A Catalogue of Coronal Mass Ejections Observed by the Heliospheric Imagers throughout the STEREO Mission

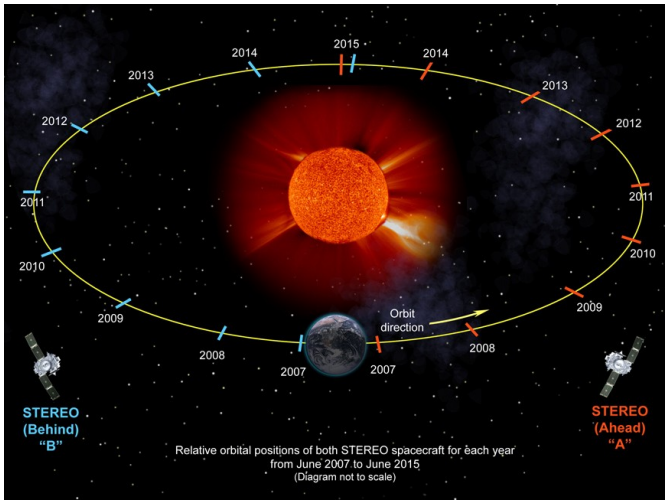
D. Barnes[1], J. Davies[1], R. Harrison[1], & the HELCATS team

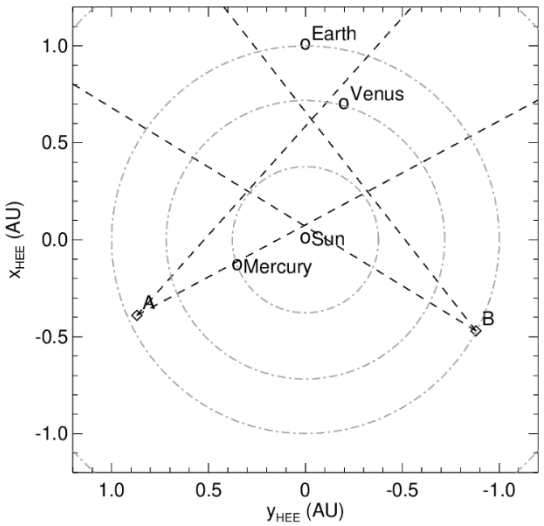
(1) STFC, Rutherford Appleton Laboratory, UK;

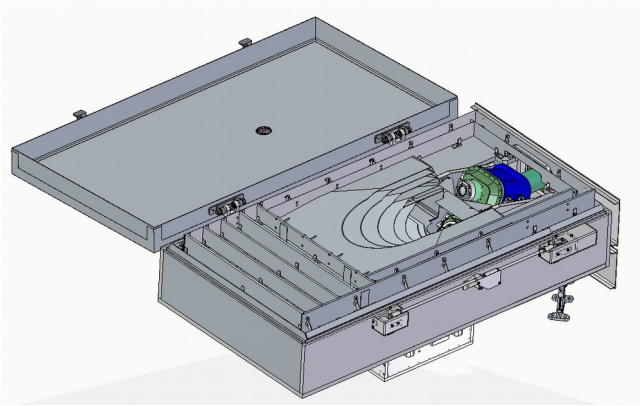
Overview

- An introduction to STEREO and HI
- An explanation of CME tracking methods and geometric models applied in order to determine kinematic properties
- Results from single-spacecraft models
- Results from stereoscopic models
- A comparison of the results from single-spacecraft models and those from stereoscopic models
- Summary

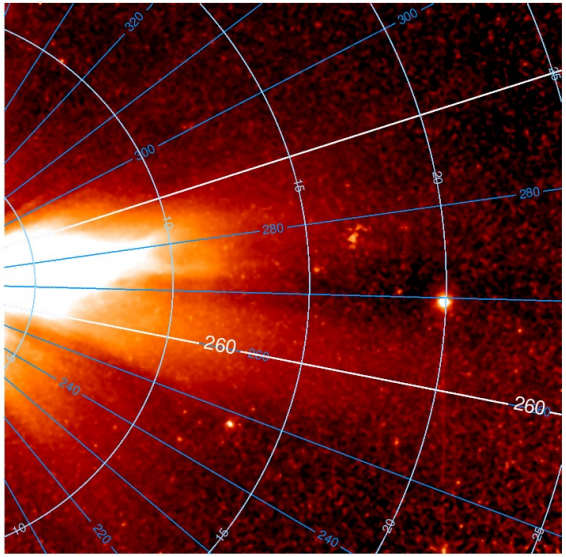
The STEREO Heliospheric Imagers





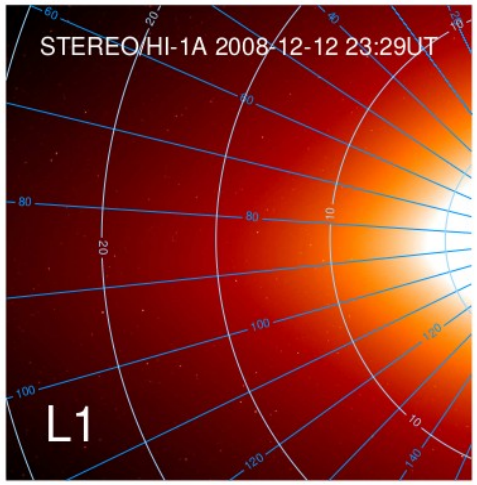


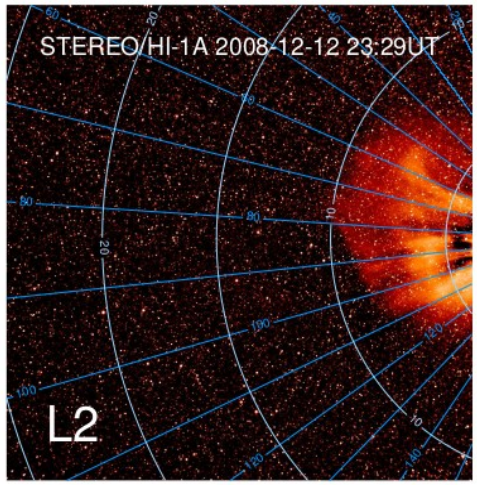
STEREO/HI-1A
2019-11-07 15:29UT

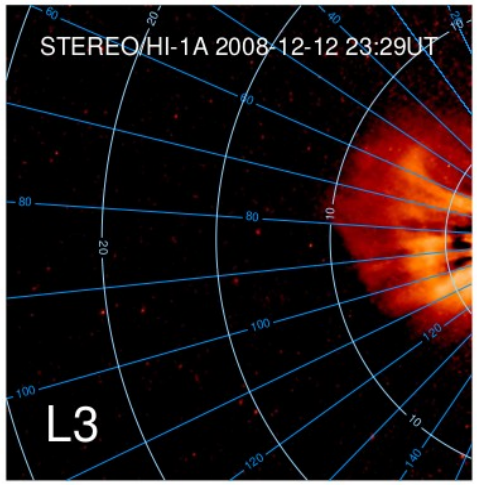


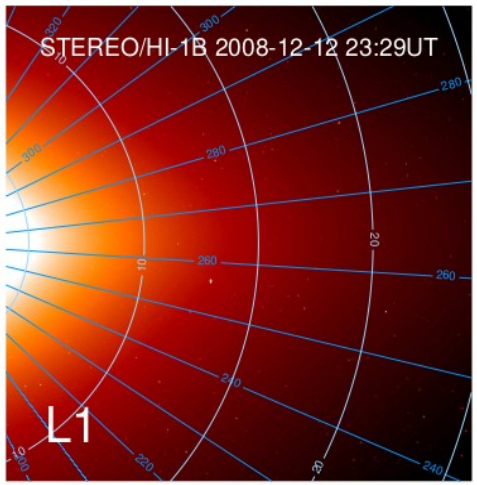
- Two spacecraft launched in 2006 with identical remote sensing instruments
- We have observed 1000s of CMEs over an entire solar cycle
- STEREO-A is still transmitting data

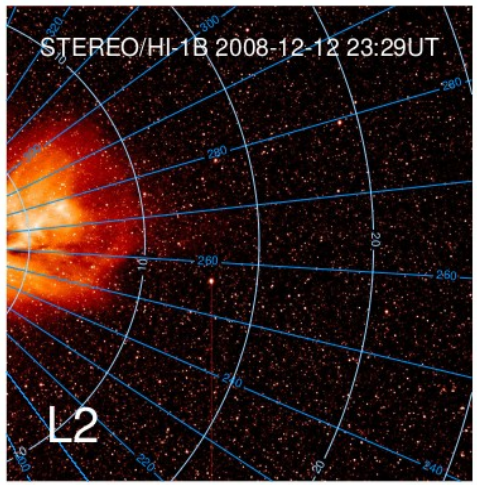
Identifying CMEs in HI

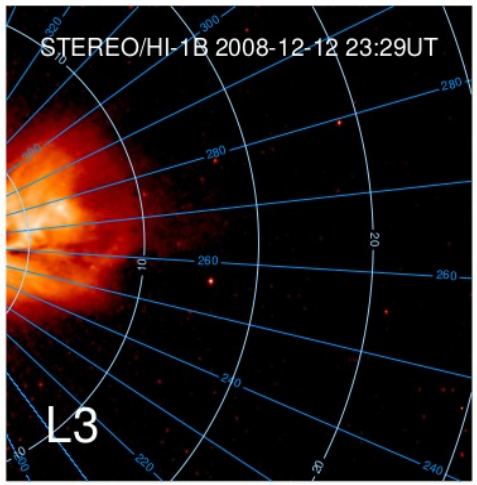












CMEs in HI

HELCATS

Harrison *et al.* 2018

http://www.helcats-fp7.eu/

CORSET

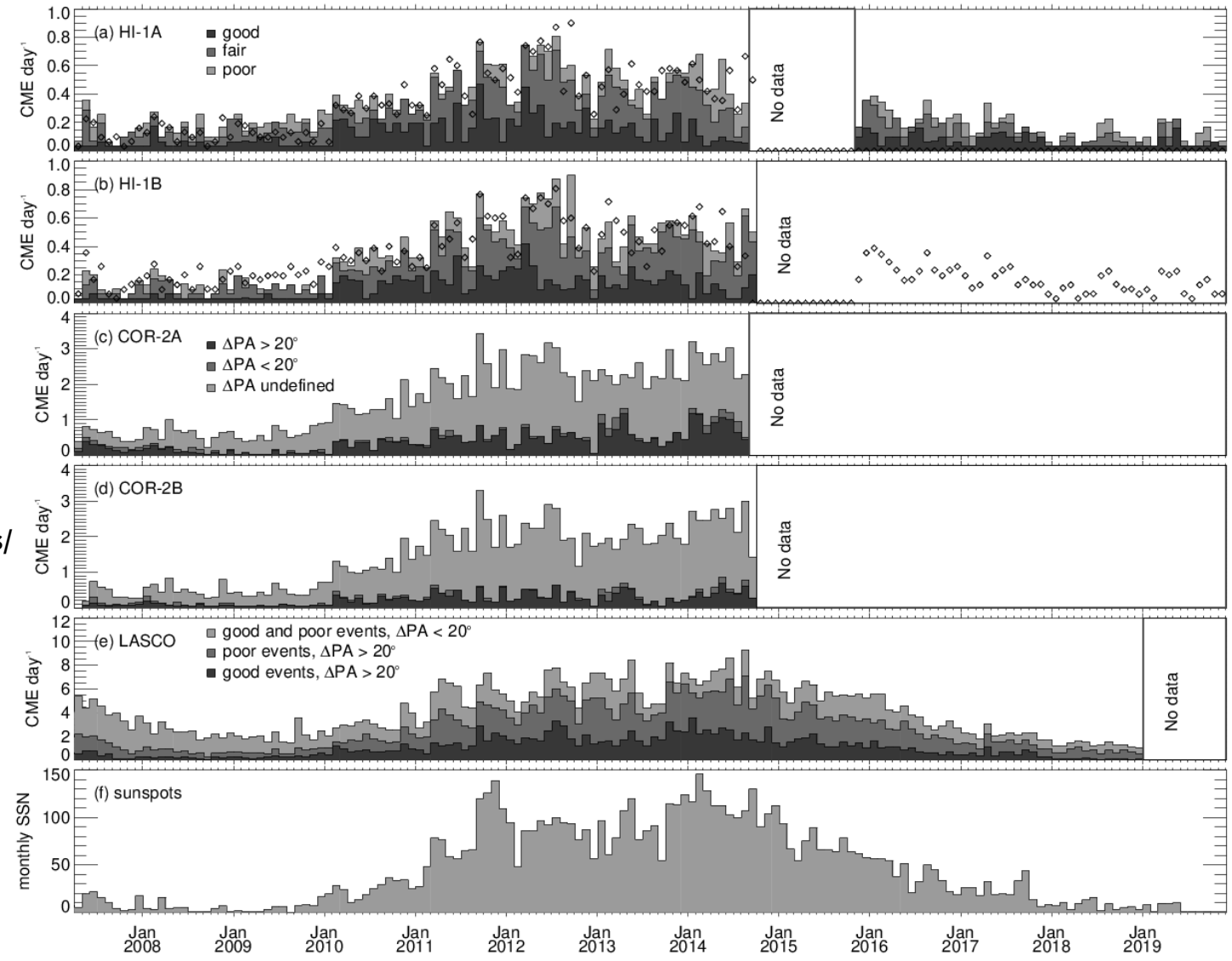
Vourlidas *et al.* 2017

solar.jhuapl.edu/Data-Products/COR-CME-Catalog.php

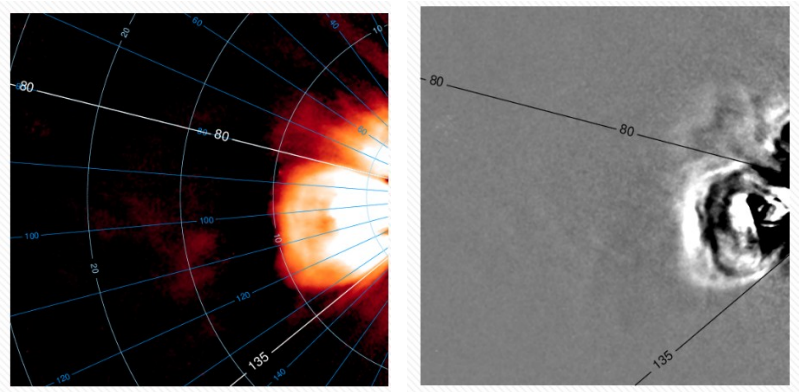
LASCO CDAW

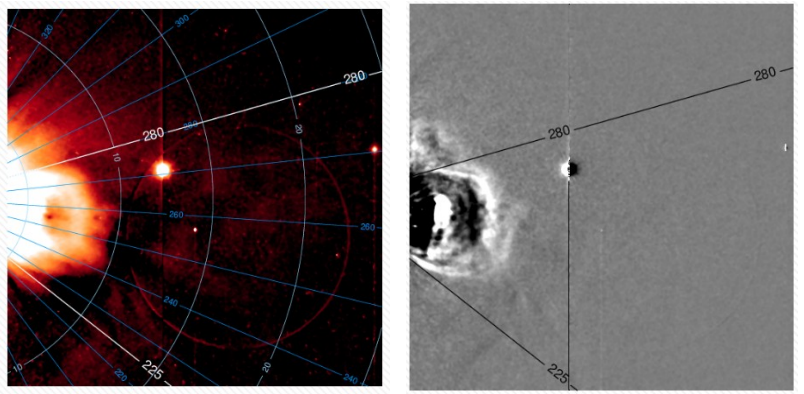
Yashiro *et al.* 2004

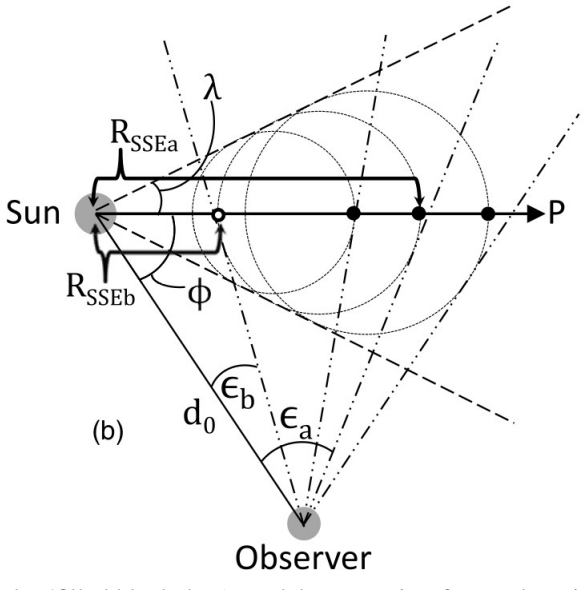
cdaw.gsfc.nasa.gov/CME_list/

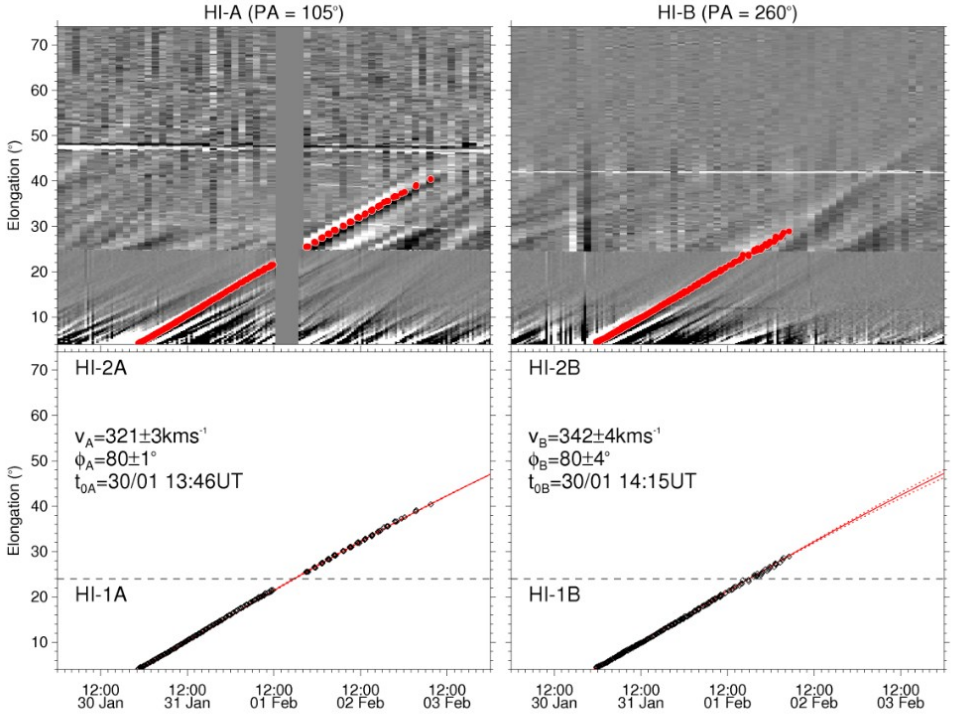


Tracking CMEs in HI



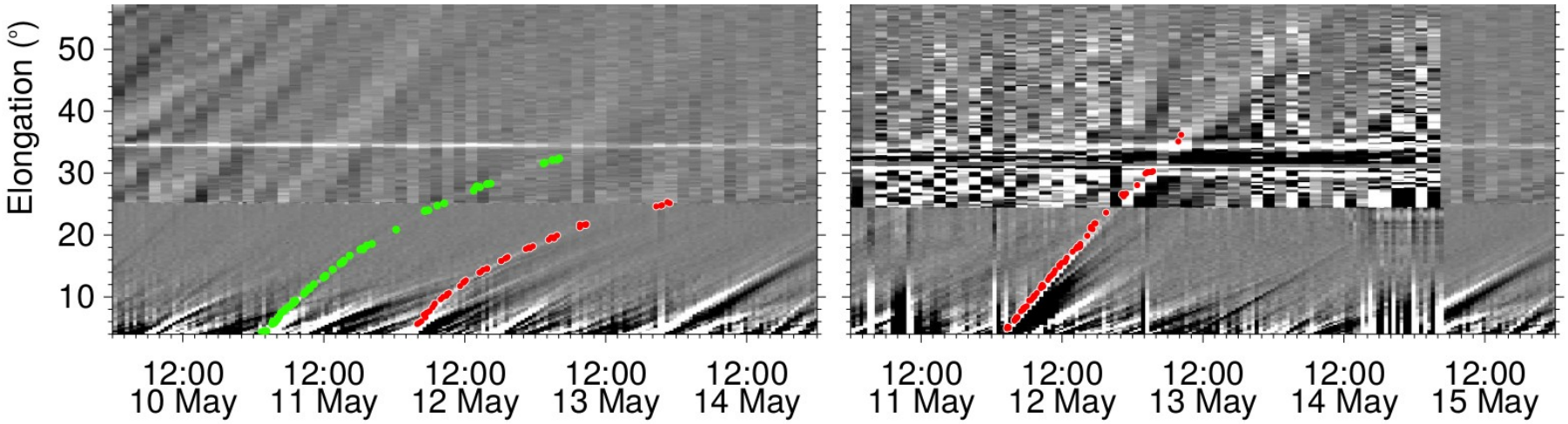


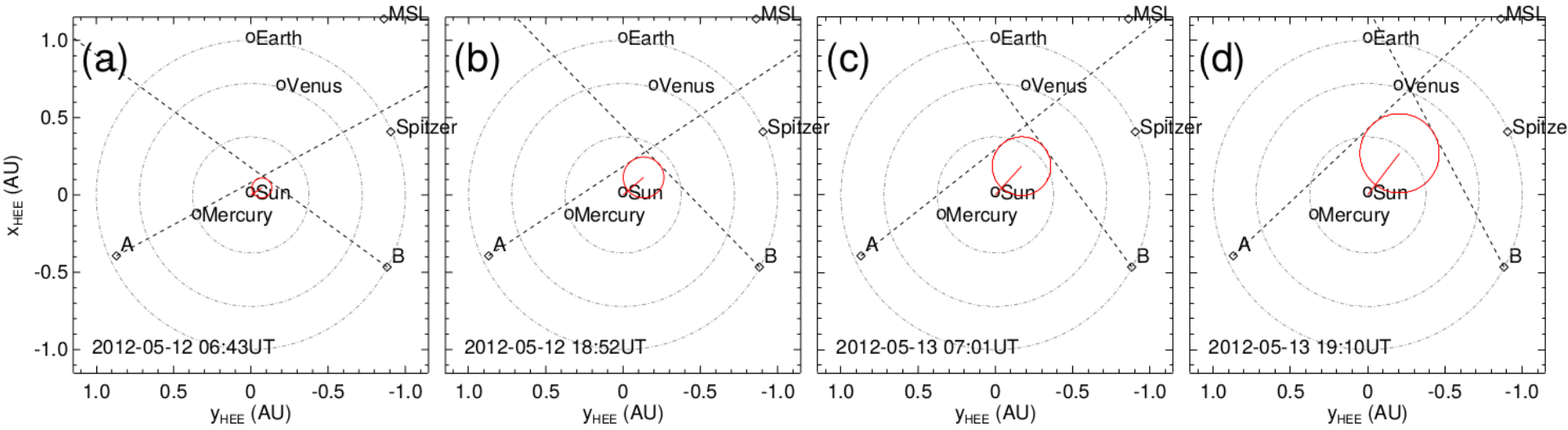




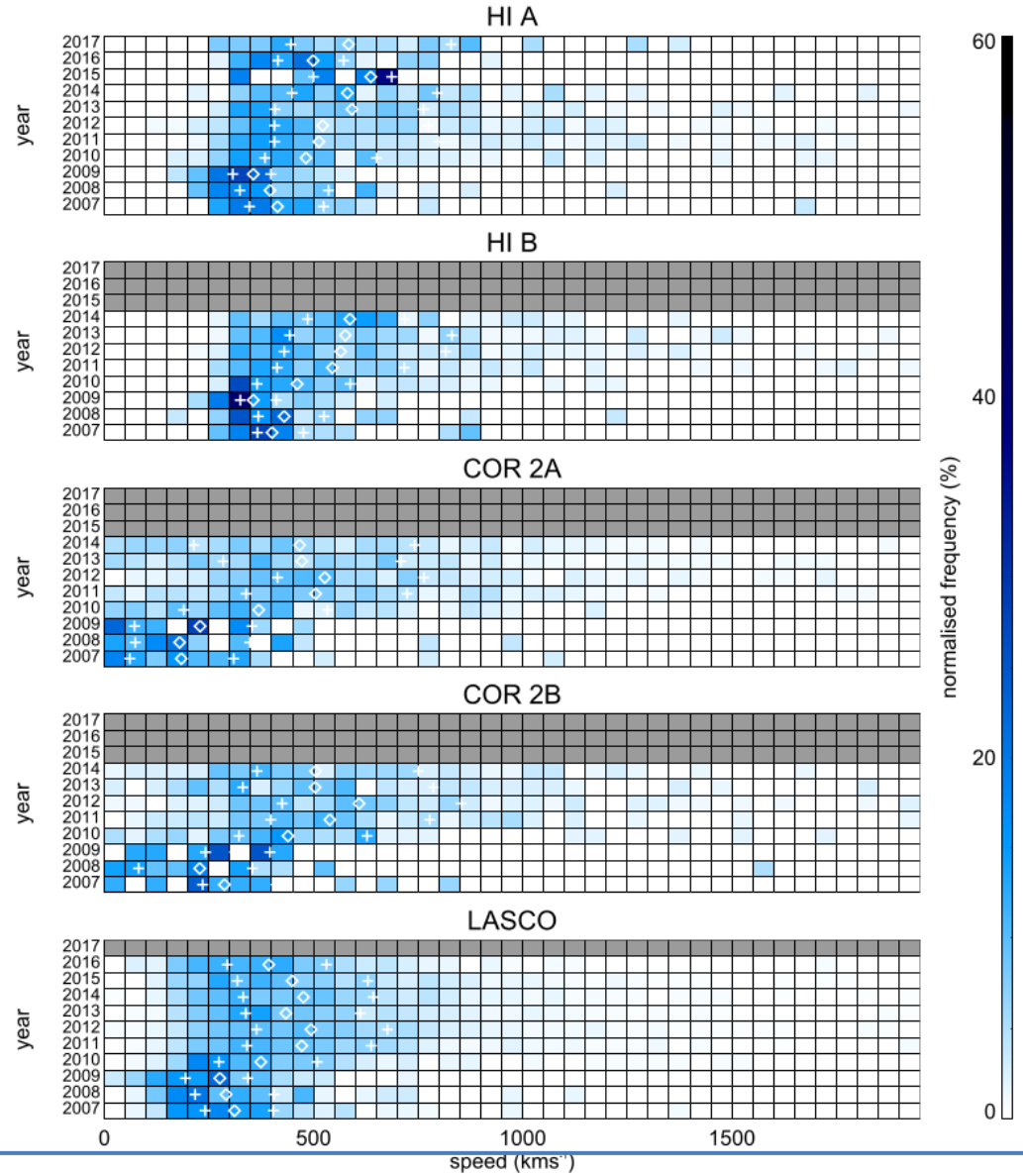
Davies *et al.* 2012

CME Tracking

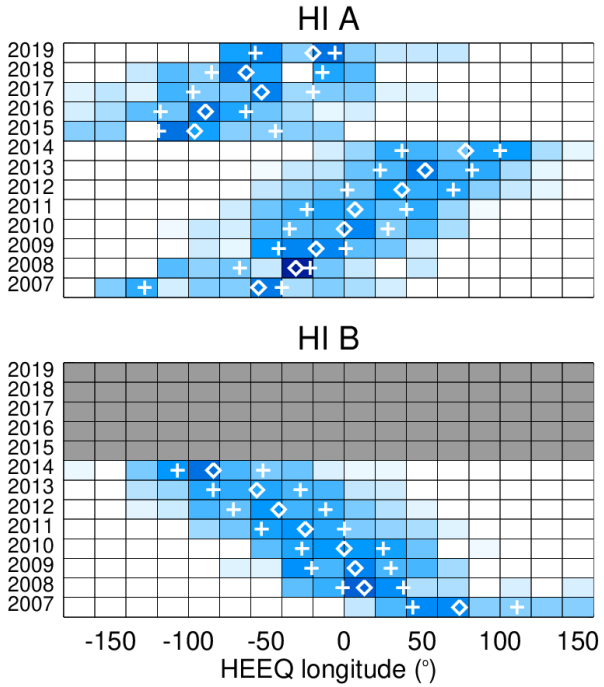




Results – Single spacecraft models



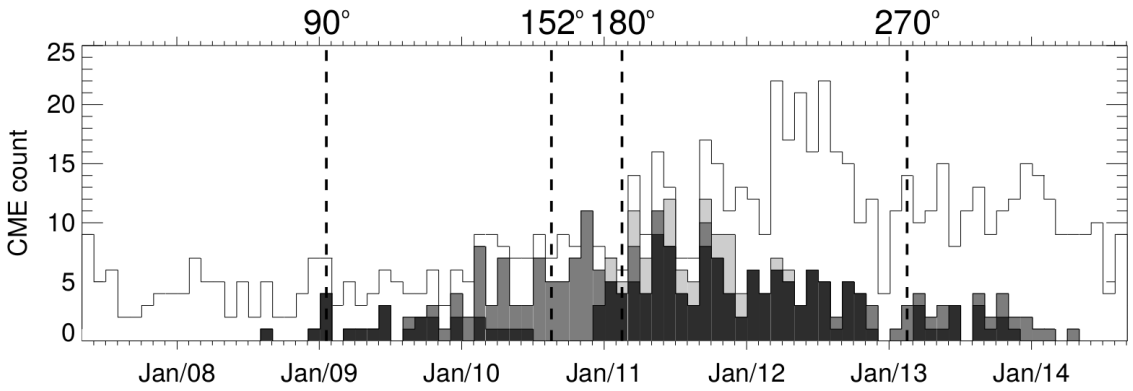
- Speed distributions follow expected solar cycle behaviour
- CME propagation directions are strongly affected by spacecraft position



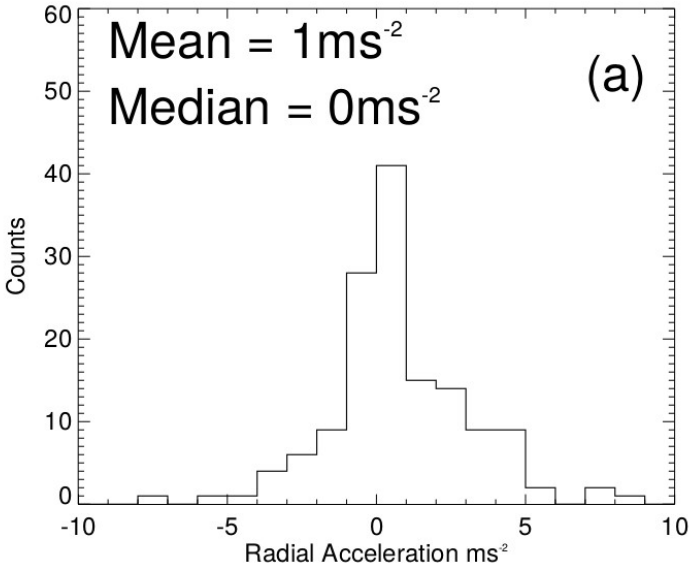
Barnes *et al.* 2019

Results – Stereoscopic models

- A total of 274 CMEs were observed by both spacecraft simultaneously
- A subset of 151 are tracked using SSSE method



- Few CMEs are seen to be significantly accelerating
- 77% are found to have positive acceleration
- CME deflections are also observed but many are found to be unphysical

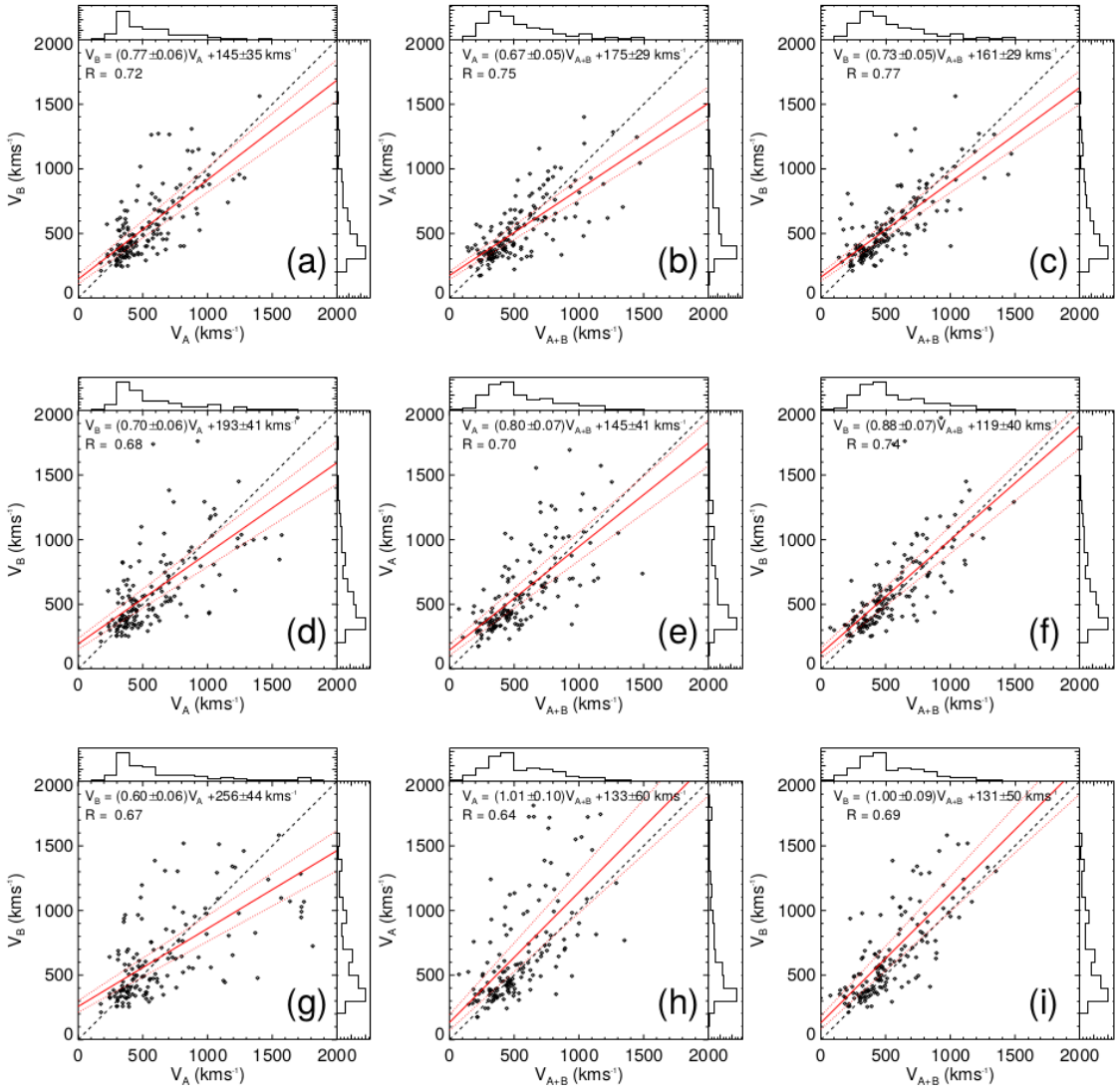


Model Comparison – CME speeds

0° half-width

30° half-width

90° half-width

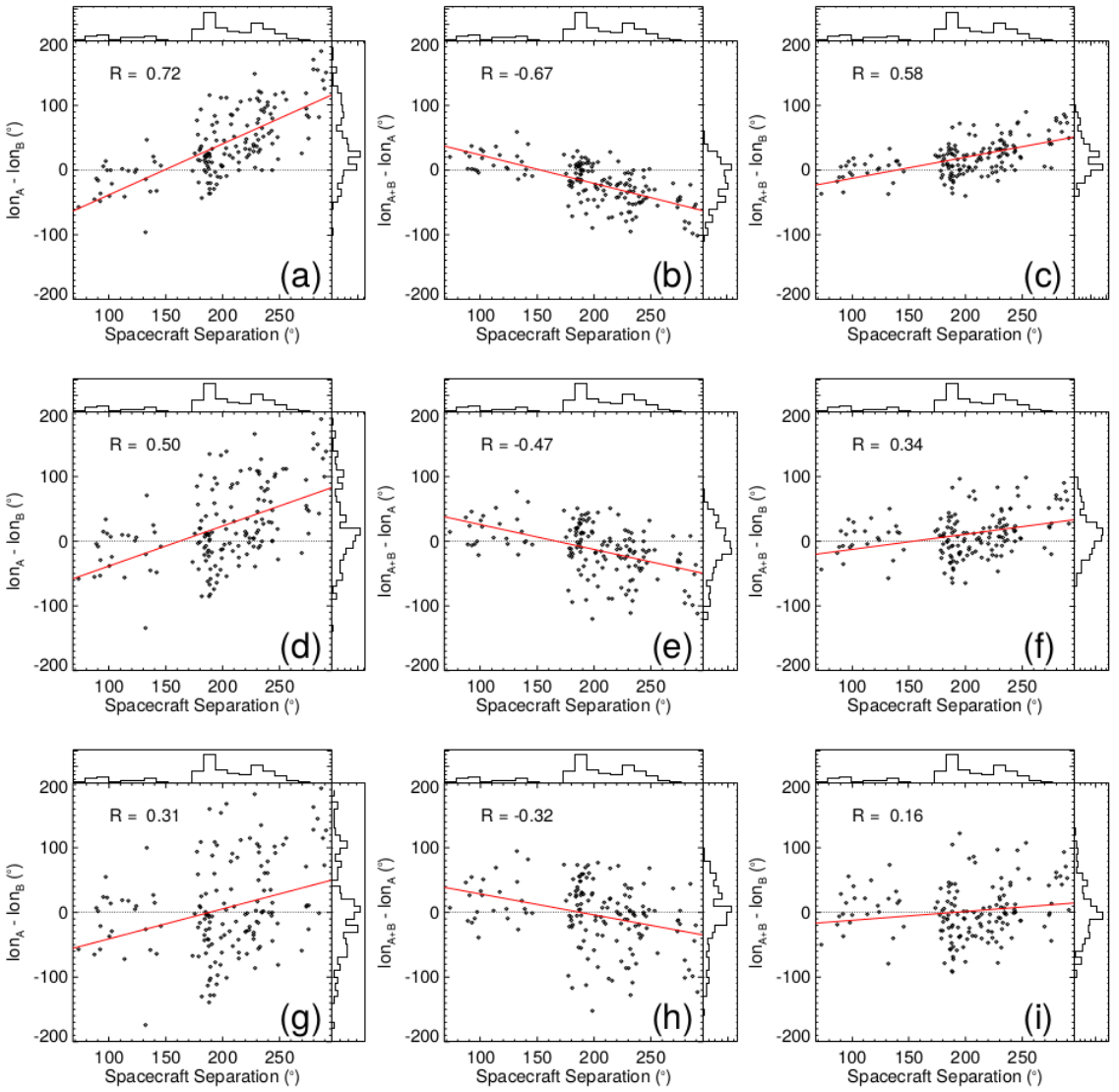


Model Comparison – CME Propagation Directions

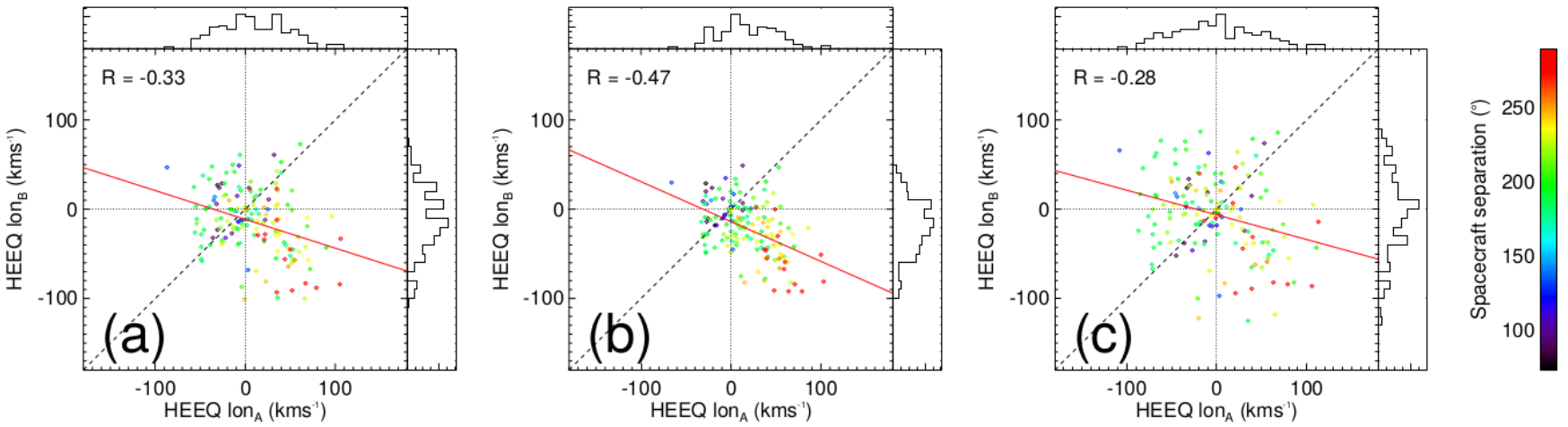
0° half-width

30° half-width

90° half-width



Model Comparison – CME Propagation Directions



- Tracking CMEs using a single spacecraft produces a significant bias in the direction of propagation
- This bias is highly dependent on the spacecraft separation angle
- These are caused by the limited range of the HI-1 FOV and by incorrect assumptions included in the single spacecraft models (constant speed, half-width)

Summary

- A catalogue of >2000 coronal mass ejections has been compiled using observations from the Heliospheric Imagers on the two STEREO spacecraft
- This began in 2008 and now spans well over 11 years, covering an entire solar cycle
- To these CMEs we apply single-spacecraft and stereoscopic modelling to determine kinematic properties (speeds, directions and launch times)
- The results are found to correlate well with existing catalogues and with established solar-cycle behaviour
- A subset of 151 CMEs, observed by both spacecraft, has been modelled using stereoscopic methods
- Single-spacecraft models found to be biased at estimating CME propagation directions and this bias is a function of spacecraft position