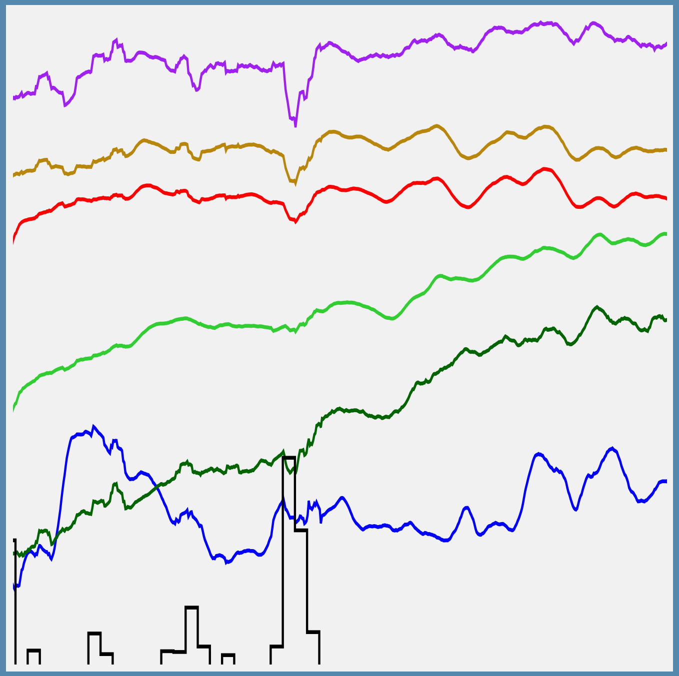
The trend in sequential brightening is not always straightforwardly observable



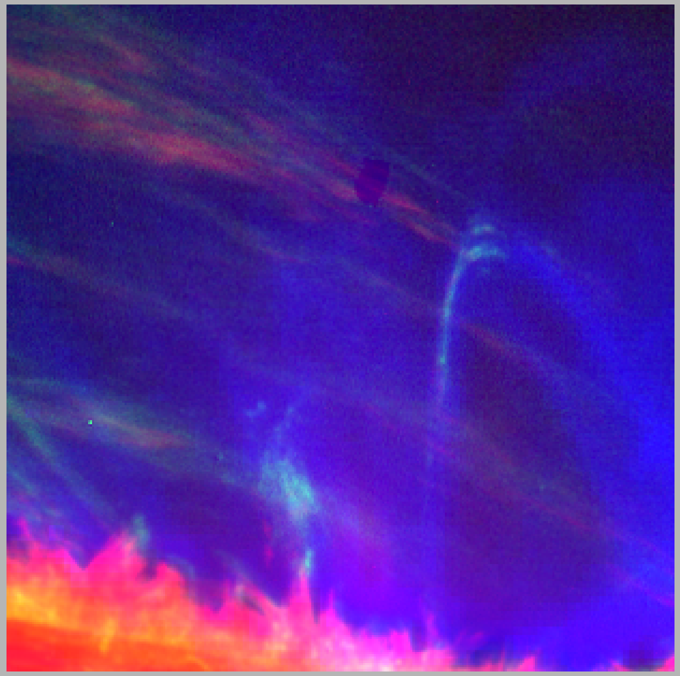
Cooling progression



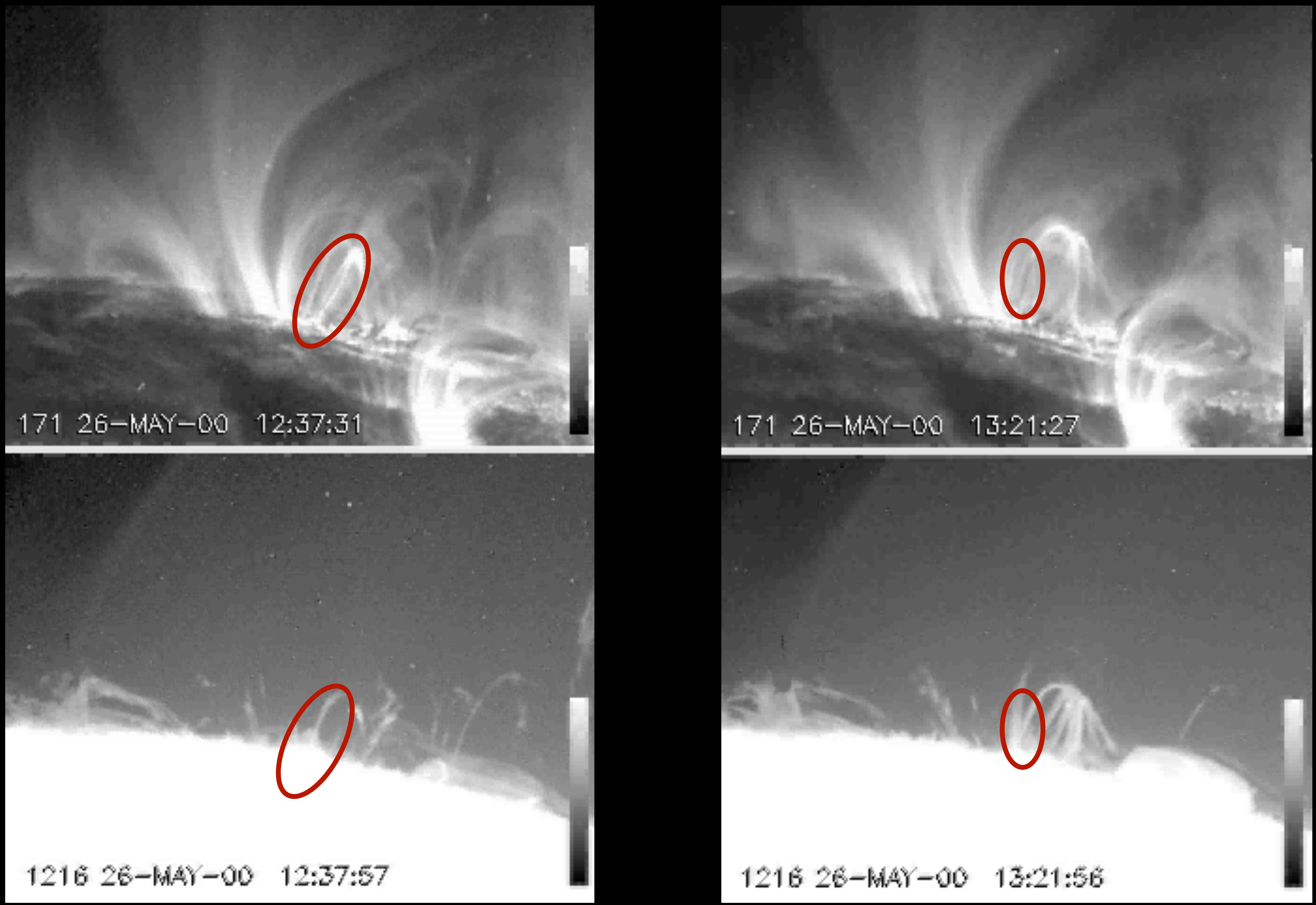
(E)UV dimming



Multi-thermal coronal rain

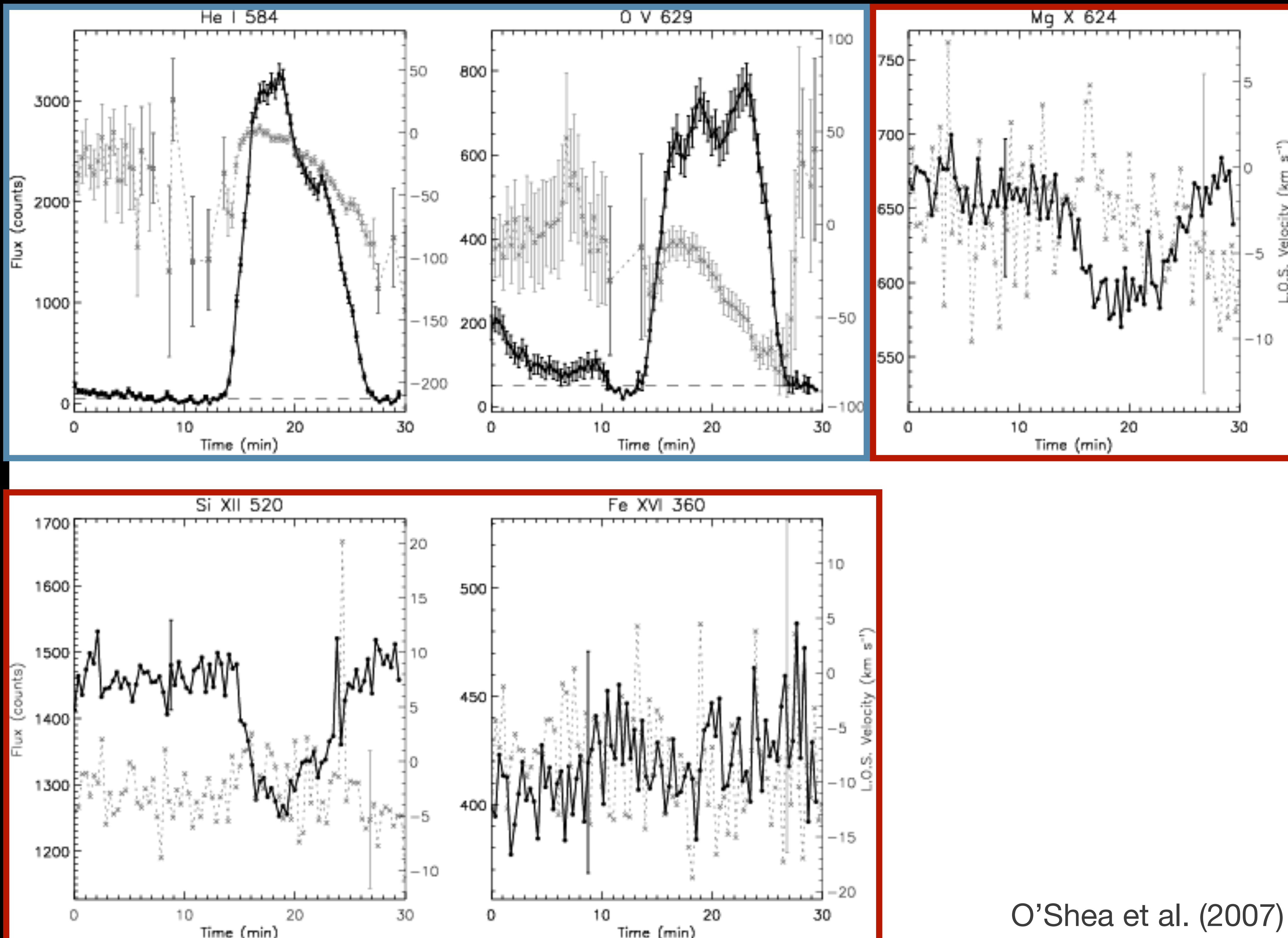


Loops remain visible in 171Å and 195Å while cool material slides down the loop legs

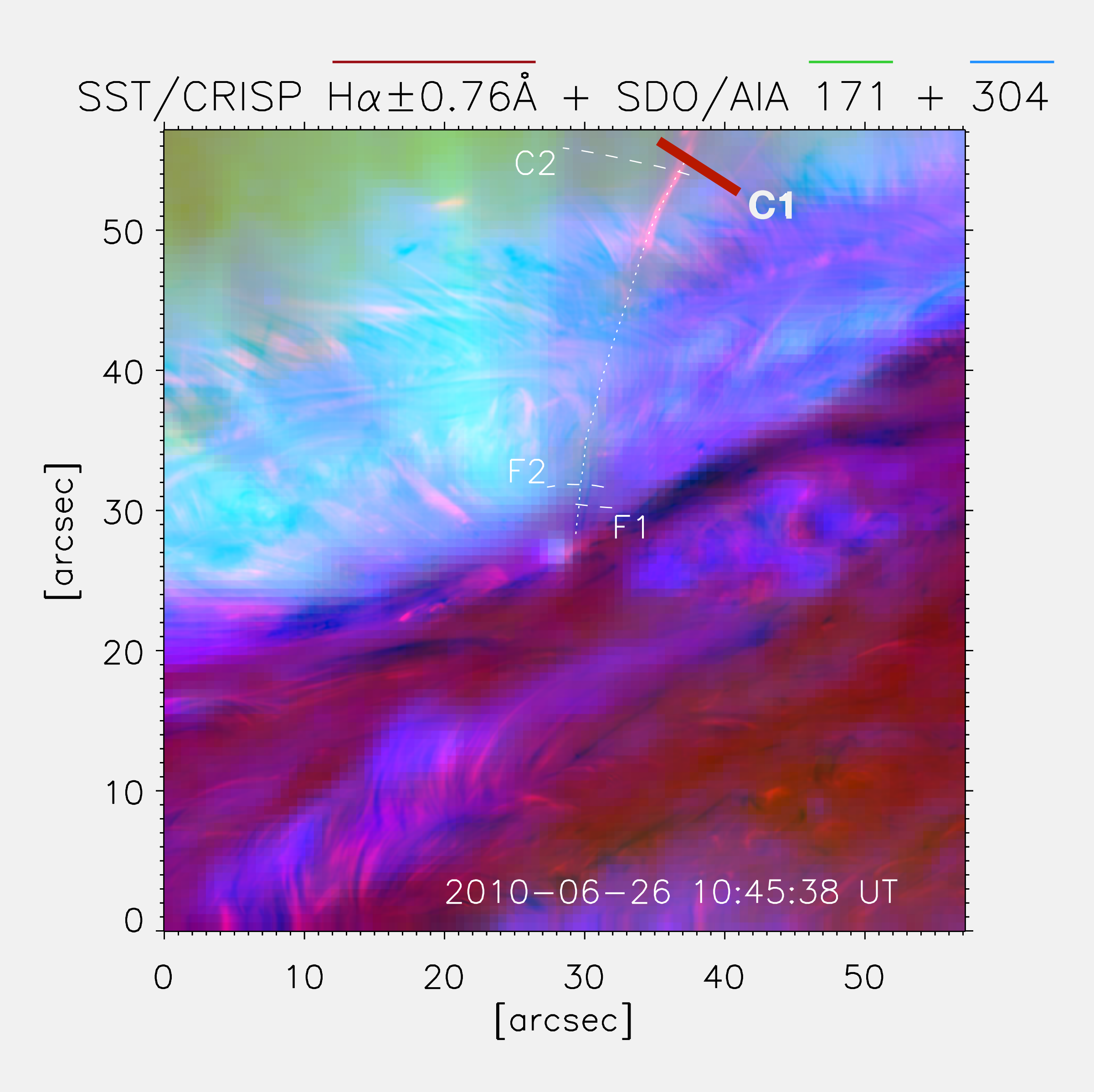


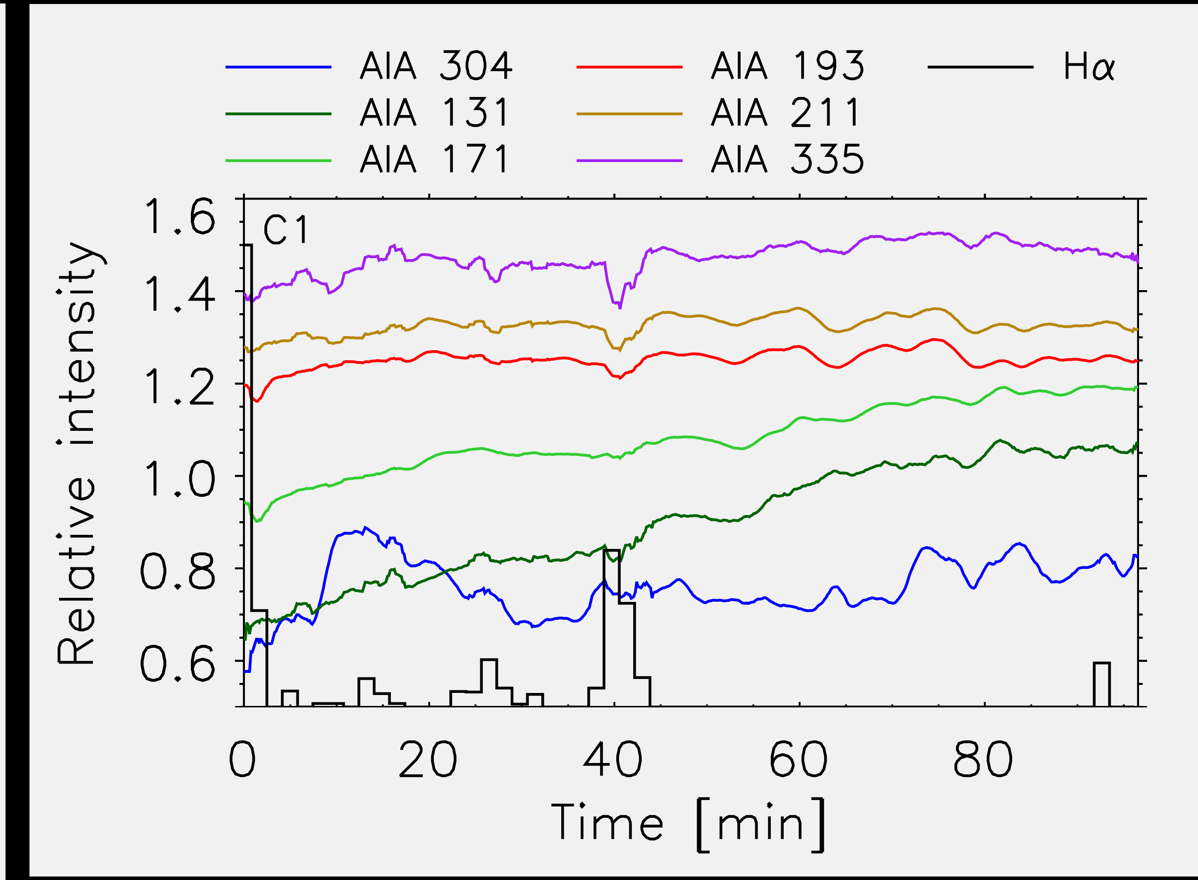
Schrijver (2001)

Transition region and coronal line lightcurves show anti-correlation



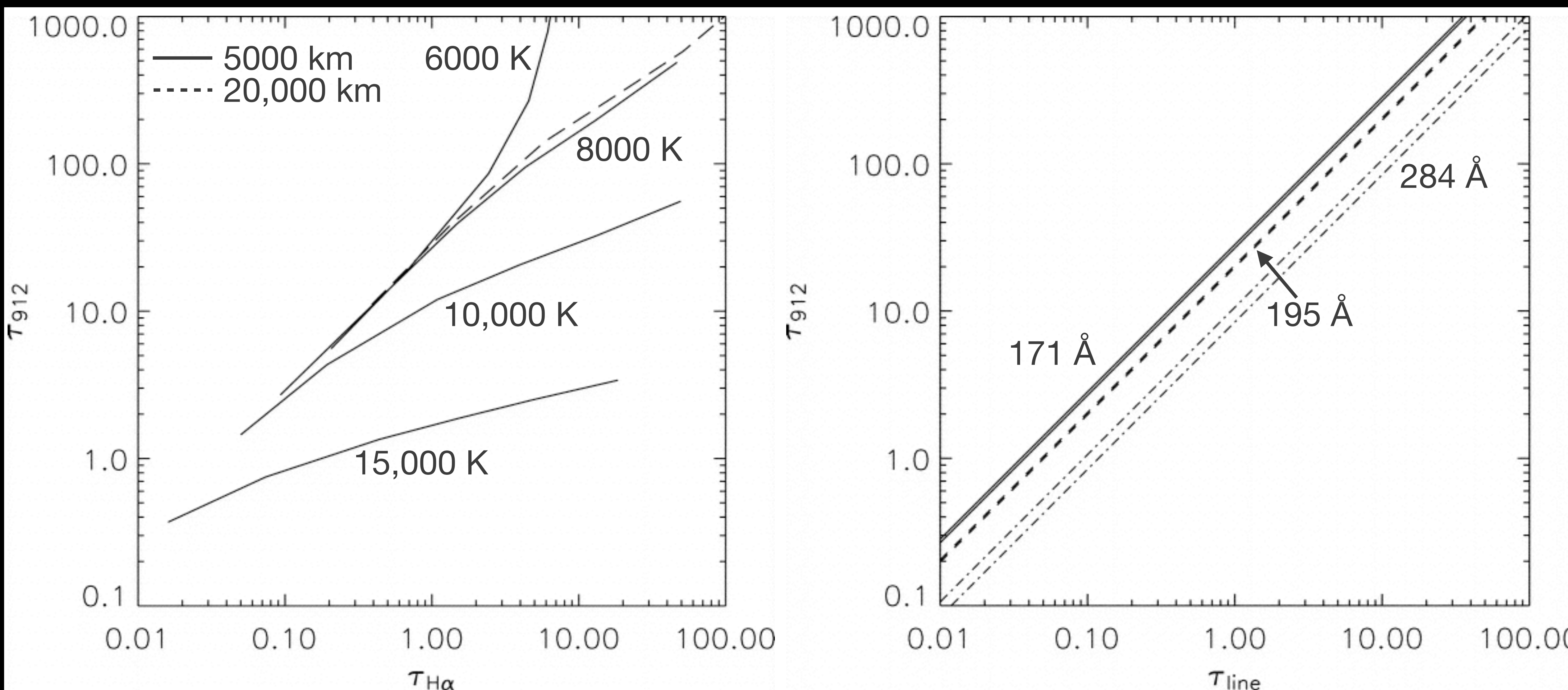
Hotter AIA channels show anti-correlated signal when compared to 304Å and Hα





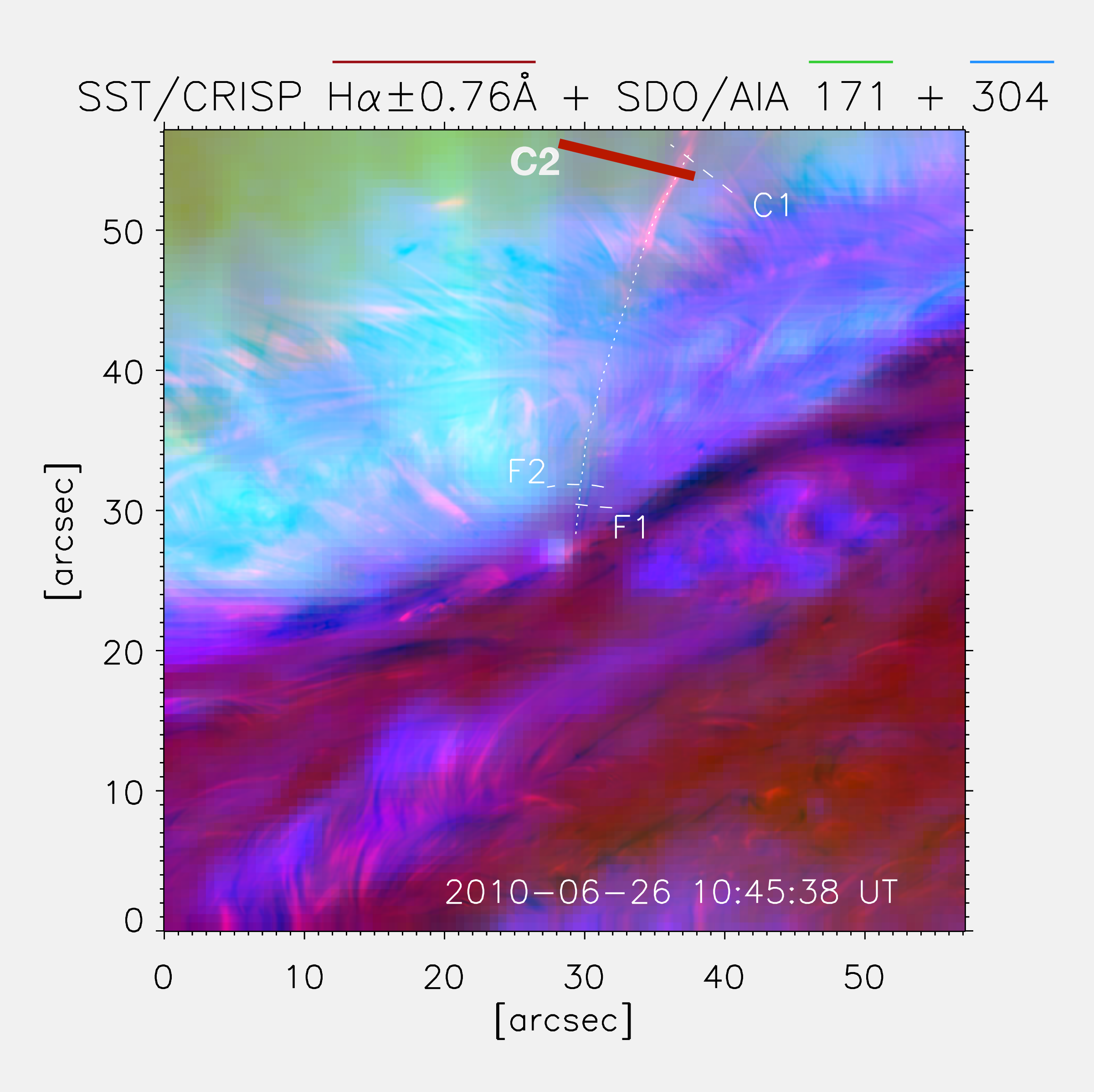
Antolin et al. (2015, submitted)

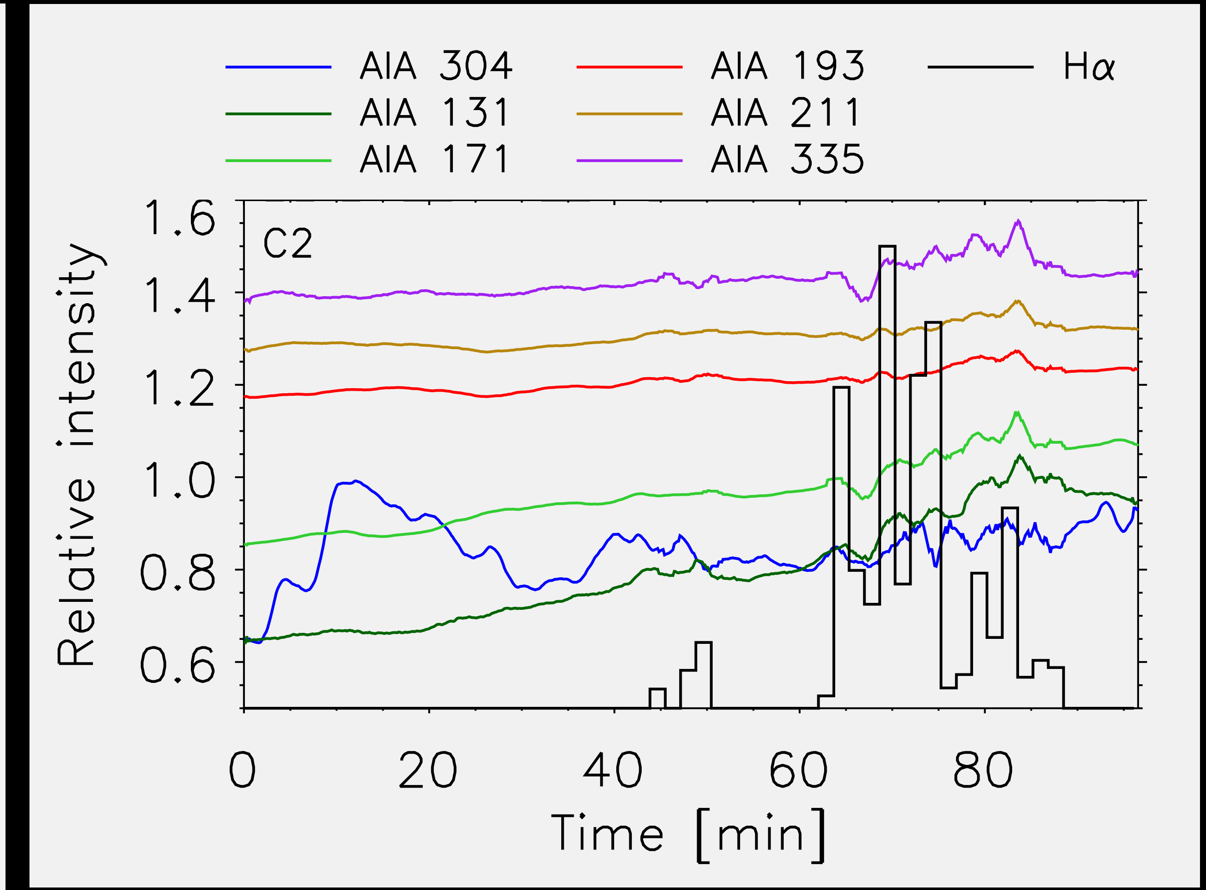
Optical thickness of several coronal lines correlates with Ly-α, in turn correlates with Hα



Anzer & Heinzel (2005)

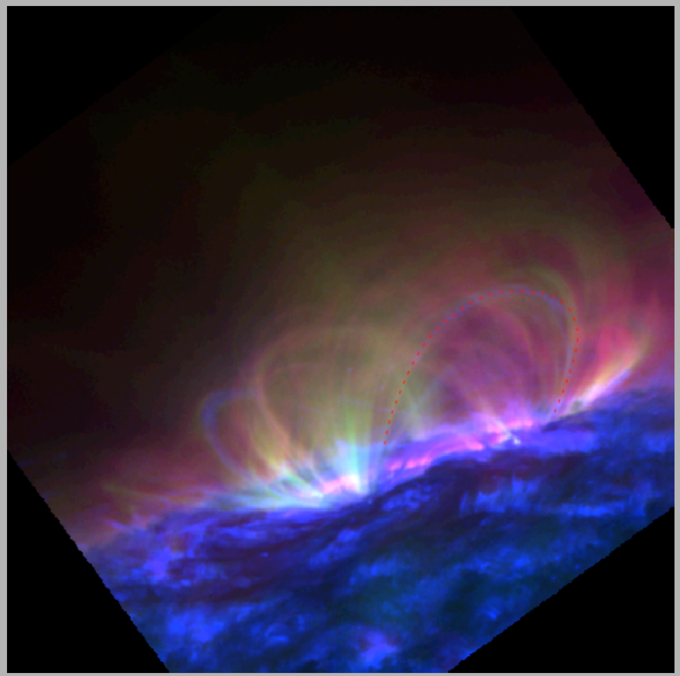
Positive correlations between EUV lines and Hα are also observed





Antolin et al. (2015, submitted)

Cooling progression



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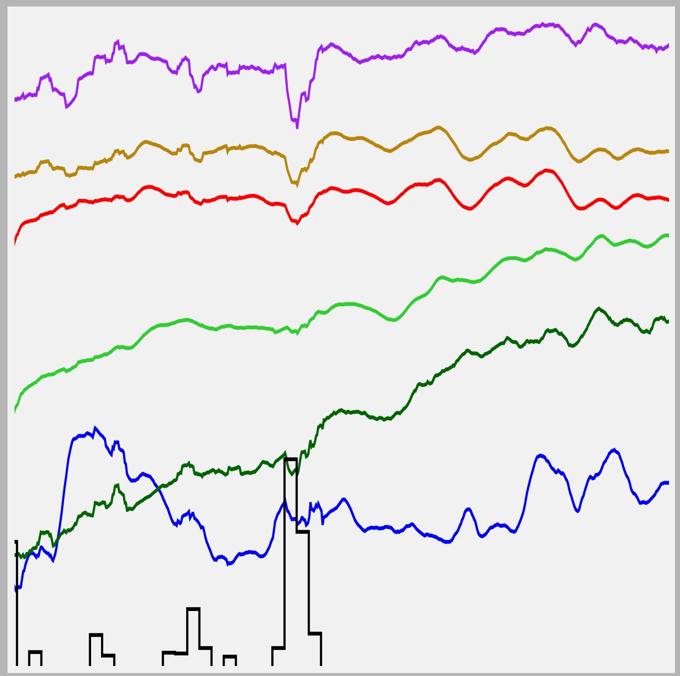
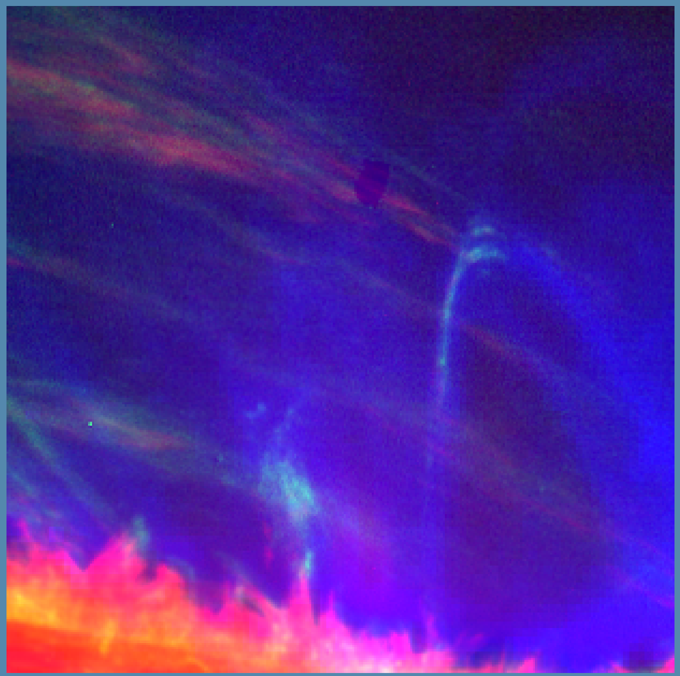
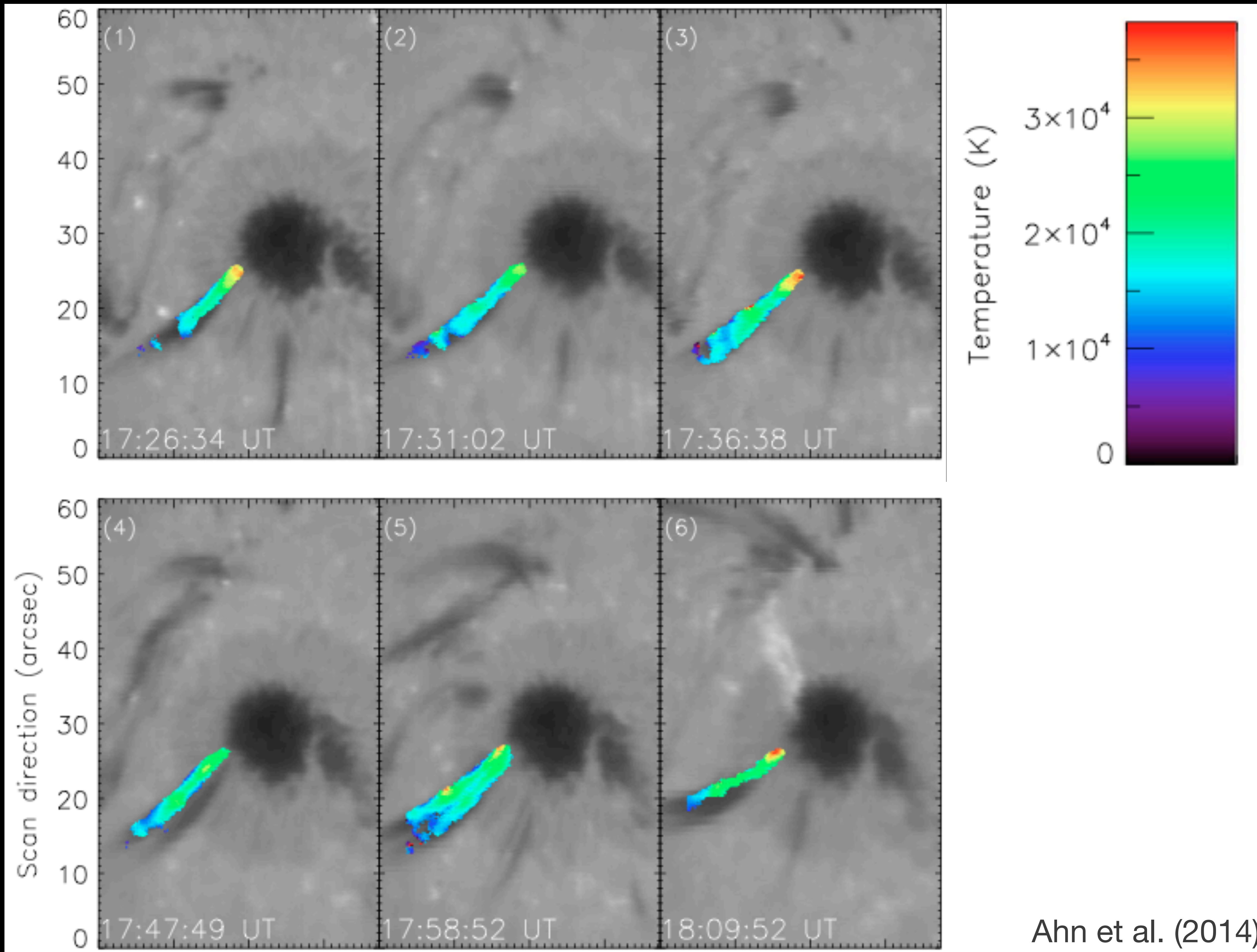


Multi-thermal coronal rain

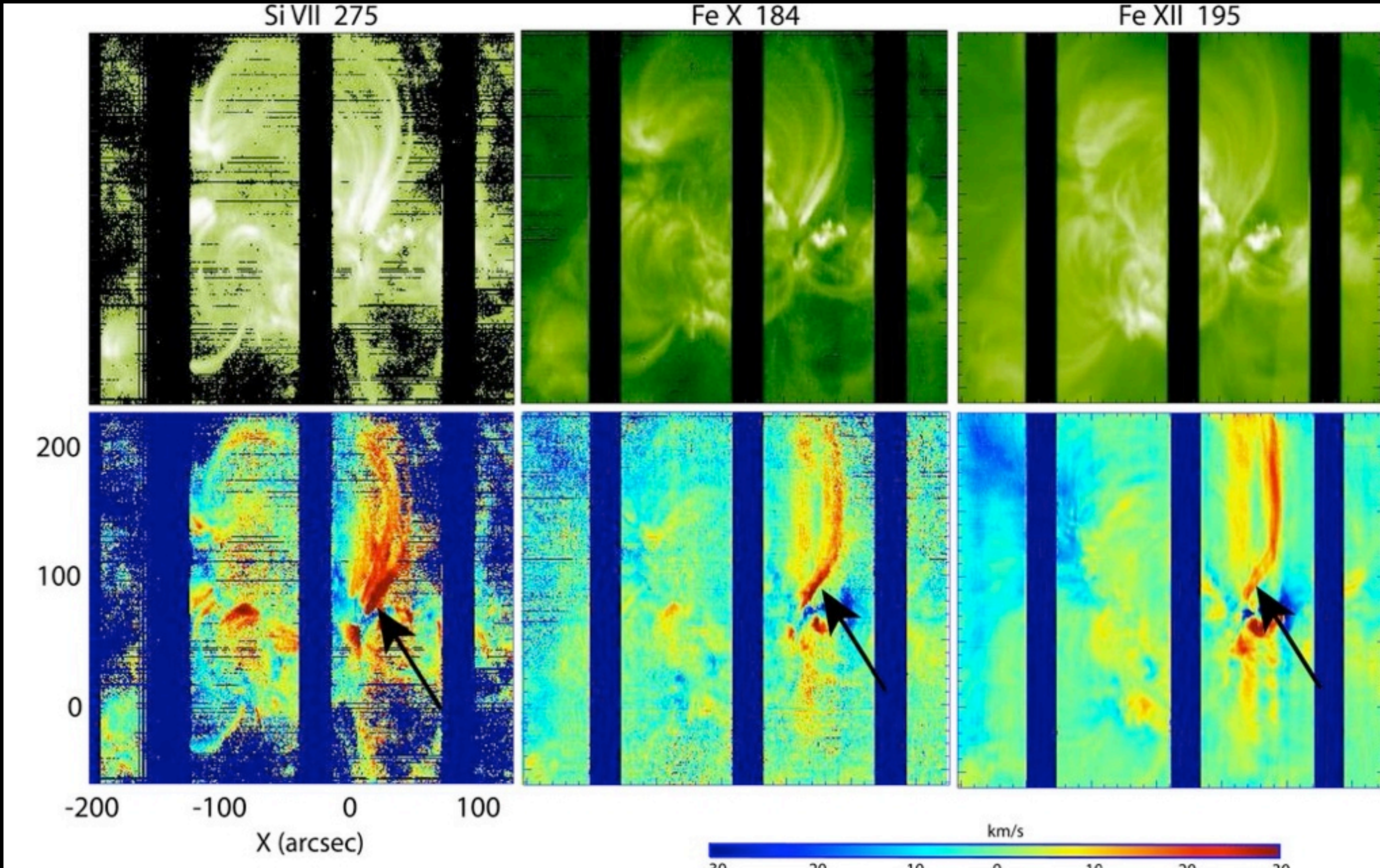


Coronal rain show a range of temperatures, hotter towards the downflow footpoint



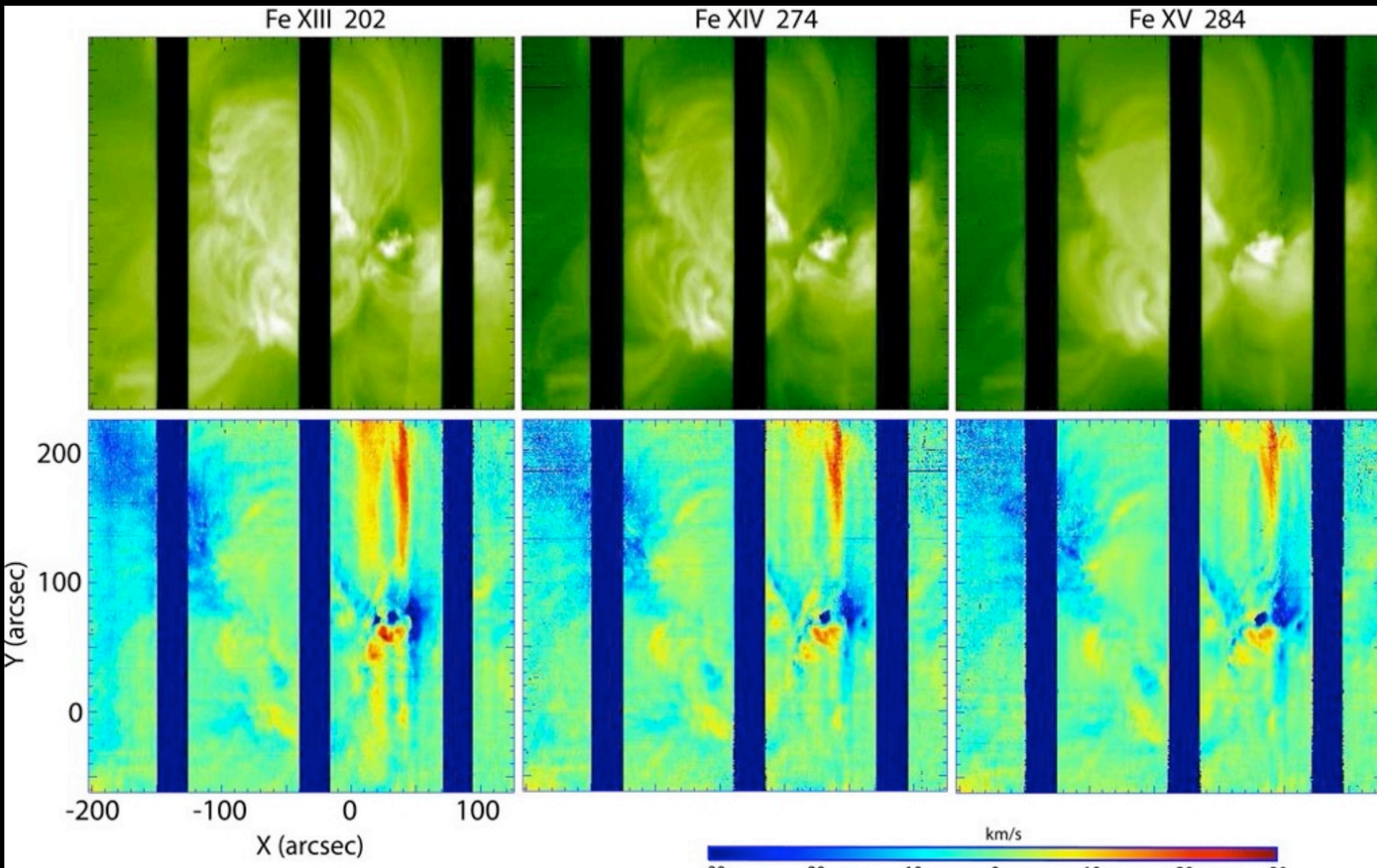
Ahn et al. (2014)

Strongest downflows are observed in transition region and “cool” coronal lines



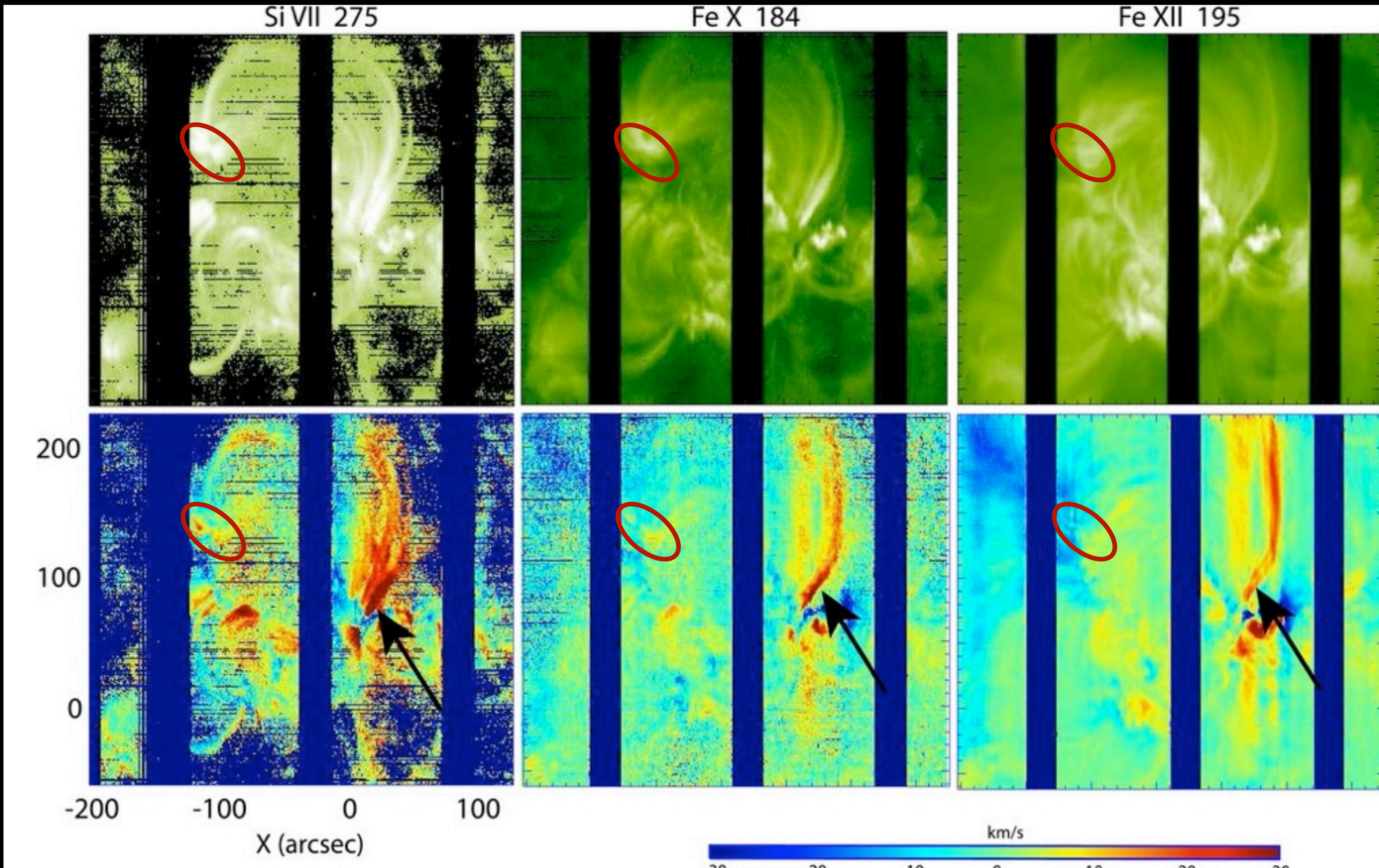
Tripathi et al. (2009)

Downflows in hotter lines are more concentrated towards the loop tops



Tripathi et al. (2009)

The other footpoint shows predominantly upflows, especially in hotter lines



Tripathi et al. (2009)

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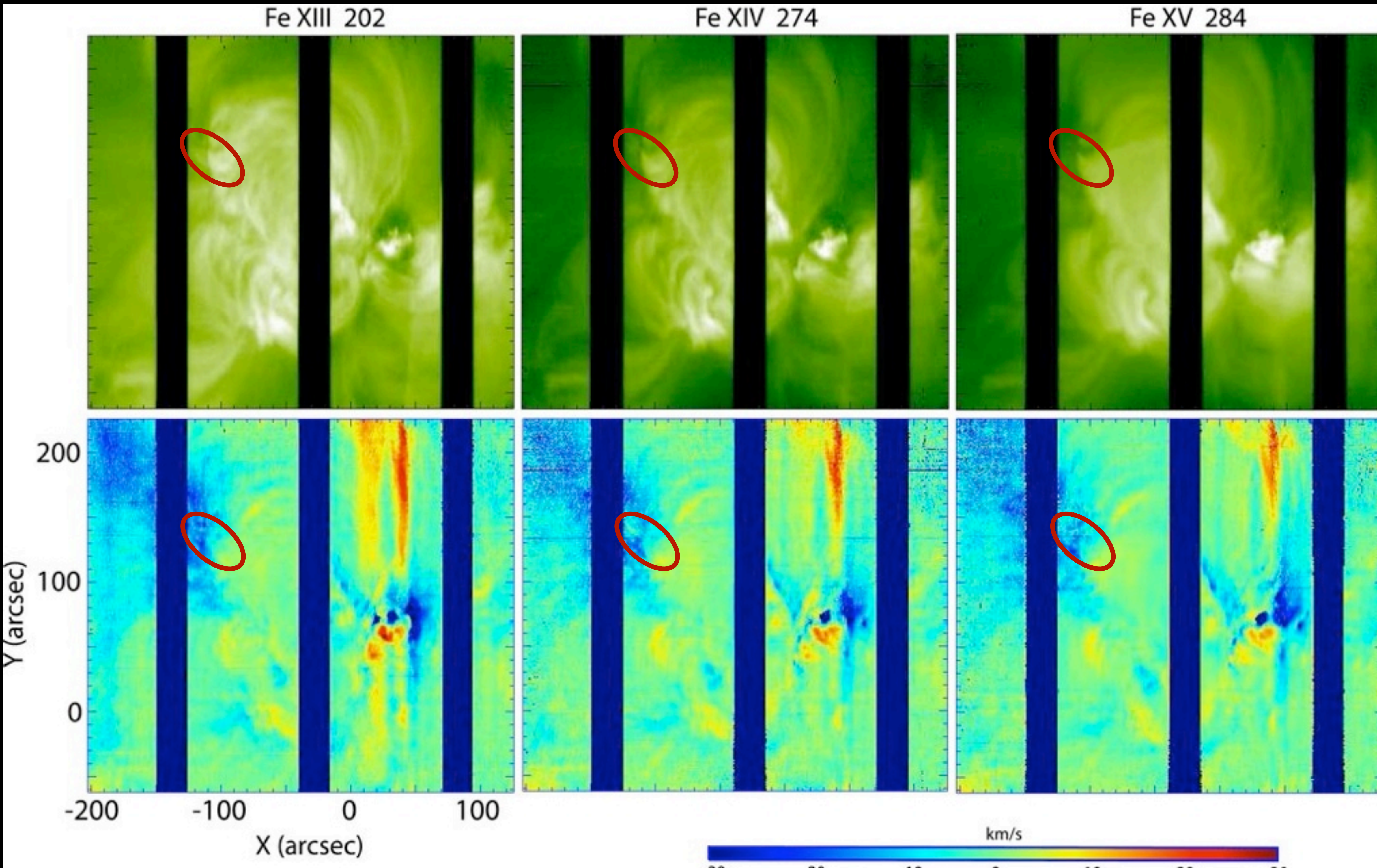
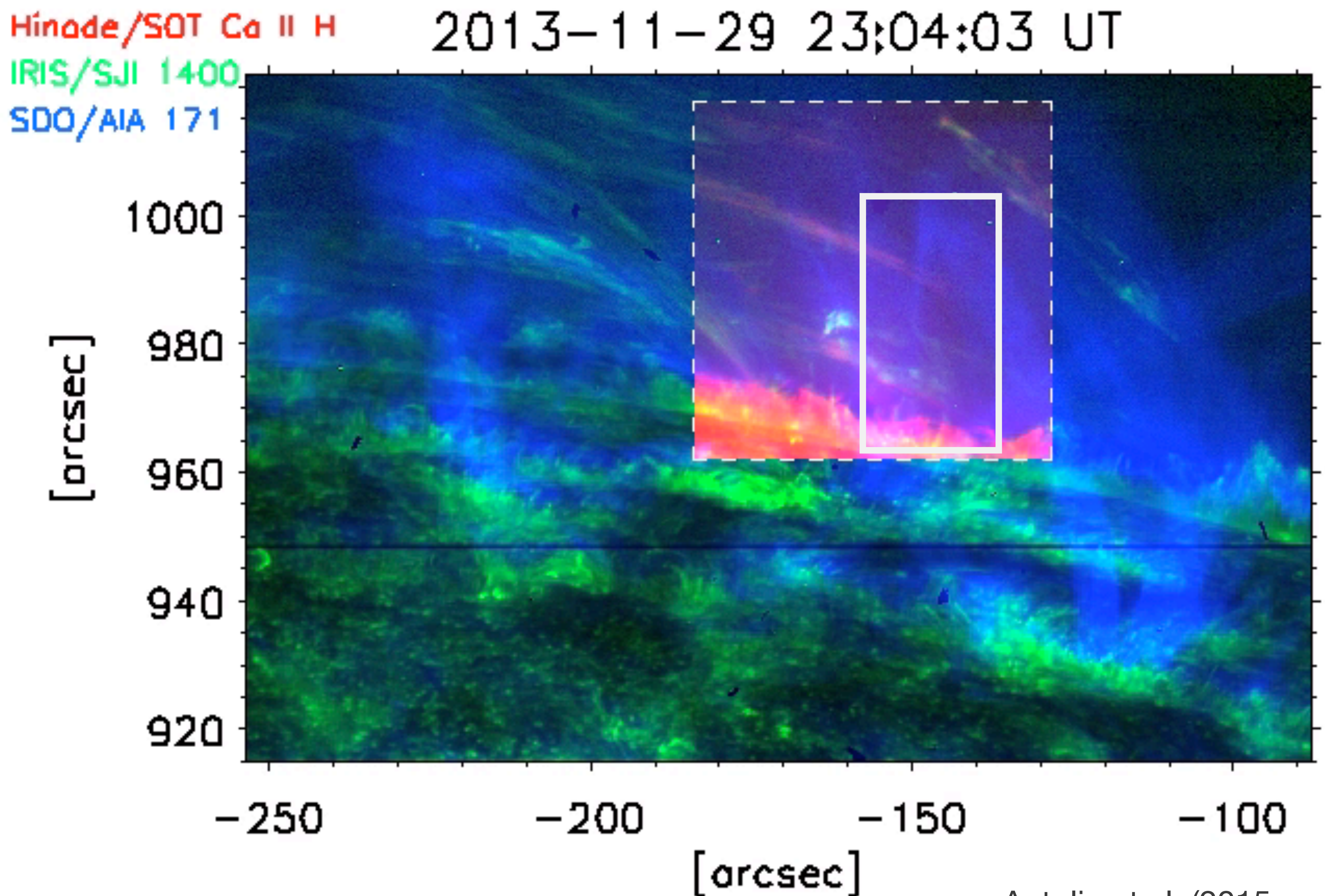
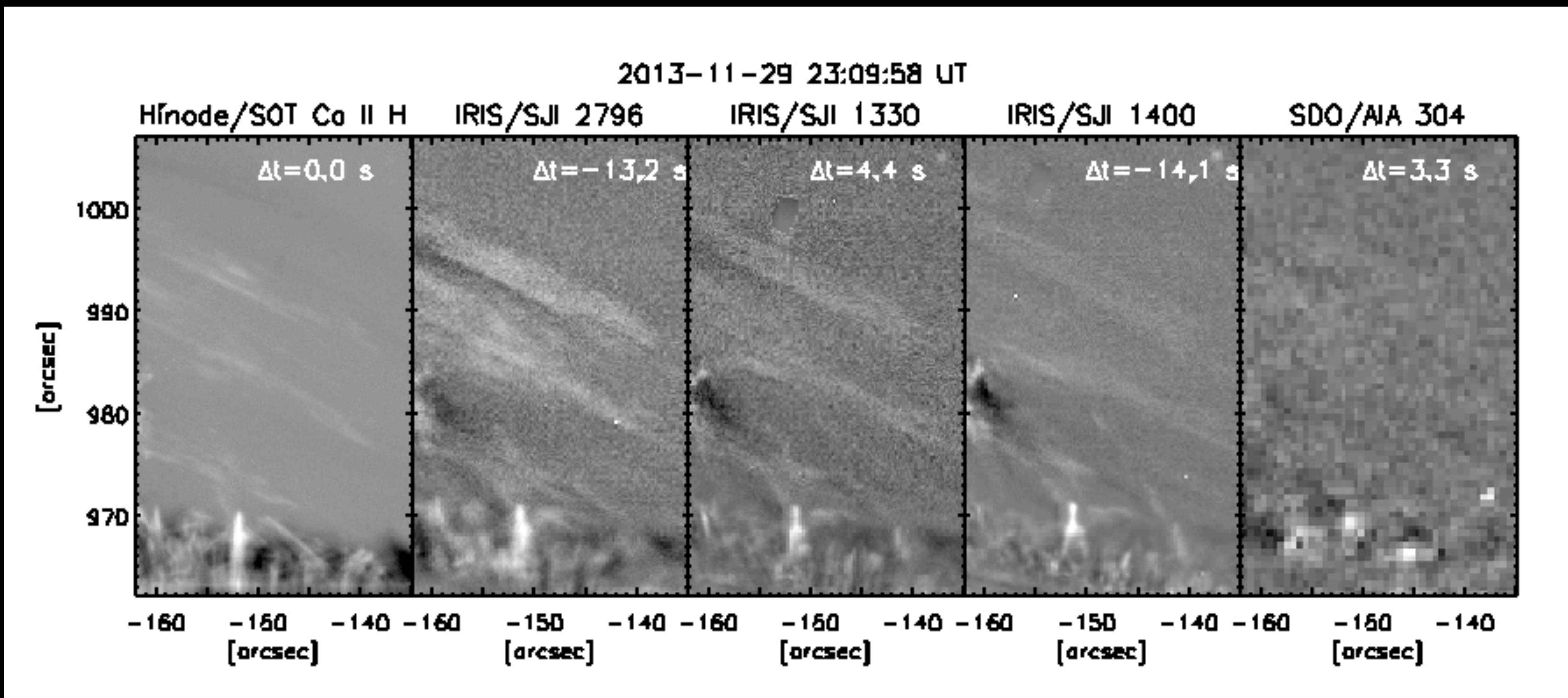


Tripathi et al. (2009)



Antolin et al. (2015, submitted)

Coronal rain appears first in the IRIS channels, before showing in Ca II H



Antolin et al. (2015, submitted)

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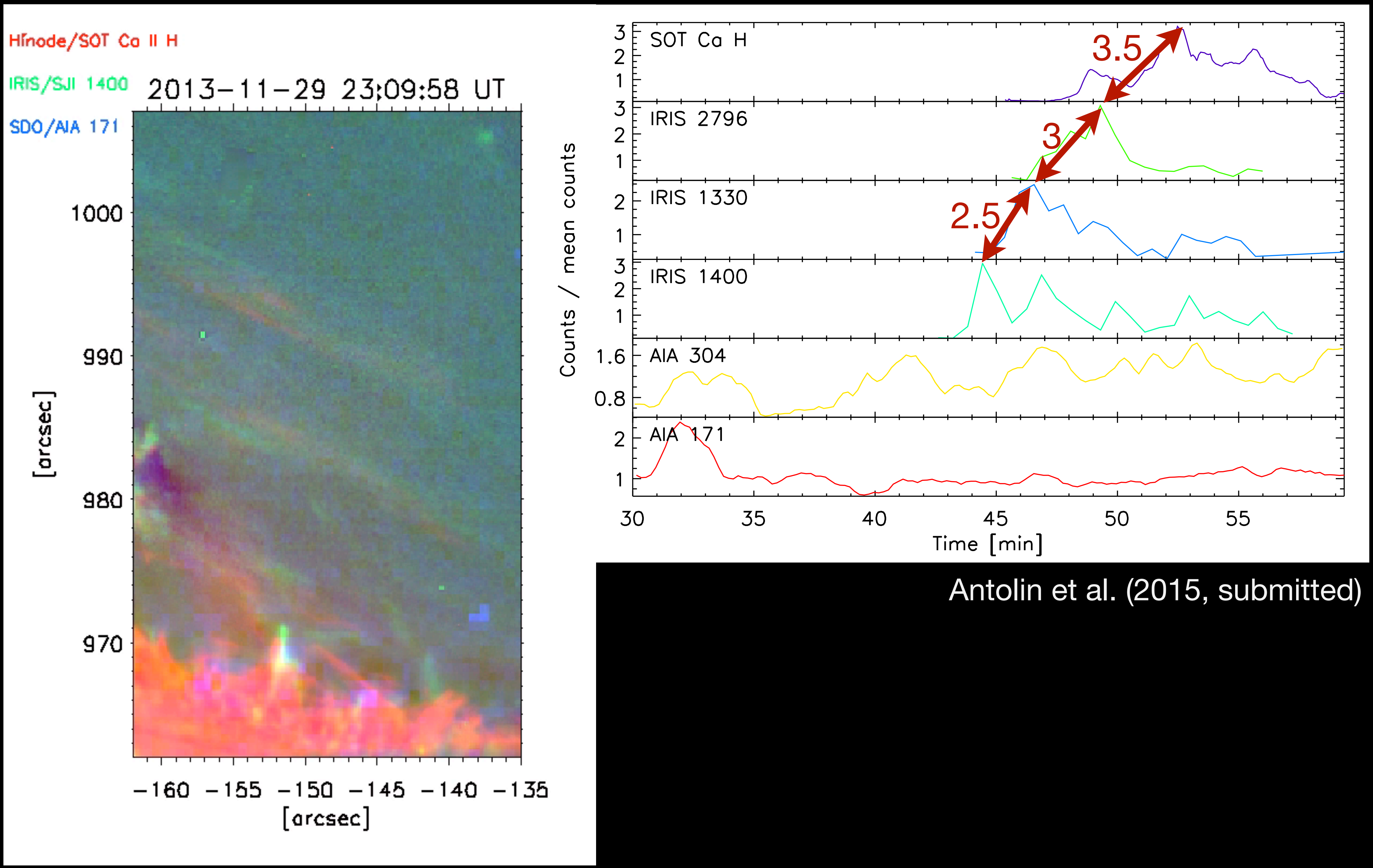
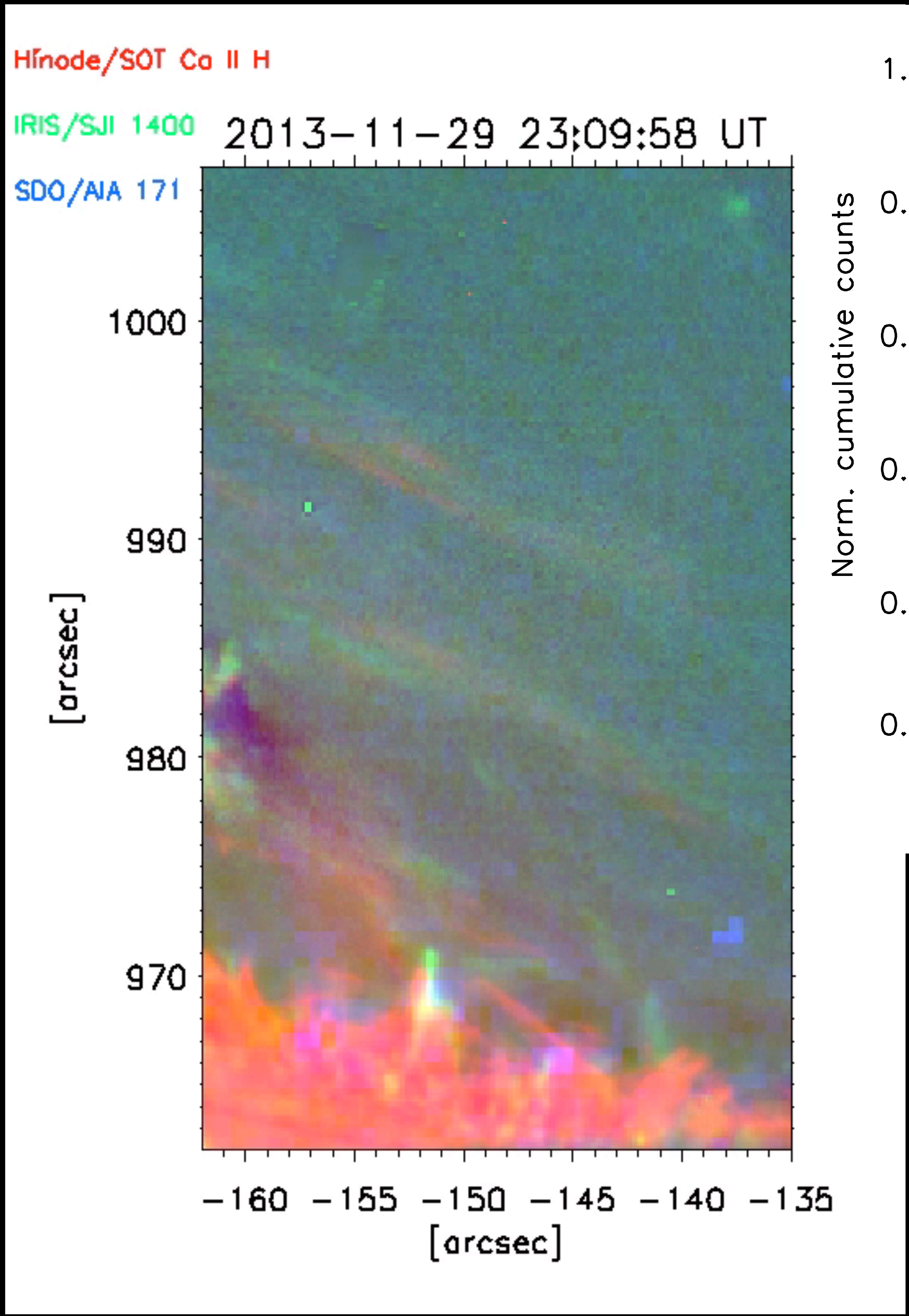
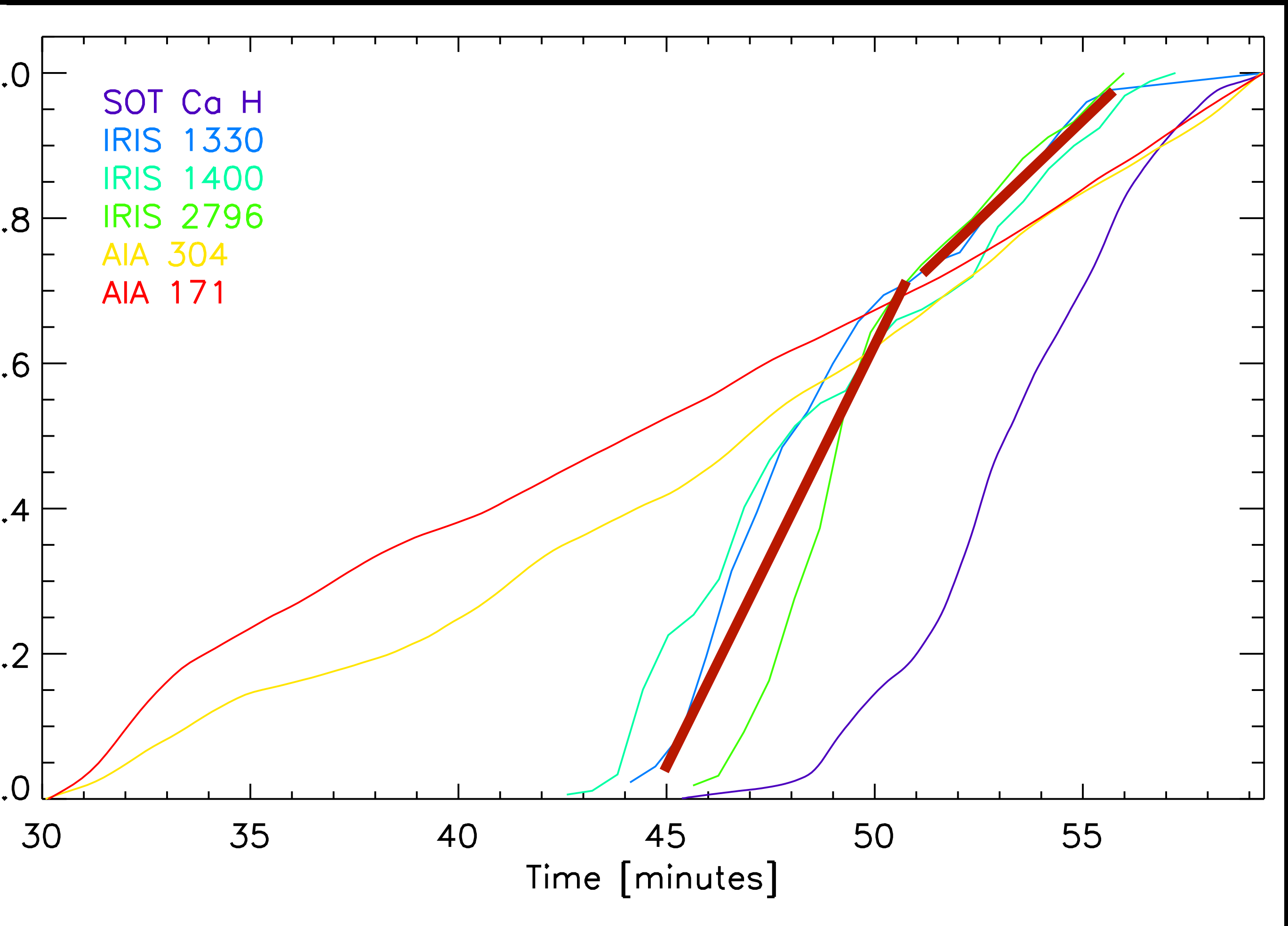


Antolin et al. (2015, submitted)

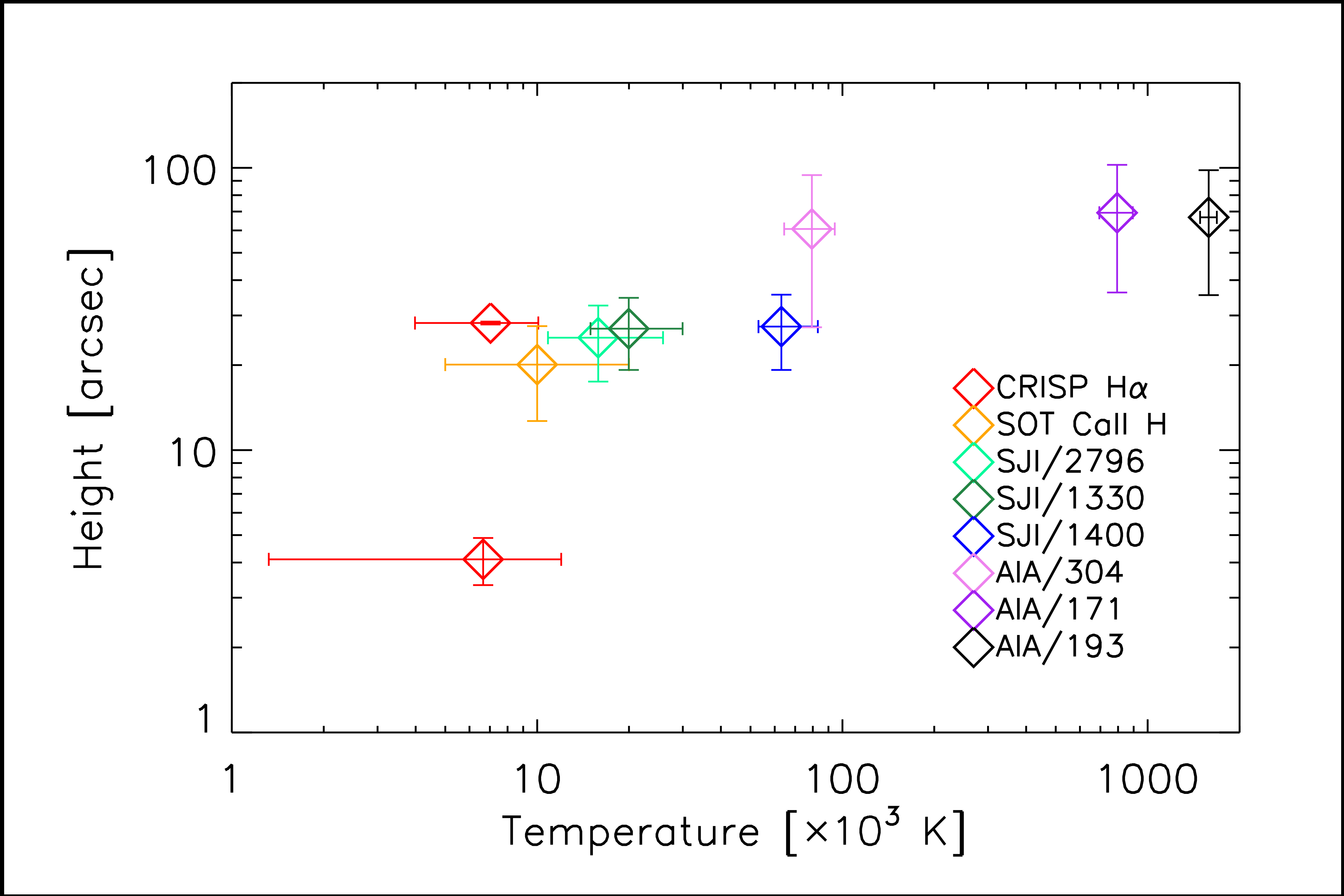
Cumulative lightcurves of IRIS diagnostics suggest a two-step cooling process





Antolin et al. (2015, submitted)

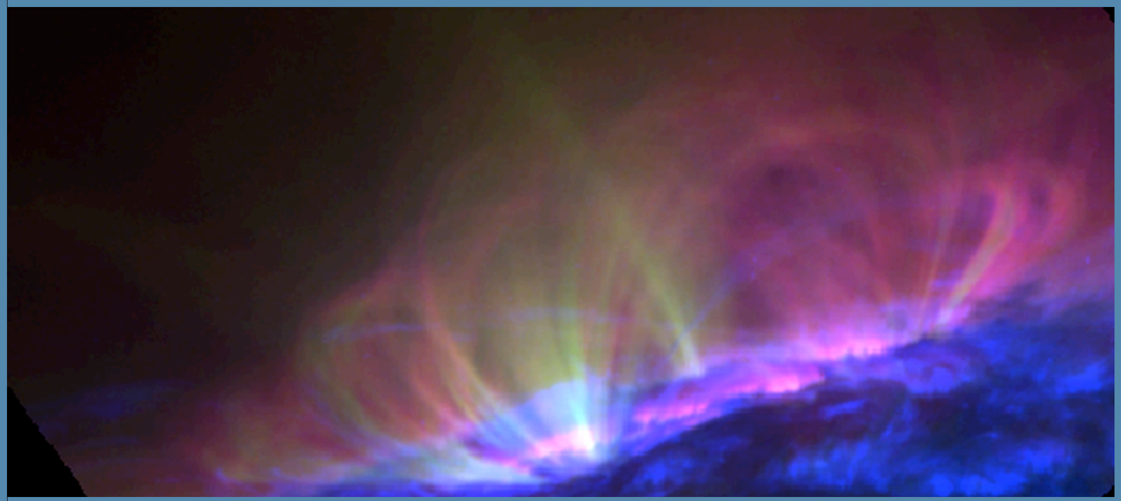
The progressive cooling from thermal instability predicts height-dependent emission



Antolin et al. (2015, submitted)

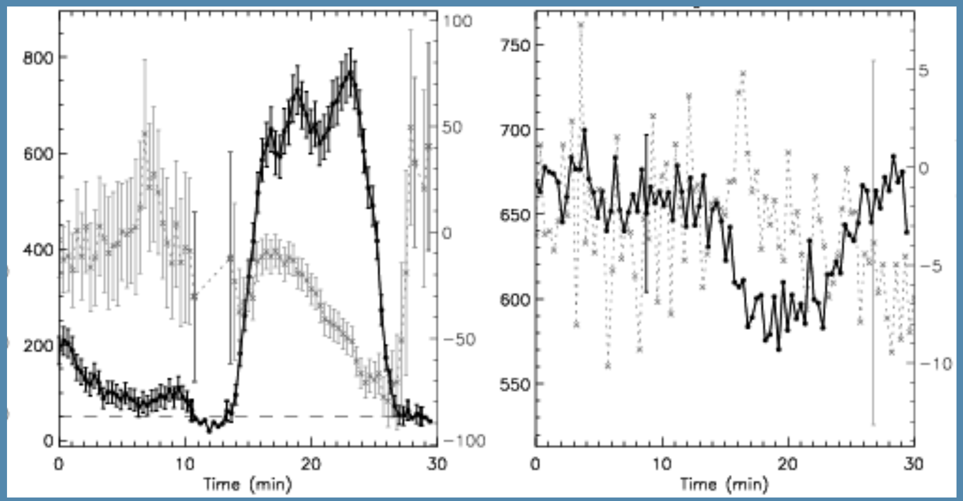
(E)UV variability could largely be explained through the multi-thermality of coronal rain

Progressive cooling in loops



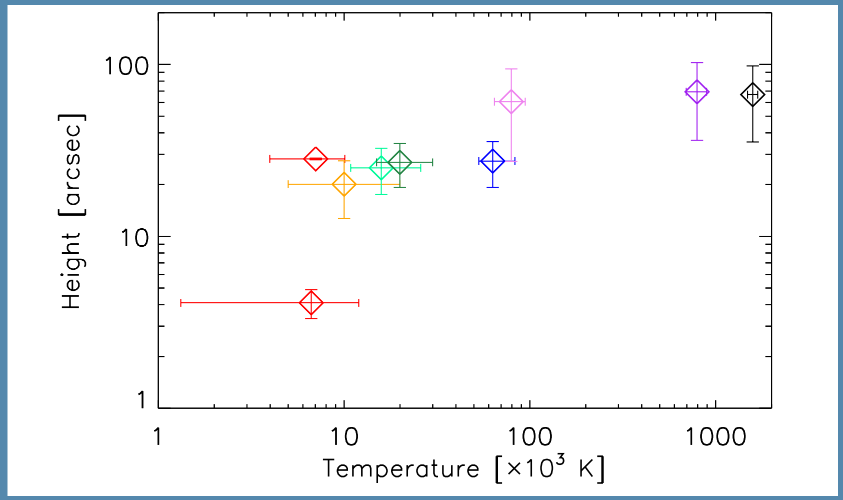
Antolin et al. (2015)

EUV dimming by coronal rain



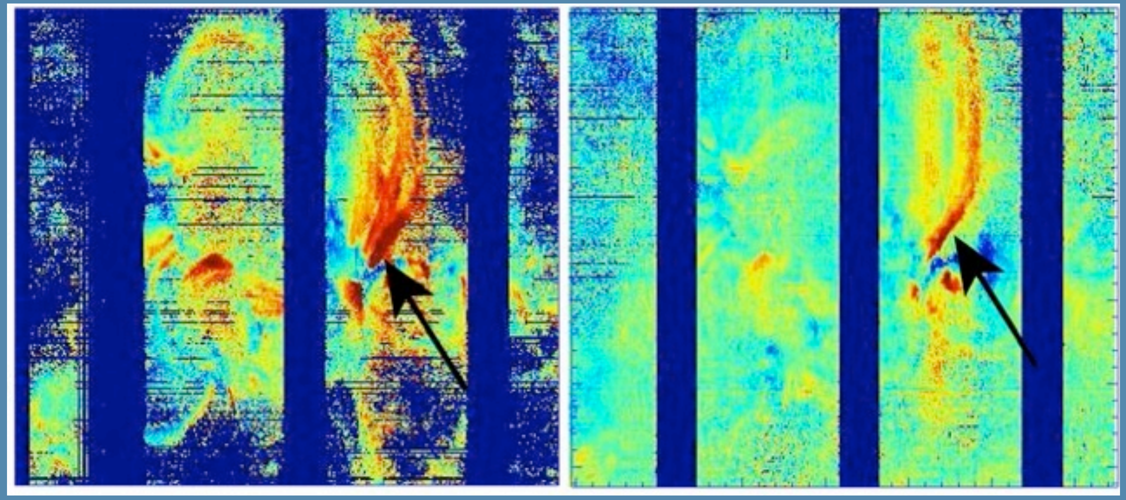
O’Shea et al. (2007)

Complete thermal instability



Antolin et al. (2015)

Coronal rain is multi-thermal



Tripathi et al. (2009)