

Magnetic Flux Cancellation as the Buildup and Trigger Mechanism for CME-Producing Eruptions in two Small Active Regions

Alphonse C. Sterling¹

Ronald L. Moore^{2,1}

Navdeep K. Panesar¹

1. NASA/MSFC

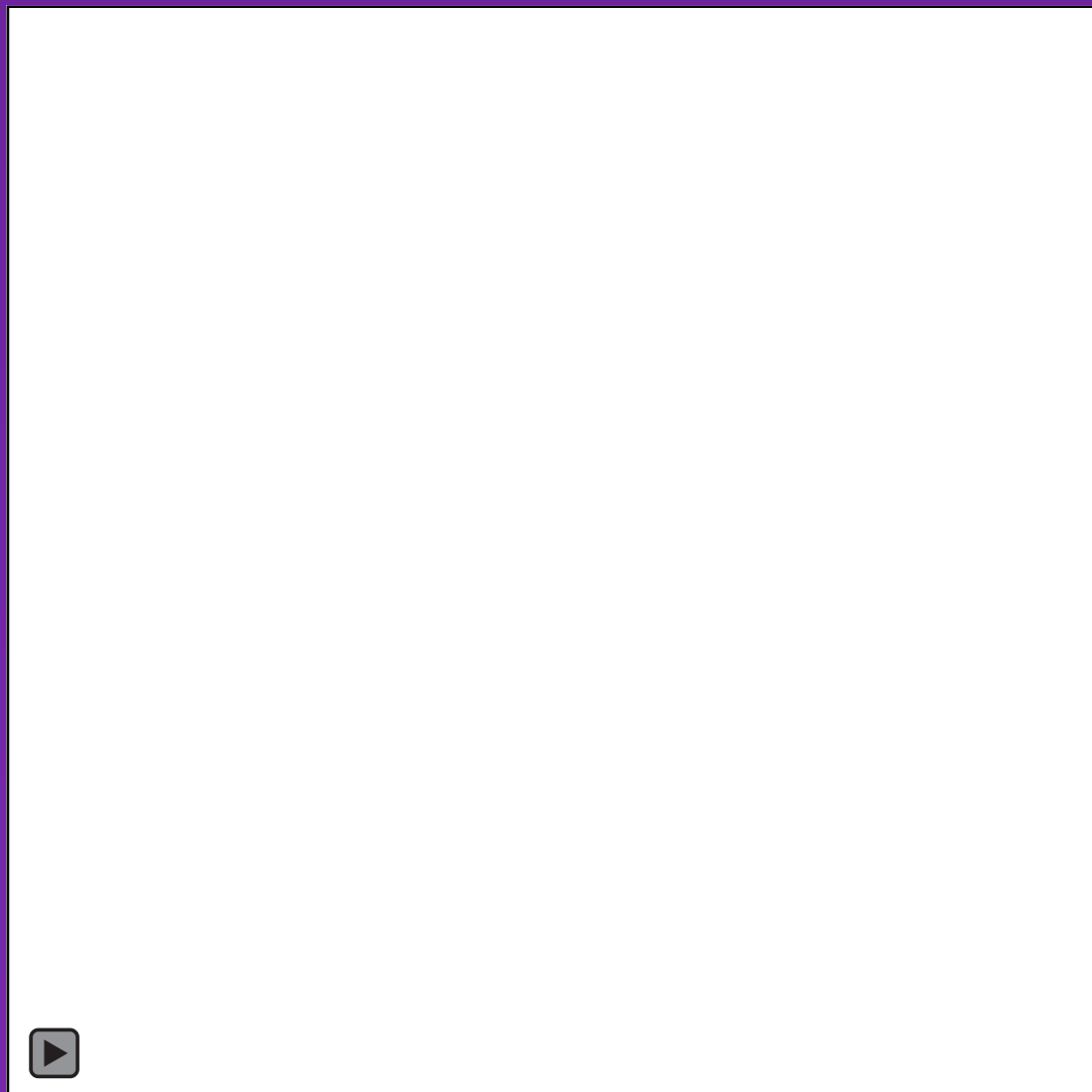
2. University of Alabama Huntsville

(Supported by NASA's HGI and NPP programs, and the MSFC/Hinode project.)

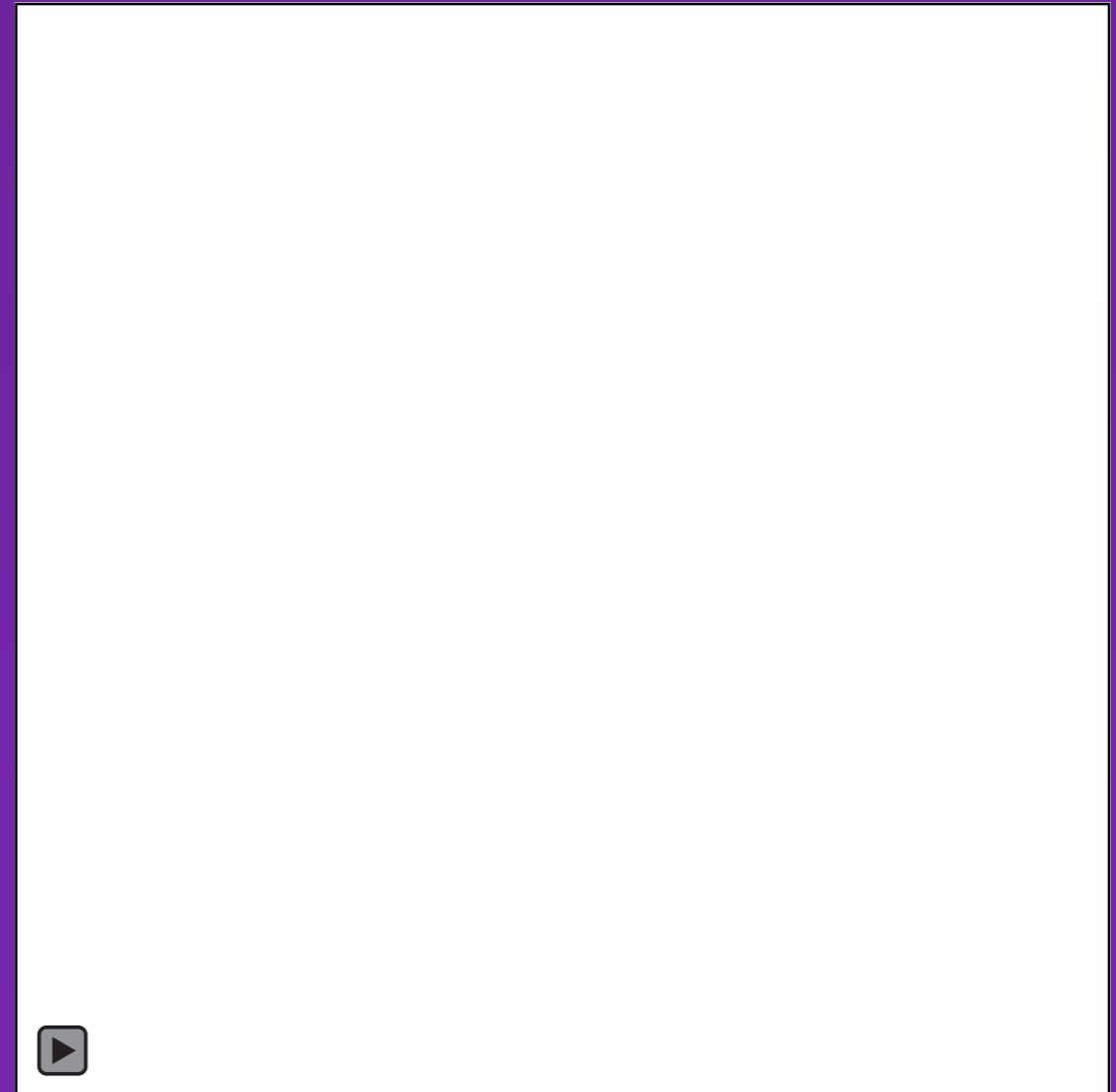
Introduction

- ◆ Recent studies indicate that many/most Coronal Jets are small-scale versions of solar eruptions that produce flares and CMEs; a minifilament erupts to cause the jet.
- ◆ Large-scale eruptions can tell us about coronal jets (e.g., the jet-base bright point is a small-scale flare).

Hinode/XRT



AIA 193



Sterling et al. (Nature, 2015)

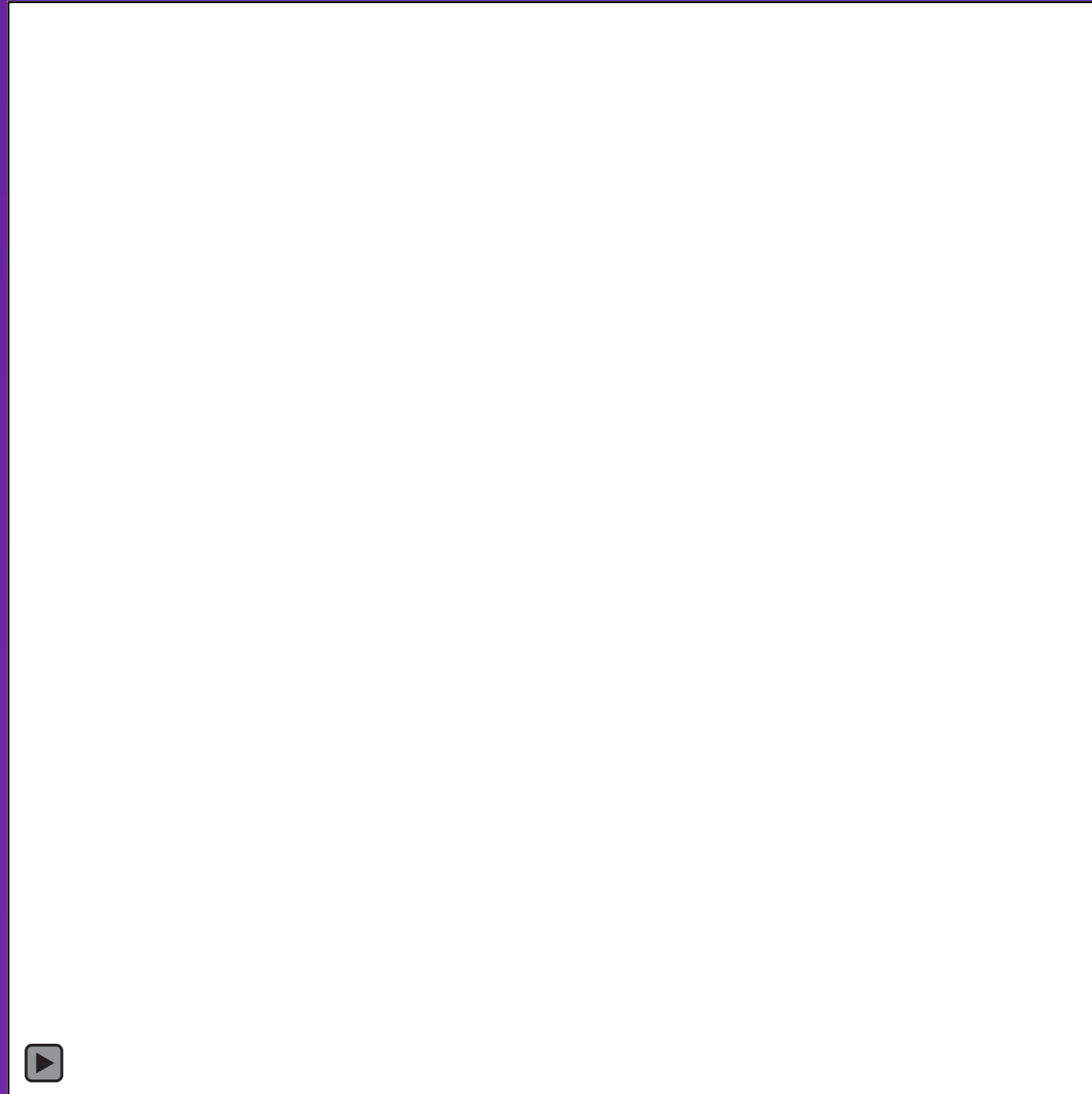
Can Jets Tell Us About CME-Producing Eruptions?

Can Jets Tell Us About CME-Producing Eruptions?

Let's Check out the Onset Mechanism!

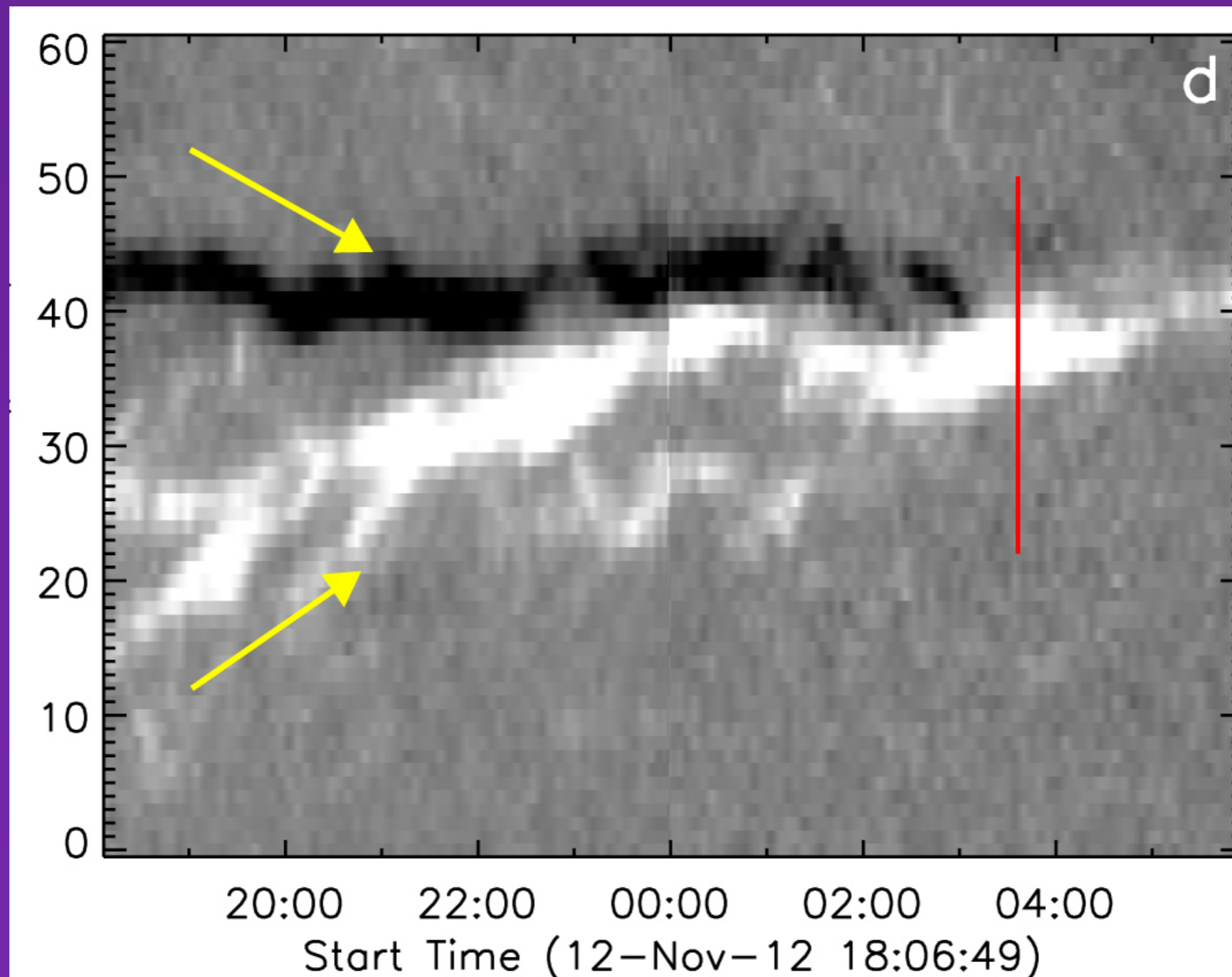
Can Jets Tell Us About CME-Producing Eruptions?

Let's Check out the Onset Mechanism!



Can Jets Tell Us About CME-Producing Eruptions?

Let's Check out the Onset Mechanism!

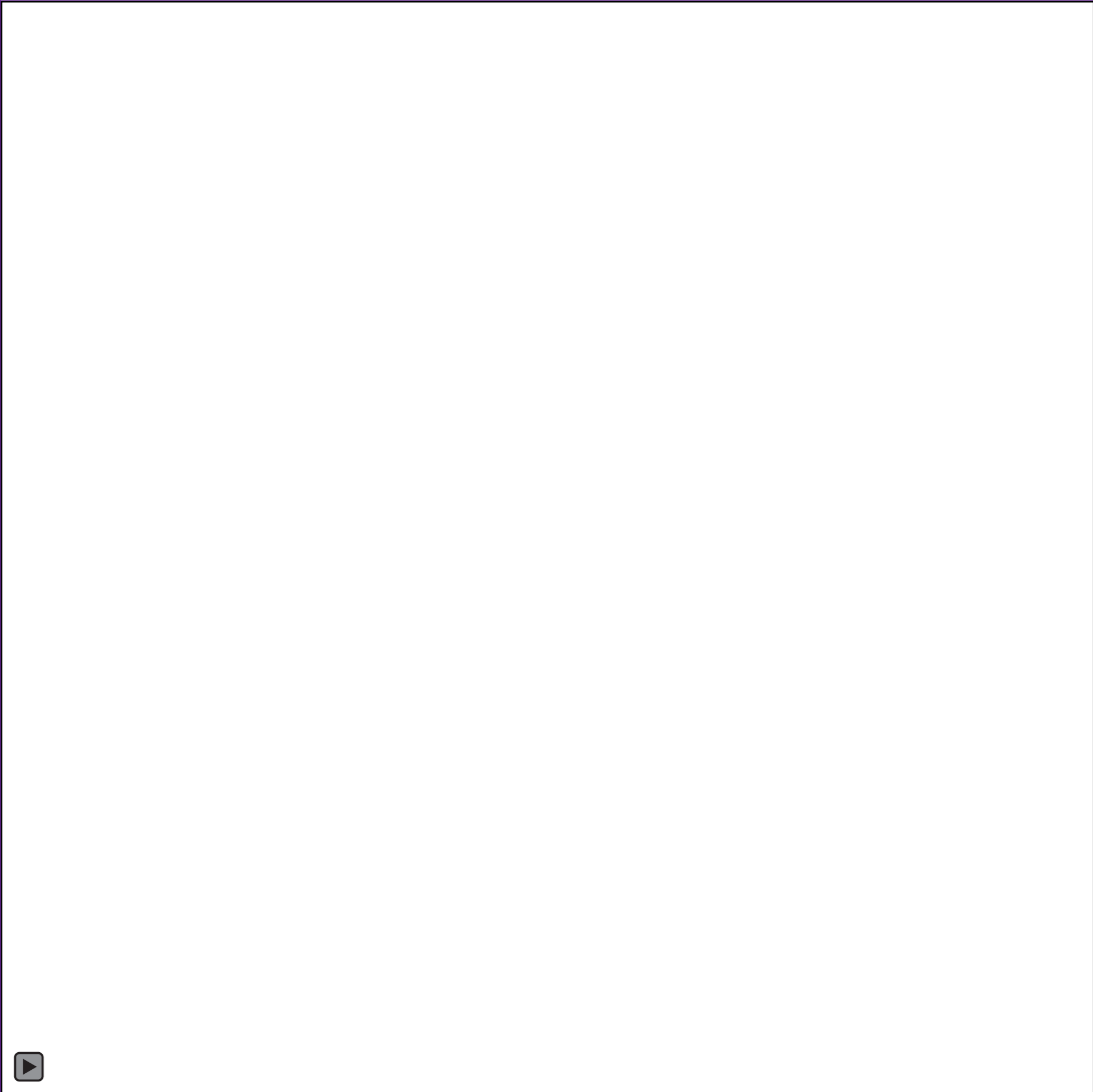


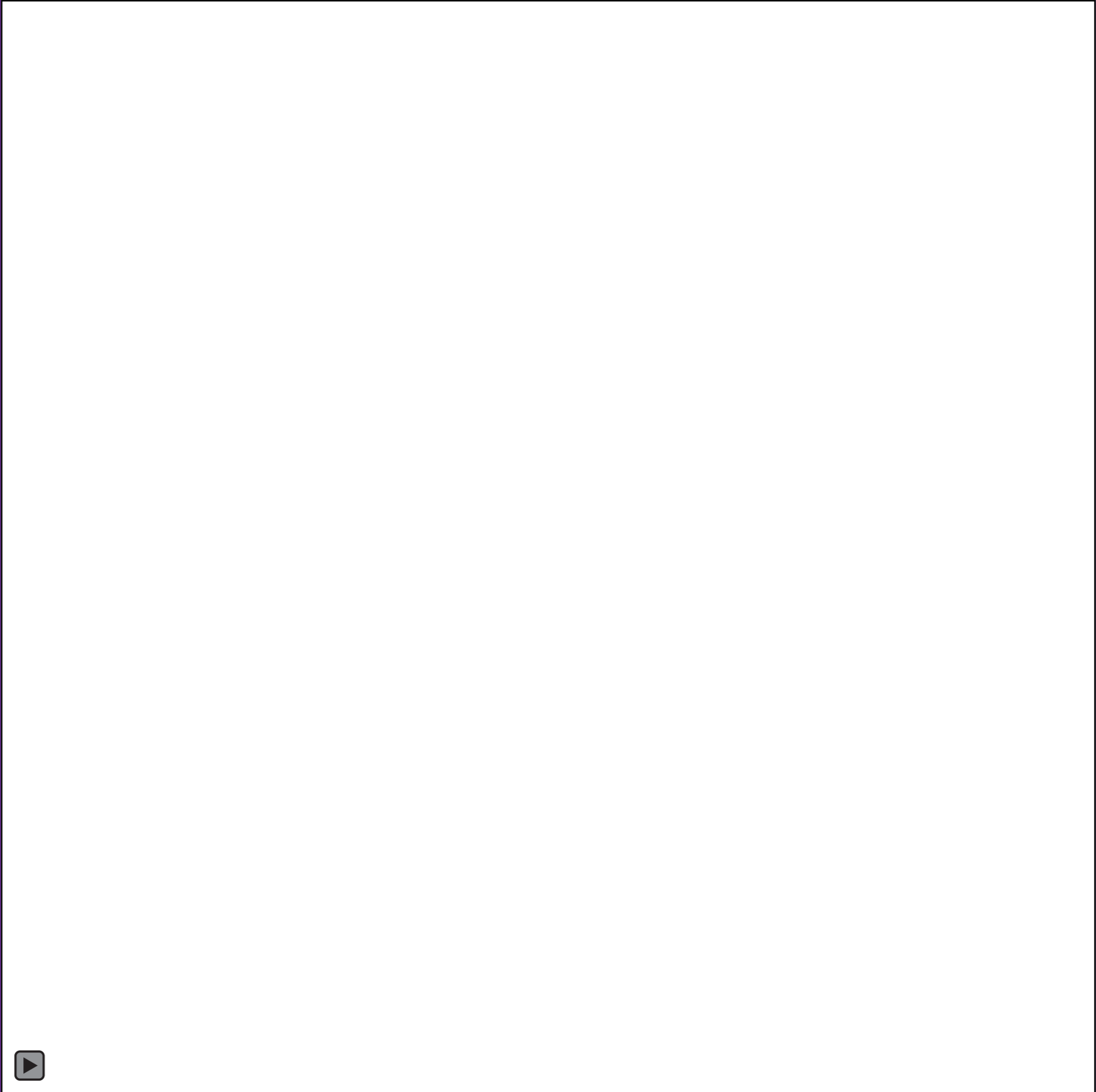
What causes CME-producing eruptions in magnetically-isolated ARs?

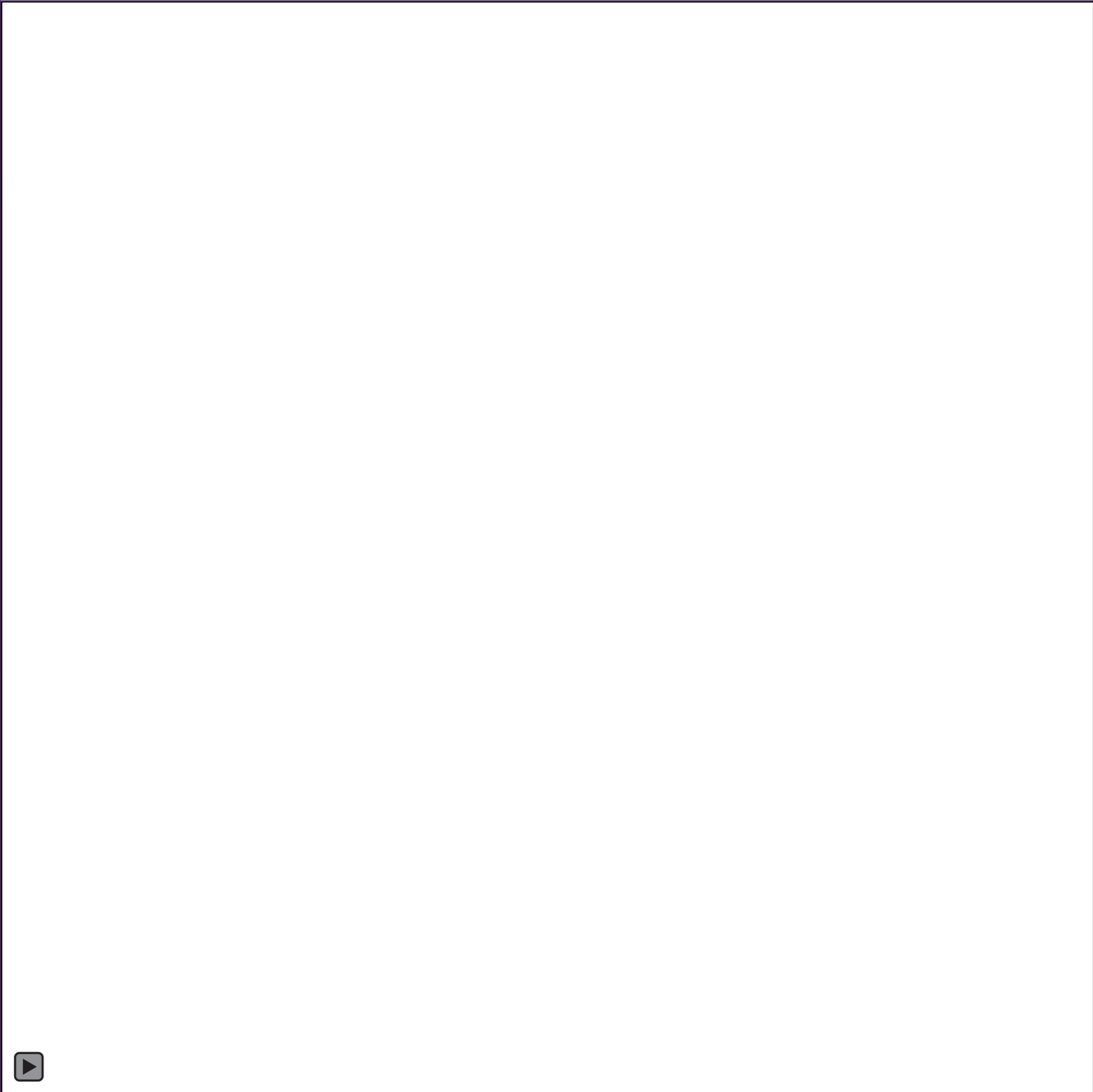
- ◆ Study CME-producing ARs.
- ◆ Use SDO/AIA and SDO/HMI (+STEREO COR).
- ◆ Follow the AR development from emergence to eruption.
 - ◆ Regions must be (largely) magnetically isolated;
 - ◆ Birth-to-eruption lifetime less than one-disk passage.
- ◆ Two small ARs: $\sim 10^{21}$ Mx; lifetime ~ 5 days.

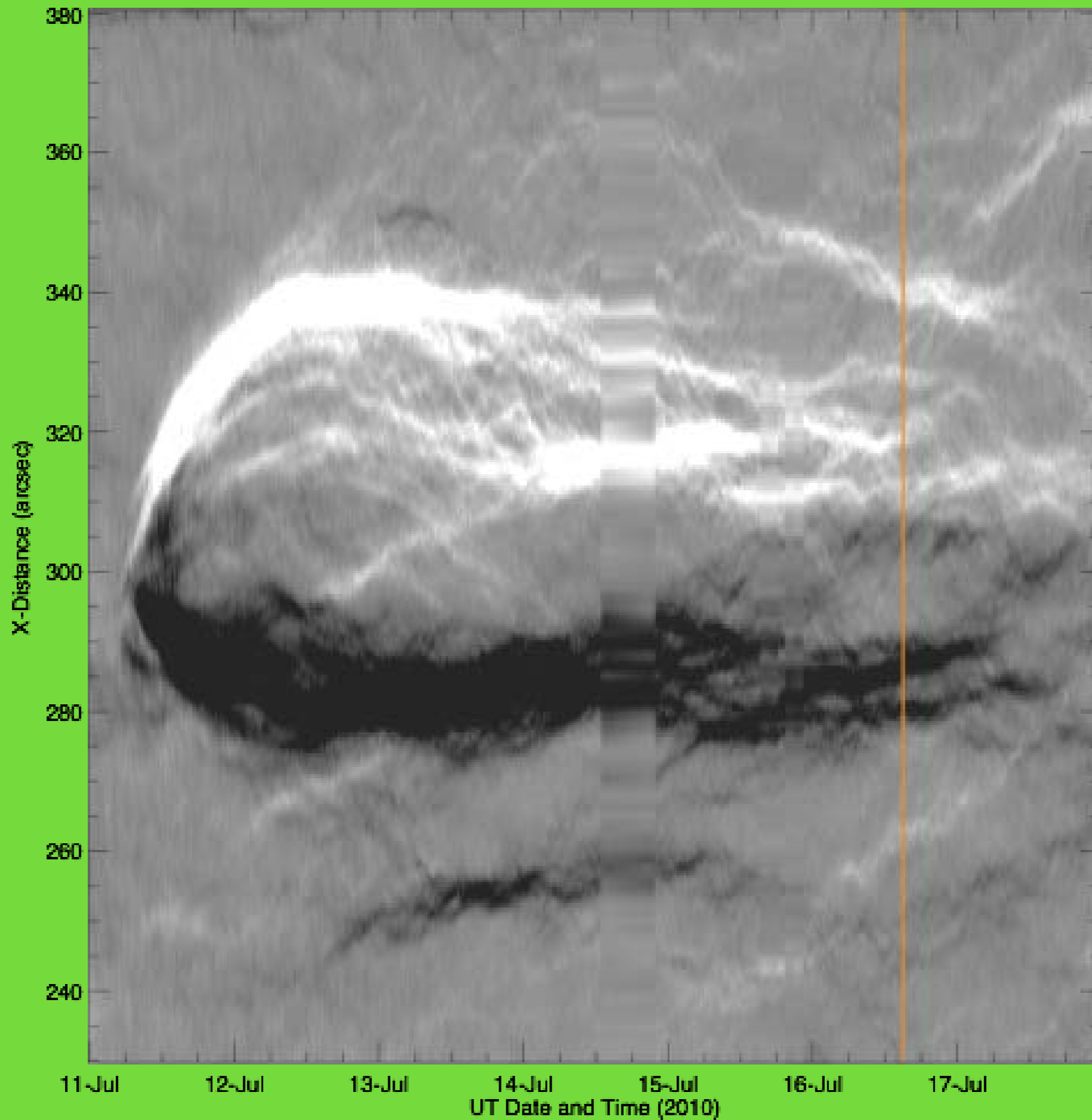
First Region

- ◆ Eruption on 2010 July 16
- ◆ AR 11088
- ◆ GOES B-class flare
- ◆ CME (width $\sim 35^\circ$)
- ◆ Single filament eruption

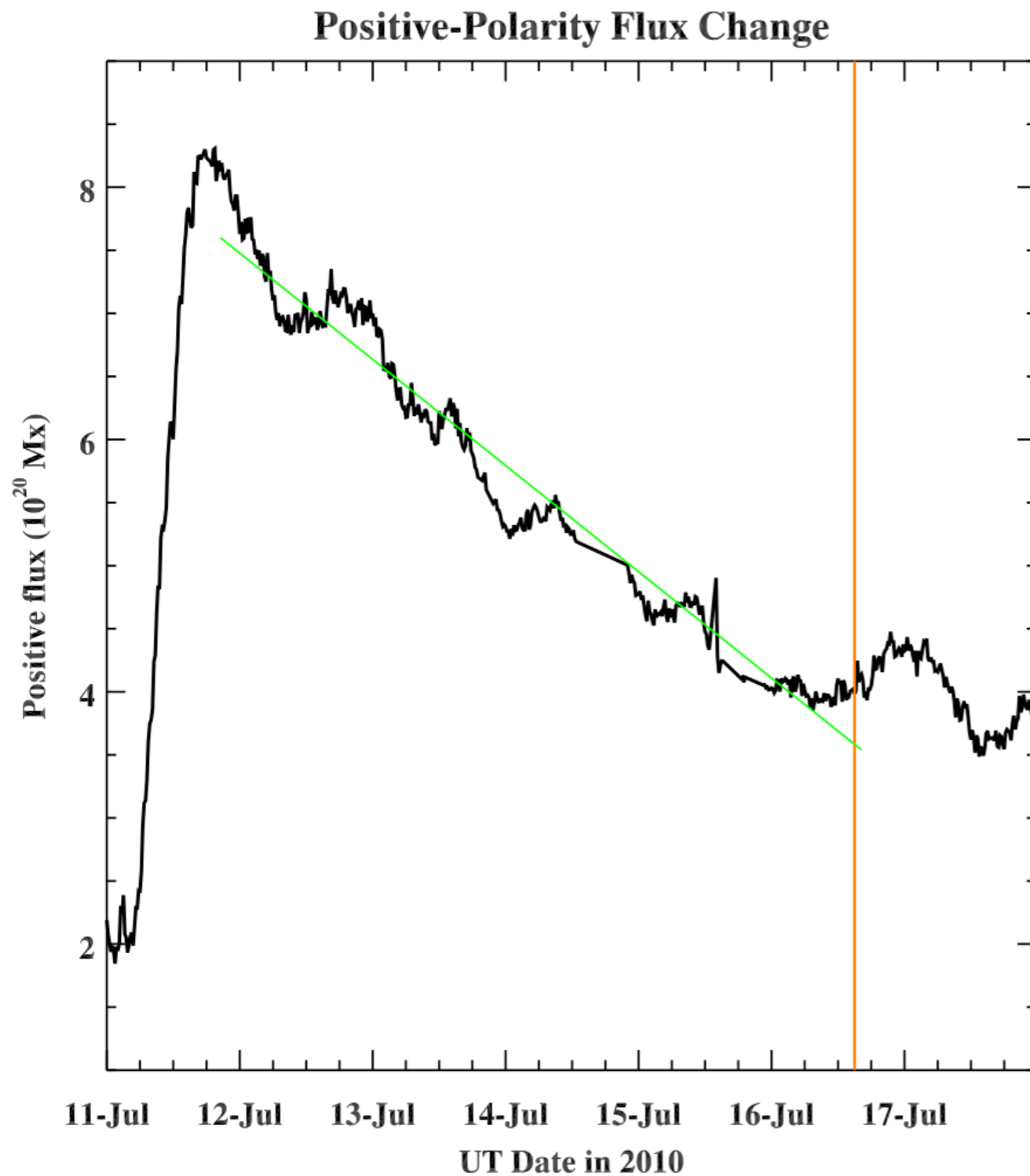








Positive-Polarity Flux Change



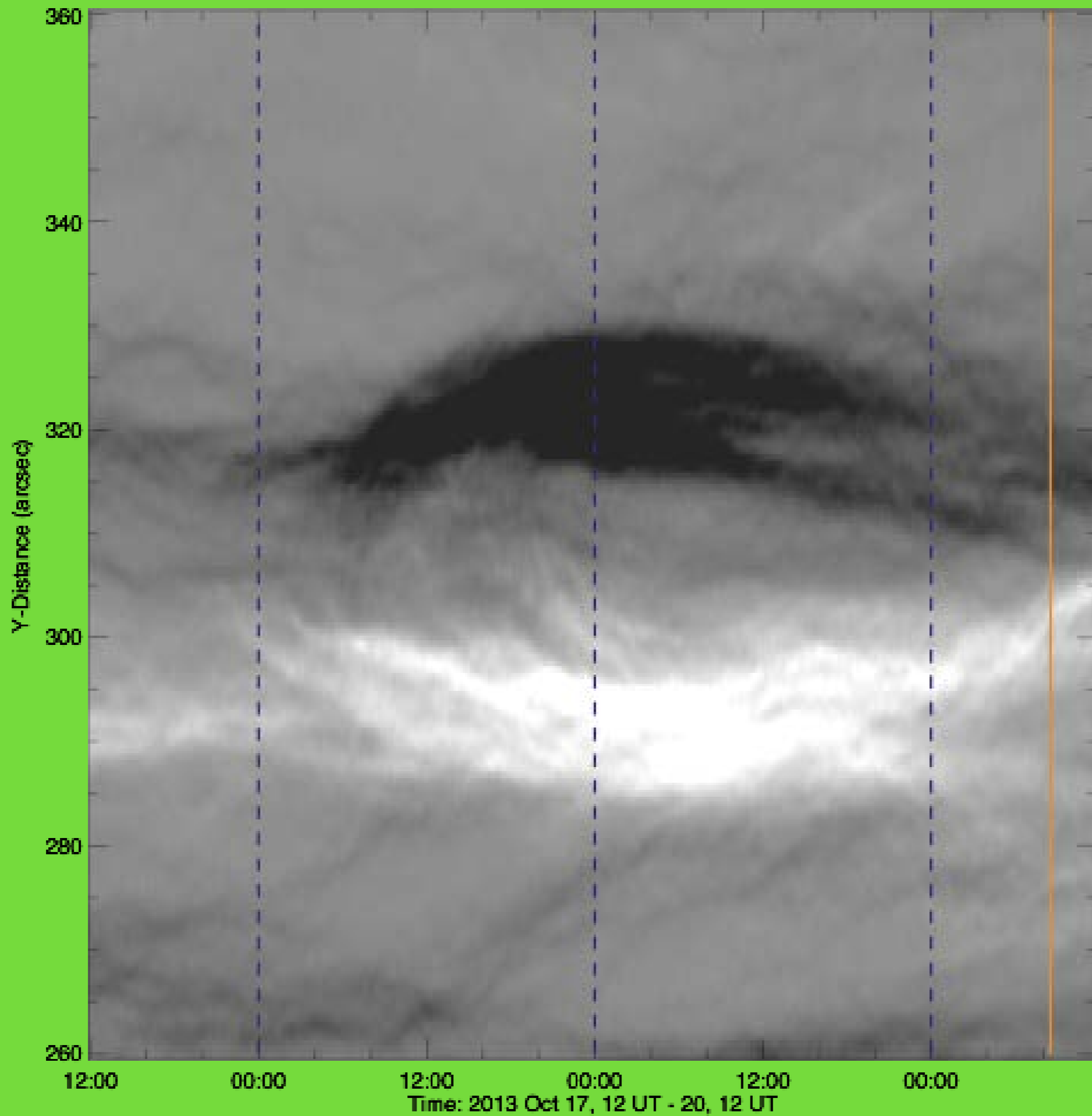
~51% of max flux remove

Second Region

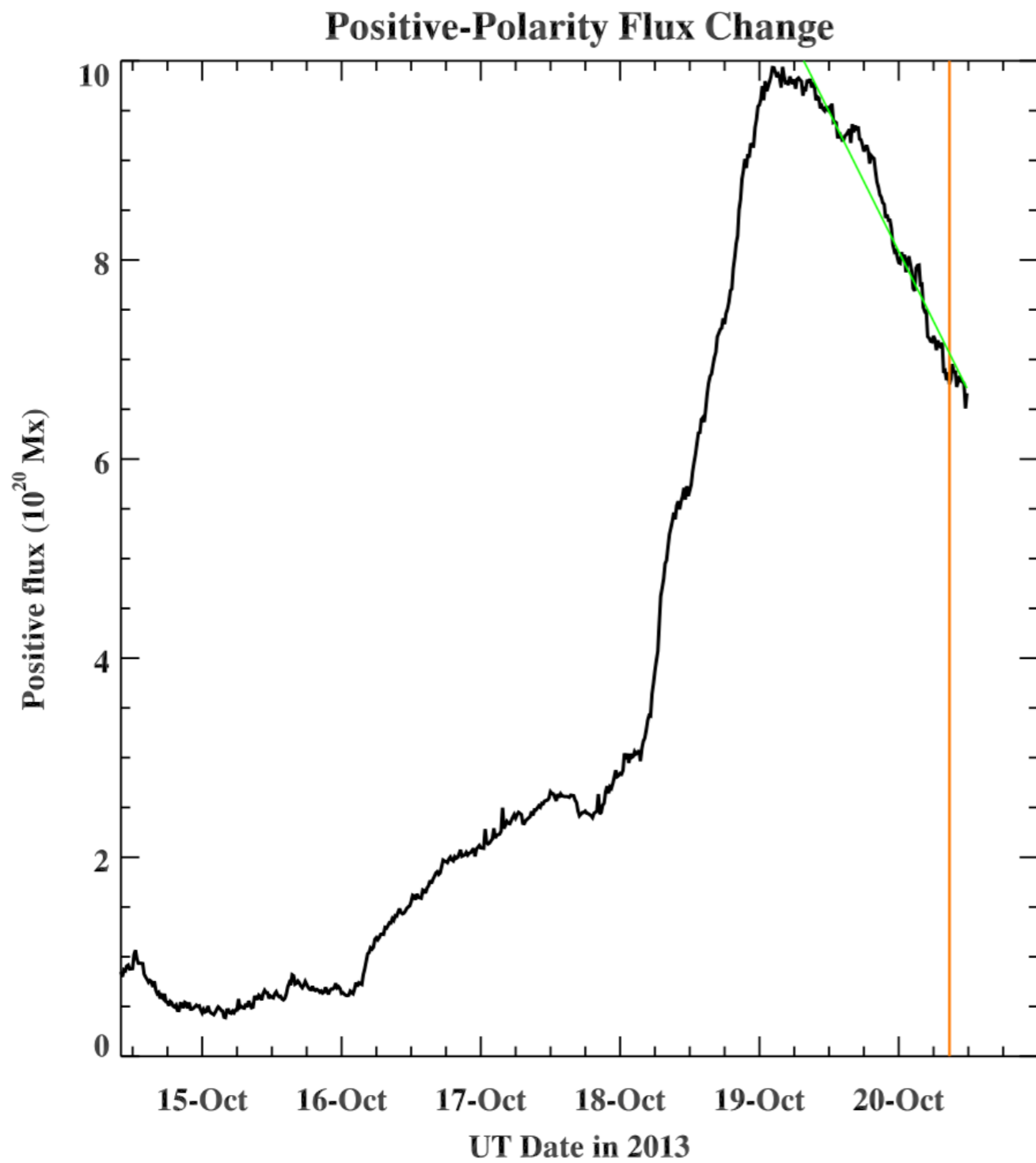
- ◆ Eruption on 2013 October 20
- ◆ AR 11868
- ◆ GOES C-class flare
- ◆ CME (width $\sim 60^\circ$)
- ◆ Two ("sympathetic") filament eruptions.

Second Region

- ◆ Eruption on 2013 October 20
- ◆ AR 11868
- ◆ GOES C-class flare
- ◆ CME (width $\sim 60^\circ$)
- ◆ Two (“sympathetic”) filament eruptions.



Positive-Polarity Flux Change



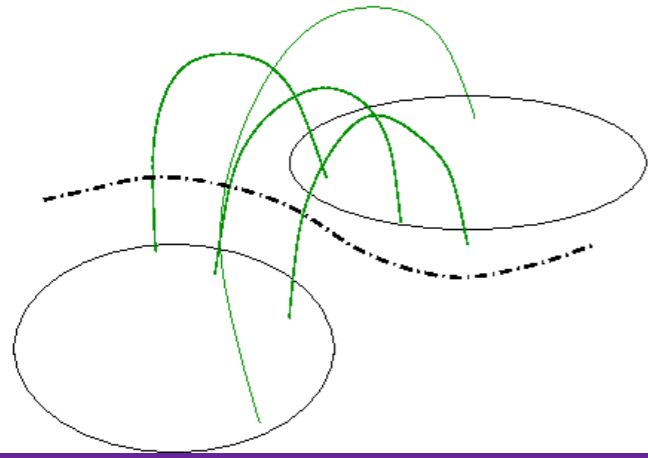
~29% of max flux remove

Flux Cancellation Rates and Percentages:

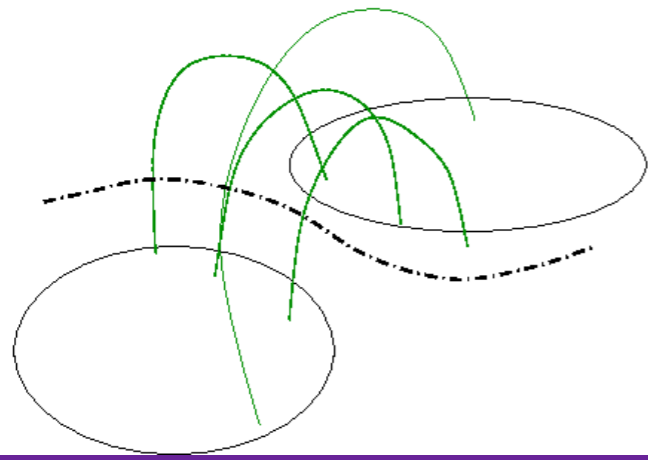
(% flux canceled)

- For CH jets (~10 events): 45
- For QS jets (~10 events): 37
- Small AR Event 1: 51
- Small AR Event 2: 29

(Panesar et al. 2016, 2018; Sterling et al., 2018):

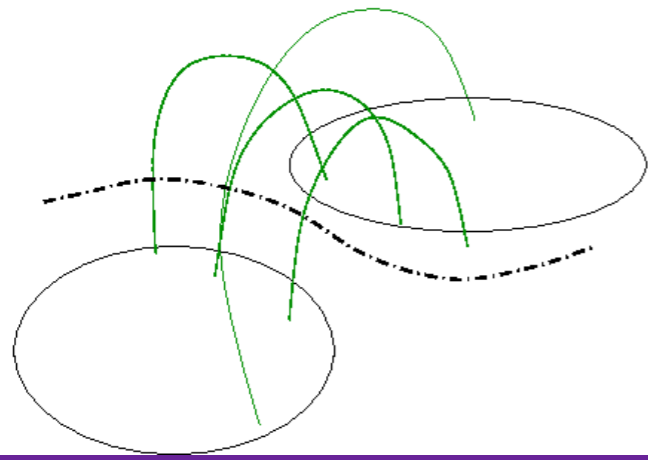


(e.g., van Ballegoijen & Martens 1989,
Moore & Roumeliotis 1992)



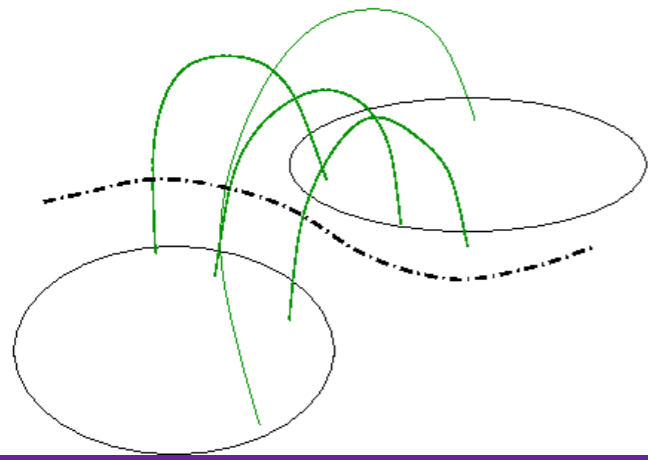
(e.g., van Ballegoijen & Martens 1989,
Moore & Roumeliotis 1992)





(e.g., van Ballegoijen & Martens 1989,
Moore & Roumeliotis 1992)

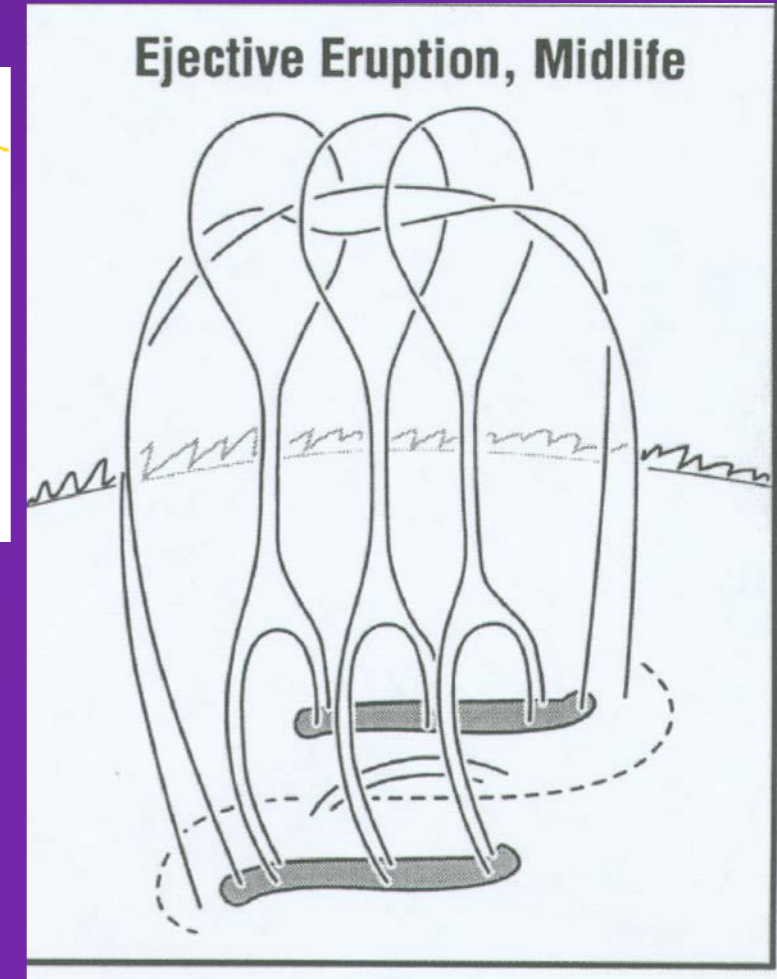




(e.g., van Ballegoijen & Martens 1989,
Moore & Roumeliotis 1992)



(Moore et al. 2001)



Summary and Conclusions

Investigation of two CME-producing small ARs:

- ◆ ~Magnetically isolated from other solar regions.
- ◆ Both began with flux emergence, following by separating poles, and then retracting poles.
- ◆ Filaments formed and eruptions occurred during the retracting phase, as flux cancelation was occurring.
- ◆ Thus the small ARs behave as scaled-up coronal jets: flux cancelations leading to (mini)filament eruptions!
- ◆ It may be that many eruptions (on small and large scales) occur when ~50% of the total flux of the region has canceled.

(Details: Sterling, Moore, & Panesar 2018, ApJ, in press)