

Fitting Flux Ropes to a Global MHD solution: A comparison of techniques

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The Motivation

- Flux rope fitting models are a useful tool for recovering intrinsic and global properties of Magnetic clouds
- Difficult, if not impossible, to assess accuracy of fits as underlying global structure cannot be independently determined
- MHD models, on the other hand can provide both a global view as well as localized time series at specific points in space

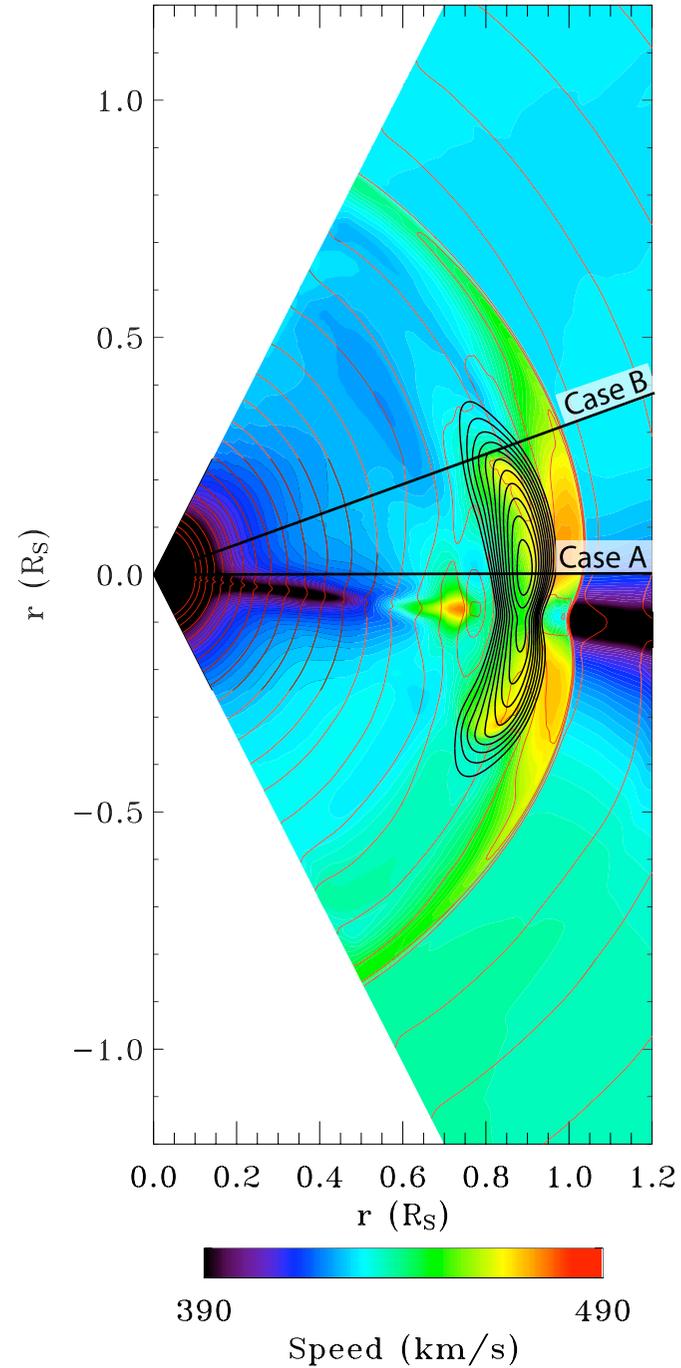
The Teams

- Riley, Linker, Mikic at SAIC and Odstroil at NOAA/SEC (MHD Model)
- Hidalgo and Cid at U. de Alcalá, Madrid (Elliptical Cross Section Model)
- Hu at UC Irvine (GSR Model)
- Lepping at NASA/GSFC (Force Free Model)
- Lynch at U. Michigan (Force Free Model)
- Rees at Imperial College, London (Force Free Model)

The Techniques

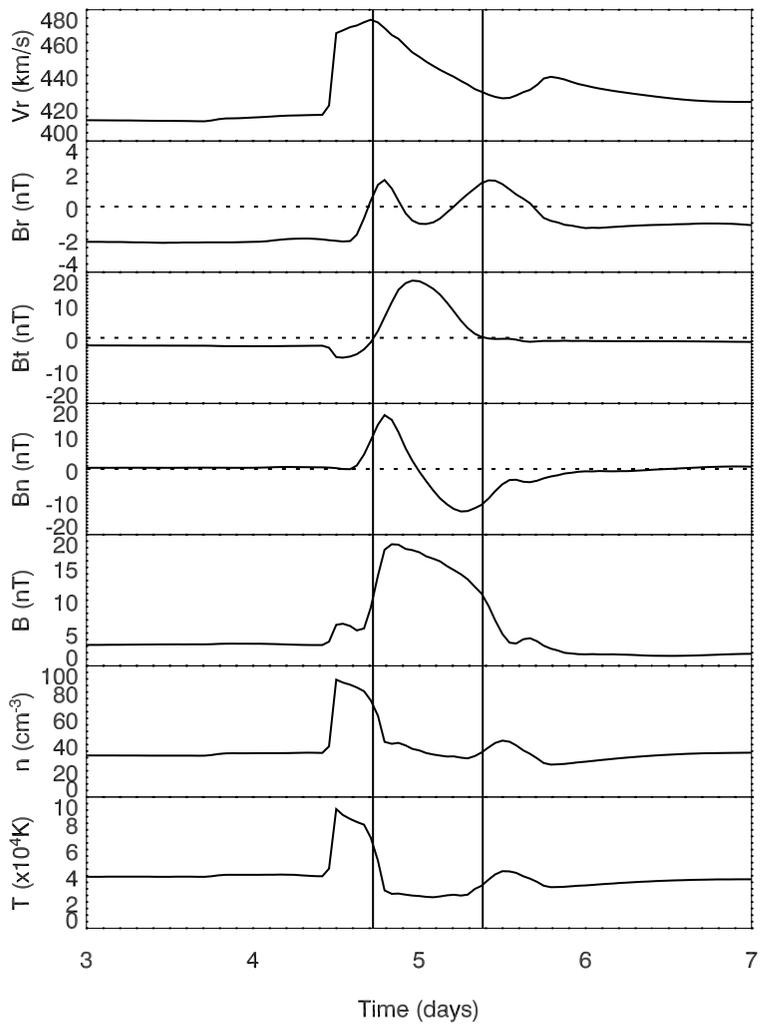
- MHD Simulation
- Force Free Model
- Elliptical Cross Section Model
- Grad-Shafranov Reconstruction Technique

The MHD Simulation

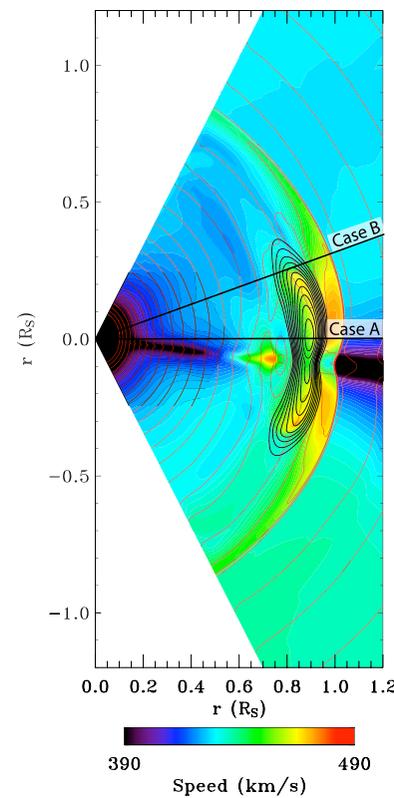
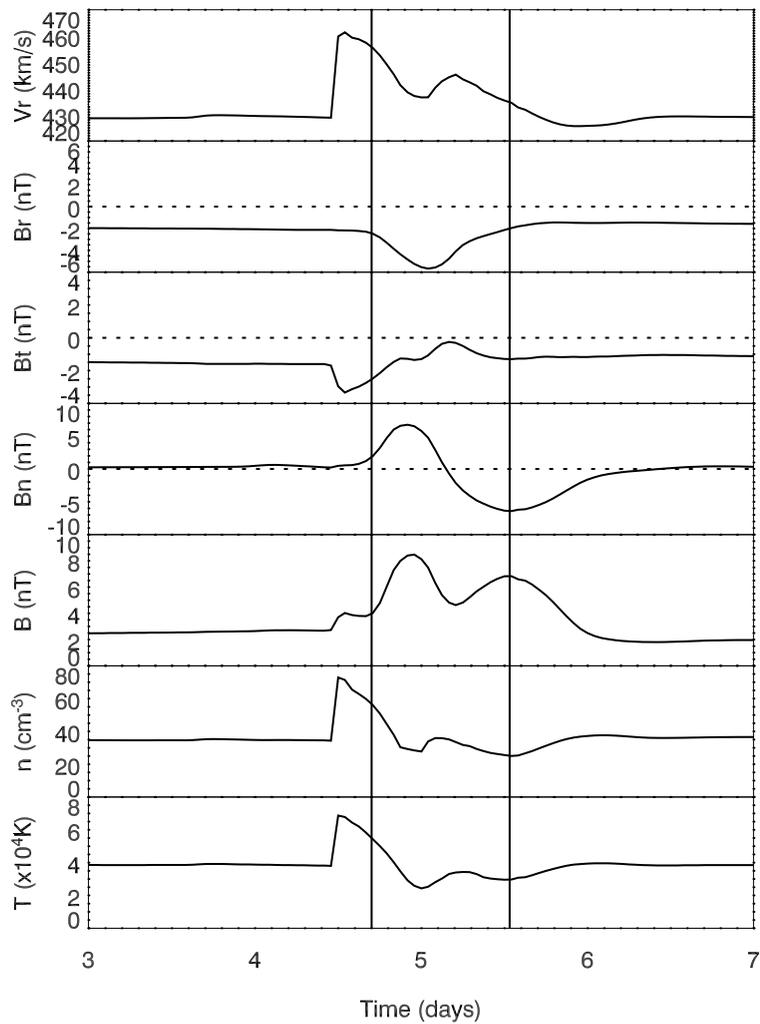


Simulated Time Series

Case A

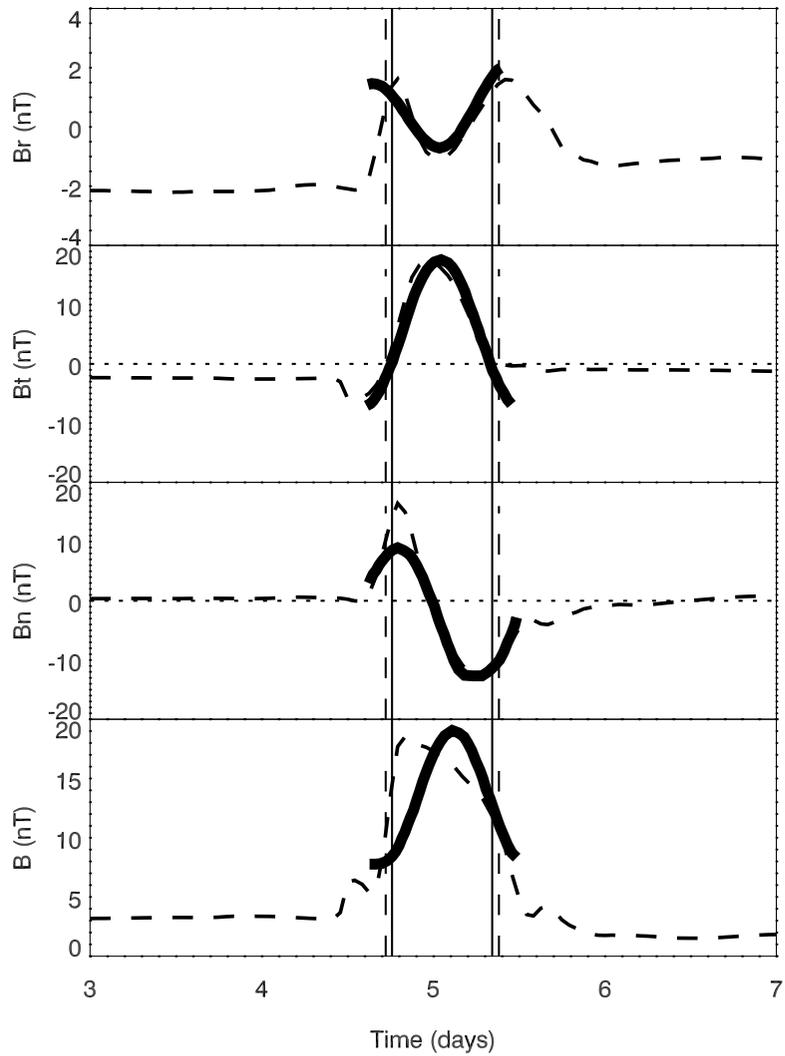


Case B

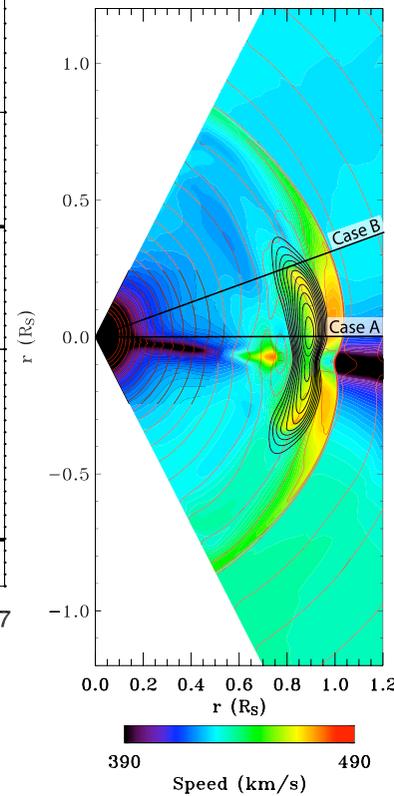
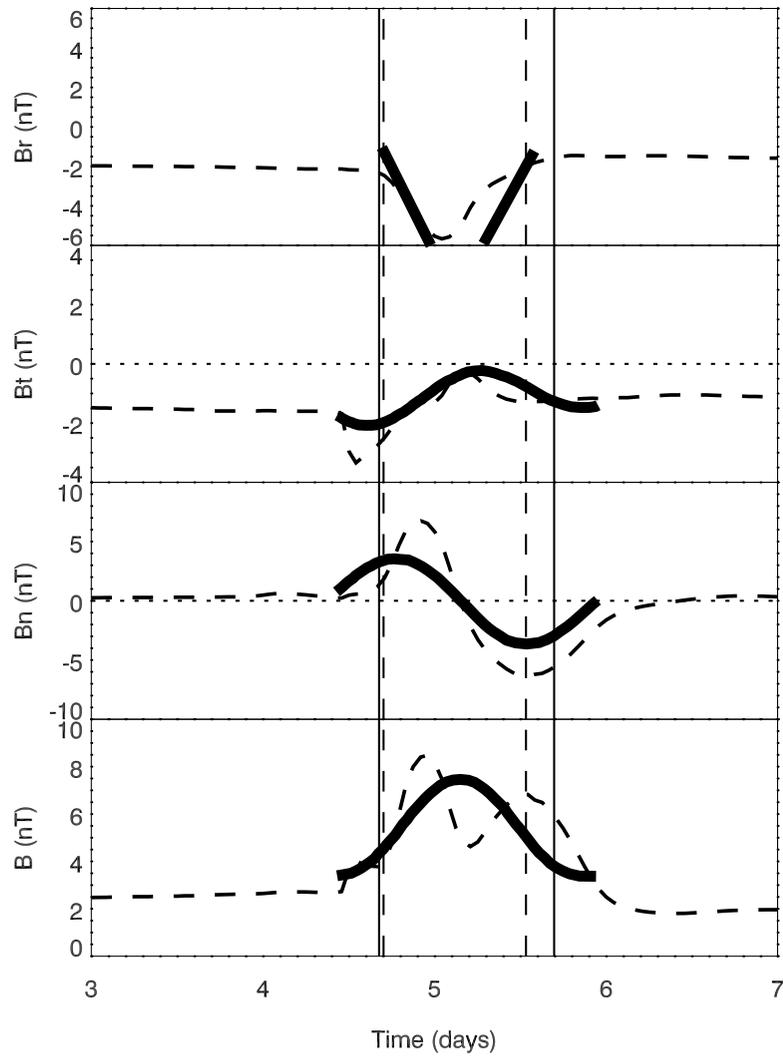


Lepping Force Free Fit

Case A: Lepping

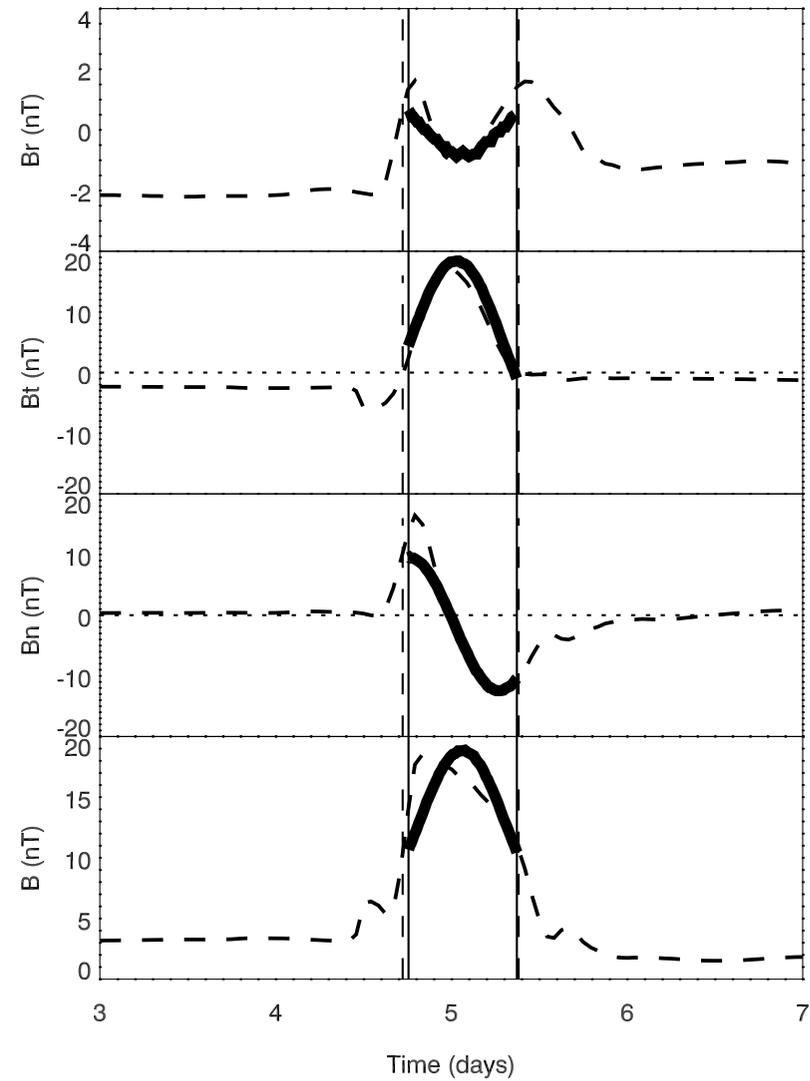


Case B: Lepping

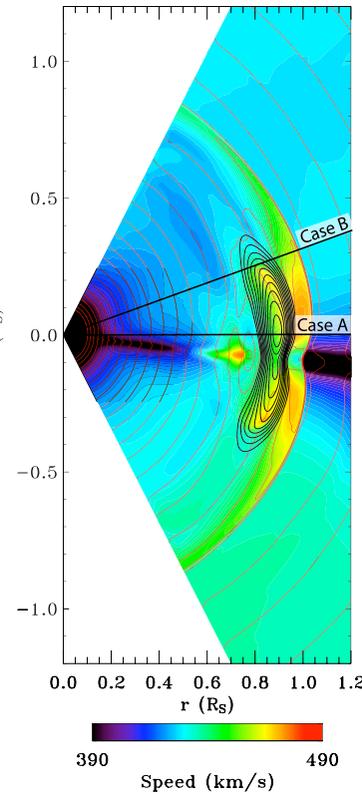
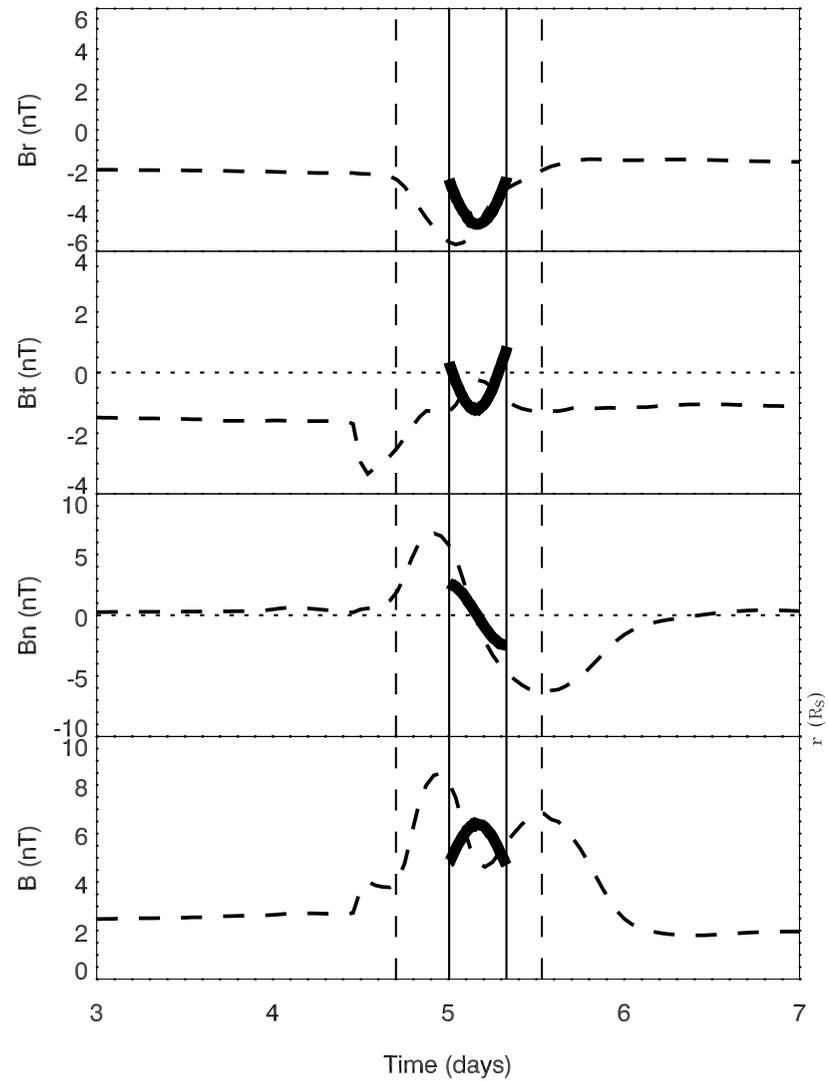


Lynch Force Free Fit

Case A: Lynch

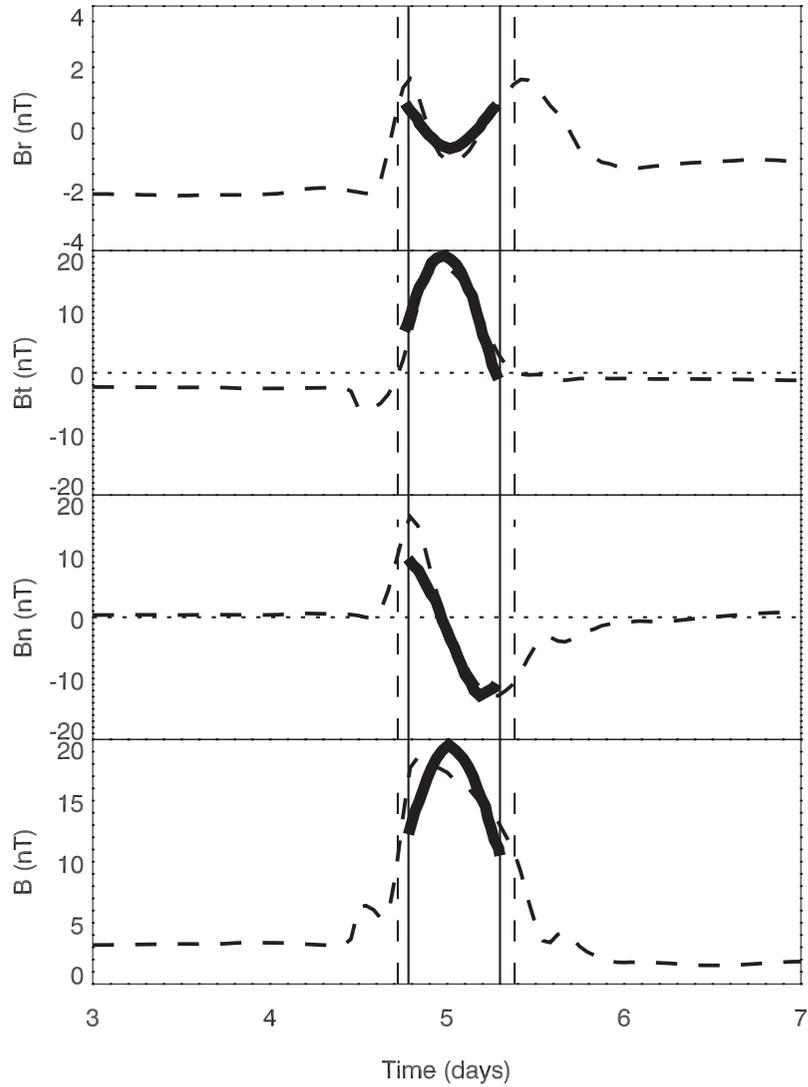


Case B: Lynch

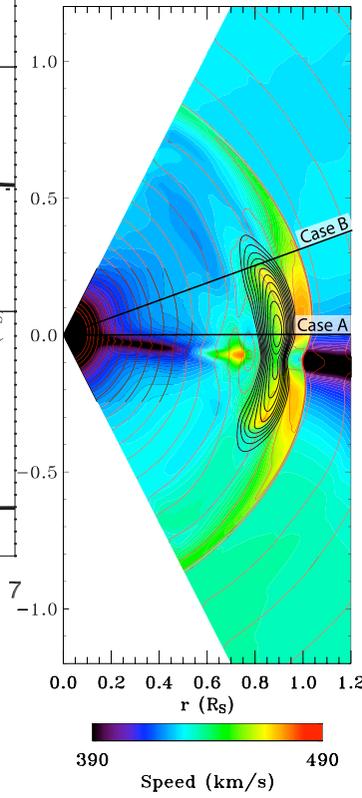
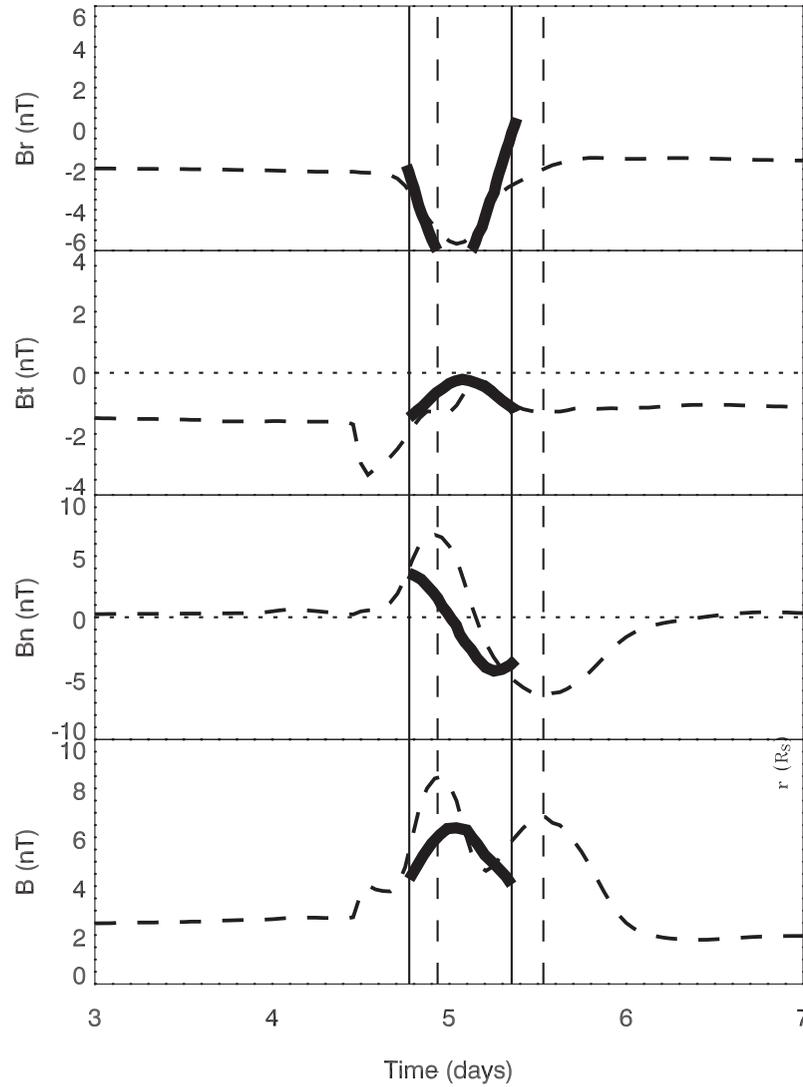


Rees Force Free Fit

Case A: Rees

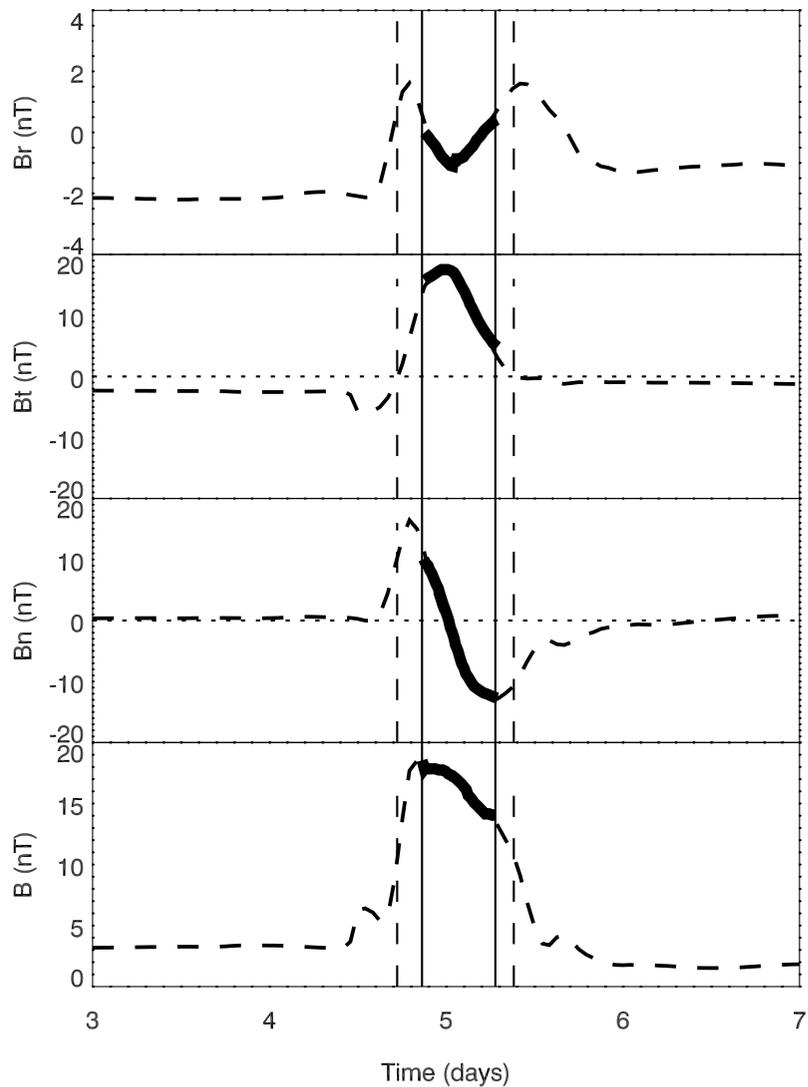


Case B: Rees

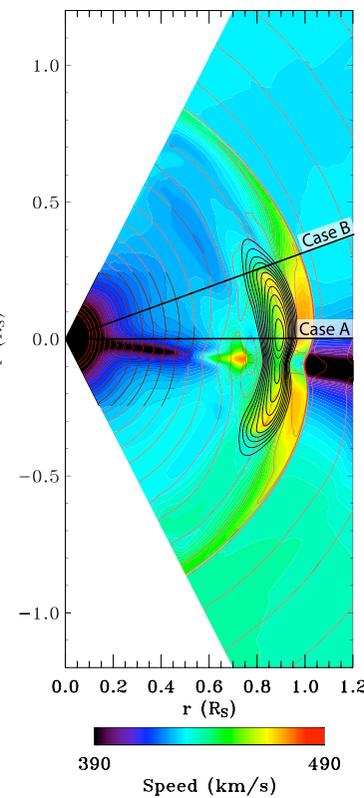
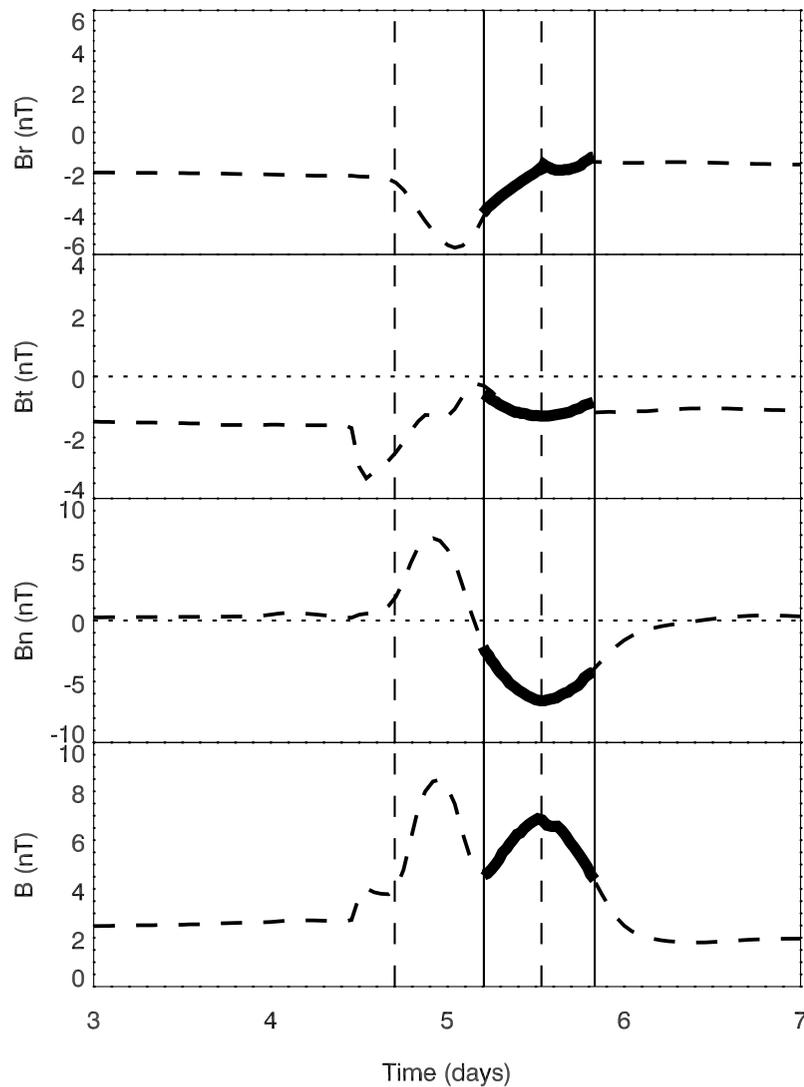


Hidalgo Elliptical CS Fit

Case A: Hidalgo

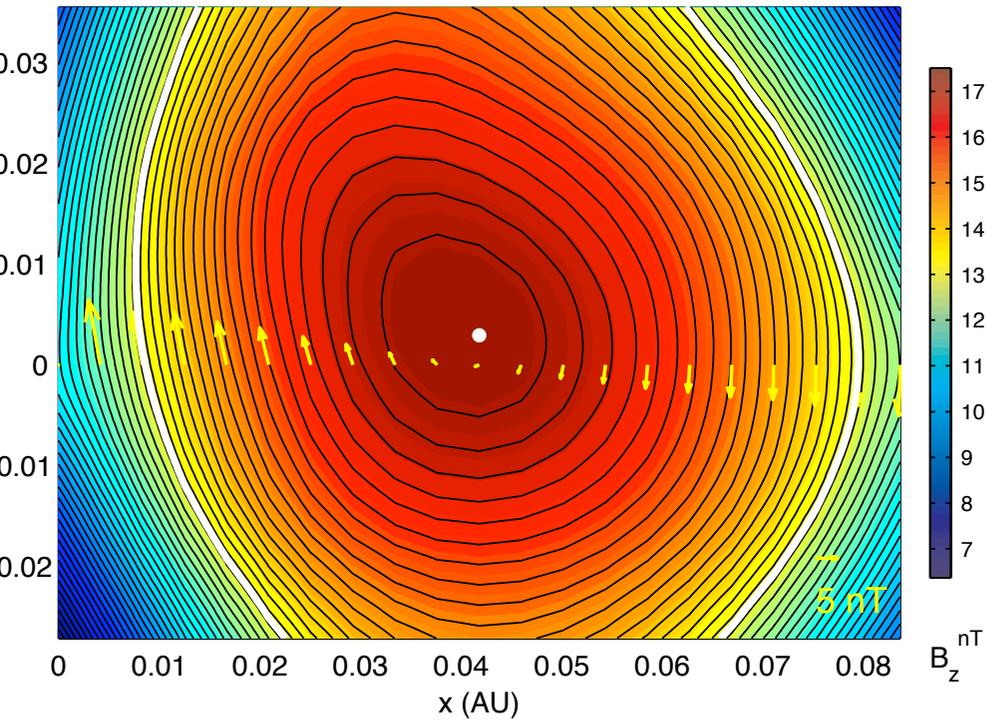


Case B: Hidalgo

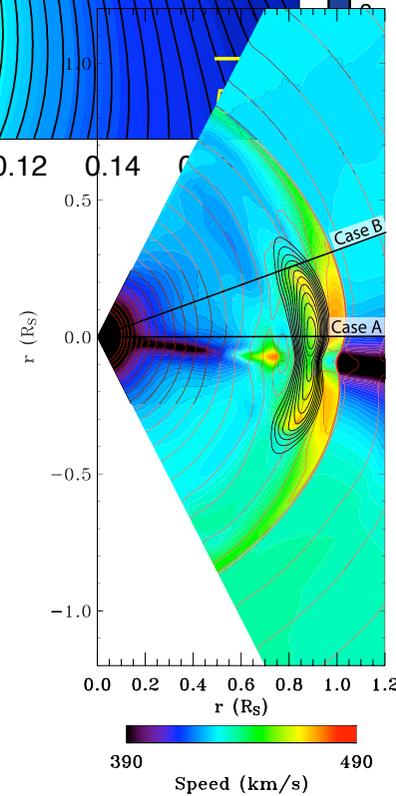
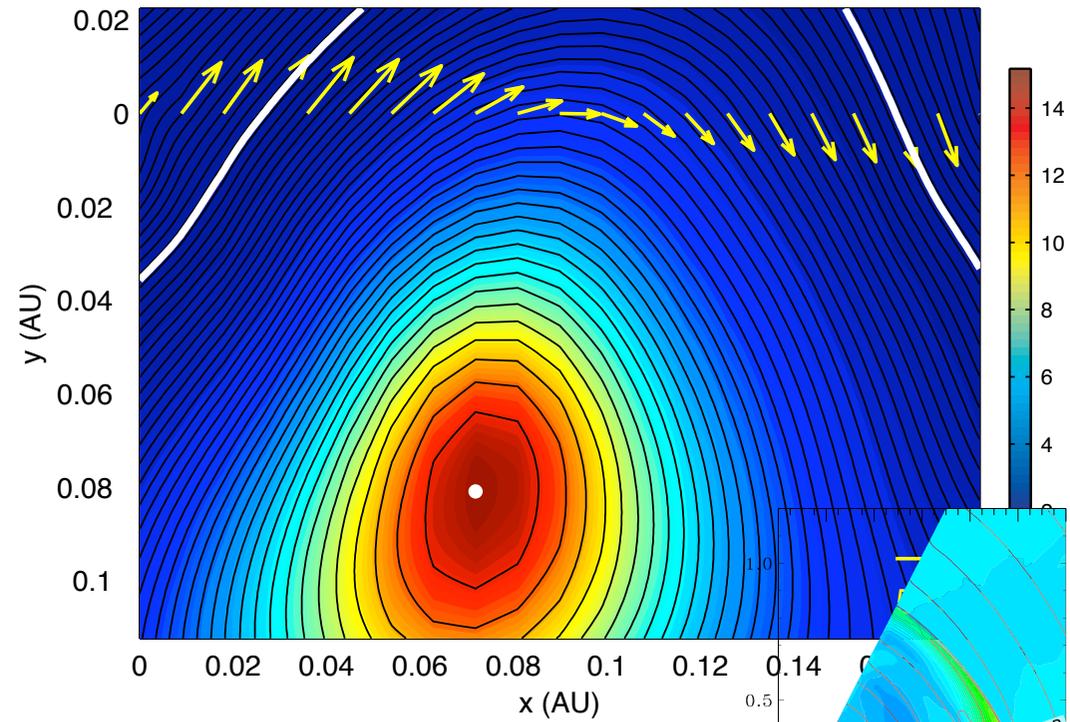


HU GSR Fit

Case A: Hu



Case B: Hu



Comparison of Results: Case A

team	Model	theta	Phi	P
Riley	MHD	0	-90	< 0.1
Hidalgo	Elliptical Cross-Section	9	-85.0	0.16
Hu	GSR	15	-84.6	0.0083
Lepping-1	Linear force free	-31.5	-77.3	0.136
Lepping-2	Linear force free	-2.6	-80.1	0
Lynch-1	Linear force free	-14.3	-81.9	0.08
Lynch-2	Linear force free	-27	-80.4	0.11
Lynch-3	Linear force free	14.3	-89.2	0.00
Rees	Linear force free	10.4	-81.2	0.1

Comparison of Results: Case B

team	Model	theta	Phi	P
Riley	MHD	0	-90	0.7
Hidalgo	Elliptical Cross-Section	-11	-165	—
Hu	GSR	-4.0	-65.1	0.54
Lepping	Linear force free	2.8	-31.5	0.401
Lynch-1	Linear force free	0.7	48.1	0.45
Lynch-2	Linear force free	-4	63.1	0.63
Lynch-3	Linear force free	-18.7	73.4	0.57
Lynch-4	Linear force free	-33.8	171.0	0.91
Rees	Linear force free	-26.8	6.3	0.4

Conclusions

- All fitting techniques are, and will continue to be useful tools for describing magnetic clouds
- Some limitations to note:
 - Boundary identification is a critical issue
 - Minimum variance analysis is poor technique for identifying orientation of axis
 - Results from models that reproduce global shape must be treated with caution

Future Directions

- We need to make progress in identifying the boundaries (GSR Technique)
- We need to assess which, if any, of the models provides the best fits, and under what conditions?
- What are the improvements from multi-spacecraft techniques?