3D Model of Magnetic Reconnection in Sigmoidal Regions

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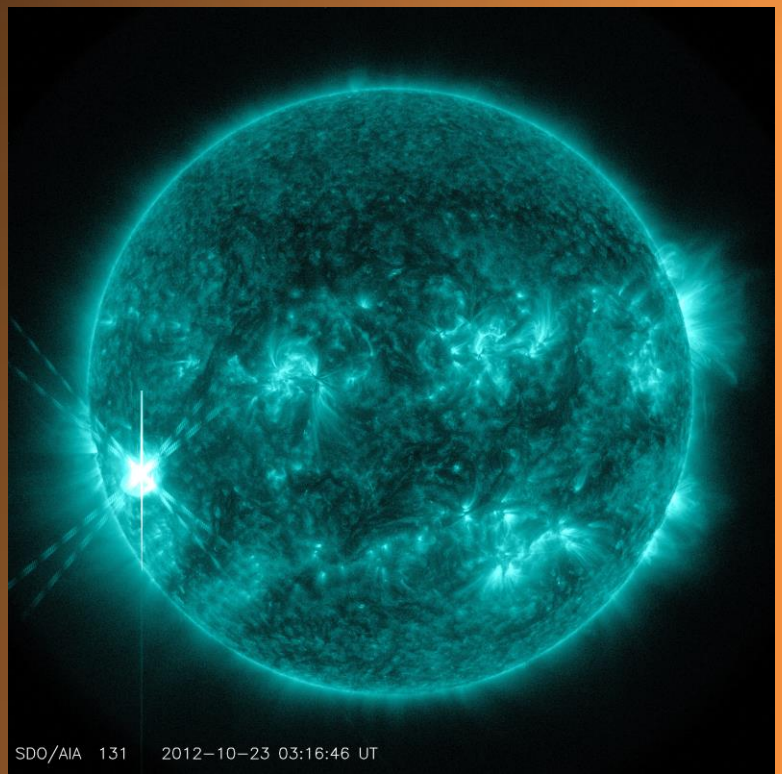
Background Info

- Controls all the activity that you can and cannot see on the sun
- Twisting magnetic field lines

Video: UCAR via SOHO (ESA & NASA)

Outline

Jargon: Sigmoids, QSLs, Slip-Running Reconnection



Process: Coronal Modeling System (CMS) via IDL

Analysis: Compare slippage observations with 3D models

JARGON YOU NEED TO KNOW TO MAKE MODELS

Sigmoids

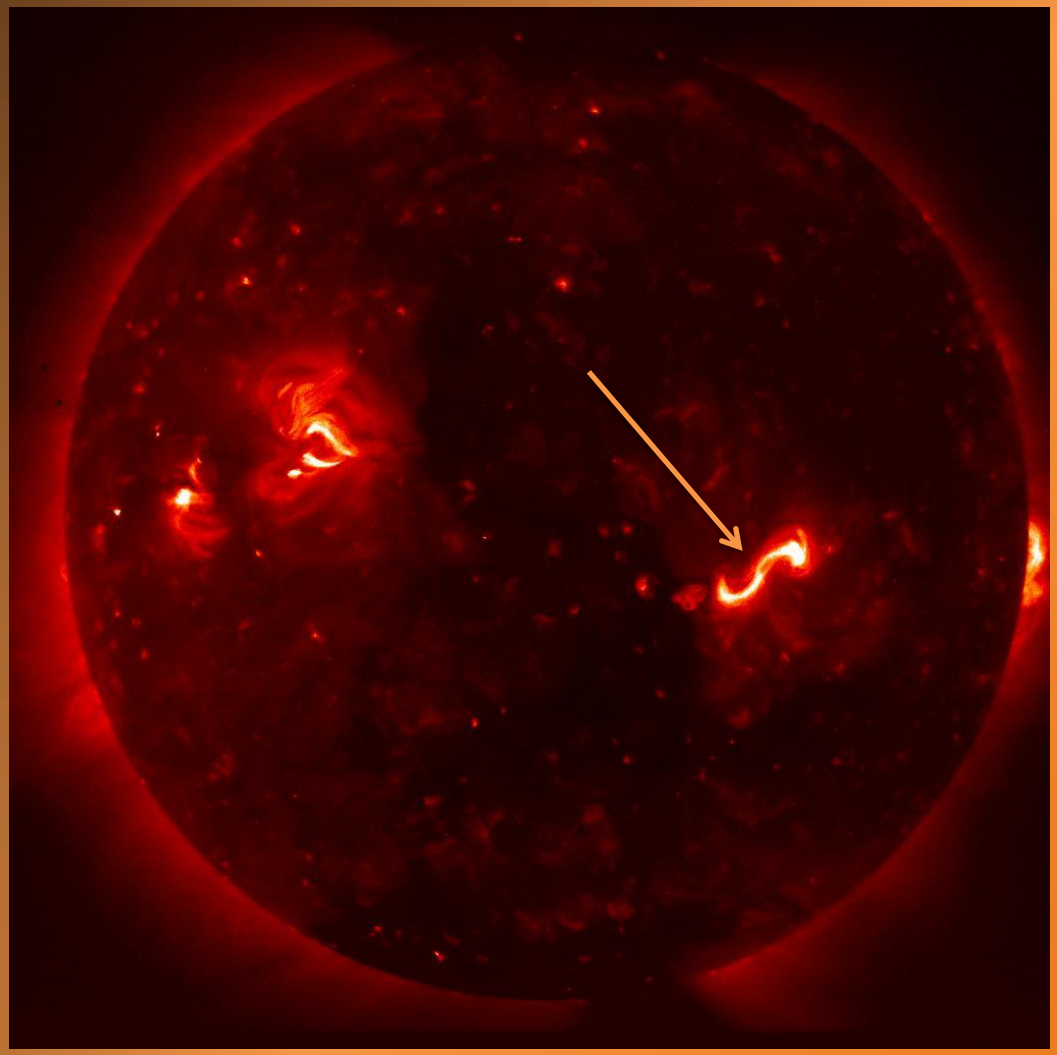
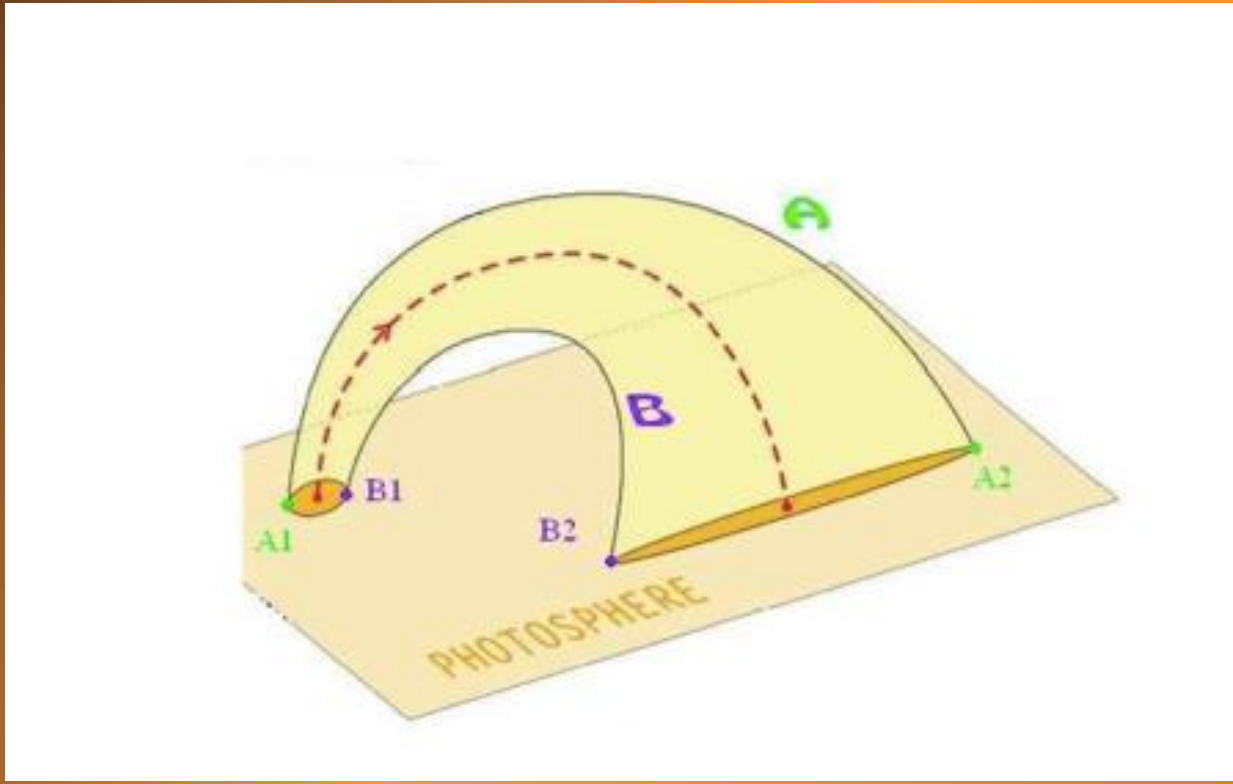


Image: NASA/STFC/ISAS/JAXA

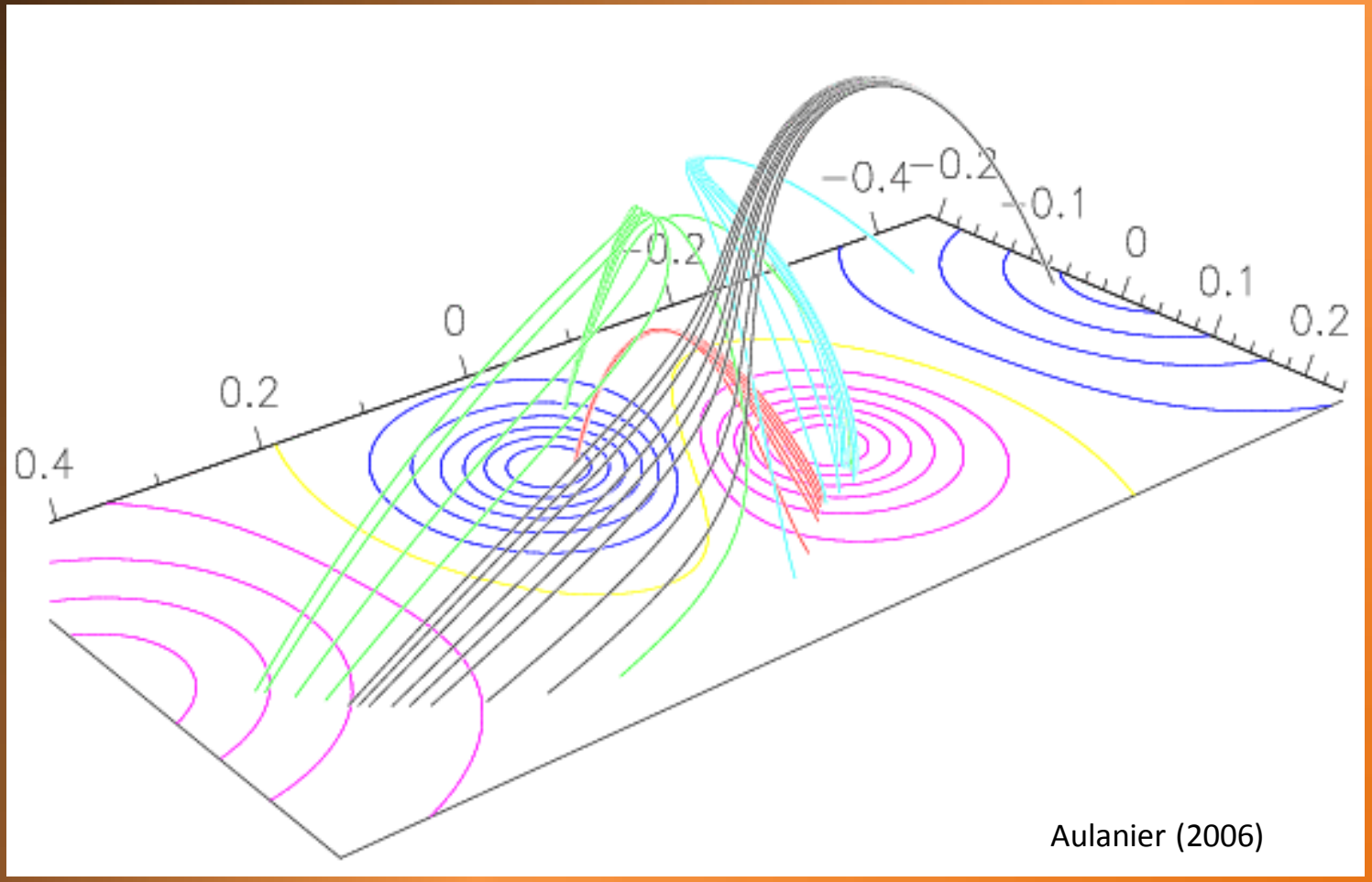
Quasi Separatrix Layers (QSLs)

3D topological features



Pariat (2006)

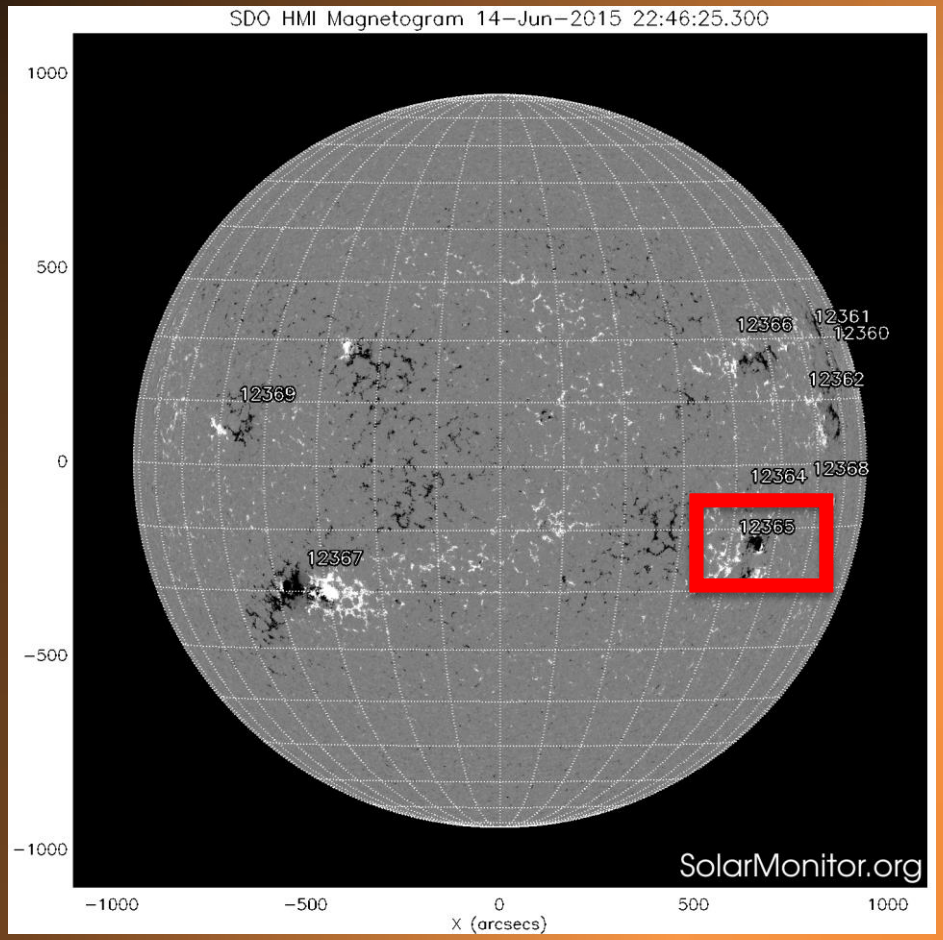
Slip Running Reconnection



Aulanier (2006)

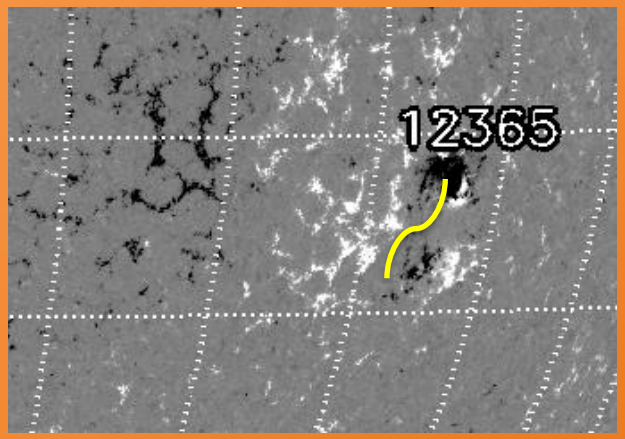
CMS MODELING PROCESS

CMS Modeling



3. Compute Potential field (axial flux and poloidal flux)

4. Relax the solution for ~30,000 to 60,000 iterations

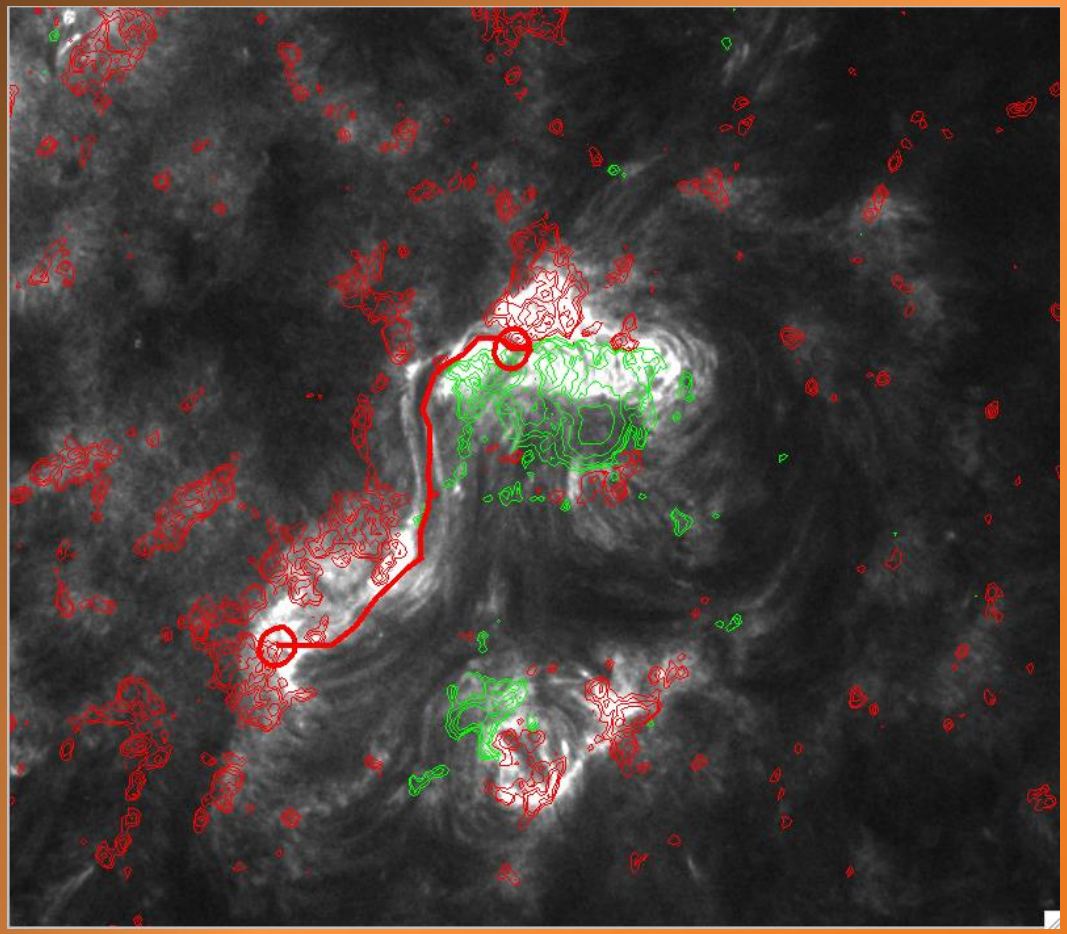


Non-linear force free field (NLFFF) – used for investigating the structure, dynamics and evolution of the coronae of solar active regions (DeRosa et al 2009)

Non-linear Force Free Field

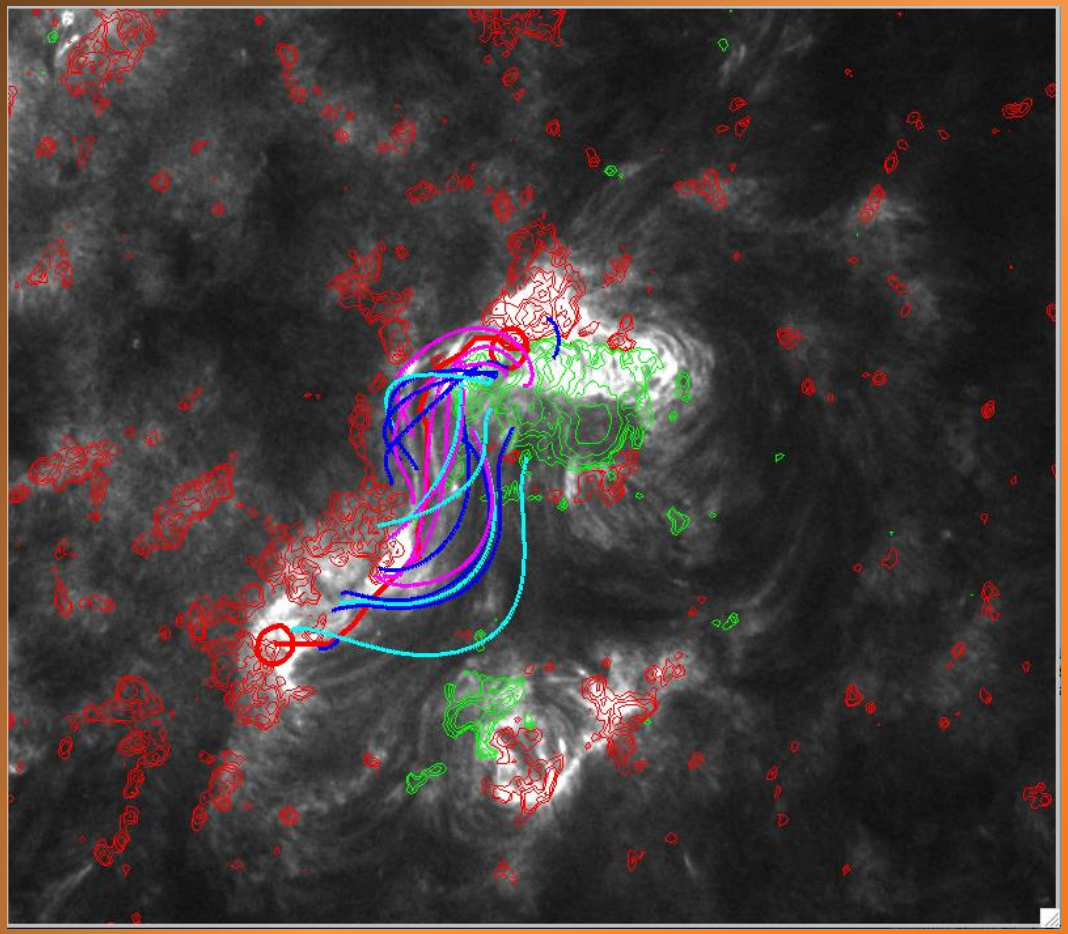
- Assume Lorentz force is zero
- $\boldsymbol{J} \times \boldsymbol{B} = (\boldsymbol{\nabla} \times \boldsymbol{B}) \cdot \boldsymbol{B} = 0$, $\boldsymbol{\nabla} \cdot \boldsymbol{B} = 0$
- $\boldsymbol{J} = 0$ linear force (potential field)
- $\boldsymbol{J} \,||\, \boldsymbol{B} = 0$, $\boldsymbol{J} = \alpha * \boldsymbol{B}$ non-linear force
  - $\alpha = C$ linear force free field ($\alpha = 0$ special linear field)
  - $\alpha \neq C$ non linear force free field
- Makes numerical simulations not as complex

Flux Rope Path



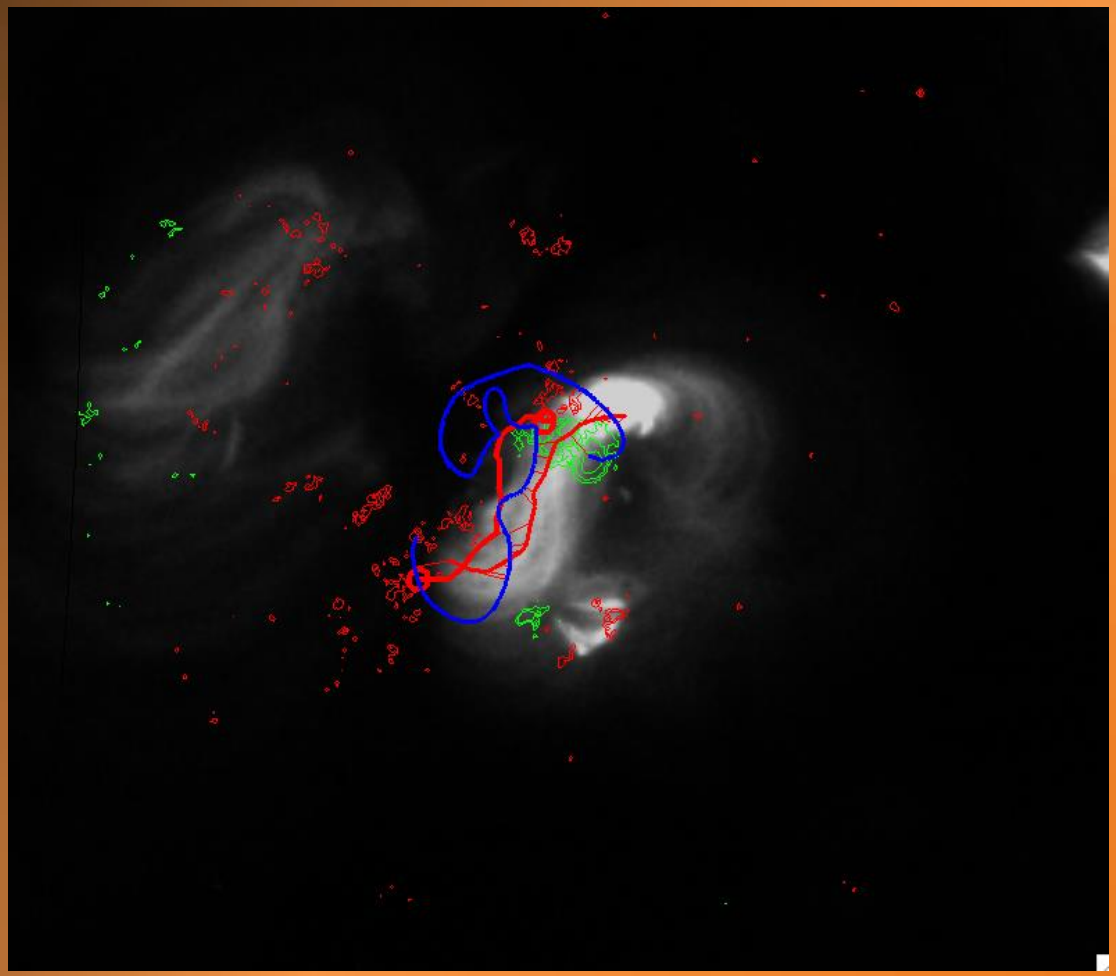
AIA 304 Å: 14 June 2015

Viewing Field Lines



AIA 304 Å: 14 June 2015

Fitting the Data



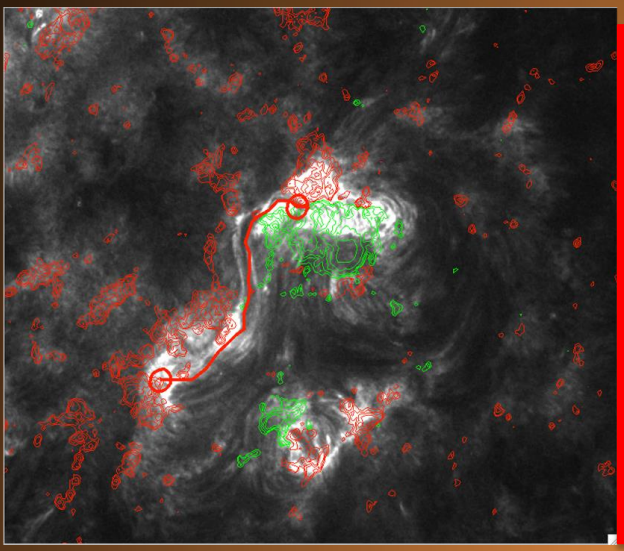
XRT: 14 June 2015

Good Fit (0.00525)

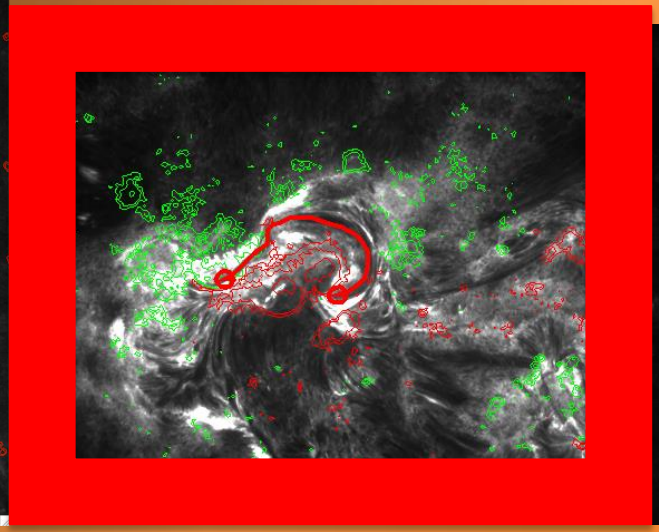
Bad Fit

ANALYSIS & RESULTS

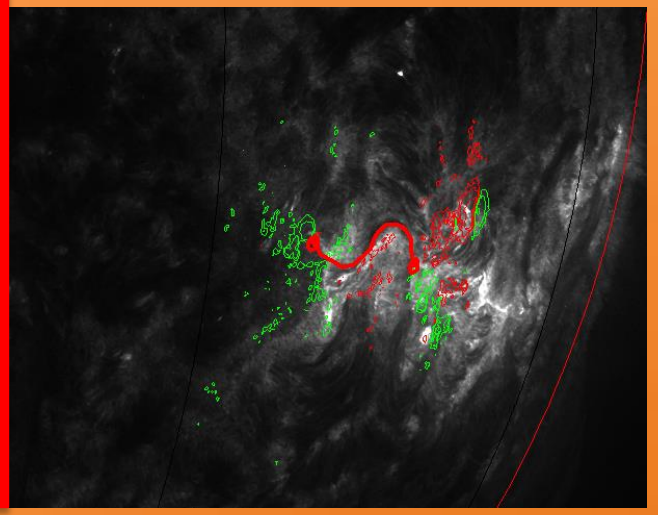
3 Regions Modeled



14 June 2015

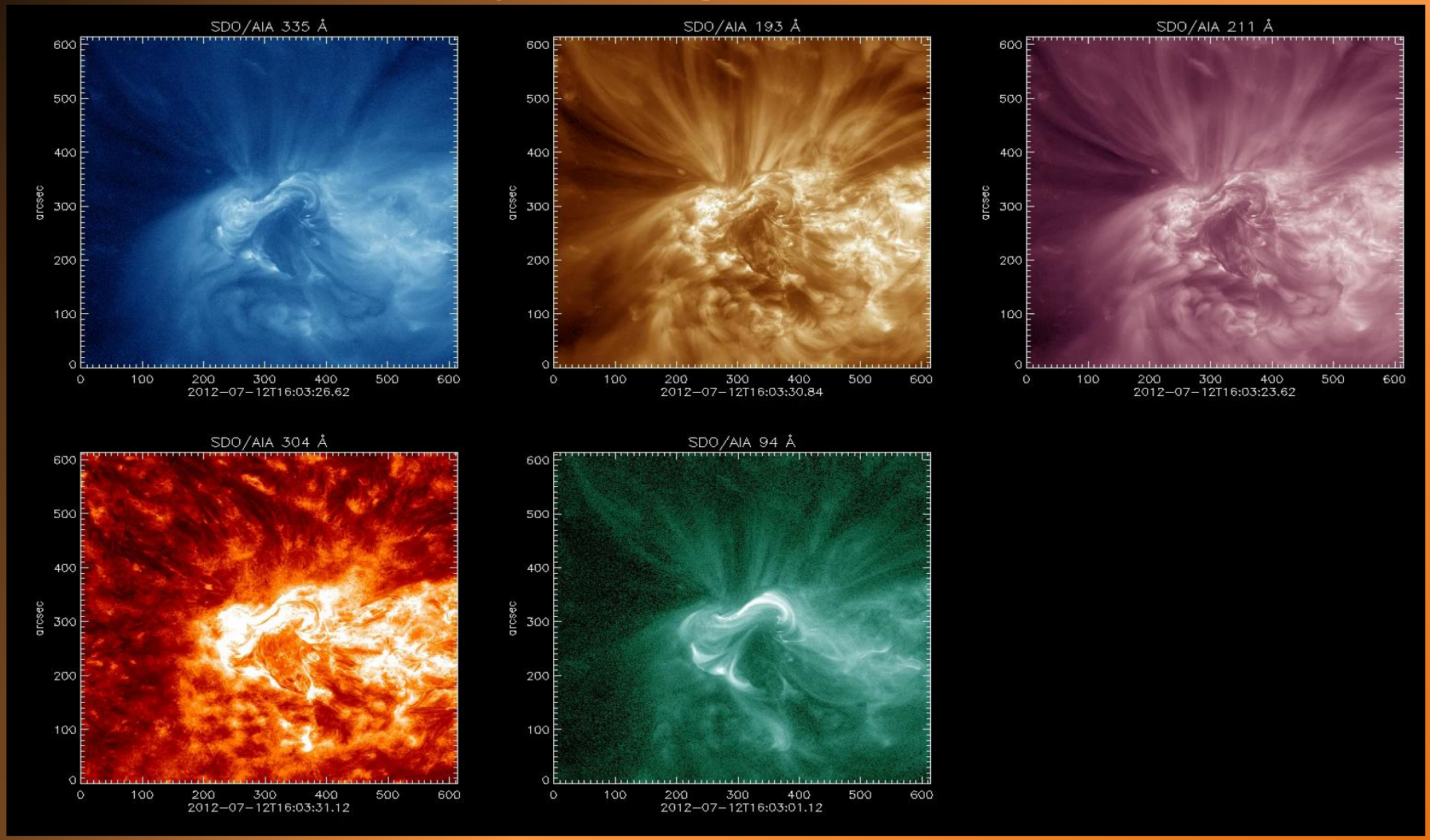


12 July 2012



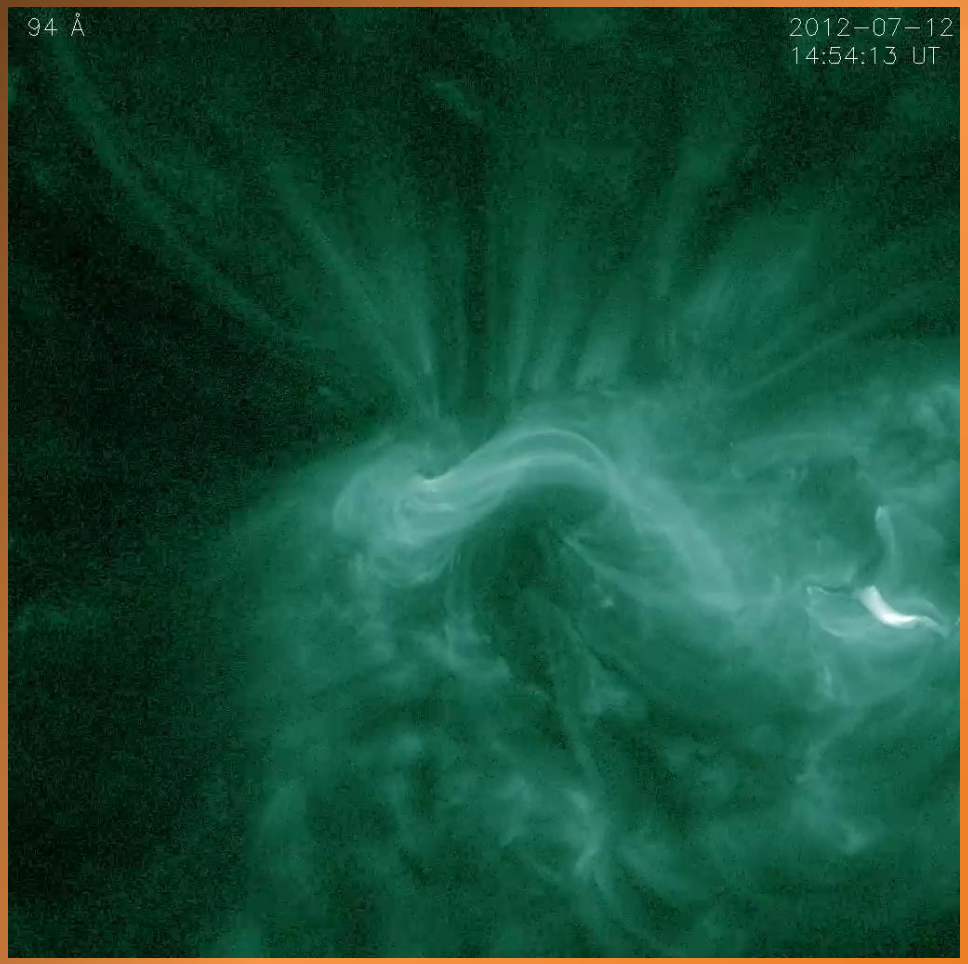
30 September 2014

Comparing the Data



12 July 2012

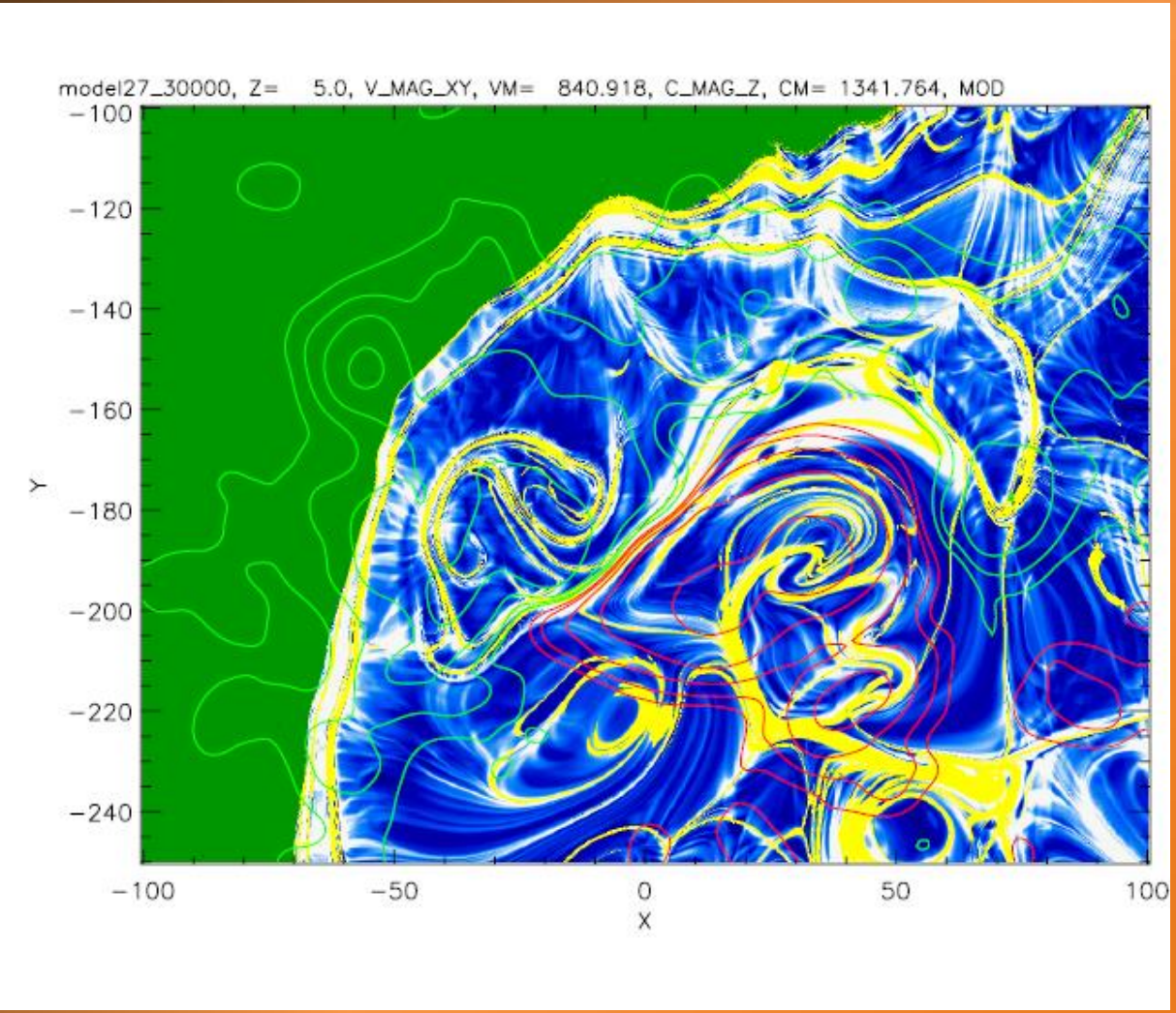
Comparing the Data



AIA 94 Å: 12 July 2012

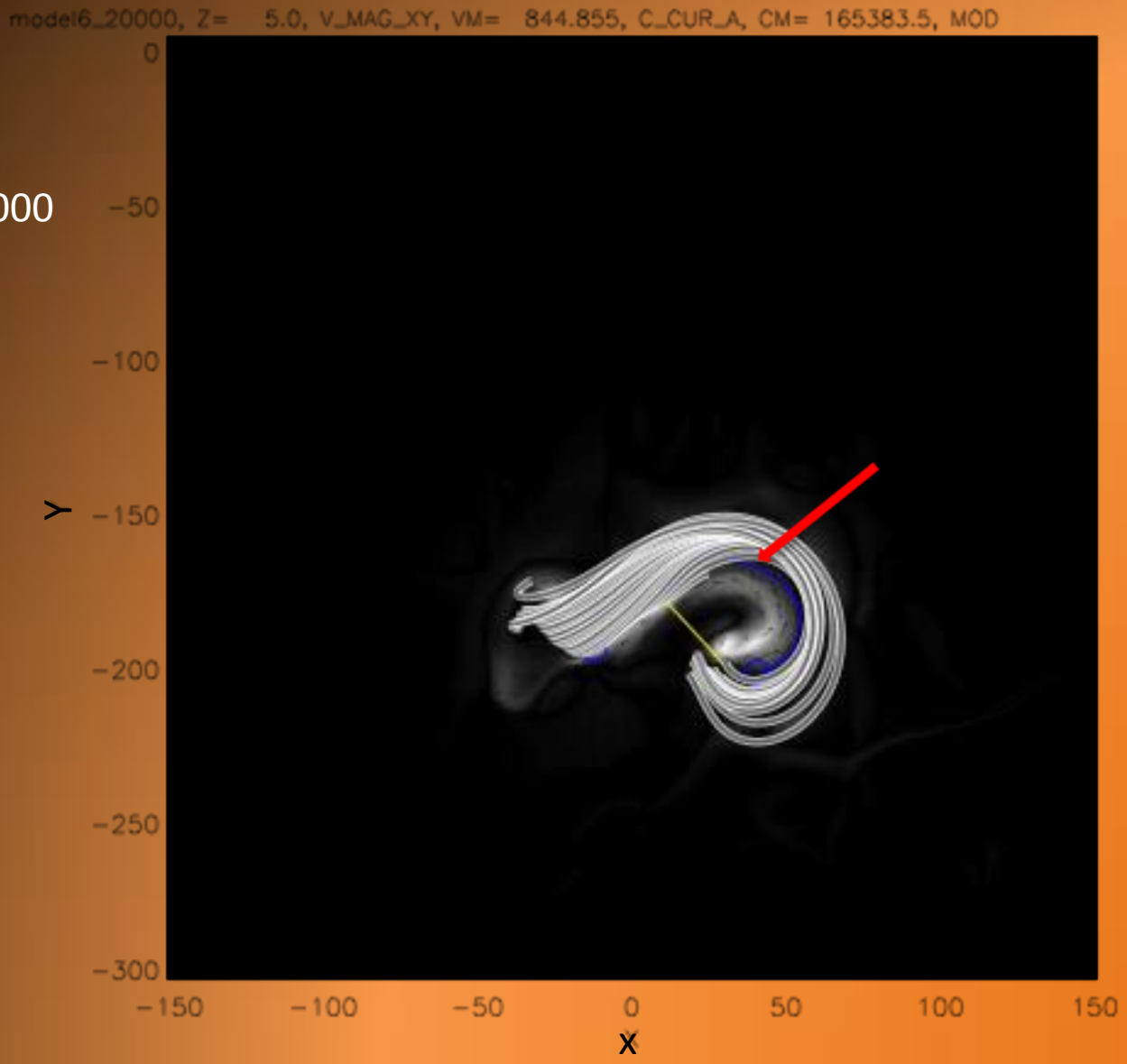
QSL Map

Model27_30000
QSL Map

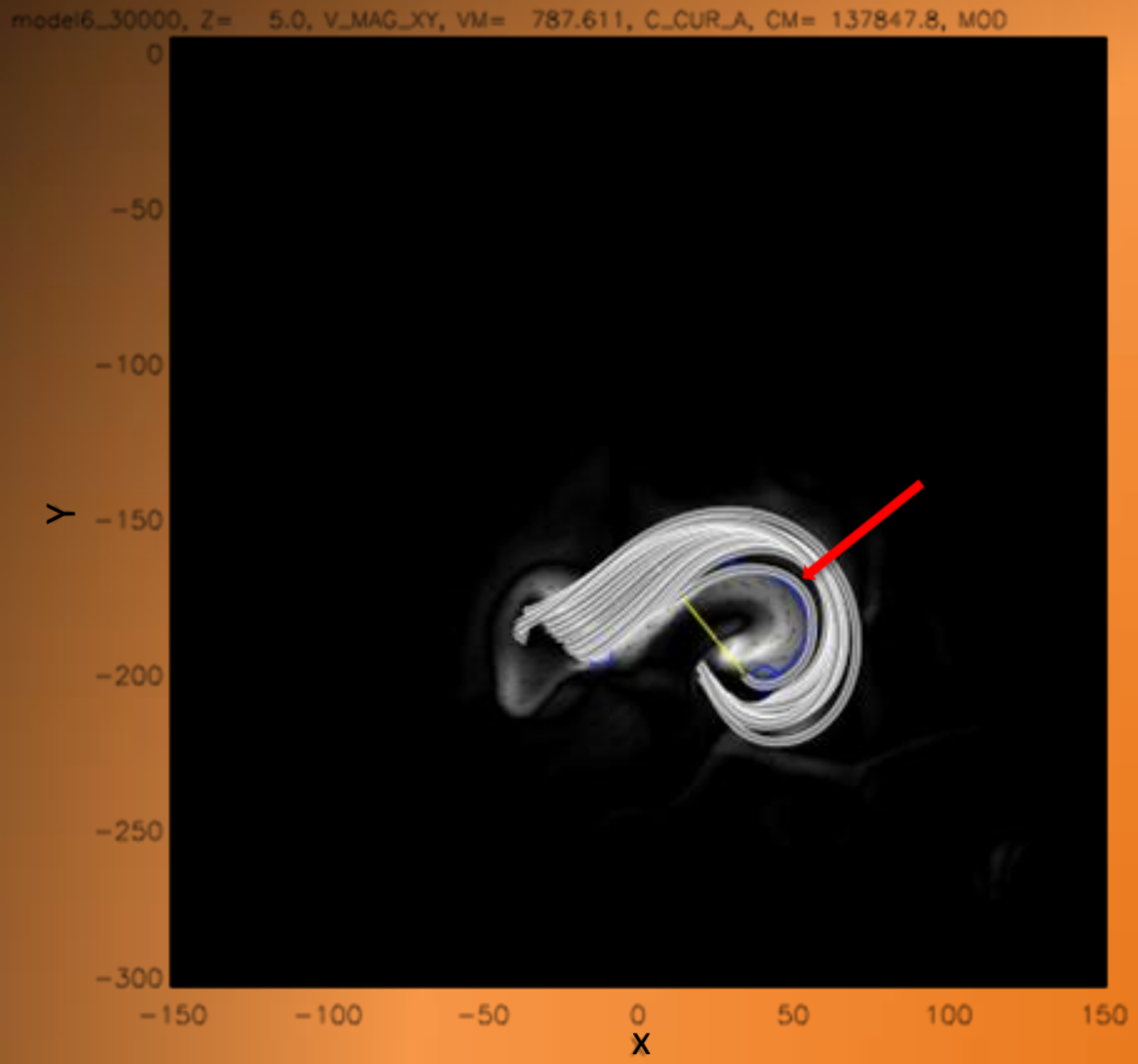


Plotting best fit data

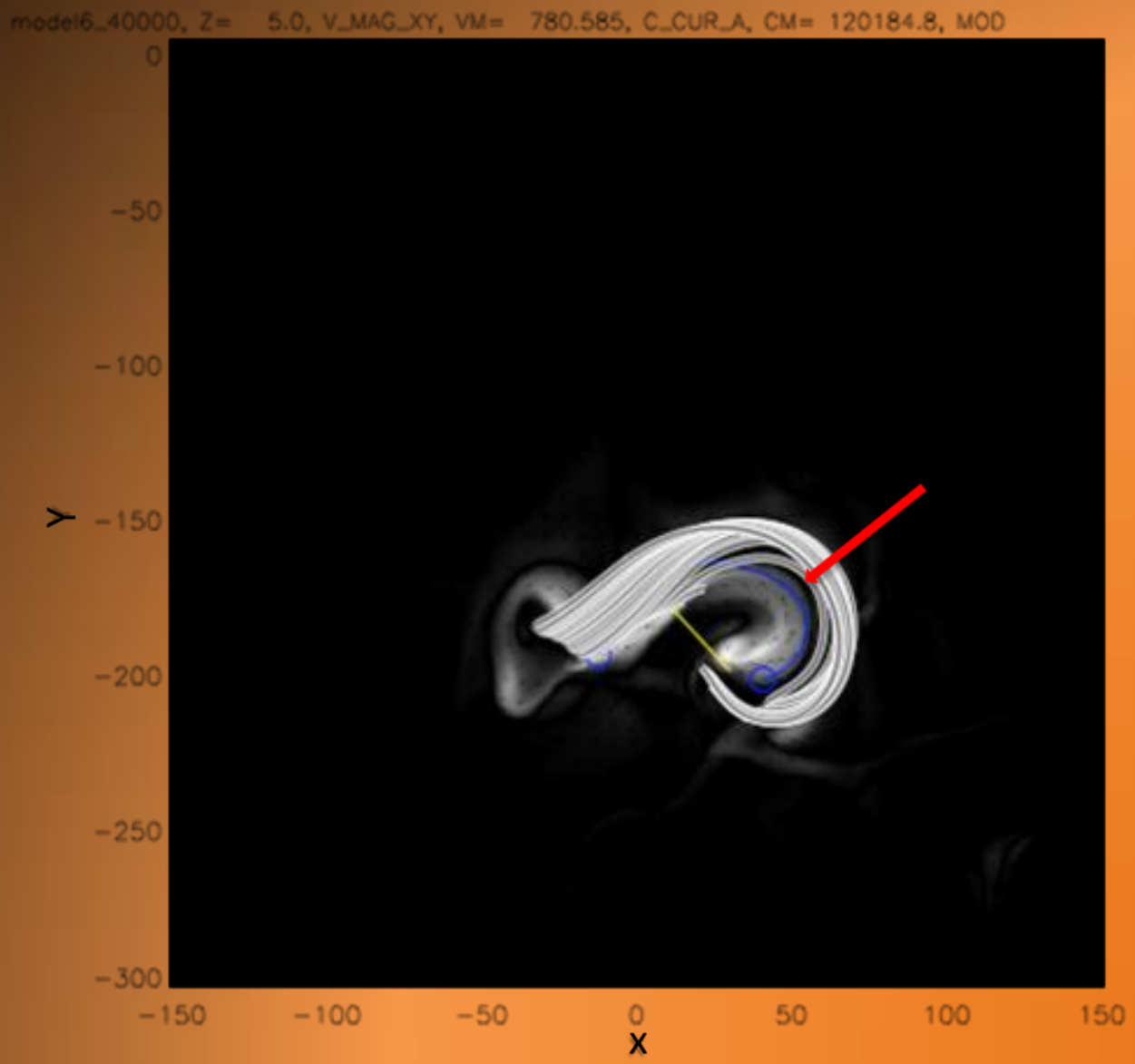
Model 6_20000
XY- Plane



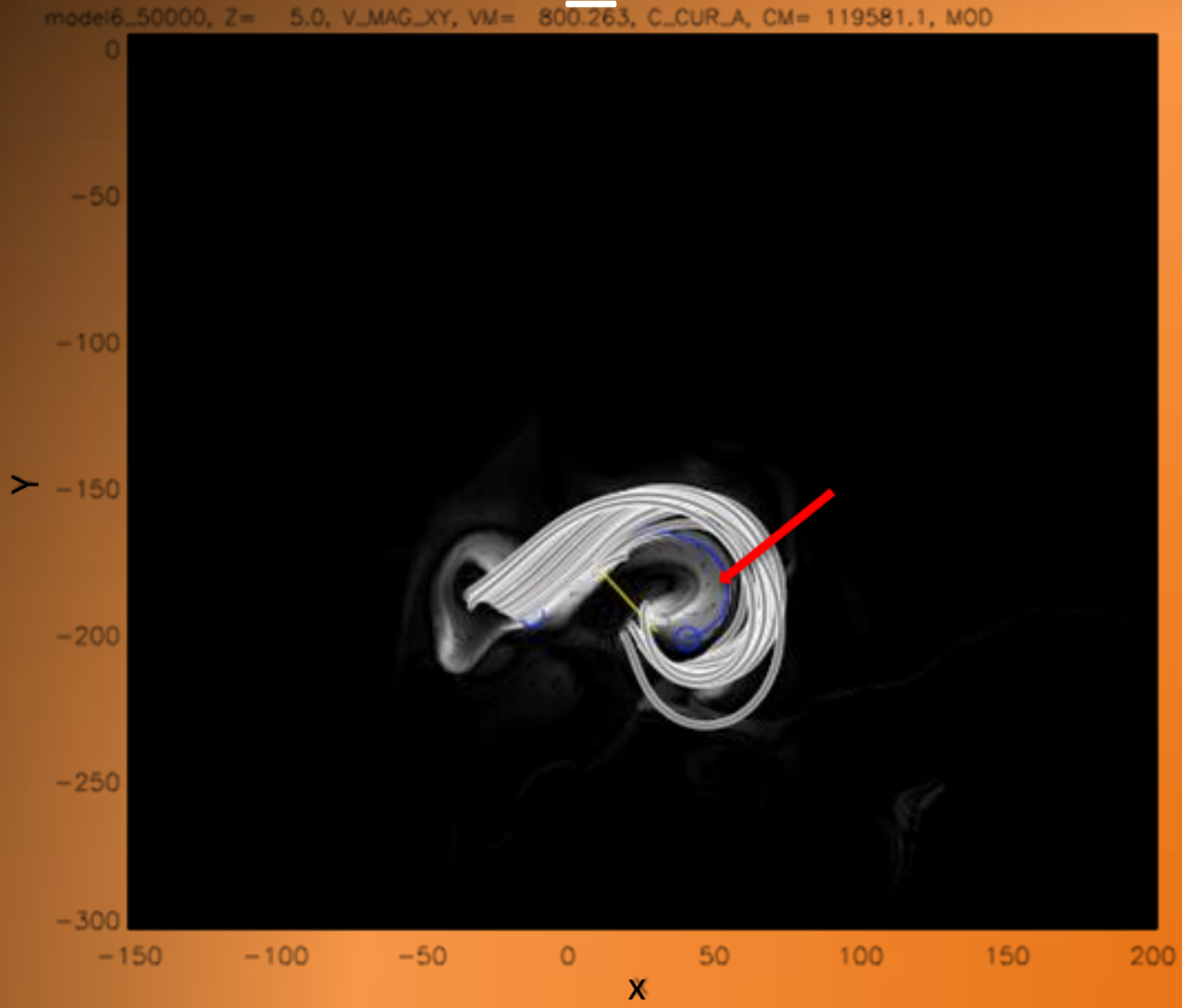
Model6_30000



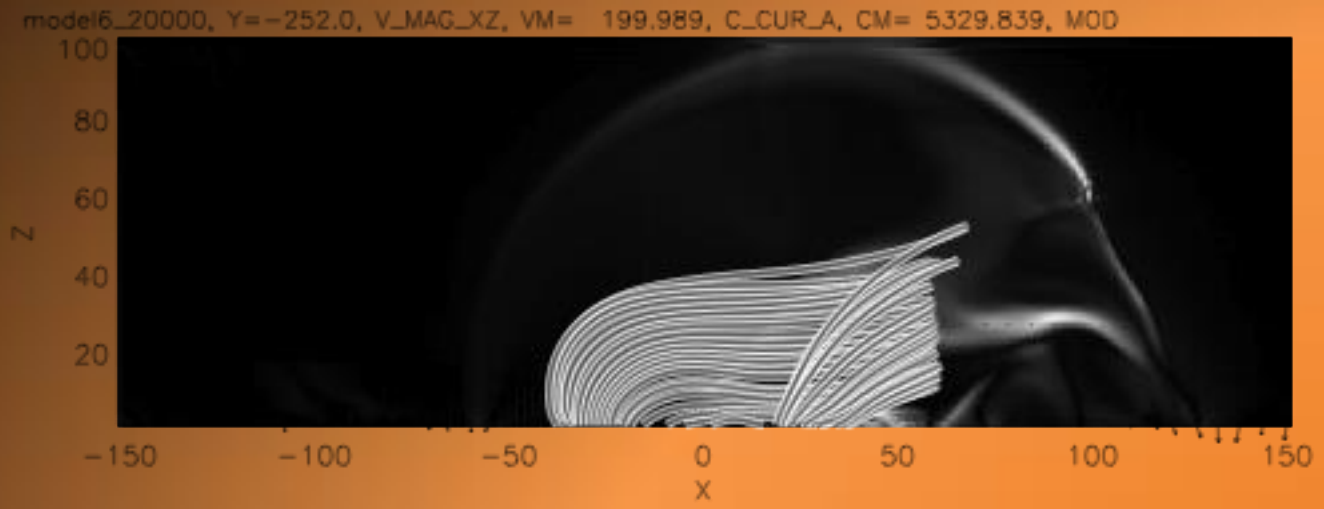
Model6_40000



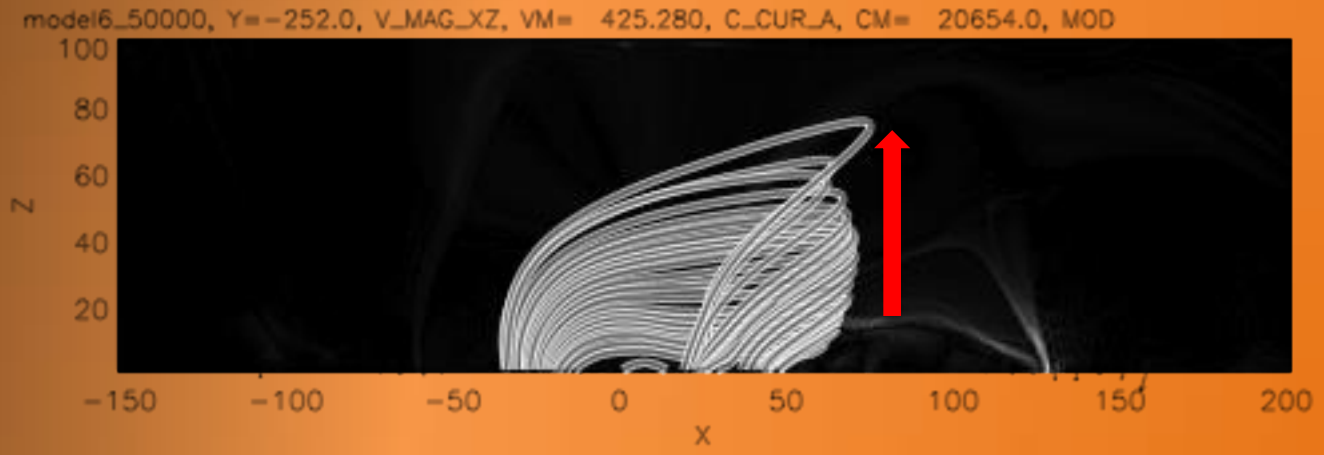
Model6_50000



Model 6_20000 SZ Plane



Model 6_50000 SZ Plane



Summary

- Sigmoids are areas where eruptive events caused by change in connectivity can occur
- There is a correlation between slipping reconnection and the created models
- NLFFF modeling may be able to capture realistic 3D magnetic structures associated with slipping reconnection

Thank You!

Acknowledgements

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Questions?