

Sigmoid Eruptions & Quadrupolar Magnetic Structure

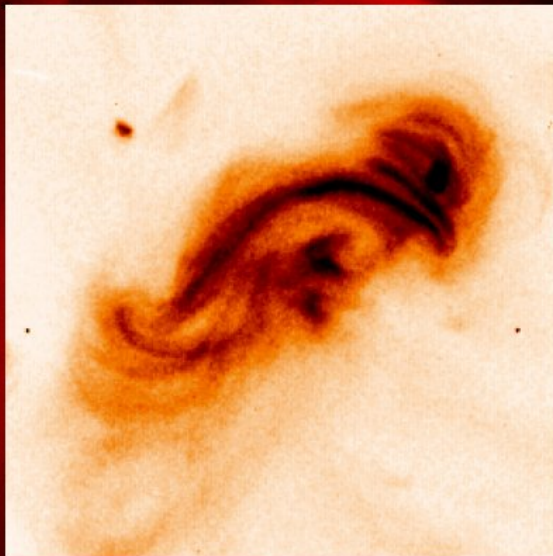
MSU Solar Physics REU Program 2009

Meghan Cassidy

Mentors: Dr. Loren Acton & Dr. Richard Canfield

Project Goal

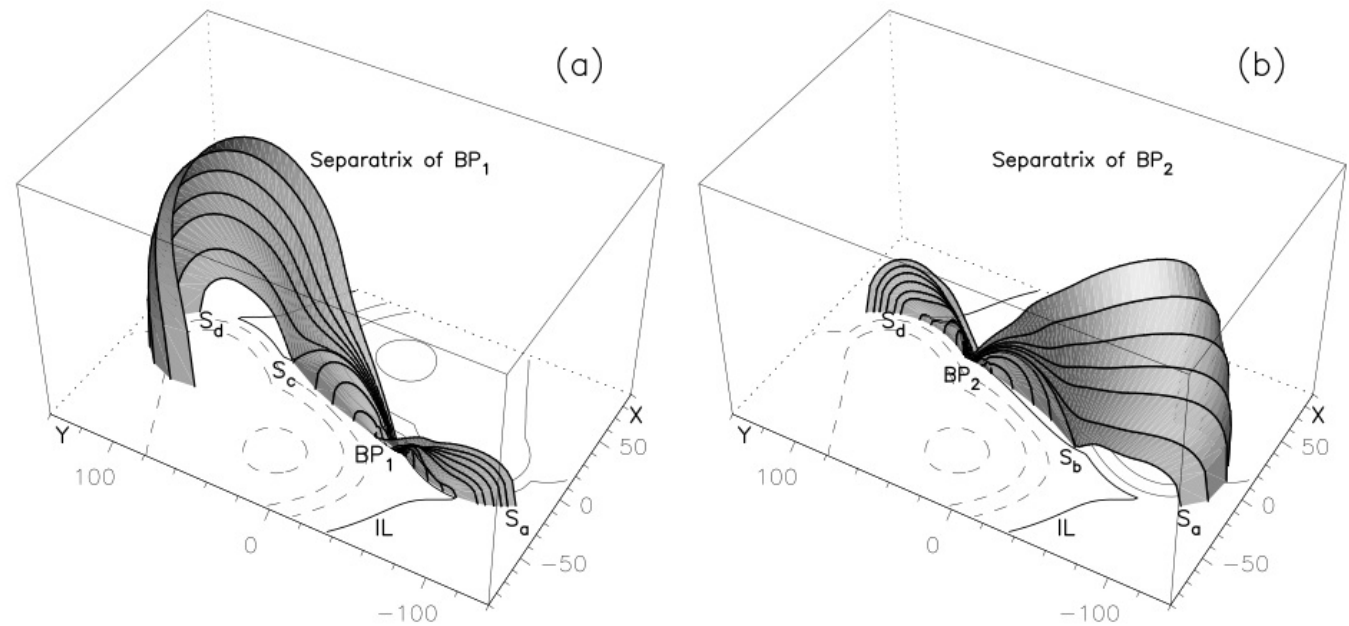
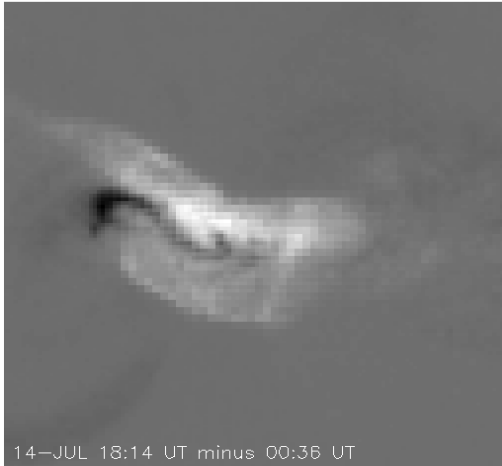
Is the frequency of sigmoid eruptions greater if the underlying field is quadrupolar?



- Determine the frequency of eruption of each sigmoid
- Determine the number of polarity inversion lines (PILs) in the underlying field

What are Sigmoids?

Sigmoids are comprised of multiple, twisted magnetic loops, which all together form two inverse J-like bundles or an overall sinuous S or reverse-S shape.

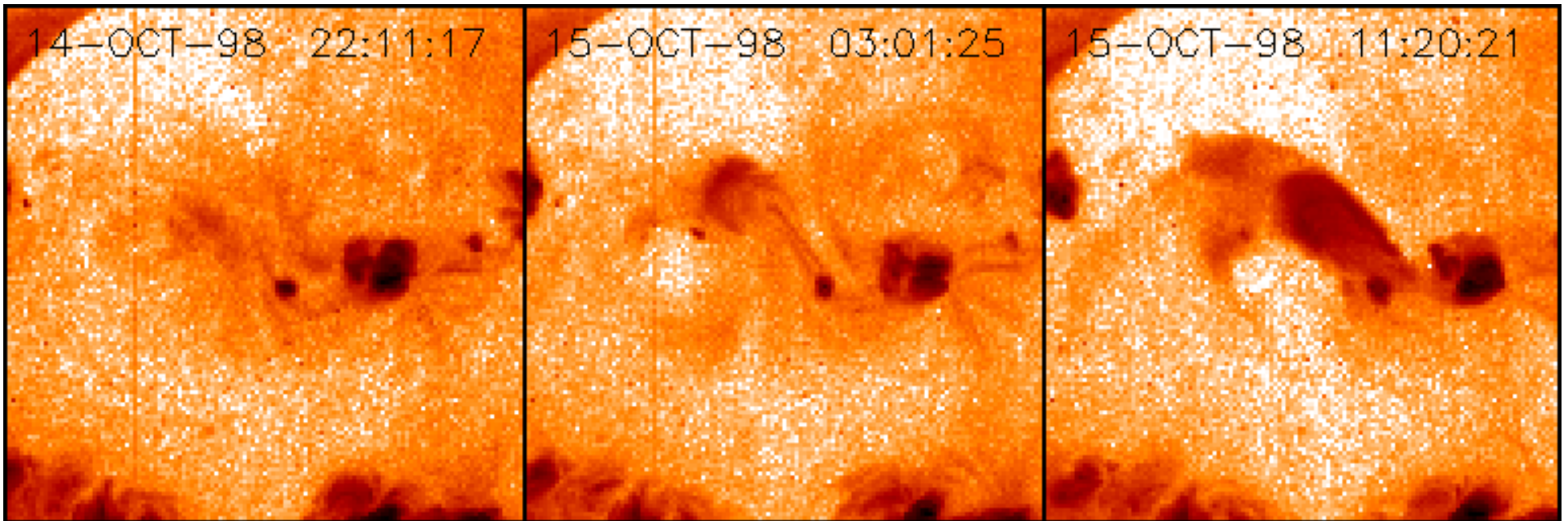


The Simpson-Vogel Model of Sigmoidal Structure



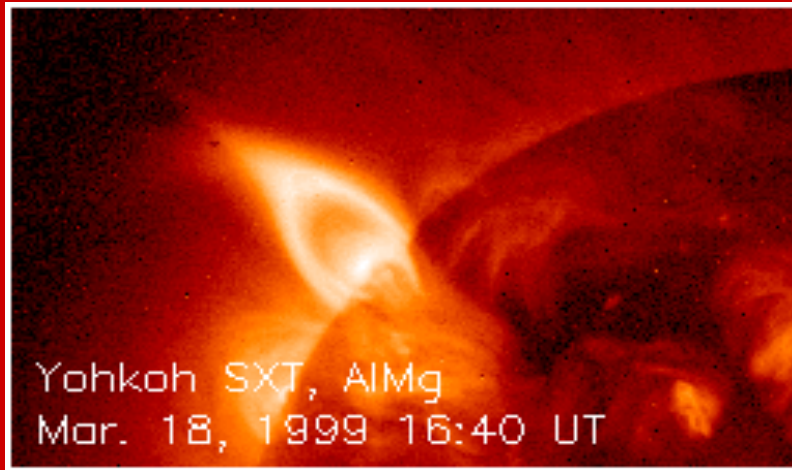
Why Study Sigmoids?

- associated with CME eruptions
- relevant to solar activity and space weather

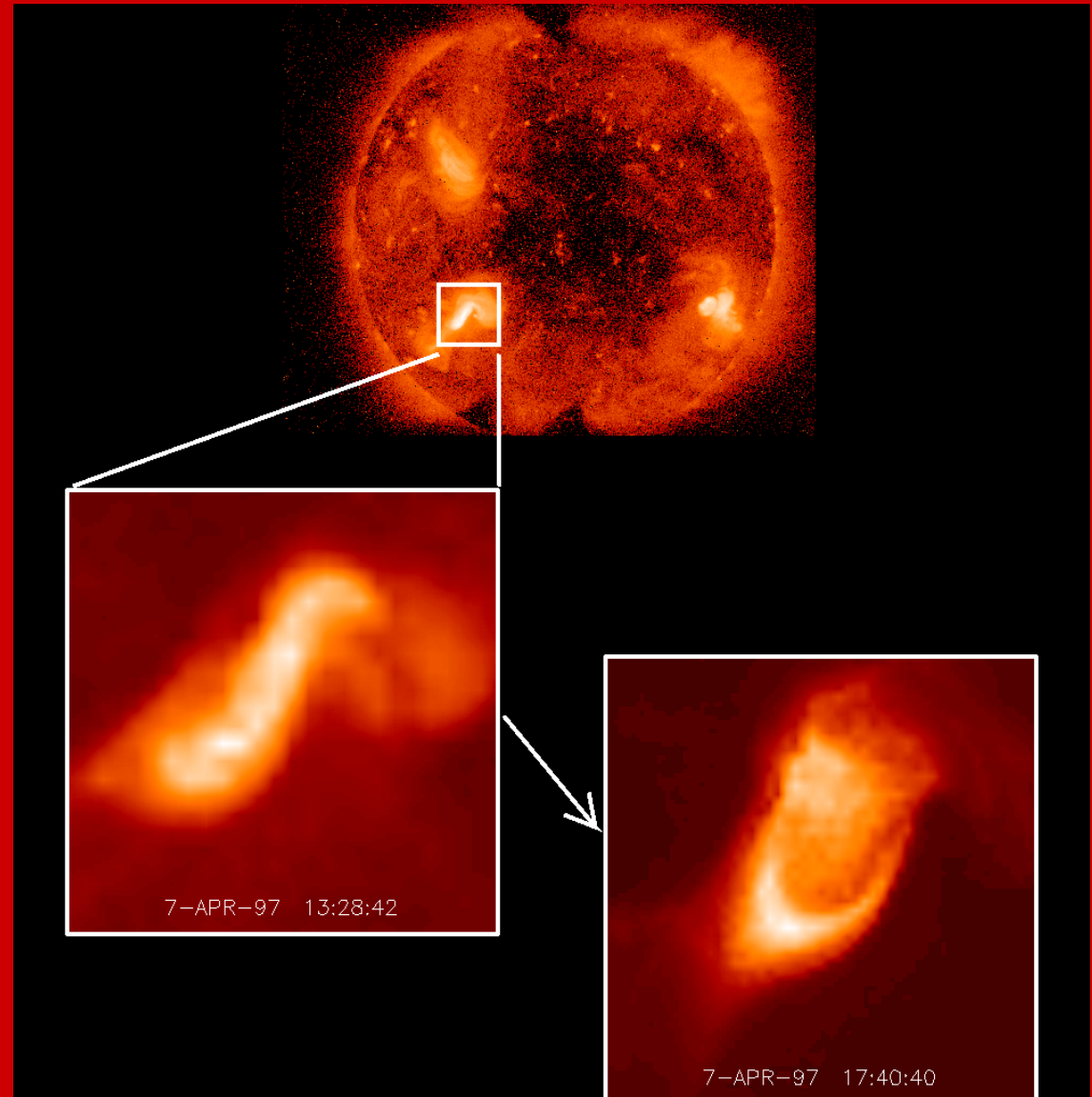
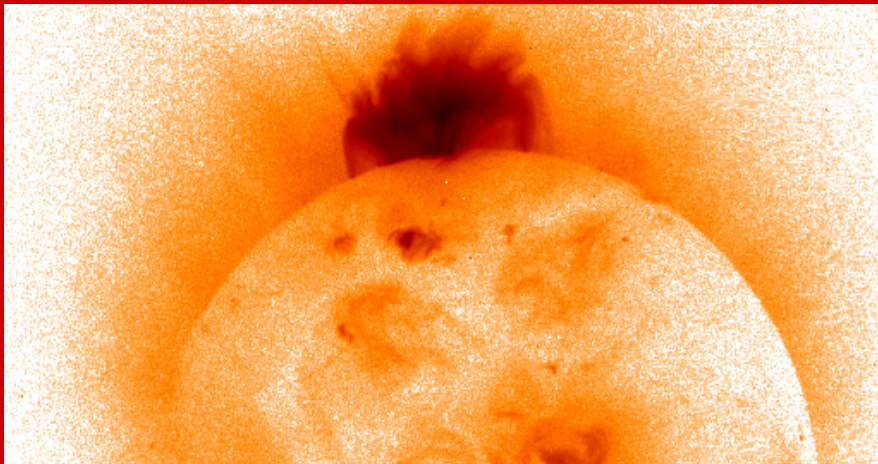


Identifying Sigmoid Eruptions

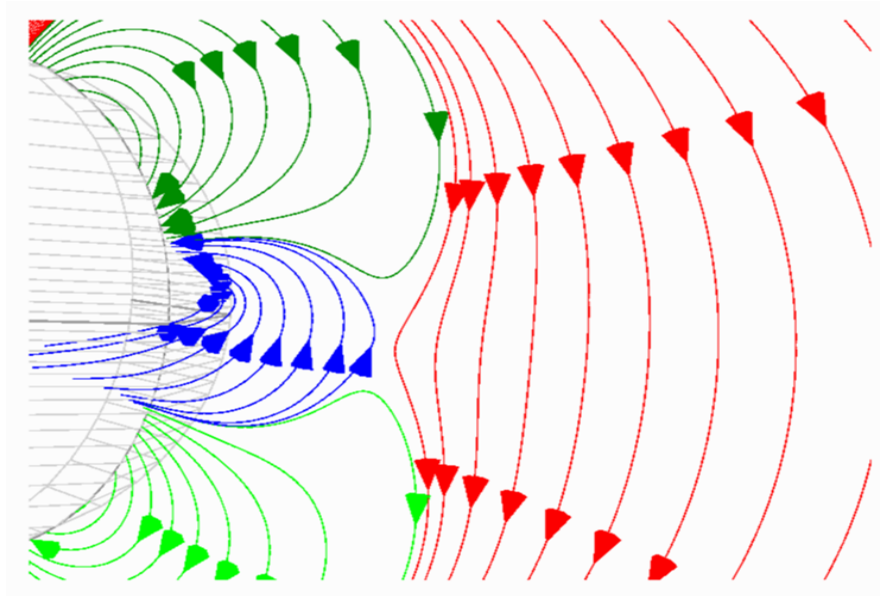
Cusps



Arcades



Magnetic Breakout Model



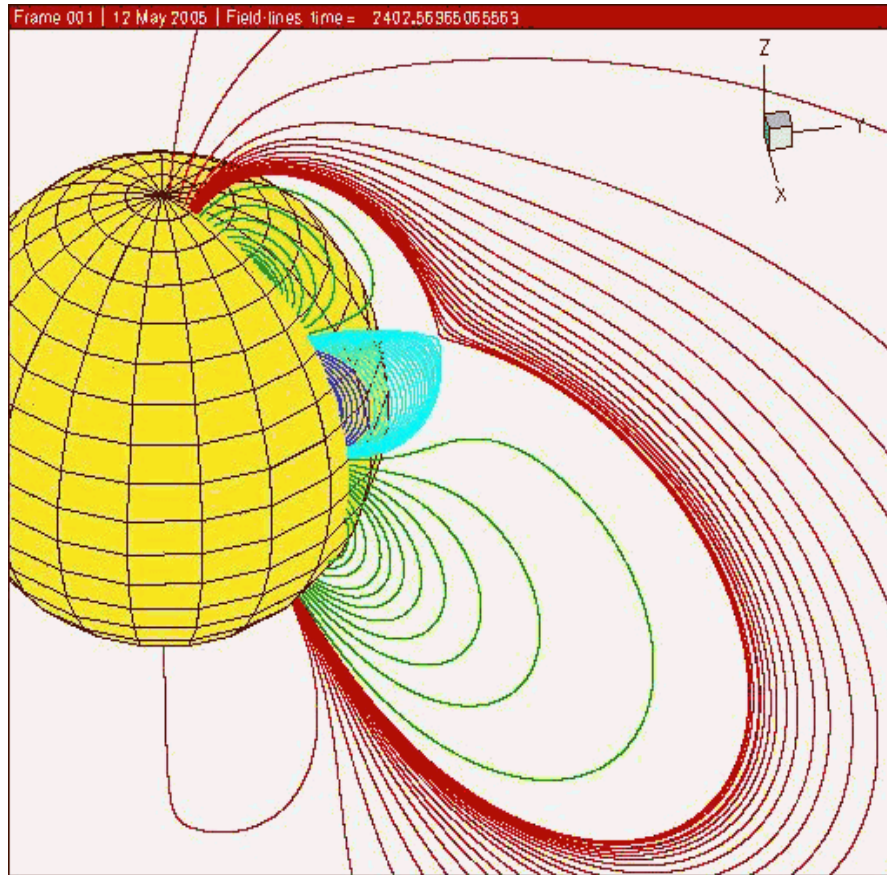
The *magnetic breakout model* of Antiochos et. al (1999) provides an explanation for the origin of an eruption in a quadrupolar region.

Process

- Shear applied to photospheric neutral line
- Reconnection at coronal null
- Overlying, unsheared flux decreases
- Enclosed flux "breaks out"

Magnetic Breakout Model

The overlying field confines the core field until enough shear has accumulated to power an eruption, and then facilitates eruption by reconnecting with the outer parts of the core field.



The necessary reconnection can occur only in a multipolar system containing a null point, so this eruption process cannot take place in a bipolar magnetic field.

Bipolar or Multipolar?: Method

1. Counting PILs

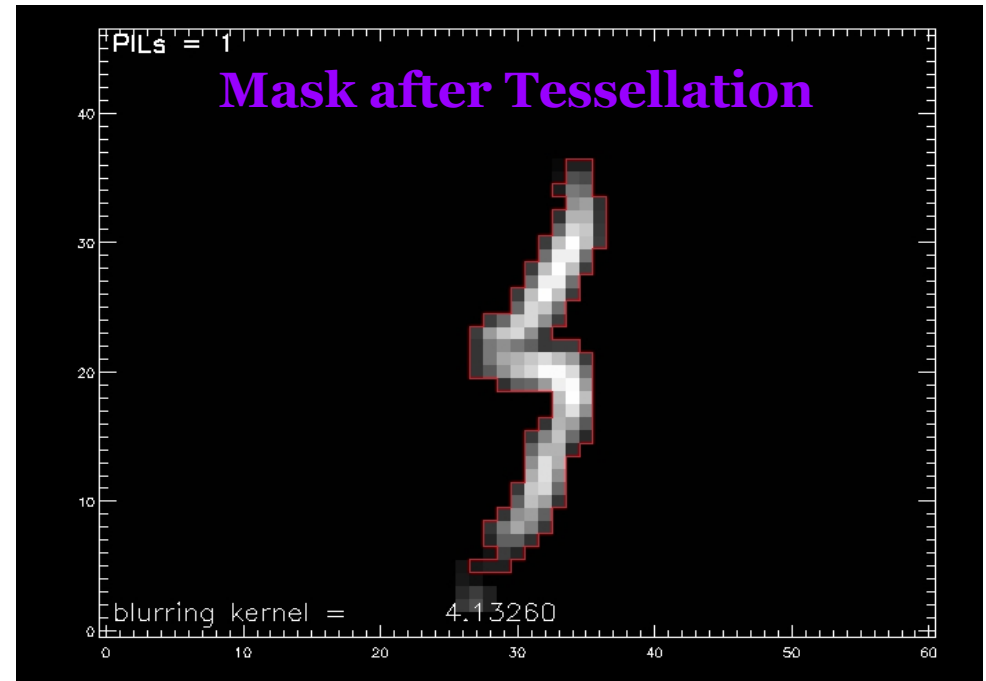
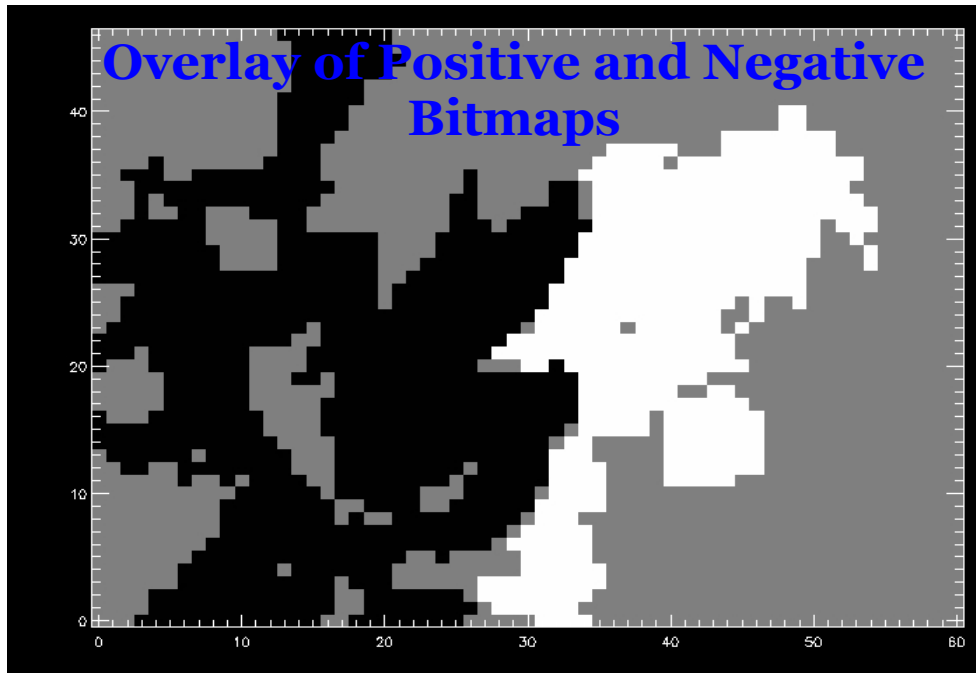
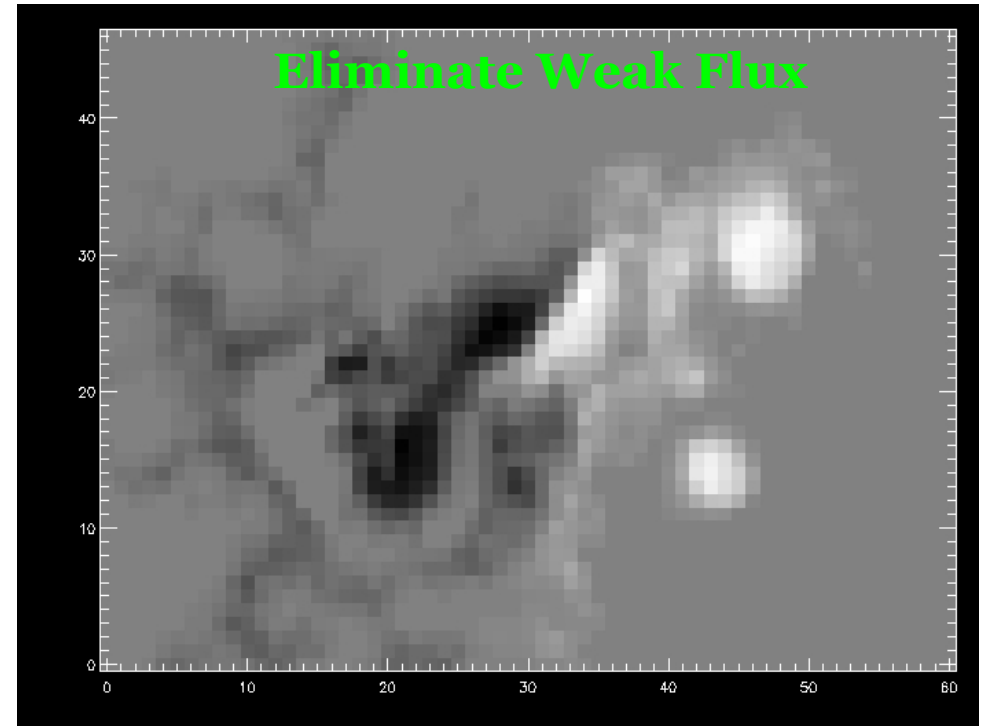
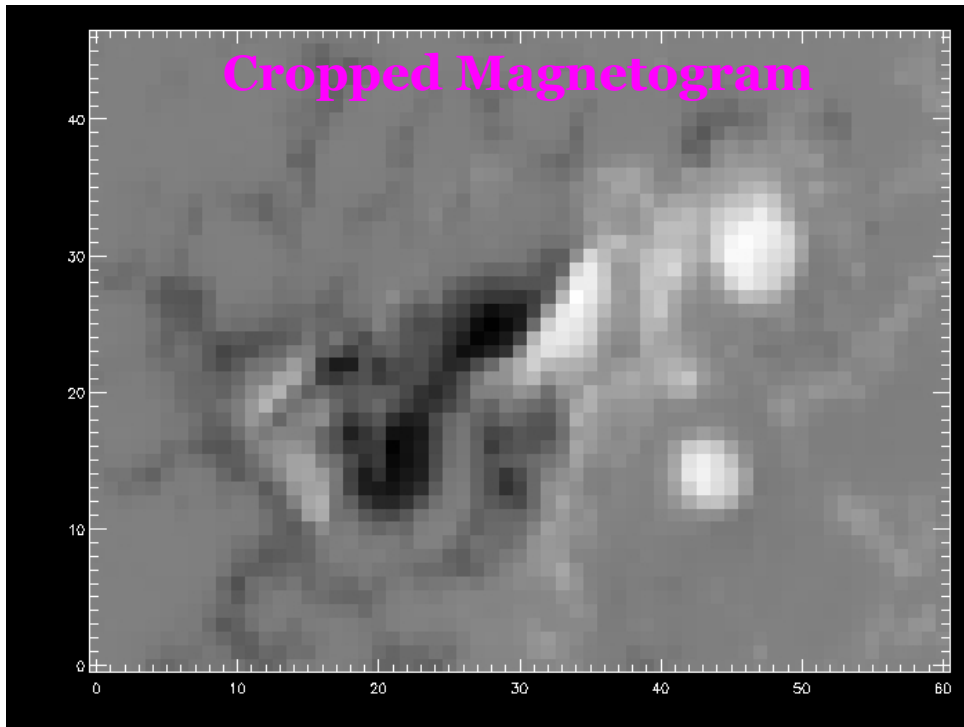
Schrijver's Method

Alexander Russell's Tessellation Program

Procedure

- Tess KPVT magnetogram twice
- From tess'd magnetogram, create bitmaps of positive and negative flux
- Convolve bitmaps with a boxcar blurring kernel
- Multiply bitmaps to yield a mask
- Tess mask to find the number of PILs

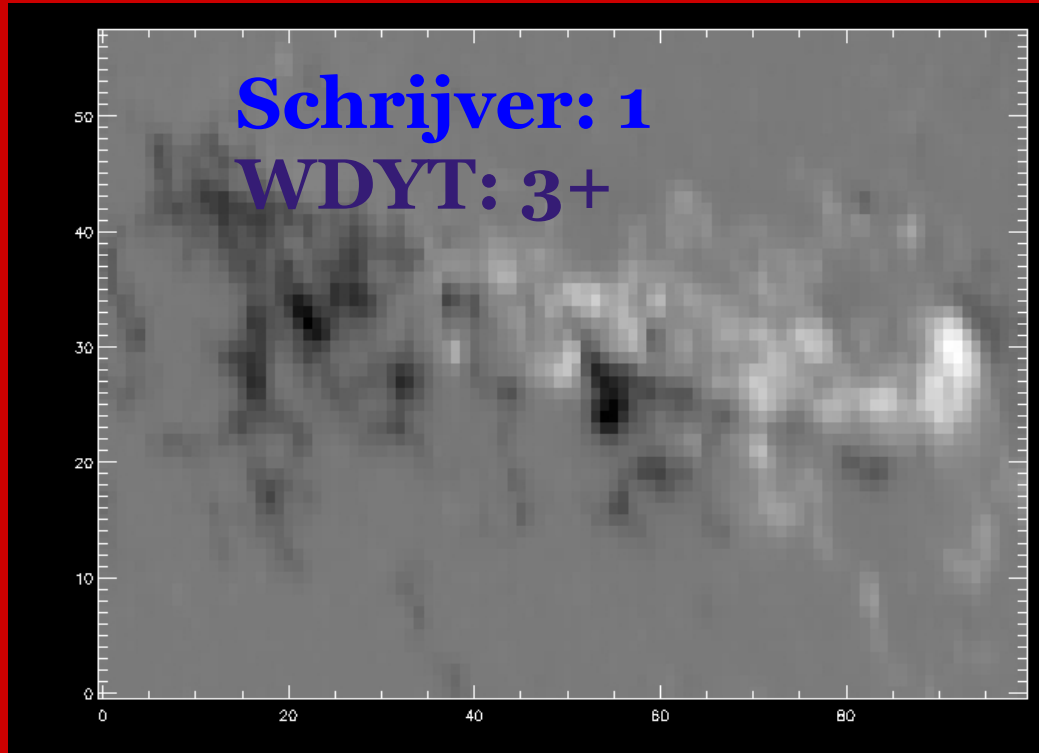
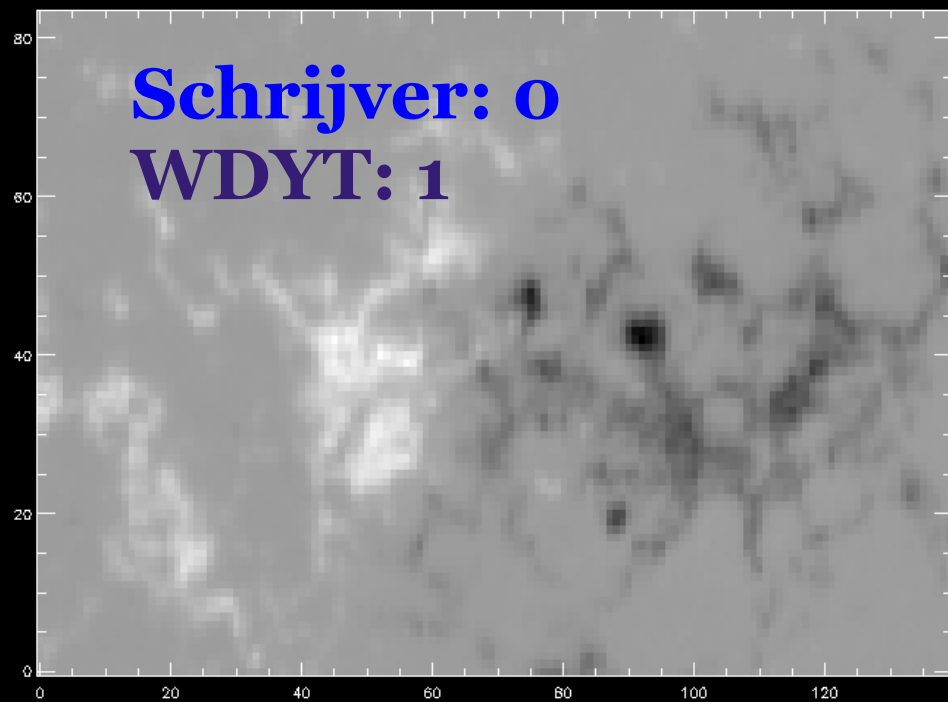
Bipolar or Multipolar?: Method



Bipolar or Multipolar?: Method

2. WDYT Approach

What do YOU think?... subjective

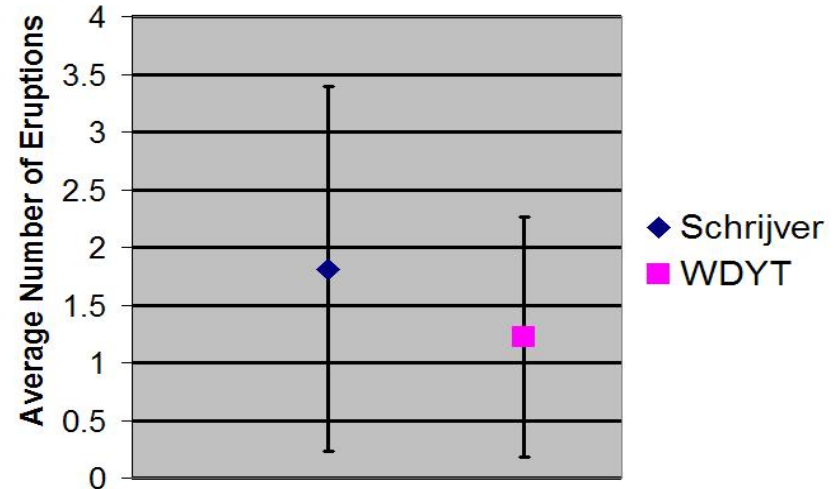


Imperfect schemes: both methods have shortcomings

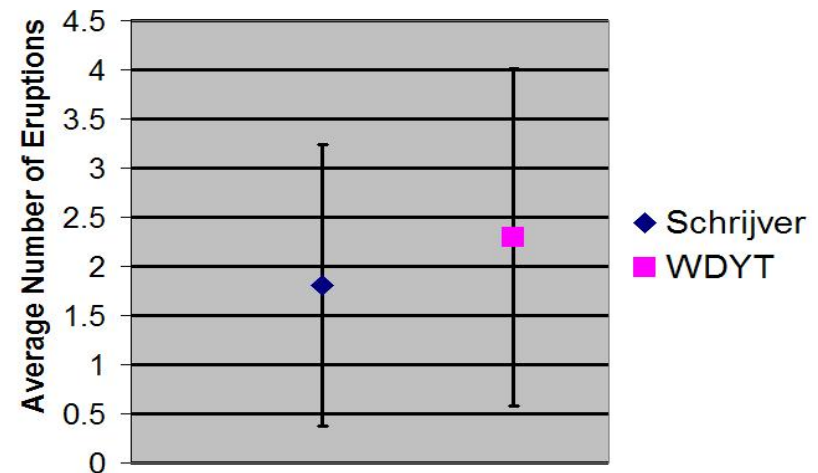
Results

Bipolar Schrijver	1.8095 +/- 1.5810 eruptions
Bipolar WDYT	1.2188 +/- 1.0391 eruptions
Multipolar Schrijver	1.7083 +/- 1.4289 eruptions
Multipolar WDYT	2.2941 +/- 1.7150 eruptions

Bipolar Regions



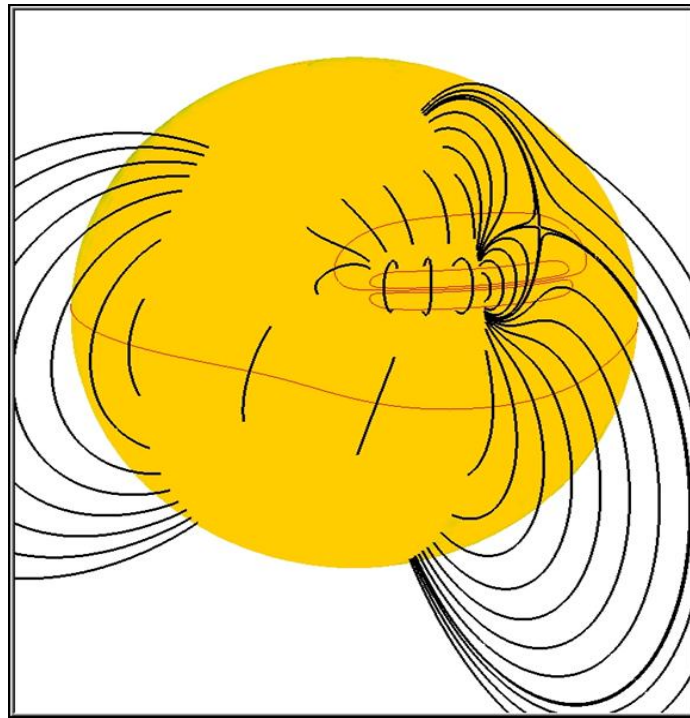
Multipolar Regions



Conclusions

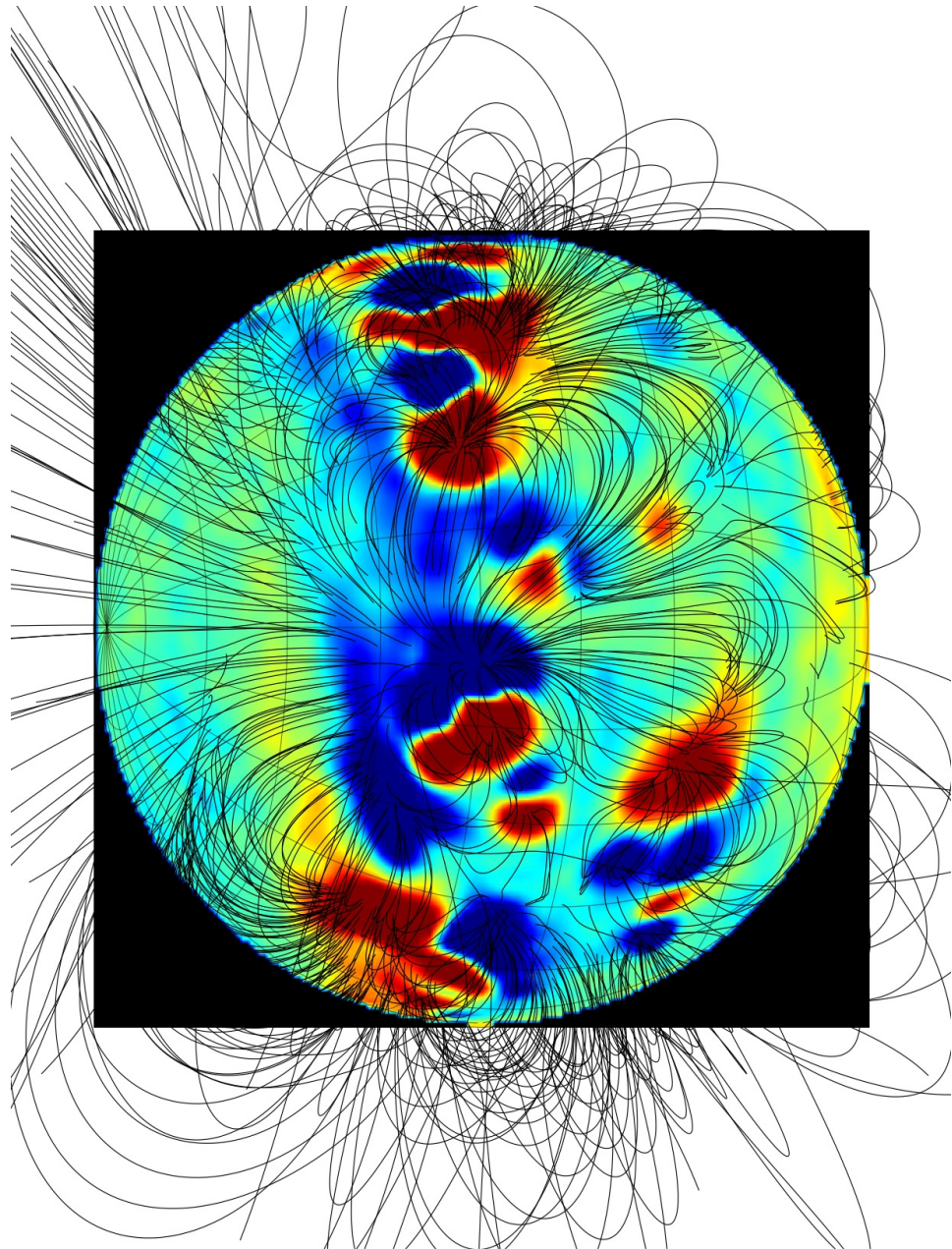
Sigmoid eruption frequency is not significantly dependent on the *local* polarity of the active region.

However, on a *global* scale, magnetic breakout can still apply.



active region bipole + global bipole = quadrupole

Future Work



Global magnetic field at and above 1.1 solar radii

Sigmoid eruption frequency could be dependent on whether the local field and global coronal magnetic field reconnect.

Large-scale, numerical modeling, such as this Potential Field Source Surface model (PFSS) would have to be employed to determine whether this interaction occurs.

Acknowledgments...



Many, many thanks to Dr. Canfield, Dr. Acton, Masha, the Friday Solar Flare Group, MSU Solar Physics Faculty, Dr. Priest, fellow REU-ers, Johnstone RHAs, & the NSF for a wonderful summer.