HELCATS

UGOE contribution to WP 2

Comparison of CME catalogues

Niclas Mrotzek & UGOE Team

HELCATS BiAM, 3-4 Nov 2015, Helsinki, Finland

Objectives - WP 2, Task 2.3

- To update the STEREO/SECCHI/COR2 CME catalogue, initiated under the SOTERIA FP7 project (& DLR Stereo/Corona, AFFECTS), until the end of 2011 (including the application of forward modelling to the appropriate CMEs)

- Comparison of HI – COR2 catalogues

→ WP3

To compare the results from the geometrical and forward modelling of HI CMEs with the modelling results for COR2

To prototype the use of inverse modelling to derive typical HI CME parameters (speed, size, mass), for photospheric and low coronal source regions typically associated with CMEs

Development of COR2 CME list

Selection Criteria

- Based on clarity of CME appearance in STEREO/SECCHI/COR2 FOV (2.5 – 15 R_s)

Best-Of CMEs

- List with 1071 events until end of 2011 established

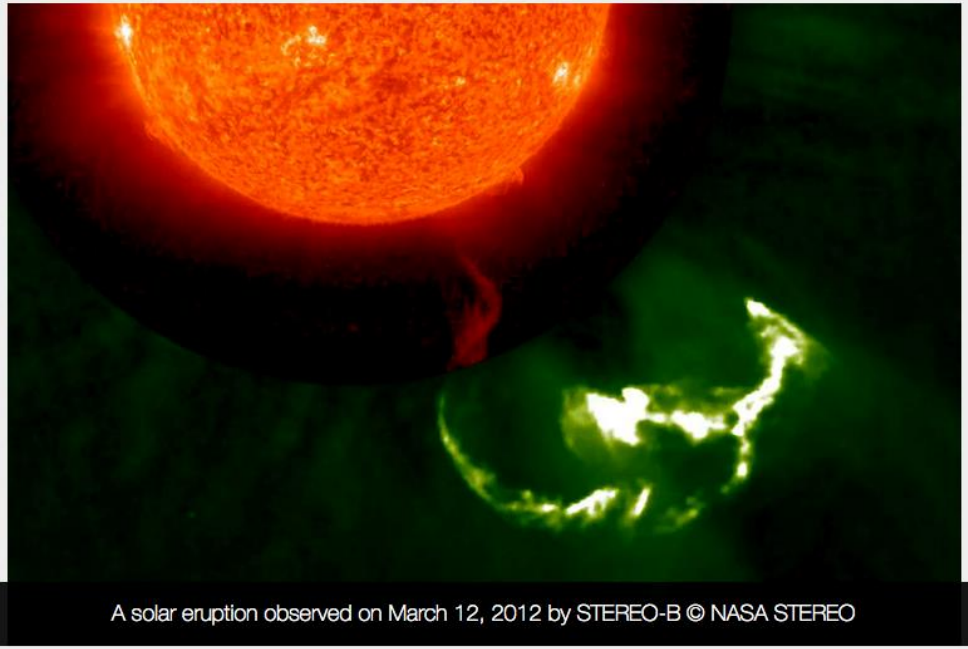
CME-Modeling

- 241 “best-of CMEs” studied by GCS modelling (Thernisien, Howard, Vourlidas, 2006) based on 3-D concept for CMEs (derived by Cremades & Bothmer , 2004)

All results are available online @ www.affects-fp7.eu/cme-database/

COR2 CME list

Institute for Astrophysics Göttingen | Home | Background | Database | People | Credits | Links | Contact



A solar eruption observed on March 12, 2012 by STEREO-B © NASA STEREO

Coronal Mass Ejection Database

Welcome to the STEREO/SECCHI/COR2 CME-Database of the Institute for Astrophysics, University of Goettingen, Germany. This site provides currently information on identified CMEs in the SECCHI/COR2 synoptic movies available at the NRL SECCHI website in the SECCHI/COR2 field of view at distances between 2 - 15 solar radii. Since launch of the STEREO mission in October 2006, 1071 bright above the coronal background appearing CMEs were identified from January 2007 until end of December 2011. For these events the database contains information about basic CME properties comparable to the SOHO/LASCO CME catalog and spacecraft positions. Out of a selected set of 264 CMEs, which appeared very clear in brightness and structure, 241 ot them were analyzed with the Graduated Cylindrical Shell (GCS) modeling technique developed by Thernisien, Vourlidas and Howard in 2006 based on the 3D CME scheme introduced by Cremades and Bothmer in 2004.

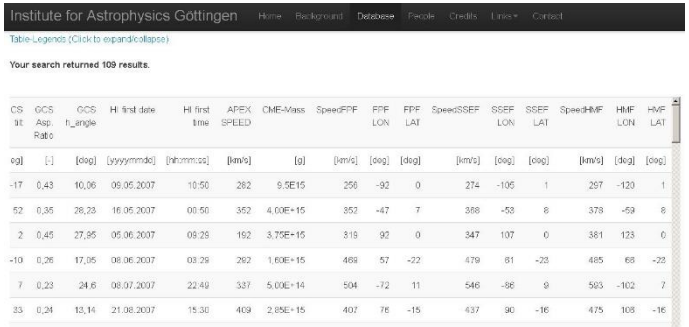
COR2 CME online database @ http://www.affects-fp7.eu/cme-database/ – implementation into HELCATS website catalogues

Institute for Astrophysics Göttingen | Home | Background | Database | People | Credits | Links | Contact

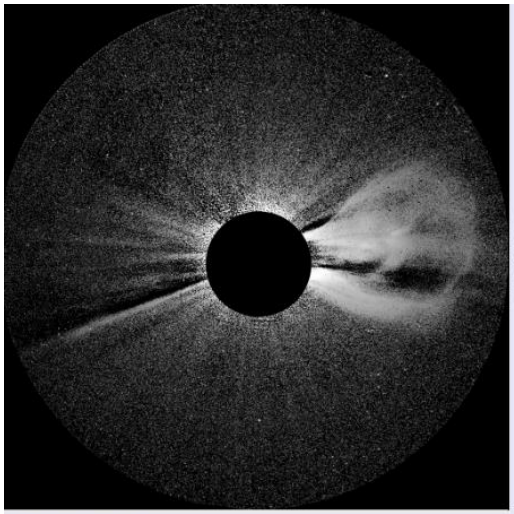
Table-Legends (Click to expand/collapse)

Your search returned 109 results.

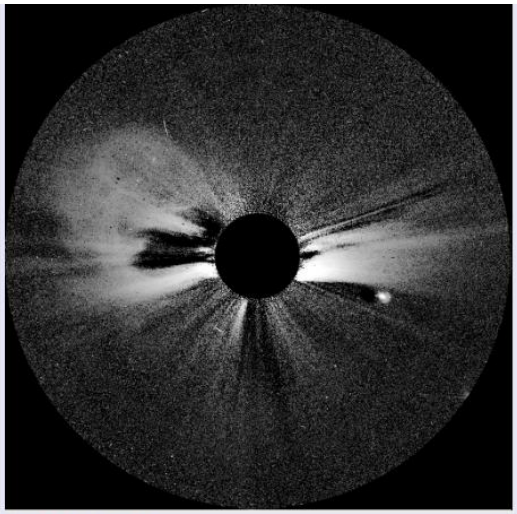
HEL no	CME no	Preevent date	Preeevent time	Last Cor2 date	Last Cor2 time	GCS carlon	GCS stoney lon	GCS lat	GCS tilt	GCS Asp. Ratio	GCS h_angle	HI first date	HI first time	APEX SPEED
[-]	[-]	[yyyymmdd]	[hh:mm:ss]	[yyyymmdd]	[hh:mm:ss]	[deg]	[lon,old]	[deg]	[deg]	[-]	[deg]	[yyyymmdd]	[hh:mm:ss]	[km/s]
1	35	09.05.2007	02:22:30	09.05.2007	12:52:30	88	-116	1	-17	0,43	10,06	09.05.2007	10:50	282
2	38	15.05.2007	18:52:30	16.05.2007	01:22:30	39	-79	13	52	0,35	28,23	16.05.2007	00:50	352
3	49	04.06.2007	17:00:00	05.06.2007	09:23:59	320	111	-10	2	0,45	27,95	05.06.2007	09:29	192
4	50	07.06.2007	18:30:00	08.06.2007	03:54:00	240	68	-12	-10	0,26	17,05	08.06.2007	03:29	292
5	60	08.07.2007	16:52:30	09.07.2007	00:52:30	55	-69	-8	7	0,23	24,6	08.07.2007	22:49	337
6	71	21.08.2007	07:00:00	21.08.2007	14:23:00	25	118	-13	33	0,24	13,14	21.08.2007	15:30	409



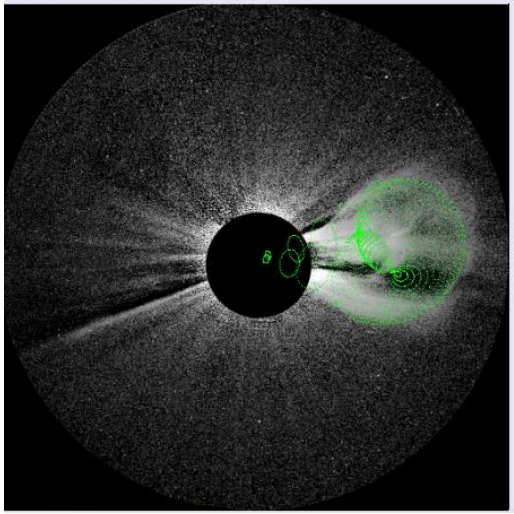
Sample STEREO/SECCHI/COR2 CME GCS Forward Modelling – December 12, 2008, 14:22 UT

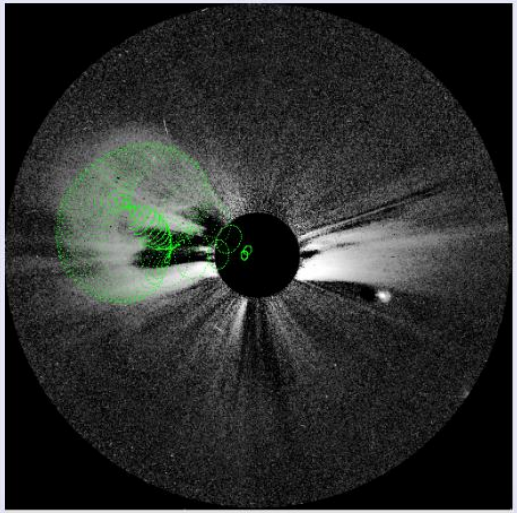


COR2B white-light Coronagraph image



COR2A white-light Coronagraph image





The Fitting with the GCS Forward-Modeling Code yields the following results.

GCS Fit-Parameter from Modeling:
Carrington Longitude: **70.434**
Carrington Latitude: **5.031**
Tilt Angle: **50.870**
Height: **16.071**
Ratio: **0.268**
Half Angle: **10.061**

Timestamp of used COR2-Images for Modeling: **20081212 14:22:00**
#formatting: yyyymmdd hhmmss

Courtesy: E. Bosman

HI CME lists with modelling results for STEREO A and B

```
# Header
#
# Time (UT) // that the CME is first observed in the HI-1 FOV // [yyyy-mm-dd hh:mm]
# Spacecraft [A or B]
# Northernmost position angle of CME [degrees]
# Southernmost position angle of CME [degrees]
# Potential Halo [yes or no]
# "CME"ness (0, 1, or 2 where 2 is unambiguously a CME)
# PA // along which time-elongation profile is extracted in degrees
#       (-999 in this, and subsequent, records means that no time-elongation profile was extracted,
#        and hence no fitting was done)
#
# Speed [km/s], method (FPF)
# HEEQ Longitude in degrees (FPF)
# HEEQ Latitude in degrees (FPF)
#
# Speed [km/s] (SSEF: lambda=30 degrees)
# HEEQ Longitude in degrees (SSEF: lambda=30 degrees)
# HEEQ Latitude in degrees (SSEF: lambda=30 degrees)
#
# Speed in km/s (HMF)
# HEEQ Longitude in degrees (HMF)
# HEEQ Latitude in degrees (HMF)
#
#
#
```

# date	time	S/C	PAn	PAs	Halo	CME	PA	Speed	LonFPF	LatFPF	SpeedSSEF	LonSSEF	LatSSEF	SpeedHMF	LonHMF	LatHMF
2007-04-15	15:30	A	40	90	No	0	65	304	-42	15	312	-36	13	317	-31	10
2007-04-17	15:30	A	95	130	No	0	100	316	-78	-11	334	-89	-10	351	-101	-8
2007-04-19	10:50	A	50	140	No	2	95	359	-42	-7	370	-36	-7	379	-30	-7
2007-05-01	15:30	A	65	105	No	1	90	279	-93	0	295	-105	1	315	-118	2
2007-05-09	10:50	A	50	125	No	1	90	256	-92	0	274	-105	1	297	-120	1
2007-05-15	04:10	A	35	80	No	0	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999
2007-05-16	00:50	A	35	125	No	2	80	352	-47	7	368	-53	8	378	-59	8
2007-05-18	00:10	A	95	125	No	1	110	562	-75	-20	592	-88	-20	624	-101	-19
2007-05-21	22:10	A	60	140	No	2	100	329	-74	-10	338	-81	-10	347	-89	-9
2007-05-23	21:30	A	50	100	No	1	75	233	-53	12	237	-49	12	240	-45	11
2007-05-29	23:29	A	60	140	No	1	100	373	-68	-10	385	-76	-10	397	-84	-10
2007-06-10	10:49	A	100	125	No	1	115	391	-79	-24	417	-91	-23	448	-103	-22
2007-06-12	12:49	A	60	105	No	2	80	305	-55	10	309	-59	10	312	-63	10
2007-06-25	06:09	A	60	110	No	0	75	260	-117	10	315	-139	5	409	-166	-2
2007-07-08	22:49	A	50	125	No	2	80	504	-72	11	546	-86	9	593	-102	7
2007-07-11	02:09	A	60	110	No	2	90	362	-54	2	373	-50	2	385	-46	2
2007-07-13	02:49	A	50	90	No	1	70	318	-66	21	326	-74	20	333	-82	20
2007-07-14	02:09	A	80	135	No	1	80	406	-76	10	450	-93	8	502	-111	6
2007-07-16	11:29	A	95	135	No	1	115	423	-43	-18	435	-48	-20	443	-54	-21
2007-07-29	04:49	A	50	90	No	1	70	372	-80	20	392	-92	18	414	-104	15
2007-08-08	22:49	A	55	110	No	1	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999

STEREO/SECCHI/HI-1A

2007-2013: 821 events

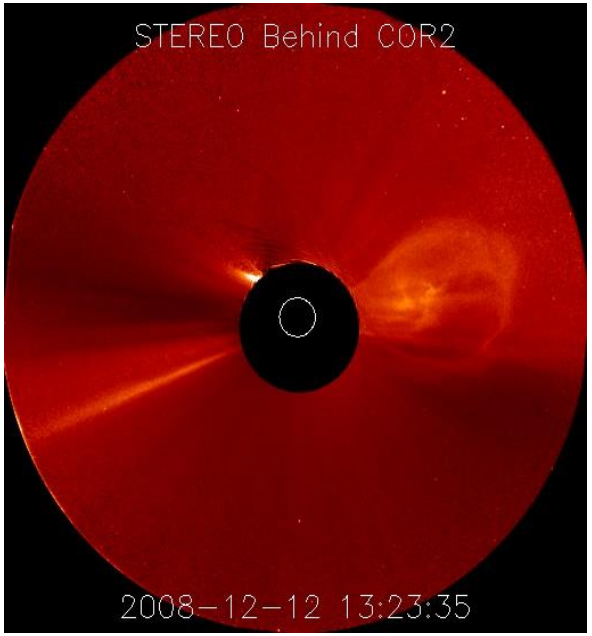
2007-2011: 496 events, 197 definite ones

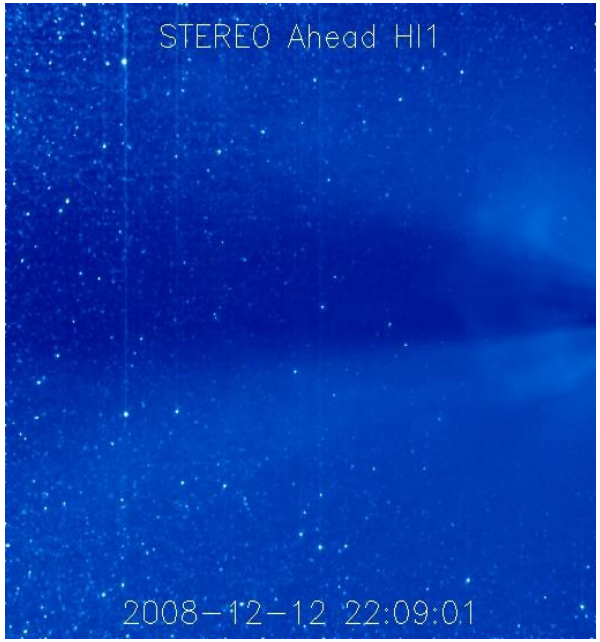
STEREO/SECCHI/HI-1B

2007-Jun 2013: 698 events, 226 def. ones

2007-2011: 399 events, 136 definite ones

HI – COR2 CME comparison





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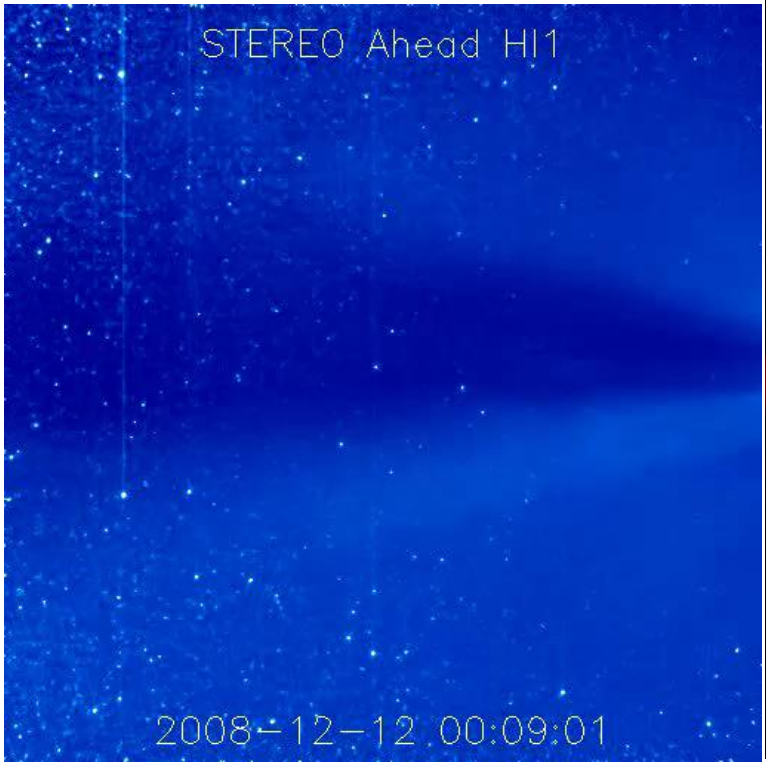
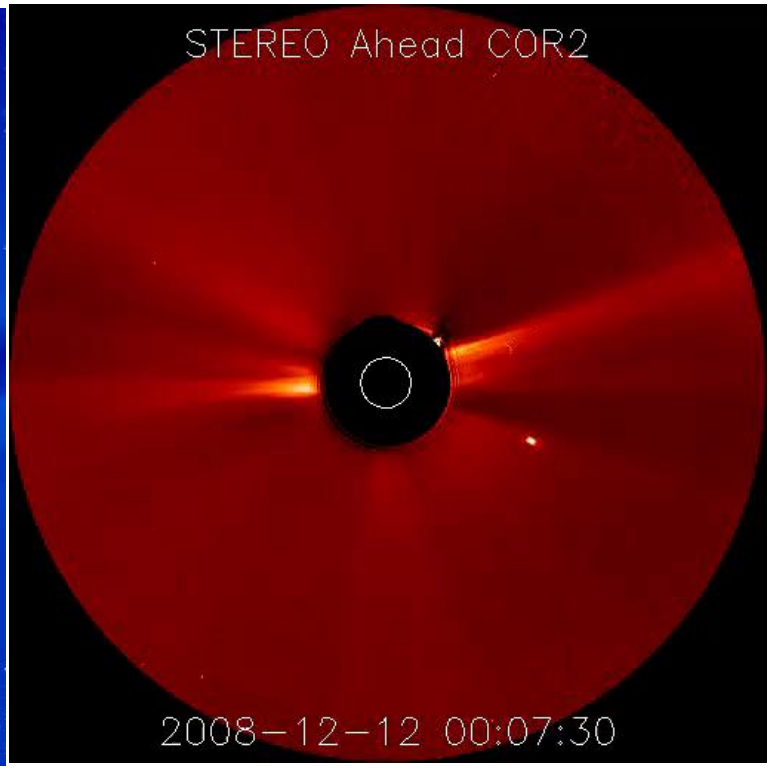
RAL

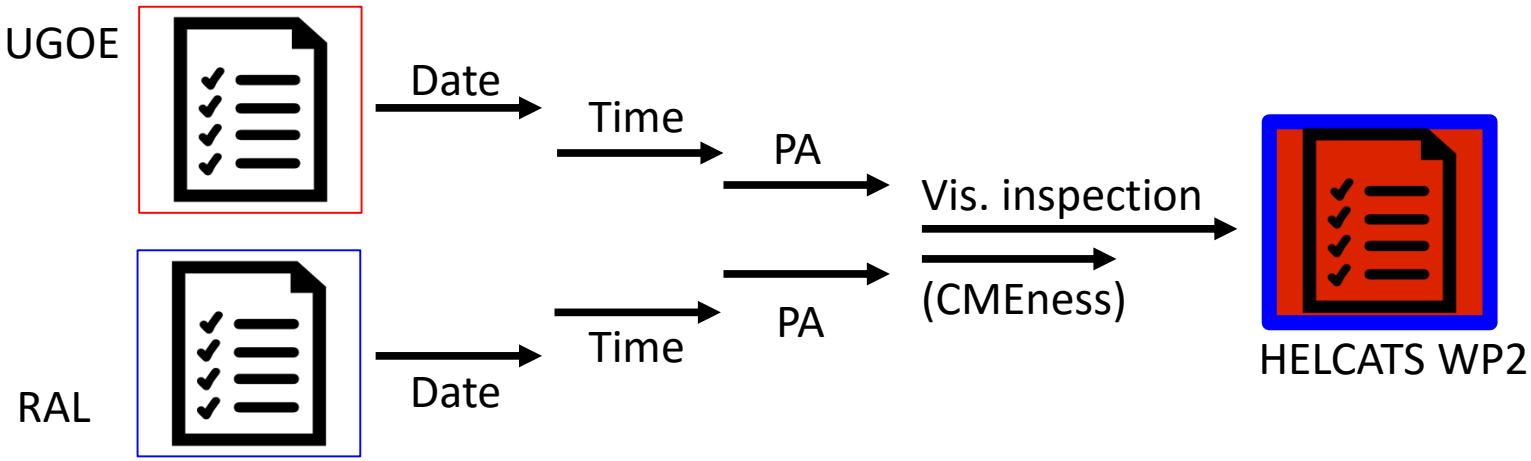
COR2 list 2007-2011
STEREO A&B

HELCATS

HI list 2007-2013
STEREO A&B


STEREO Ahead HI1
2008-12-12 00:09:01


STEREO Ahead COR2
2008-12-12 00:07:30


UGOE
Date
Time
PA
Vis. inspection
(CMEness)
HELCATS WP2
RAL
Date
Time
PA

```
# Header
#
# Time (UT) // that the CME is first observed in the HI-1 FOV // [yyyy-mm-dd hh:mm]
# Spacecraft [A or B]
# Northernmost position angle of CME [degrees]
# Southernmost position angle of CME [degrees]
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# PA // along which time-elongation profile is extracted in degrees
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#
# Speed [km/s], method (FPF)
# HEEQ Longitude in degrees (FPF)
# HEEQ Latitude in degrees (FPF)
#
# Speed [km/s] (SSEF: lambda=30 degrees)
# HEEQ Longitude in degrees (SSEF: lambda=30 degrees)
# HEEQ Latitude in degrees (SSEF: lambda=30 degrees)
#
# Speed in km/s (HMF)
# HEEQ Longitude in degrees (HMF)
# HEEQ Latitude in degrees (HMF)
#
# Cor: Visibility in Cor 2 A. Crosscheck with CME-List-Bosman. Running internal number.
#
#
# date»  »       time    S/C   PAn   PAs   Halo  CME    PA    Speed   LonFPF  LatFPF SpeedSSEF LonSSEF LatSSEF SpeedHMF LonHMF LatHMF   Cor      date          time
 2007-04-15»    15:30     A    40    90     No    0     65     304     -42      15     312      -36      13      317     -31      10              2007-04-15    07:30
 2007-04-17»    15:30     A    95   130     No    0    100     316     -78     -11     334      -89     -10      351    -101      -8      29      2007-04-17    06:07
 2007-04-19»    10:50     A    50   140     No    2     95     359     -42      -7     370      -36      -7      379     -30      -7      30
 2007-05-01»    15:30     A    65   105     No    1     90     279     -93       0     295     -105       1      315    -118       2      31
 2007-05-09»    10:50     A    50   125     No    1     90     256     -92       0     274     -105       1      297    -120       1      35
 2007-05-15»    04:10     A    35    80     No    0   -999    -999    -999    -999    -999     -999    -999     -999    -999    -999
 2007-05-16»    00:50     A    35   125     No    2     80     352     -47       7     368      -53       8      378     -59       8      38
 2007-05-18»    00:10     A    95   125     No    1    110     562     -75     -20     592      -88     -20      624    -101     -19              2007-05-17    14:22
 2007-05-21»    22:10     A    60   140     No    2    100     329     -74     -10     338      -81     -10      347     -89      -9      40
 2007-05-23»    21:30     A    50   100     No    1     75     233     -53      12     237      -49      12      240     -45      11      43
 2007-05-29»    23:29     A    60   140     No    1    100     373     -68     -10     385      -76     -10      397     -84     -10              2007-05-29    15:37
 2007-06-10»    10:49     A   100   125     No    1    115     391     -79     -24     417      -91     -23      448    -103     -22              2007-06-10    09:07
 2007-06-12»    12:49     A    60   105     No    2     80     305     -55      10     309      -59      10      312     -63      10      52
 2007-06-25»    06:09     A    60   110     No    0     75     260    -117      10     315     -139       5      409    -166      -2      No
 2007-07-08»    22:49     A    50   125     No    2     80     504     -72      11     546      -86       9      593    -102       7      60
 2007-07-11»    02:09     A    60   110     No    2     90     362     -54       2     373      -50       2      385     -46       2      63
 2007-07-13»    02:49     A    50    90     No    1     70     318     -66      21     326      -74      20      333     -82      20              2007-07-12    12:22
```

UGOE

RAL

COR2 list 2007-2011
STEREO A&B

HIsCORCAT
(**HI s**yncronized with **COR CAT**)

HI list 2007-2013
STEREO A&B

Results:

- **STEREO A:** 260 of 496 HI events are included in the COR2 list 2007-2011
  - 1 event not visible in COR2 A but in B
- **STEREO B:** 278 of 399 HI events are included in the COR2 list 2007-2011

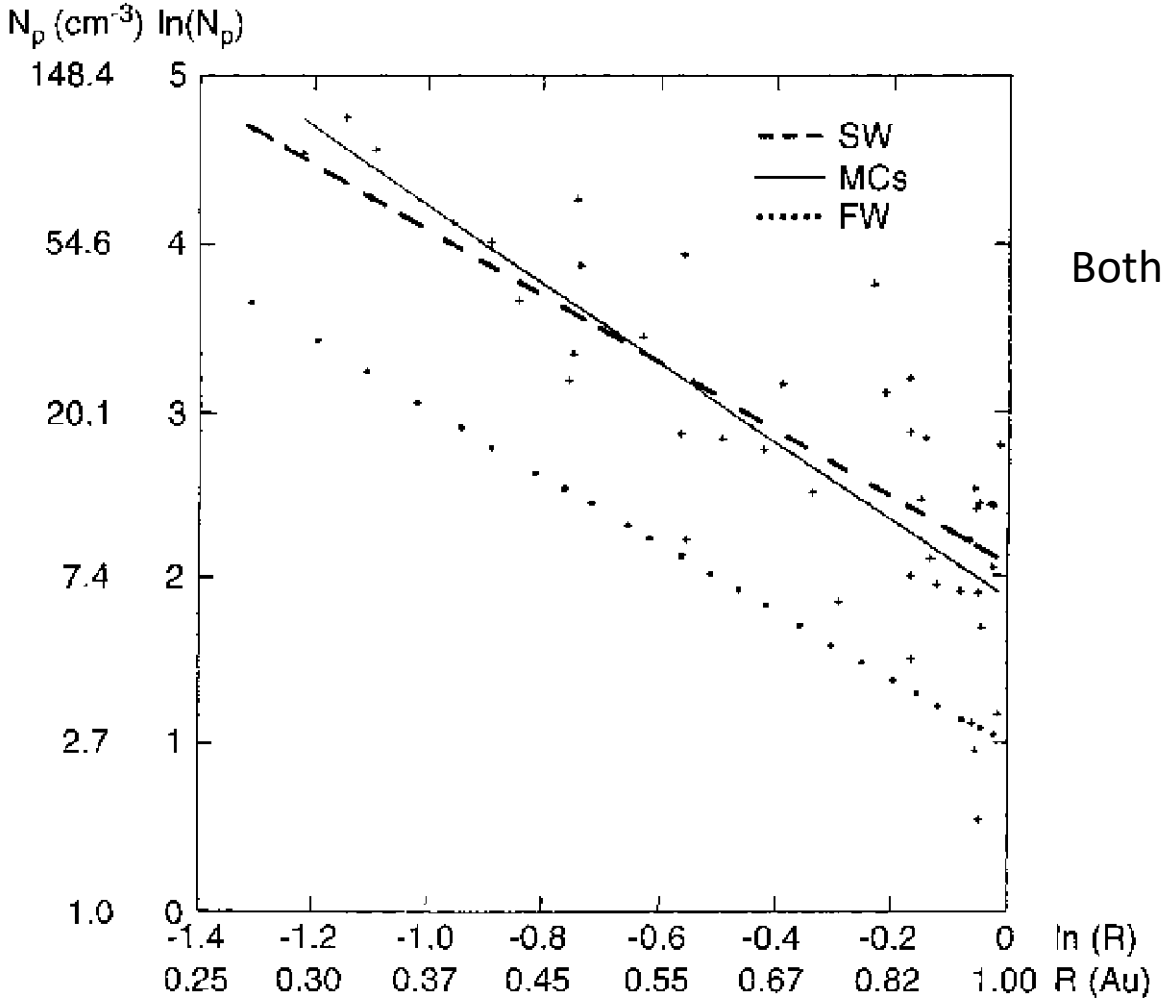
Every CME visible in HI was also visible in COR2

Seems trivial but:

- CME expansion and density decrease are different compared to slow and fast wind streams as indicated by analsis of Helios data.
- Influence of Thomson sphere.
- Near Sun brightness of coronal streamers may obscure faint CMEs.

Results:

Helios: MC type CME, HSS, SW density evolution

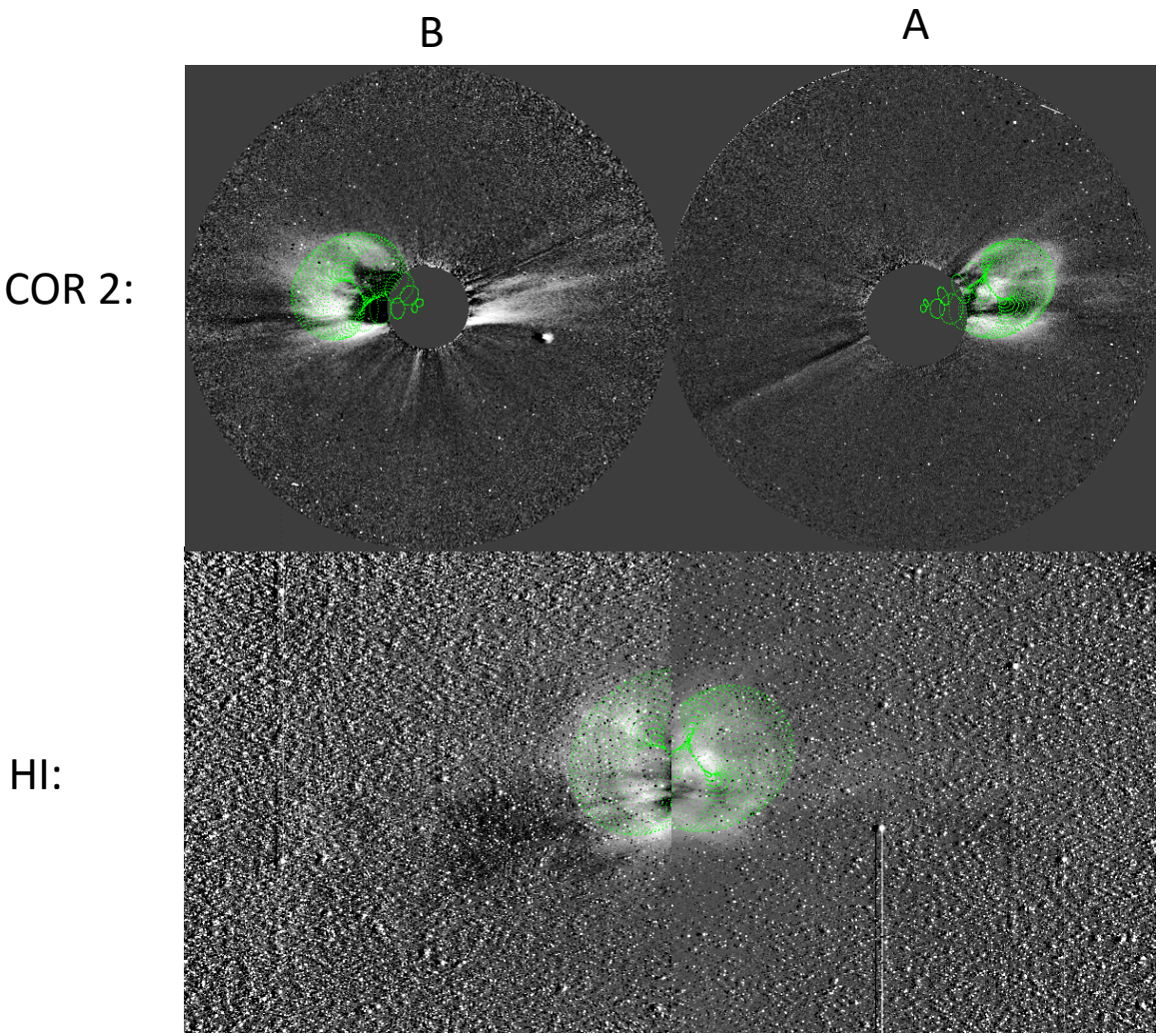


Bothmer & Schwenn, 1998

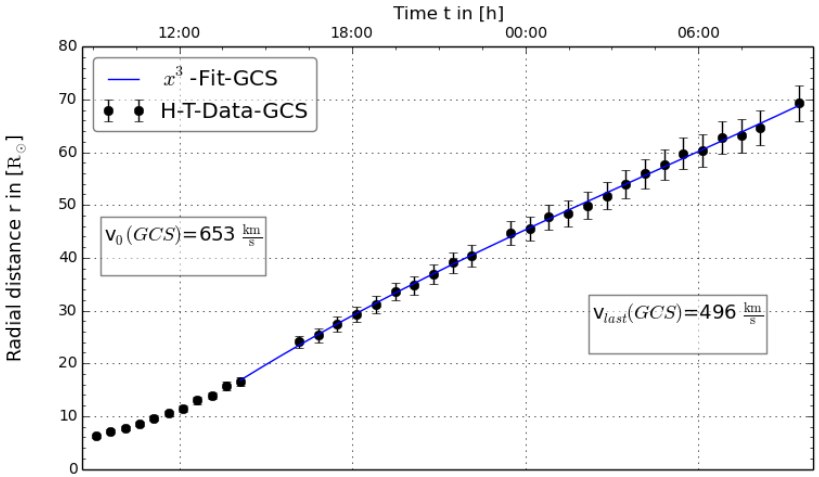
@ 0.3 au:
SW: ~ 70 p
FW: ~ 40 p
MC CMEs: ~ 100 p

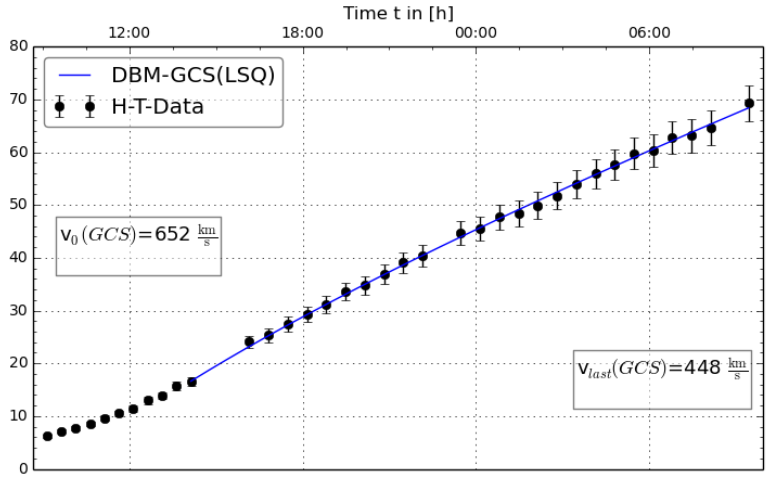
@ 0.046 au:
SW: ~ 6300 p
FW: ~ 3600 p
MC CMEs: 9000 p

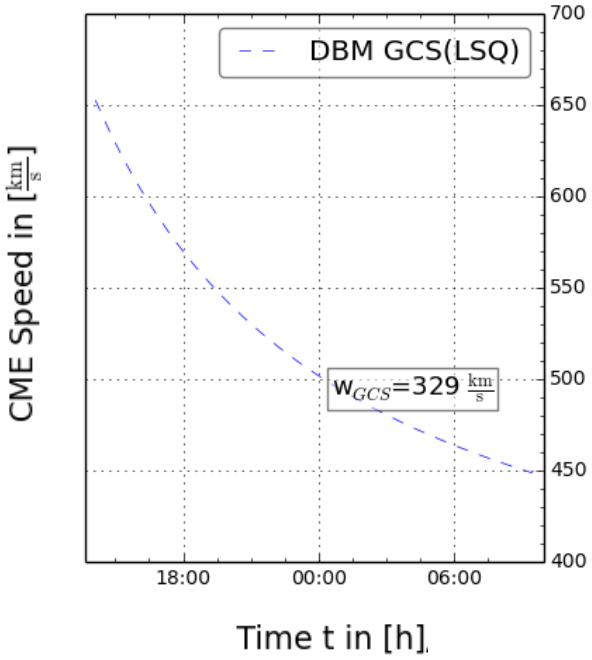
Outline:



2008-12-12







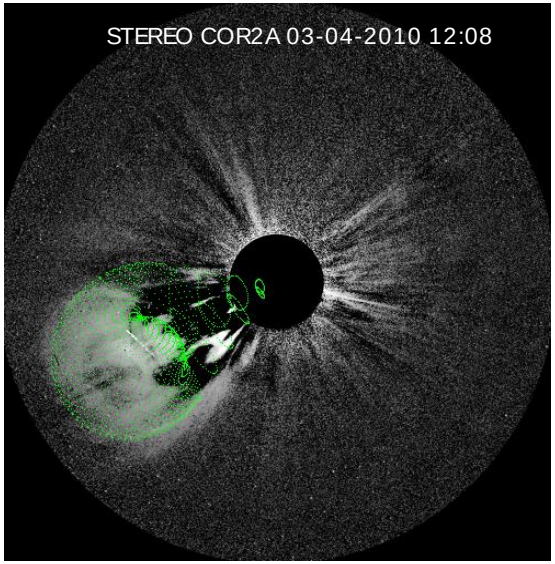
<u>HI-Speeds:</u>

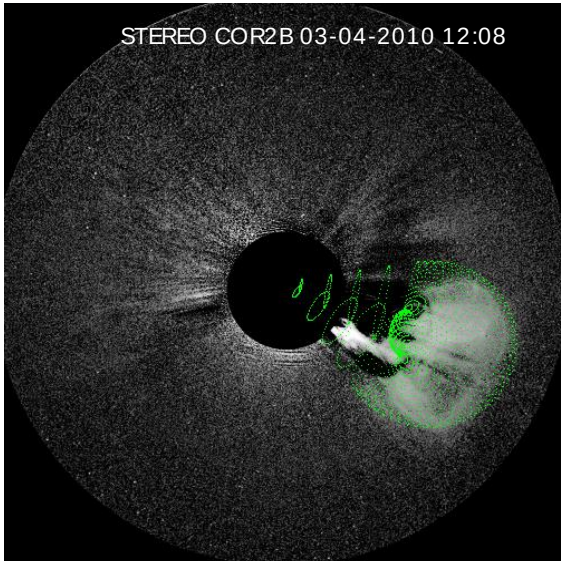
456 $^{km}/_{s}$ (FPF)

470 $^{km}/_{s}$ (SSEF)

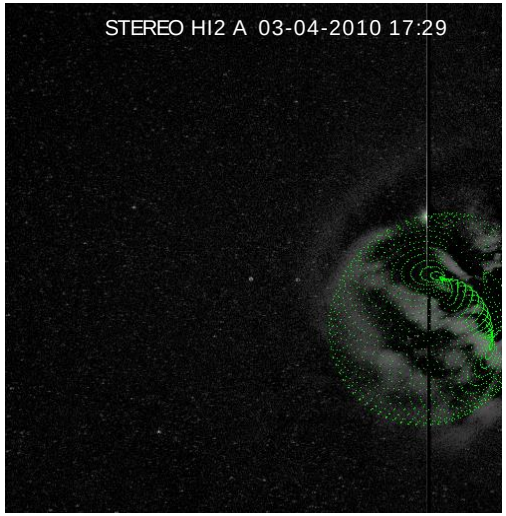
481 $^{km}/_{s}$ (HMF)

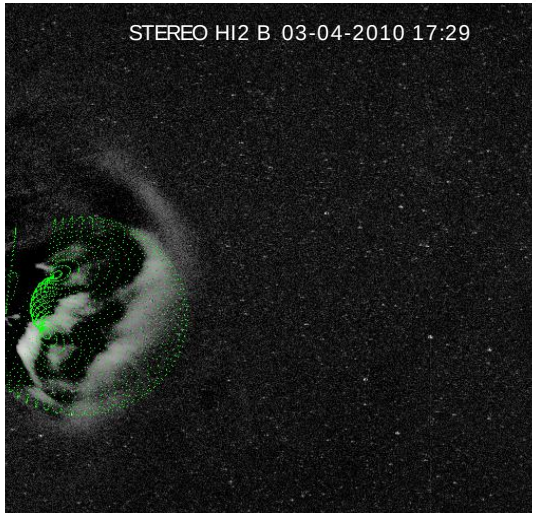
L. Volpes, E. Bosman, V. Bothmer



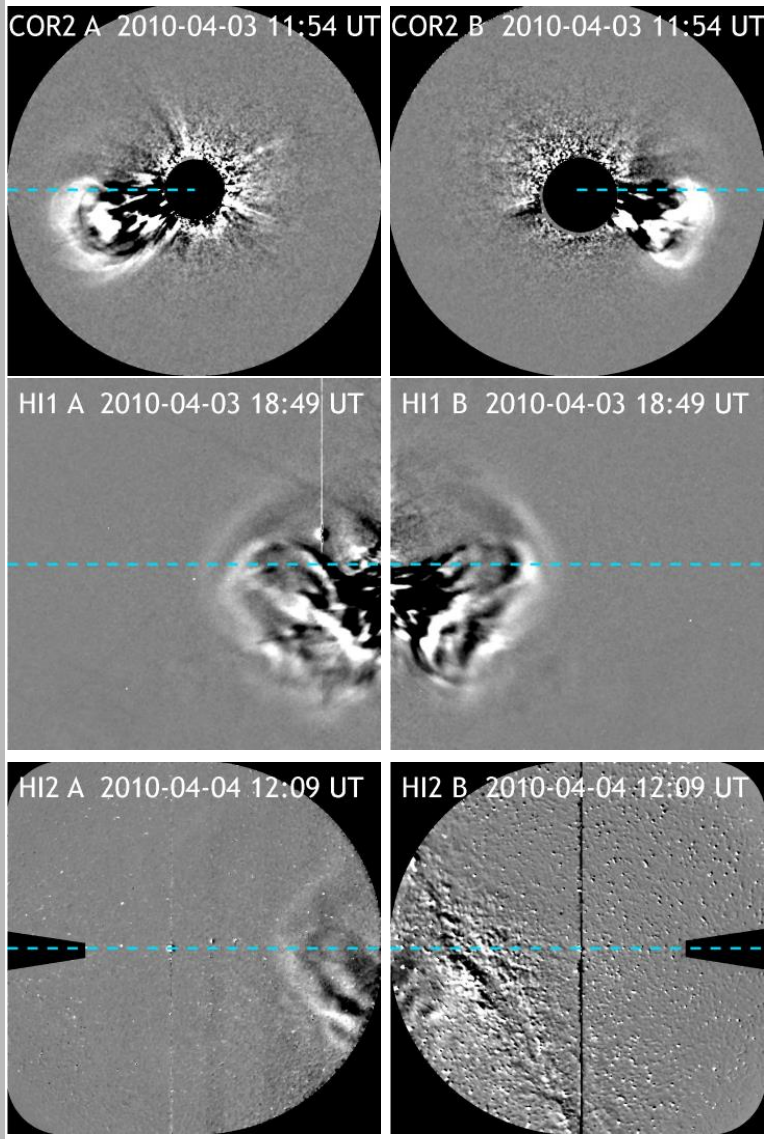


COR2 modeling courtesy of E. Bosman





An Application of the Stereoscopic Self-Similar-Expansion Model of the Determination of CME-Driven Shock Parameter



WISPR will image and detect in-situ CME shocks

	ACE	1st degree fit $\lambda = 10°$	1st degree fit $\lambda = 90°$
Standoff distance	*19* $R_\odot$	*30* $R_\odot$	*26* $R_\odot$
Mach number	*2.2*	*1.38*	*3.26*
Compression ratio	*2.84*	*0.75*	*2.82*

	ACE	2nd degree fit $\lambda = 10°$	2nd degree fit $\lambda = 90°$
Standoff distance	*19* $R_\odot$	*29* $R_\odot$	*26* $R_\odot$
Mach number	*2.2*	*1.41*	*3.46*
Compression ratio	*2.84*	*0.78*	*2.91*

Volpes & Bothmer, 2015 Sol. Physics