



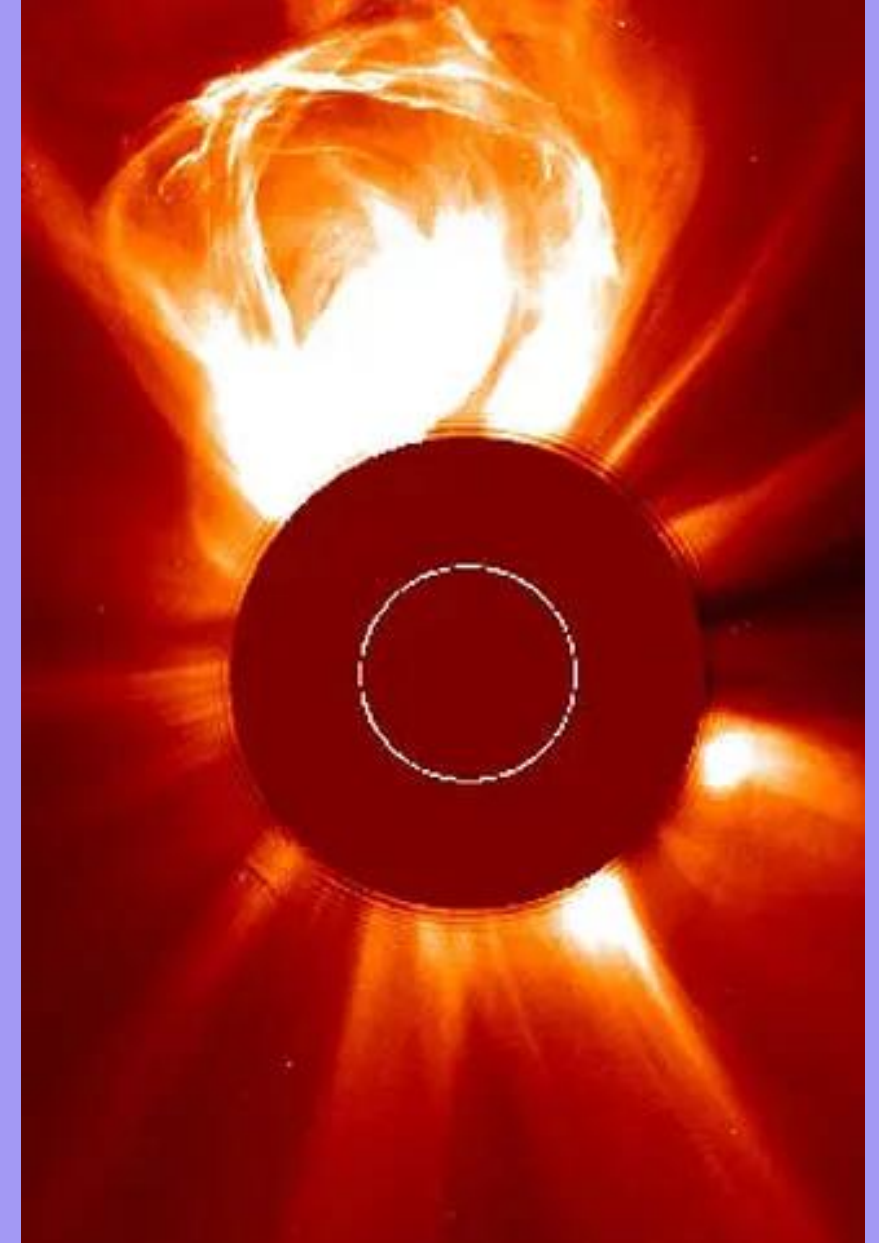
# Investigating the Structure of Magnetized Coronal Mass Ejection models

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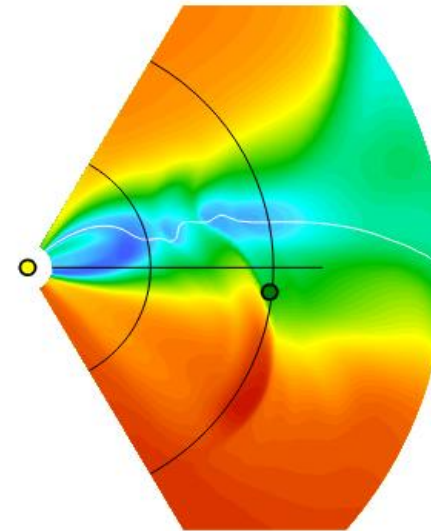
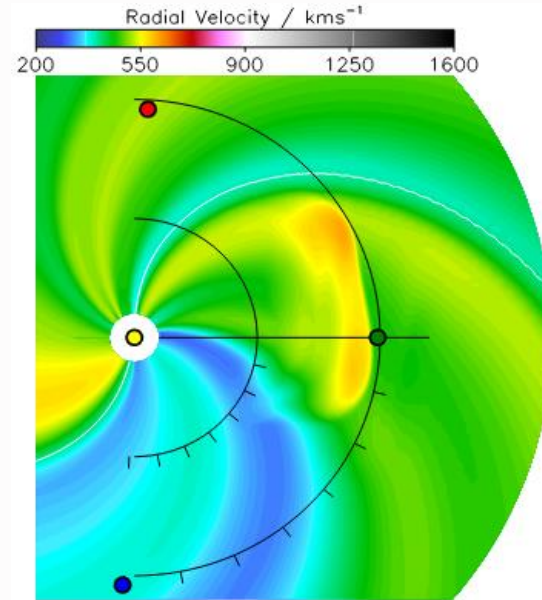
[helen.l.norman@warwick.ac.uk](mailto:helen.l.norman@warwick.ac.uk)

# Magnetized CME models

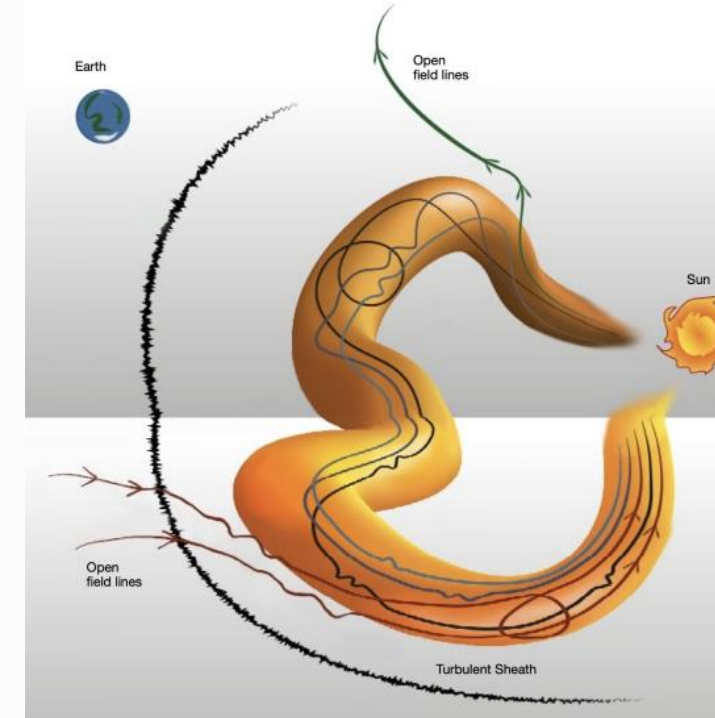
Current operational forecasts use non-magnetized CMEs - WSA-ENLIL, EUHFORIA

Currently do not incorporate  $B_z$  into forecasting

We investigate propagation of 3 different models – analytic and MHD

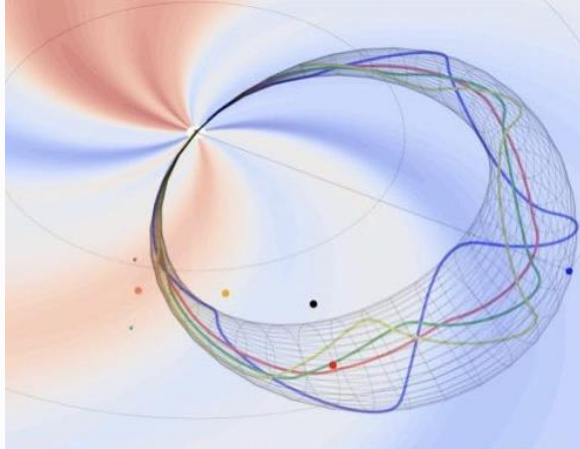


[Pizzo+, 2011]



[Al-Haddad and Lugaz, 2025]

# 3DCORE

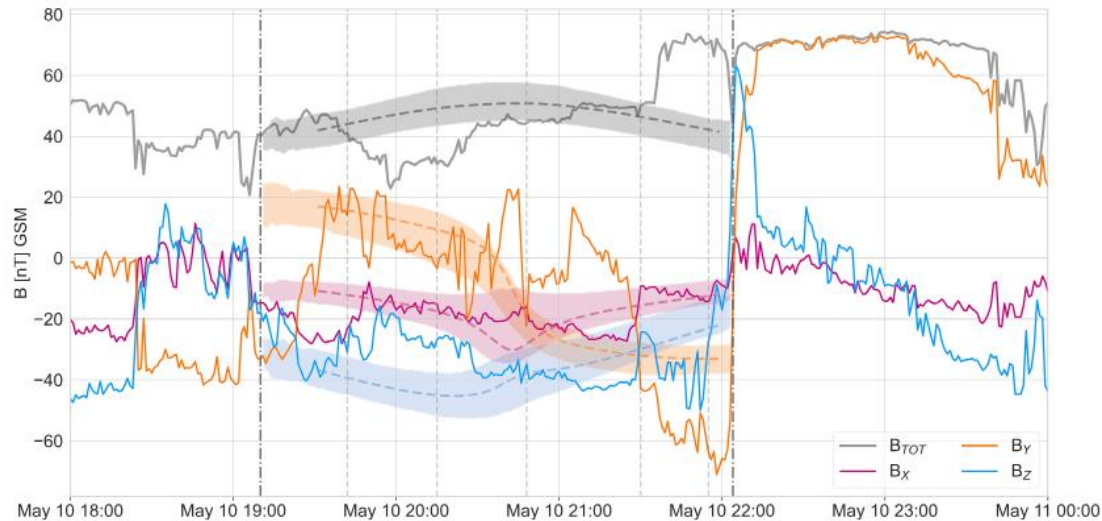


Analytic flux rope model, fit with solar wind conditions

Hindcast and developments to use for short term forecast (Weiler+, 2025)

No shock / sheath region, Does not capture the small scale variability in CME shape

Output parameters can be put into MHD models

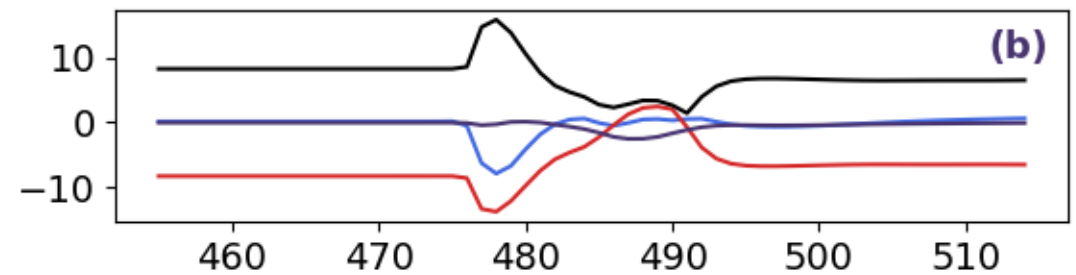
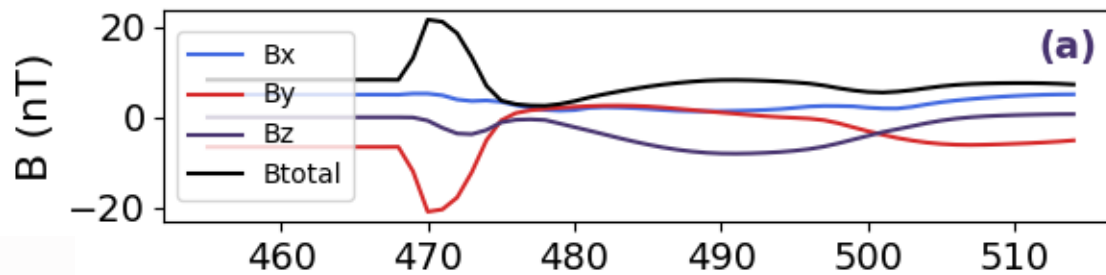
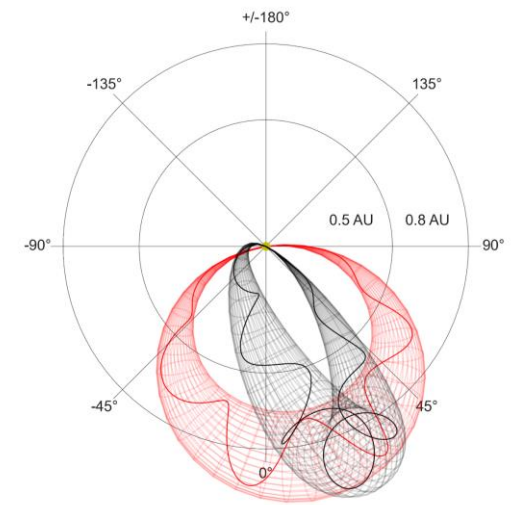
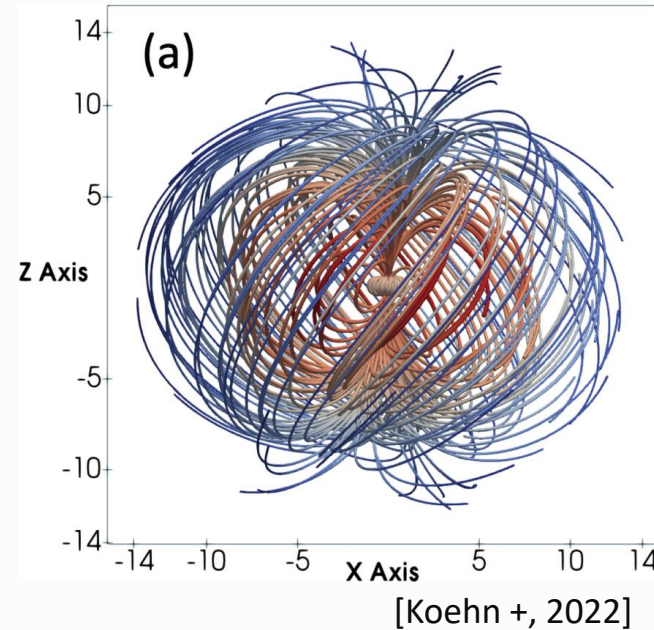


[Weiler +, 2025]

# Spheromak model

Used for hindcast statistical studies  
(Maharana+ 2023, Martinić+ 2024)

Reproduces CME profile well at centre, not good for flank impacts / multipoint measurements



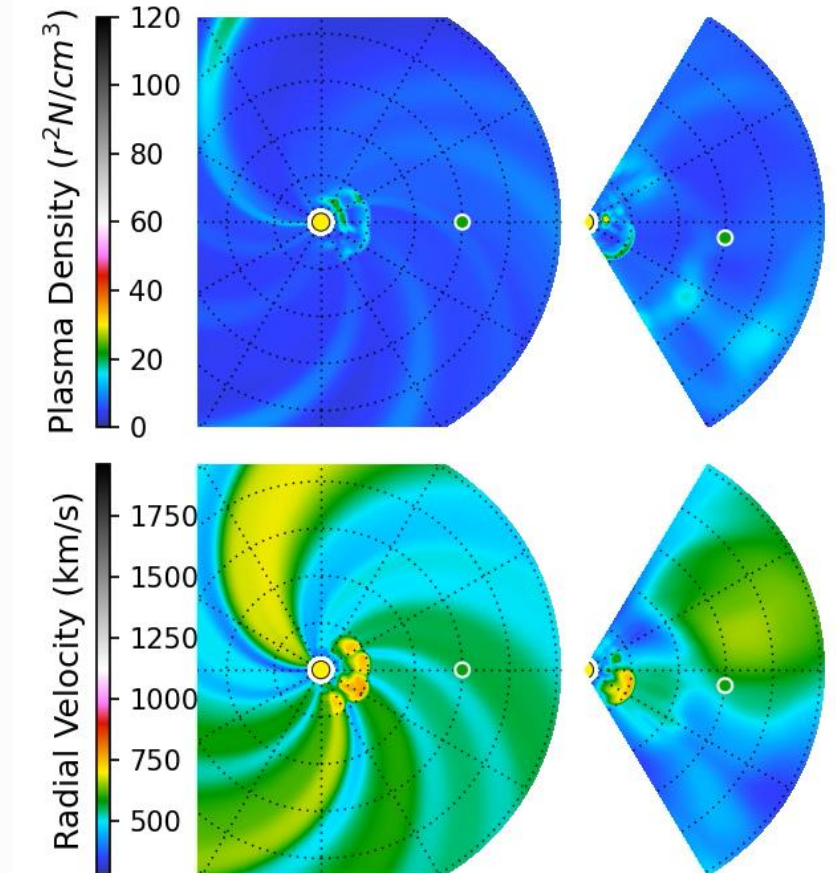
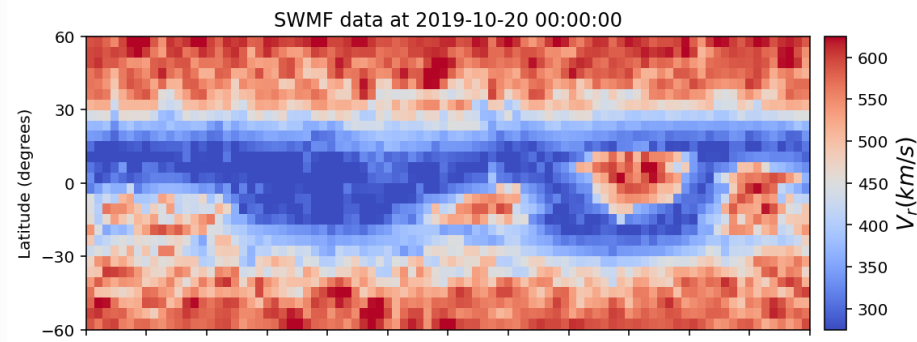
# SWIFT

Runs in real time - <https://www.spacepager.eu/>

Solar wind from ADAPT magnetograms - 1D MHD AWSoM along open field lines

Runs magnetized CME ensembles

– inserts at 0.1AU from a database of Gibson-Low flux ropes

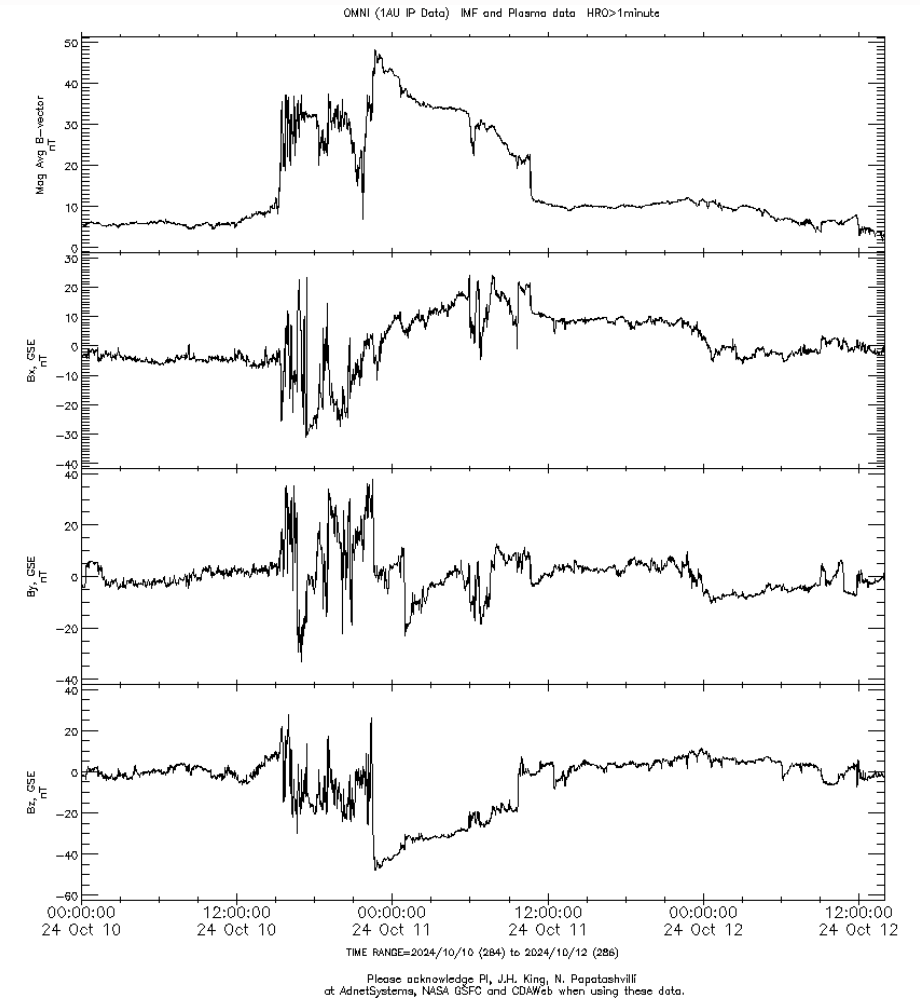
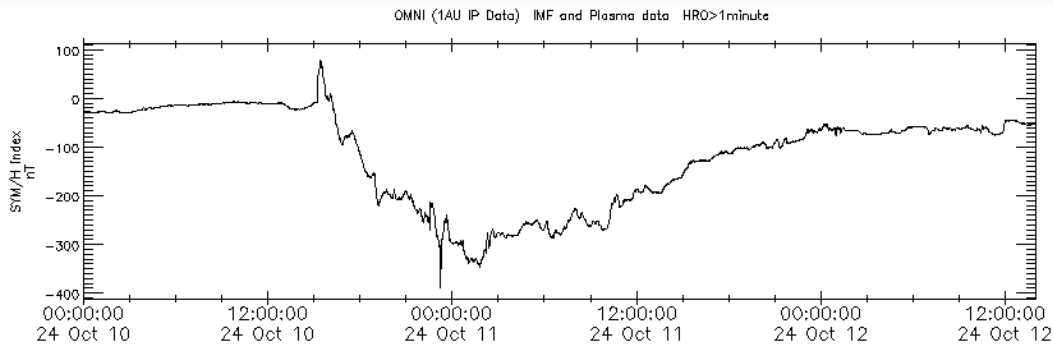


# October 2024 Geomagnetic Storm

One of 2 notable storms last year, DST = -355 nT (Pierrard+, 2025)

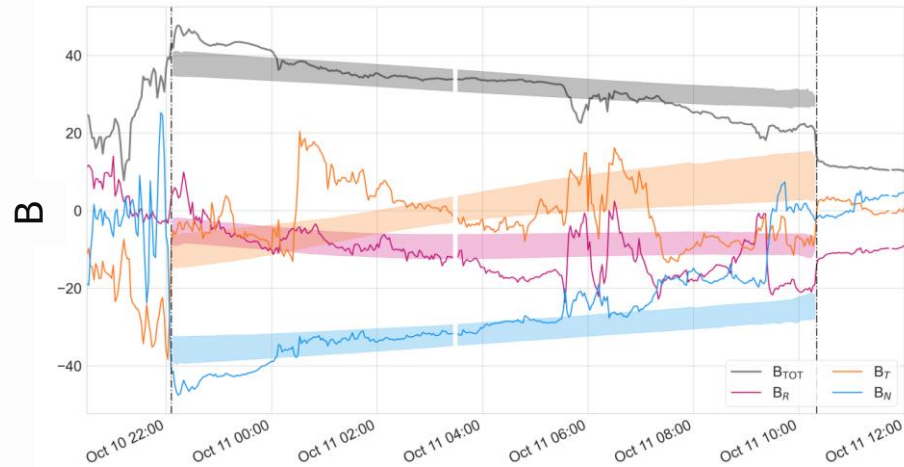
One fast CME, compared to May 2024 many CMEs

Strong Bz component in Magnetic cloud



# Modelled Event

## 3DCORE



Longitude:	16.5 +/-	2.77
Latitude:	3.56 +/-	3.74
Inclination:	86.99 +/-	3.39
Diameter 1 AU:	0.29 +/-	0.03
Aspect Ratio:	2.0 +/-	0.0
Launch Radius:	21.5 +/-	0.0
Launch Velocity:	2110.36 +/-	52.8

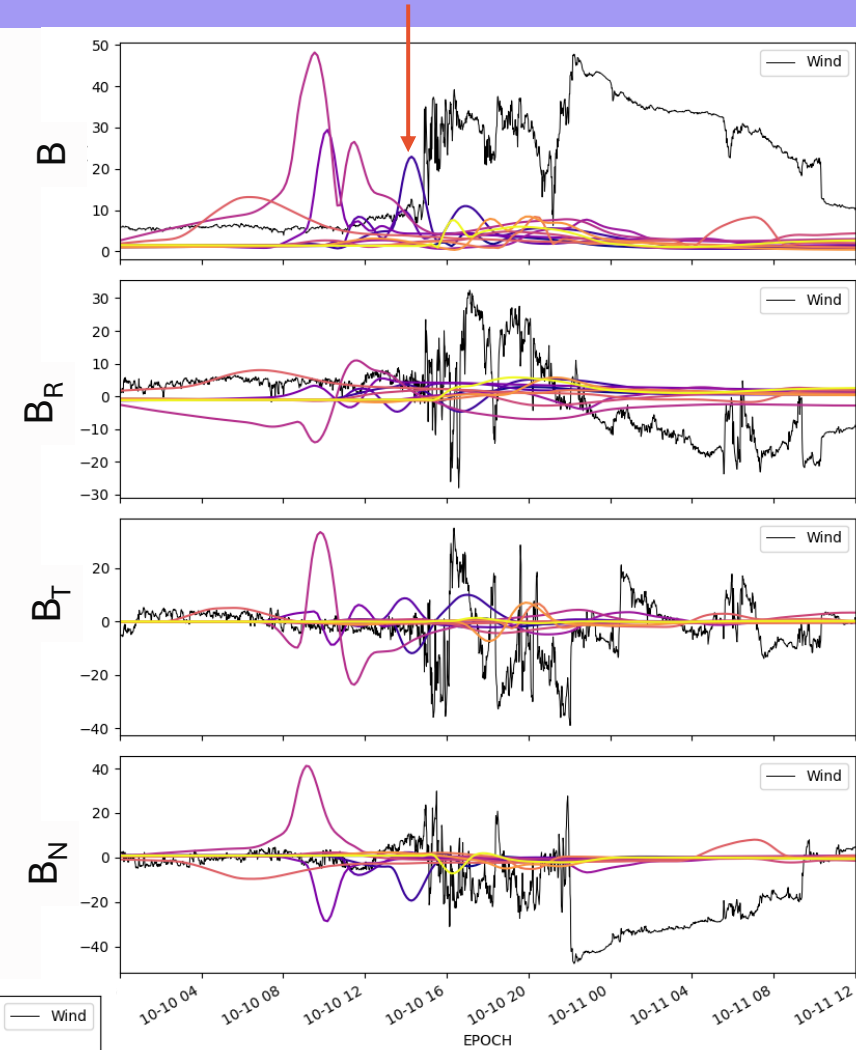
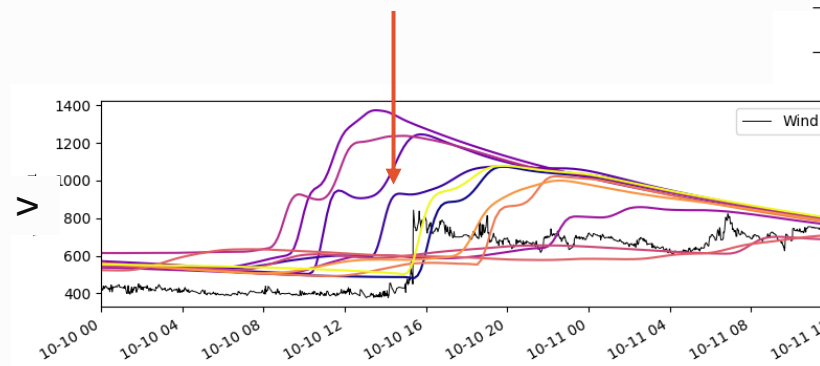
Data – U. Amerstorfer

## SWIFT

CMEs arrive early – velocity proportional to magnetic field

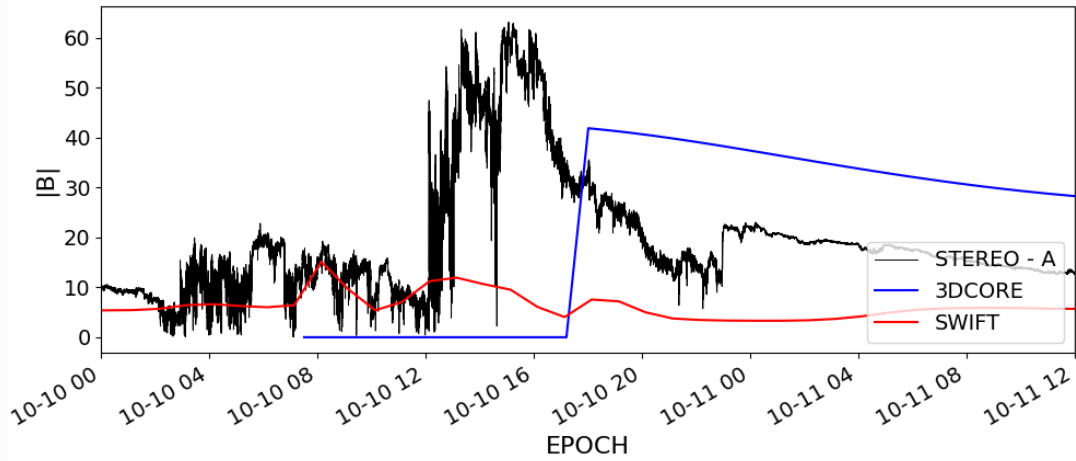
High variation in magnetic field strength

Highest B launch speed:  
1808  $\text{kms}^{-1}$ , best arrival time match:  
1190  $\text{kms}^{-1}$



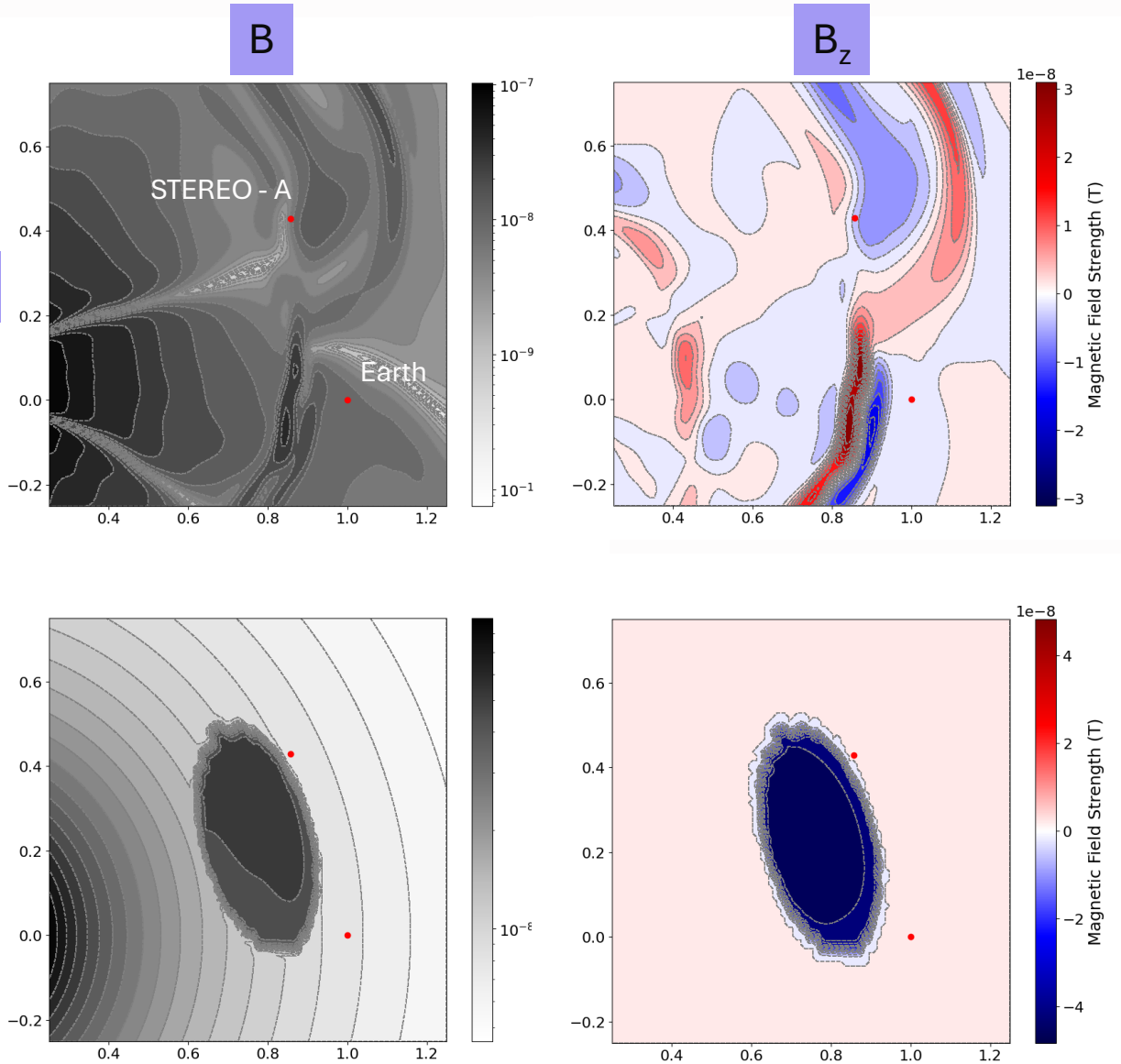
# STEREO - A

Strongest CME from SWIFT ensemble



SWIFT

3DCORE

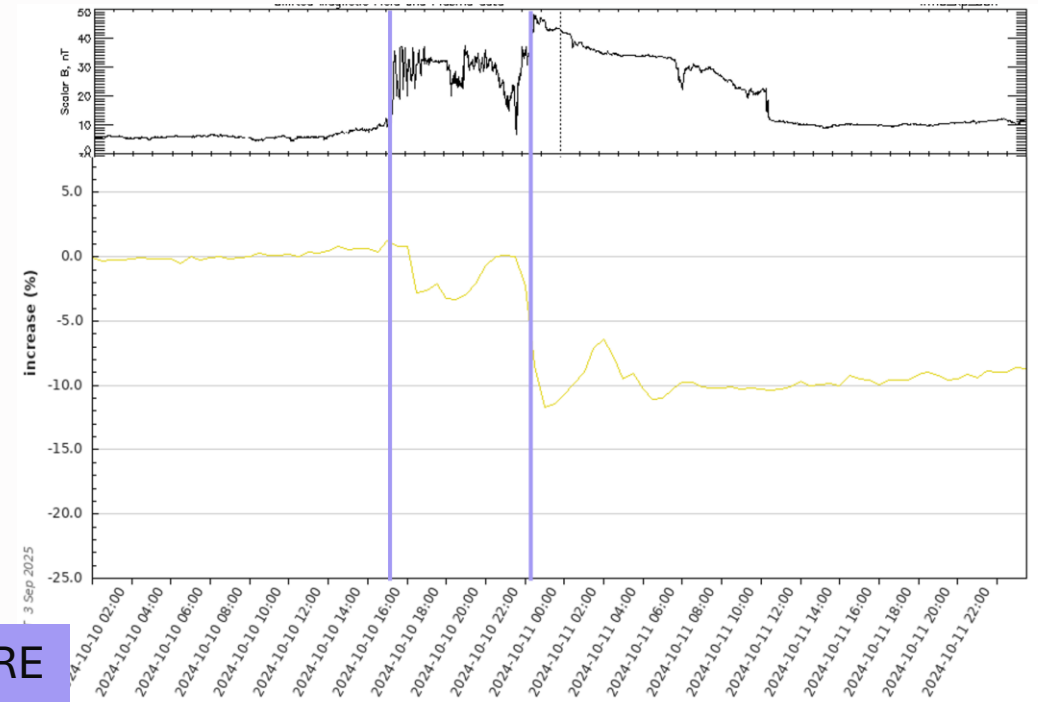


# Can we determine non-local CME structure?

FD associated with this event, 2-step structure

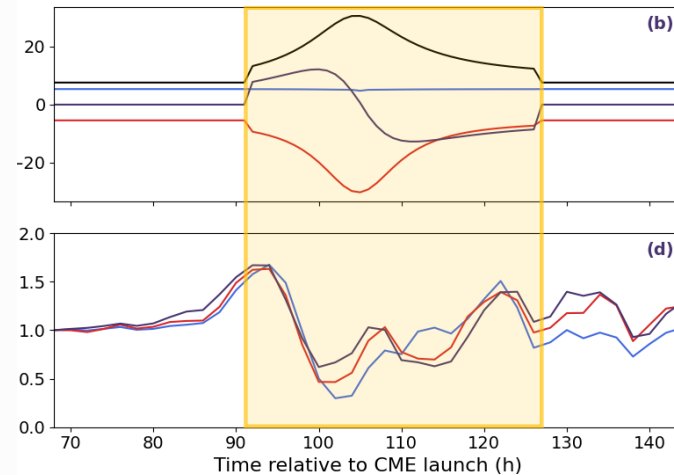
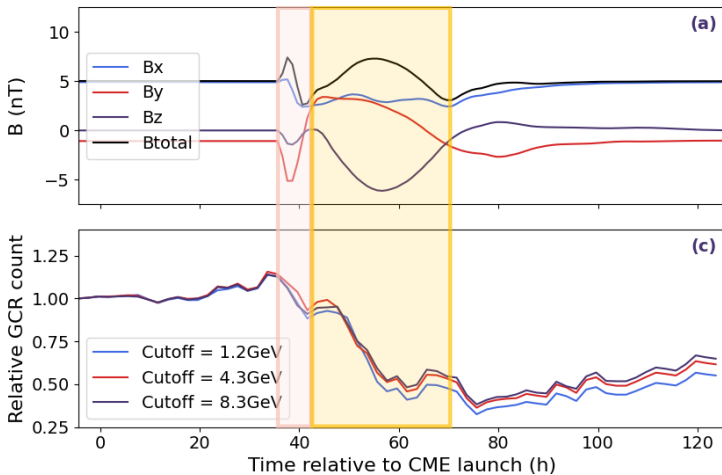
Magnitude about 10% (depending on monitor)

Model test particles on magnetic fields



## Modelled particles: MHD

## Modelled particles: 3DCORE



Modelled particles:  
Spatial  
variability

