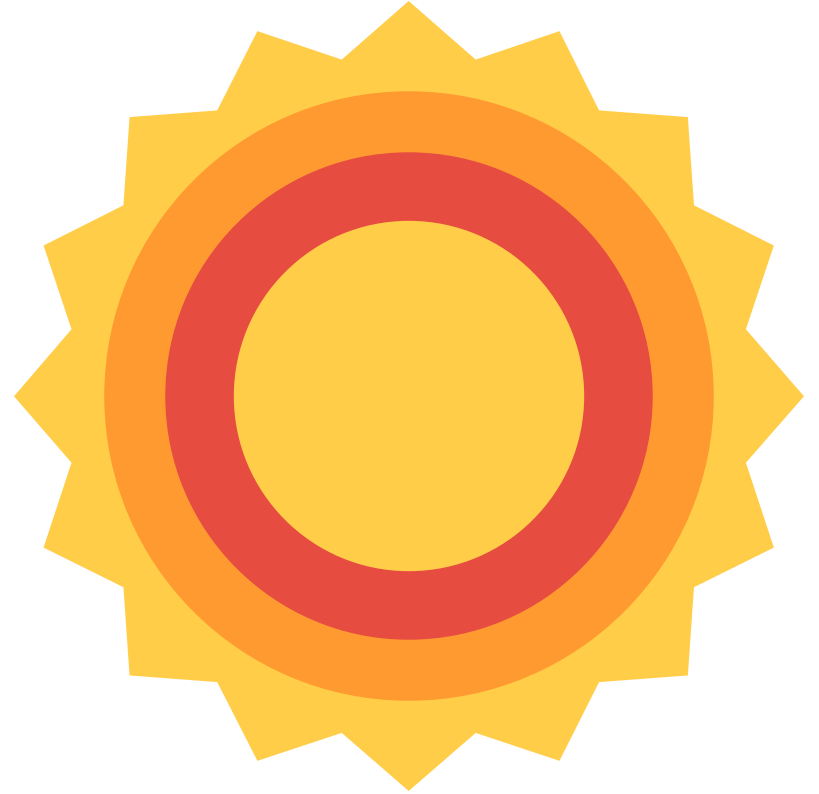
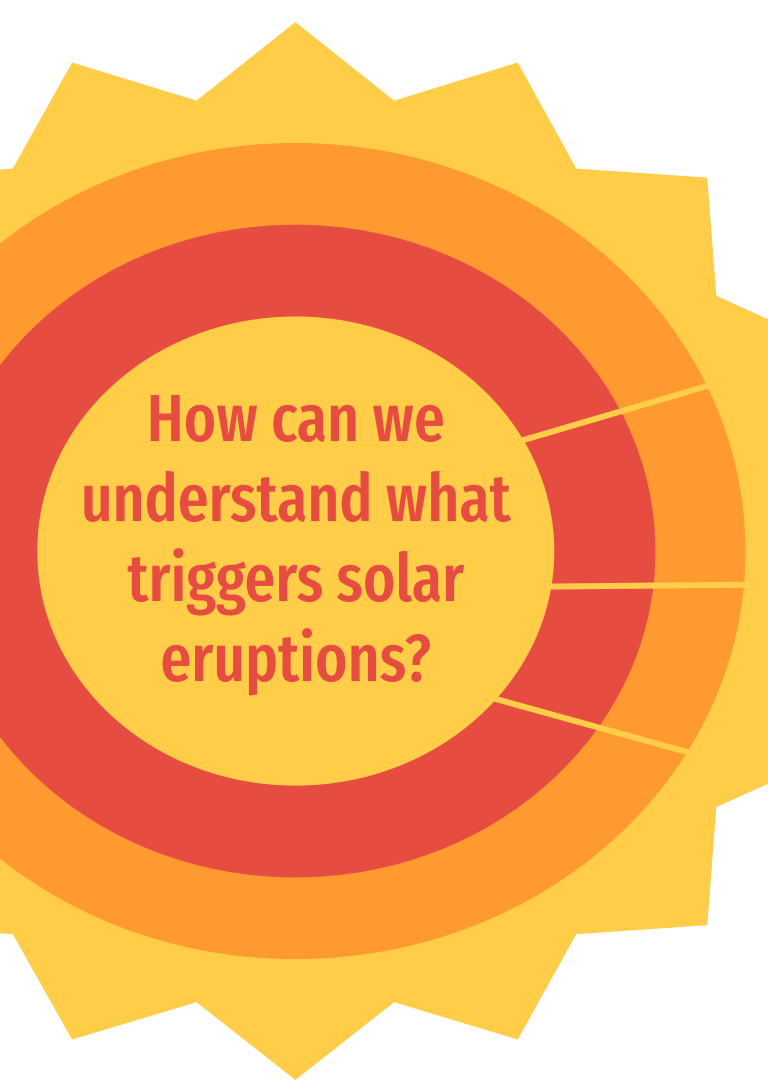


Investigation of Solar Flare Triggering Mechanisms

Zoe Schlossnagle & Dr. Chunming Zhu





Big Question!

How can we understand what triggers solar eruptions?

Analyze data from NASA's SDO satellite

Find and characterize early signatures

Categorize events and compare with models

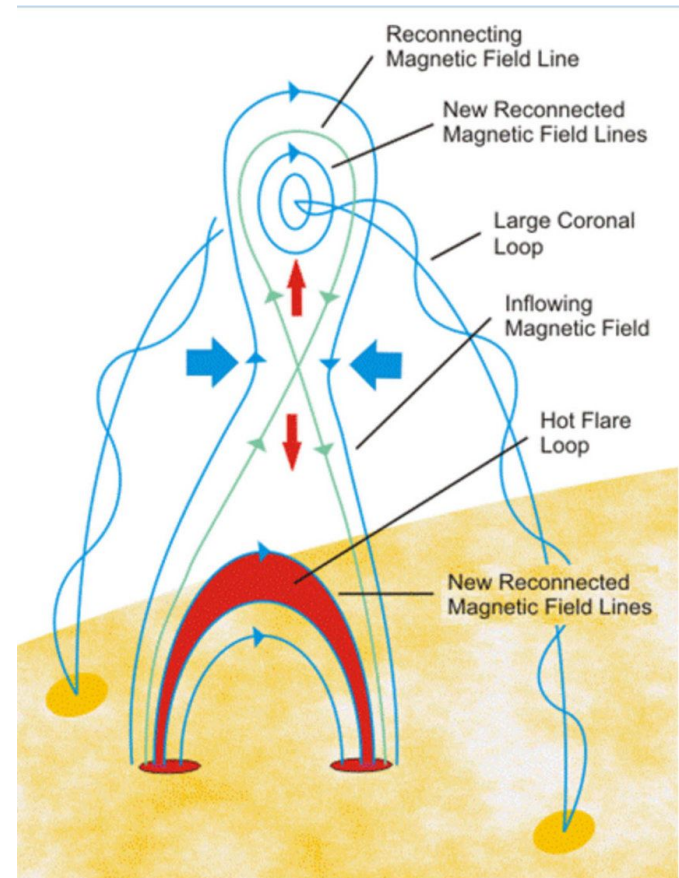
What is a solar flare?

Large, explosive events of intense radiation

Coming from active regions

Flux rope stretches the fields below

Magnetic Reconnection

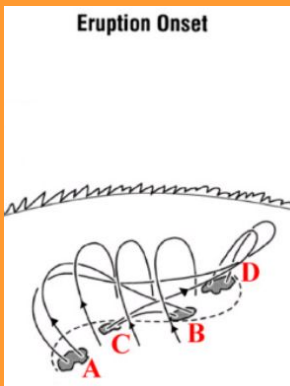


Triggering Mechanisms From *Forbes 2000* and *Chen 2011*

Tether Cutting

1

Early brightening occurs **inside** the flare ribbons

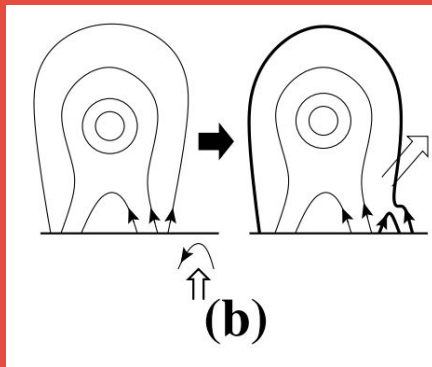


Moore, et al 2001

Flux Emergence

2

Early brightening occurs **outside** the flare ribbons

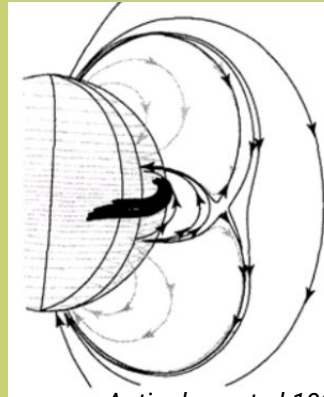


Chen 2008

Breakout Model

2

Early brightening occurs **outside** the flare ribbons



Antiochos, et al 1999

Instability

3

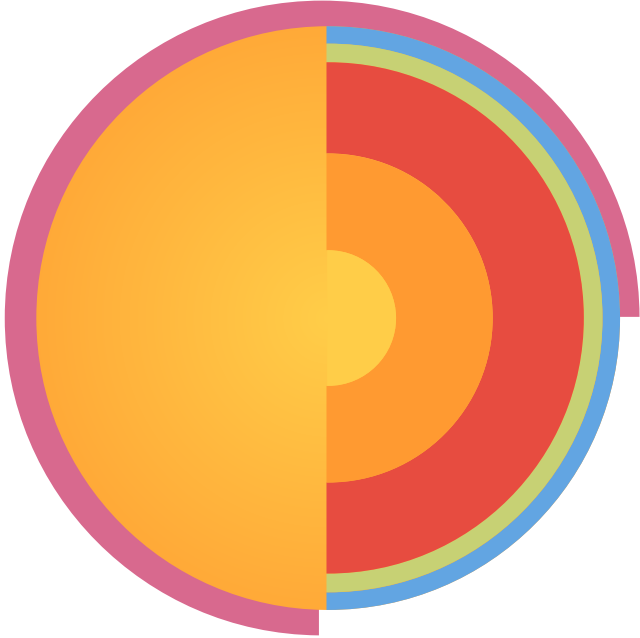
Early brightening doesn't occur at all



How does this influence our work?

By modeling early bursts and tracing the early flaring patterns in flare precursors, we can identify which triggering mechanism is happening when.

So far...



1. Got familiar with IDL and the sun

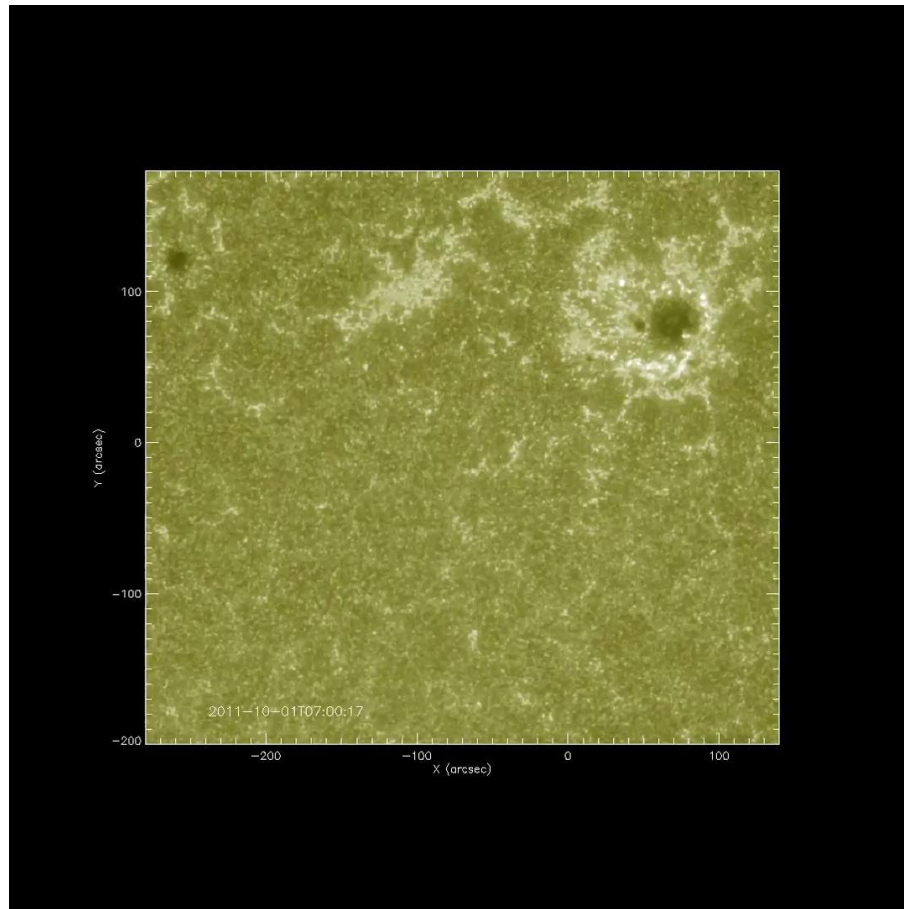
2. Began mapping areas of interest on the sun

3. Identifying flaring pixels

4. Magnetic field extrapolation and geometry

Next... stats!

AIA 1600 movie of October 1, 2011



Three Main Categories

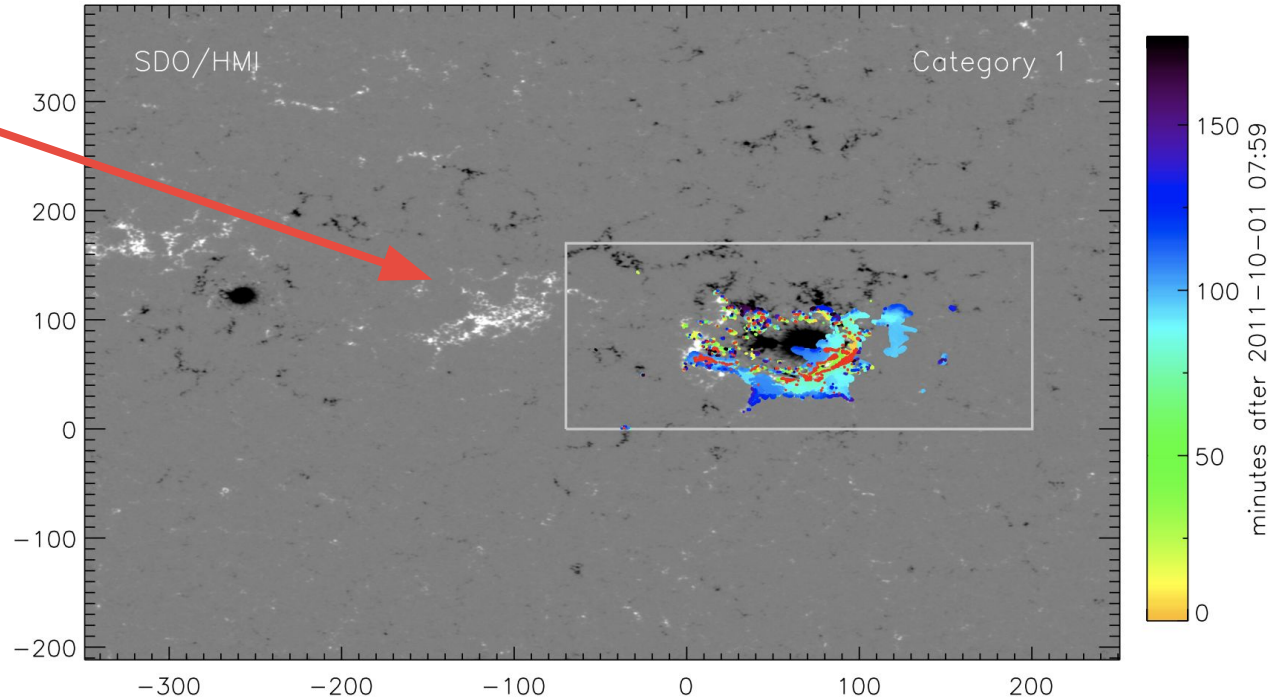
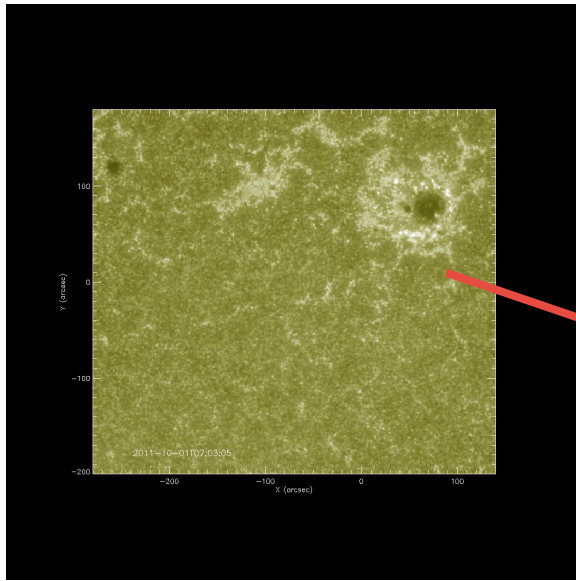
Category 1: Early brightening occurs inside the ribbons

Category 2: Early brightening occurs outside the ribbons

Category 3: Early brightening does not occur

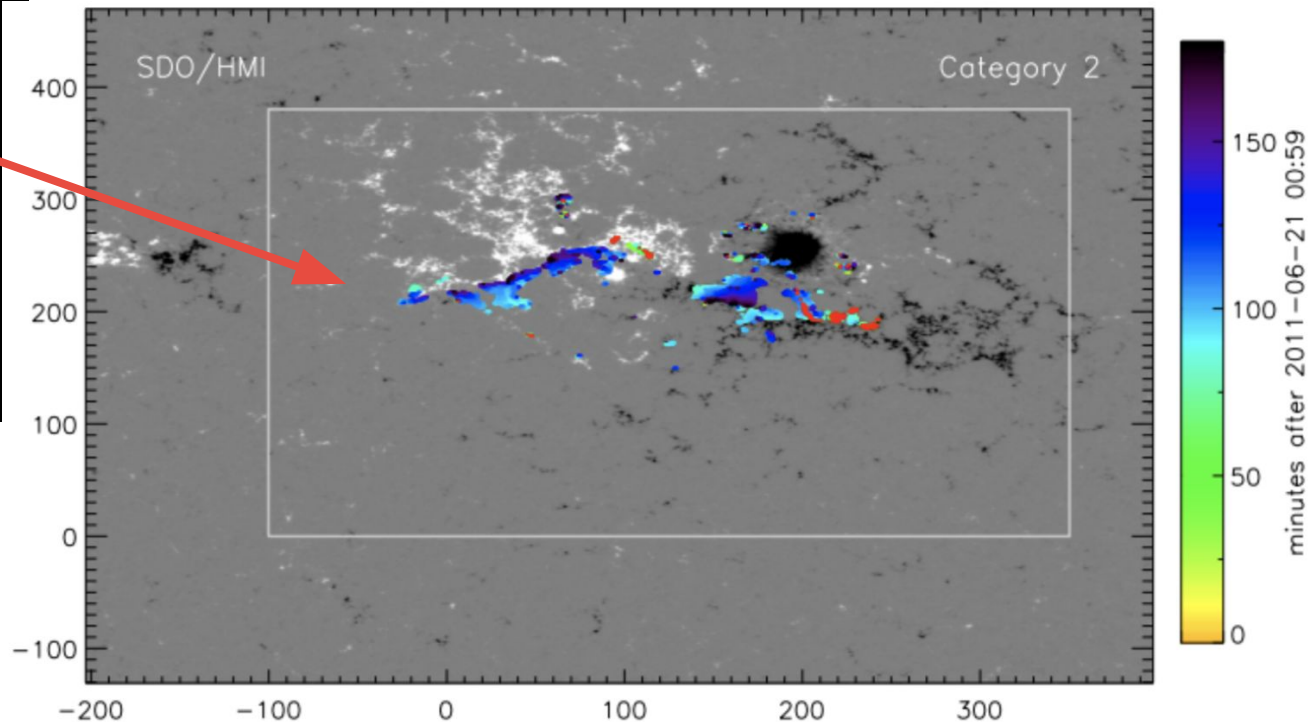
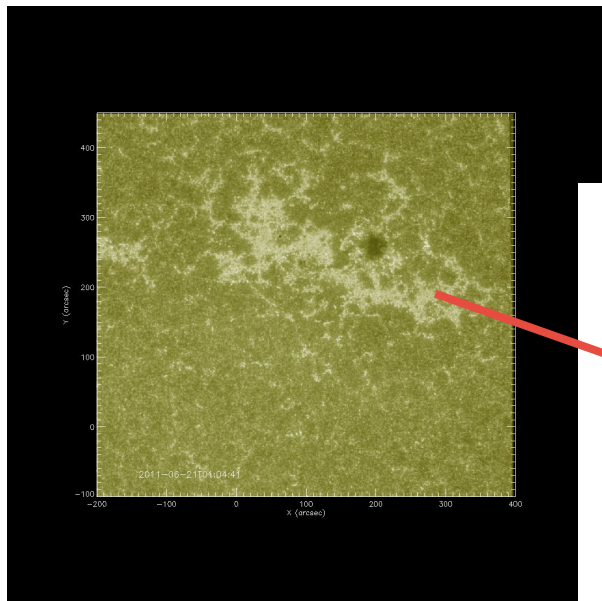


Mapping early flaring pixels: Category 1



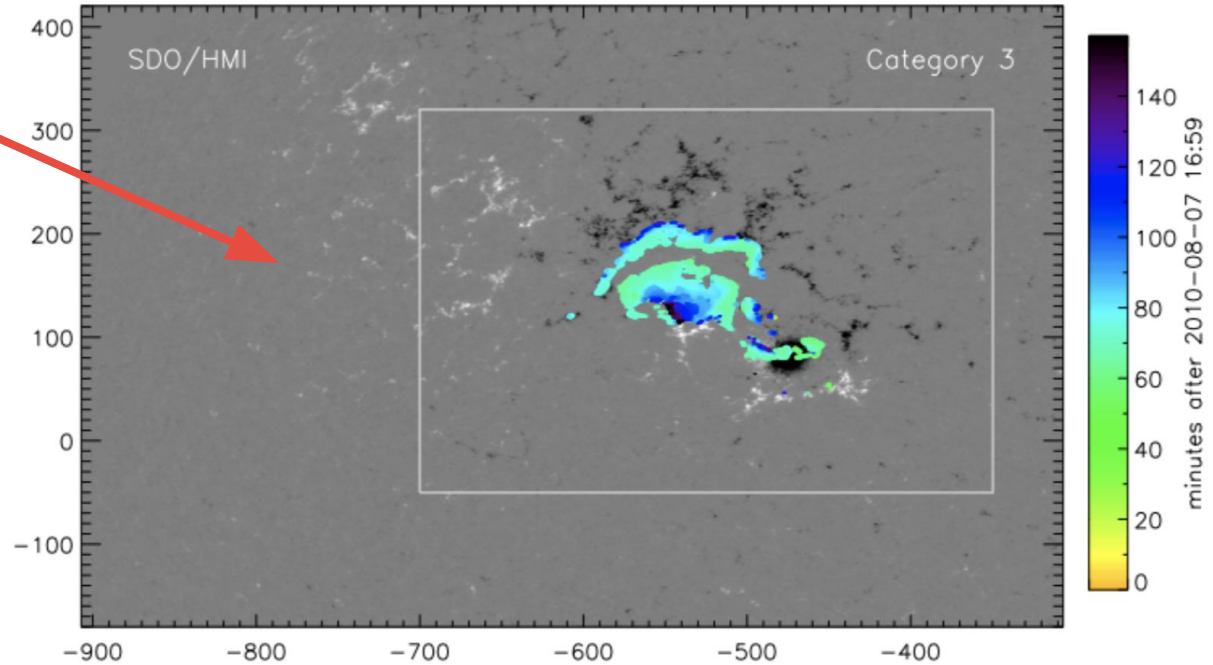
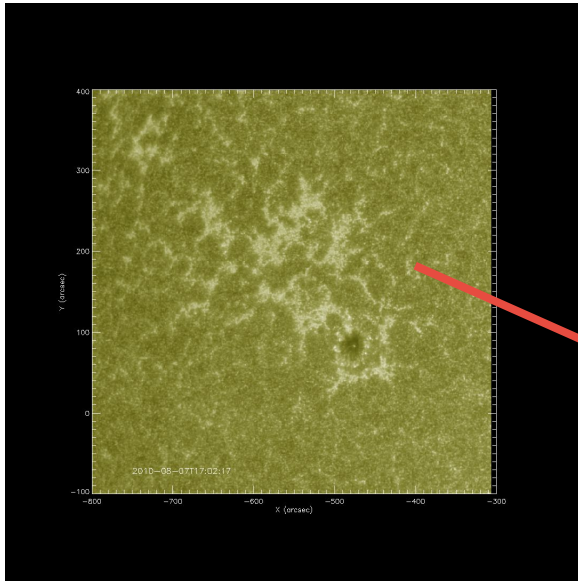
October 1, 2011 event shown in AIA 1600 (left) and as an over-layed magnetogram (right)

Mapping flaring pixels: Category 2



June 21, 2011 event shown in AIA 1600 (left) and as an over-layed magnetogram (right)

Mapping flaring pixels: Category 3

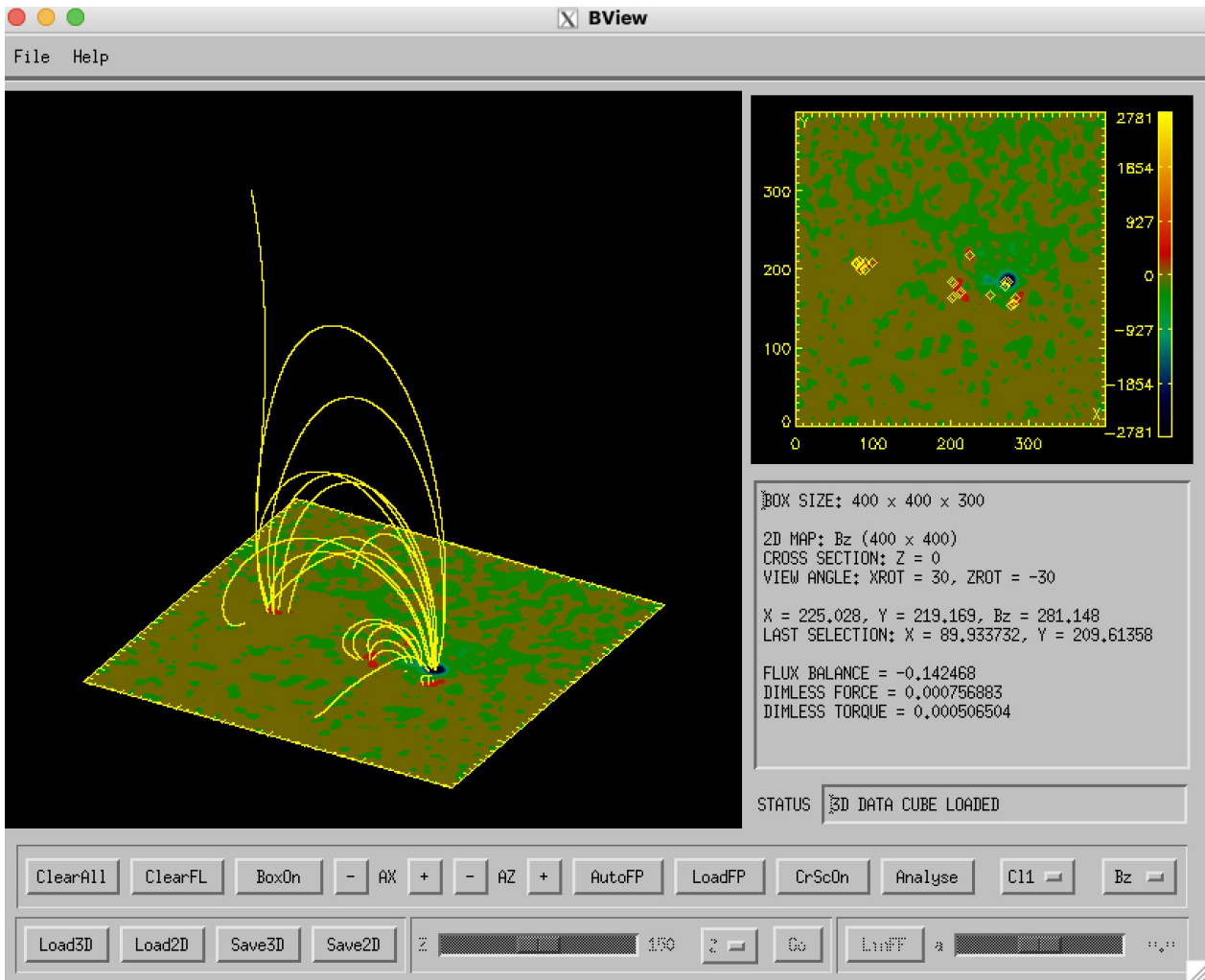


August 7, 2010 event shown in AIA 1600 (left) and as an over-layed magnetogram (right)

Magnetic Field Extrapolation

GOAL: reconstruct and model the magnetic field above an active region of the sun for non-linear and force-free fields (NLFFF)

$$(\nabla \times \mathbf{B}) = \alpha \mathbf{B}$$

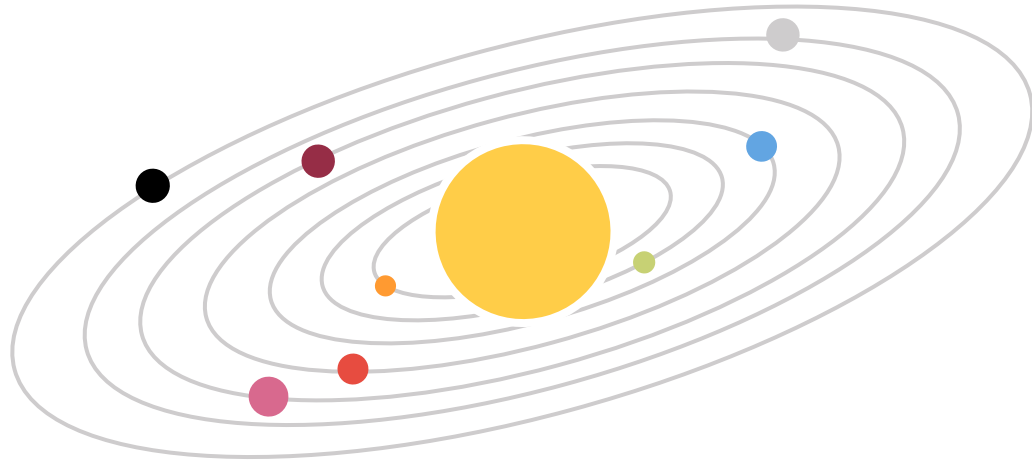


Potential magnetic field extrapolation results for the October 1, 2011 event

What is next?

Statistical analysis of the completed magnetic field geometry and comparison to observed phenomena

- timing & duration of burst
- loop length
- reconnection flux
- simultaneous observation of flare loops from AIA



THANKS!

Zhu, C. et al. "How Does Magnetic Reconnection Drive the Early-stage Evolution of Coronal Mass Ejections?" *The Astrophysical Journal*, vol. 893, no. 2, 2020, p. 141. <https://doi.org/10.3847/1538-4357/ab838a>.

Forbes, T. G, "A Review on the Genesis of Coronal Mass Ejections." *Journal of Geophysical Research: Space Physics*, vol. 105, no. a10, 2000, pp. 23153-23165. <https://doi.org/10.1029/2000JA000005>.

Chen, P.F. Coronal Mass Ejections: Models and Their Observational Basis. *Living Rev. Sol. Phys.* 8, 1 (2011). <https://doi.org/10.12942/lrsp-2011-1>