HELCATS

WP 3

Deriving/cataloguing the kinematic properties of STEREO/HI CMEs based on geometrical and forward modelling

Overview

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HELCATS AM, 3-4 November 2015, Helsinki, Finland

WP 3 - Objectives

- To obtain the kinematic properties for the STEREO/HI CMEs in the catalogue established in WP2, through application of geometrical and forward-modelling techniques to the HI data
- To augment the STEREO/HI CME catalogue with the model results, and supply those results as input for comparisons with coronal source and in-situ observations in the validation of WP4
- To update the STEREO/SECCHI/COR2 CME catalogue, initiated under the SOTERIA FP7 project, until the end of 2011 (including the application of forward modelling to the appropriate CMEs)
- 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

WP 3 – Task Summary (PMs: UGOE 21, TCD 15, STFC 9, UNIGRAZ 6)

- **Task 3.1: Geometrical modelling of STEREO/HI CMEs (Task leader: STFC; Additional participant: UNIGRAZ)**

  Instruments used: STEREO/HI

  Role of participants: STFC: J-map provision/CME extraction; STFC and UNIGRAZ: geometrical modelling application and development

  Presentation by P. Barnes (STFC)

- **Task 3.2: Forward modelling of STEREO/HI CMEs (Task leader: UGOE)**

  Instruments used: STEREO/SECCHI/HI, COR2

  Role of participants: This task will be undertaken by UGOE.

  Presentation by A. Pluta (UGOE)

- **Task 3.3: Inverse modelling of STEREO/HI CMEs (Task leader: UGOE; Additional participant: TCD)**

  Instruments used: STEREO/SECCHI/HI, COR2

  Role of participants: UGOE: modelling; TCD: source region input expertise.

  Presentation by P. Gallagher (STFC)

- **Task 3.4: Comparison of modelling results (Task leaders: RAL, UGOE; Additional participant: TCD)**

  Instruments used: STEREO/SECCHI, SOHO/MDI, SDO/HMI

  Role of participants: RAL will collate, with input from all participants.

WP 3 – Deliverables

- D3.1: Provision of time-elongation (j) maps for the CMEs in the STEREO/HI catalogue (from WP2), and incorporation of the results of the geometrical fitting into the catalogue (first release in M12, updates to follow, type: O, lead: STFC)
- D3.2: Incorporation of the results of the forward-modelling techniques into the CME catalogue established in WP2 (M 12, updates to follow, type: O, lead: UGOE)
- D3.3: Report on modelling results (M 36, type: R, lead: RAL)
- D3.4: Report on prototype inverse model based on photospheric and low coronal source region characteristics for 3-D HI CME structure (M 36, type: R, lead: UGOE)

Update Task 3.1 - Geometrical modelling of STEREO/HI CMEs
Task leader: STFC; Additional participant: UNIGRAZ

- Geometrical modelling of the STEREO/HI CMEs identified and catalogued in WP2
- Creation of J-maps for backward (to source regions) and forward extrapolations (for solar system applications)
- Derivation of CME kinematic properties (propagation speed, direction and potentially size, launch time, source region location) and augmentation of the CME catalogue with these results (for comparisons with WP4 tasks 4.1 SR and 4.2 in-situ)
- Compilation of a catalogue of CME arrival time estimates at Mercury, Venus, Earth, Mars and Saturn as support to European-funded space missions around these planets.
- Integration of the catalogues in AMDA, offering access to the catalogues to the community of planetary scientists that use the European Research infrastructure (EUROPLANET)

Deliverable in PY 1

D3.1: Provision of time-elongation (j) maps for the CMEs in the STEREO/HI catalogue (from WP2), and incorporation of the results of the geometrical fitting into the catalogue (first release in M12, updates to follow, type: O, lead: STFC)

WP 3 – Geometrical Modelling

ID	SC	Quality	PA-fit	SSE speed [kms-1]	SSE Phi [deg]	SSE HEEQ Long [deg]	SSE HEEQ Lat [deg]	SSE Carr Long [deg]	SSE Launch [UTC]
HCME_A__20070419_01	A	good	105	392	61	-58	-15	53	2007-04-19 07:30
HCME_A__20070502_01	A	fair	90	353	129	-124	2	183	2007-05-01 16:29
HCME_A__20070506_01	A	fair	100	489	133	-129	-5	120	2007-05-06 01:00
HCME_A__20070509_01	A	fair	90	559	152	-147	2	59	2007-05-09 06:20
HCME_A__20070516_01	A	good	70	385	61	-54	16	68	2007-05-15 16:32
HCME_A__20070518_01	A	fair	110	580	86	-81	-20	12	2007-05-17 20:47
HCME_B__20070519_01	B	fair	265	264	38	36	-5	122	2007-05-18 11:31
HCME_A__20070520_01	A	fair	120	448	20	-12	-11	57	2007-05-19 17:12
HCME_B__20070521_01	B	fair	305	416	75	67	32	115	2007-05-21 08:18
HCME_A__20070521_01	A	fair	85	306	72	-66	4	337	2007-05-21 15:26

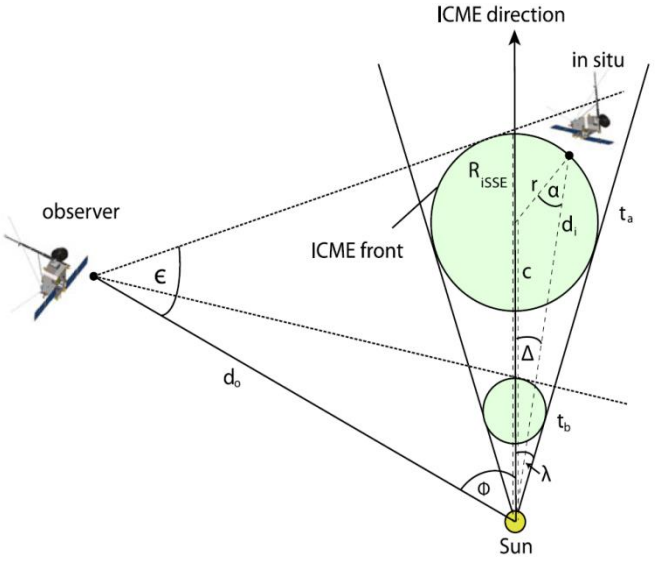
Showing 1 to 10 of 1,201 entries (filtered from 1,210 total entries)

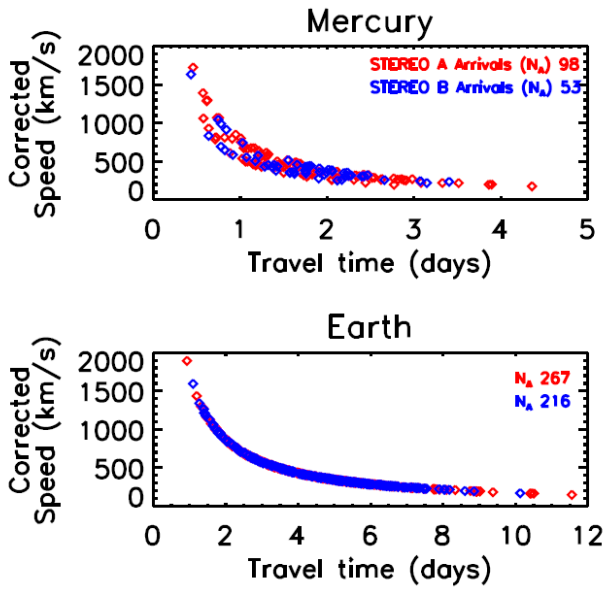
Select Save Print Previous 1 2 3 4 5 .. 121 Next

- This catalogue contains the kinematic properties derived using the geometrical fitting methods applied to STEREO/HI J-maps.
- Speeds, propagation direction and launch times are provided based on three geometrical models, fixed-phi, harmonic mean and self-similar expansion.
- This catalogue contains 1210 CMEs occurring between April ‘07 and December ’13 (635 for STEREO-A and 575 for STEREO-B).

WP 3 – Predicting In Situ Arrival Times using Geometrical Modelling

- The catalogue of geometrically-modelled CME speeds/trajectories are also used to generate a catalogue of in situ CME arrival time estimates at Mercury, Venus, Earth, Mars, and Saturn, thereby providing support to European-funded space missions around these planets
- Using state of the art SSEF geometric model (with 30° width)
- A user friendly package in IDL has been created at UNIGRAZ (C. Möstl, P. Boakes) to read in the geometrically modelled CME catalogue files and output the predicted arrival time files for any of the in situ locations.





WP 3 – Predicting In Situ Arrival Times using Geometrical Modelling

ID	SC	Apex Offset [deg]	Speed [km/s]	Arrival [UT] [deg]	Dist [AU]	Lat [deg]	Long [deg]
HCME_A__20071220_01	A	20.0	260	2007-12-26 15:10	0.98381397	-1.49703	-0.00000
HCME_A__20080213_01	A	23.0	271	2008-02-19 22:16	0.98730455	-6.74196	-0.00000
HCME_A__20080409_01	A	25.0	214	2008-04-17 14:31	1.00178489	-5.99623	0.00000
HCME_A__20080521_01	A	20.0	266	2008-05-28 09:35	1.01229287	-1.84155	0.00000
HCME_A__20080602_01	A	28.0	261	2008-06-08 22:02	1.01429036	-0.48398	0.00000
HCME_A__20080607_01	A	24.0	277	2008-06-14 05:50	1.01505733	0.20600	-0.00000
HCME_A__20080721_01	A	4.0	363	2008-07-26 08:32	1.01602762	4.95954	-0.00000
HCME_A__20080807_01	A	29.0	194	2008-08-16 15:02	1.01405248	6.24936	-0.00000
HCME_A__20080820_01	A	27.0	194	2008-08-28 15:08	1.01189079	6.85920	0.00000
HCME_A__20080913_01	A	21.0	282	2008-09-19 23:37	1.00592248	7.21837	0.00000

Showing 1 to 10 of 267 entries

Select Copy Save Print Previous 1 2 3 4 5 .. 27 Next

- This catalogue (ARRCAT) includes the predicted arrival times and speeds at the planet or spacecraft, the target location, the PA of the CME along which the elongations for the fit were measured, and the target PA.
- Only CMEs are selected that *extend in latitude (i.e. PA) over the target.*
- ARRCAT will be finished in the upcoming months with the final SSEF fits.
- Catalogue includes unique id linked to the original CME catalogue.
- Current ARRCAT contains for Earth 251 predicted arrivals up to 6/2013

Update Task 3.2 - Forward modelling of STEREO/HI CMEs (Task leader: UGOE)

- GCS (Graduated Cylindrical Shell) modelling of the STEREO/HI CMEs of the WP2 catalogue
- Augmentation of CME catalogue with the derived parameters - CME geometries, speeds, propagation directions and mass estimates, including update of the COR 2 catalogue until end of 2011
- Calculation of back-projected launch time/location and forward-projected arrival time estimates at various solar system locations and inclusion of information into CME catalogues

Deliverable in PY 1

- D3.2: Incorporation of the results of the forward-modelling techniques into the CME catalogue established in WP2 (M 12, updates to follow, type: O, lead: UGOE)

KINematic CATalogue – Now online

KINCAT - Catalogue | KINCAT - small

You can **download** the data as ASCII-file here.

Select smaller table

show comrimised table | show all data

HEL no | CME no | Preevent date | Preevent time | Last COR2 date | Last COR2 time | GCS carlon | GCS stony lon | GCS stony lat | GCS tilt

HI first date | HI first time | APEX speed | CME mass | FPF speed | FPF lon | FPF lat | SSEF speed | SSEF lon | SSEF lat

HEL no	CME no	Preevent date	Preevent time	Last COR2 date	Last COR2 time	GCS carlon	GCS stony lon	GC
[-]	[-]	[yyyymmdd]	[hh:mm:ss]	[yyyymmdd]	[hh:mm:ss]	[deg]	[lon]	
28	288	31.10.2009	03:08:15	31.10.2009	10:08:15	157	33	
29	299	21.11.2009	07:08:00	21.11.2009	15:09:00	169	-36	
30	307	16.12.2009	02:08:15	16.12.2009	07:08:15	238	-2	
31	325	01.02.2010	14:08:15	01.02.2010	22:09:04	39	67	
32	333	11.02.2010	12:00:00	12.02.2010	01:10:00	219	20	
33	337	13.02.2010	20:08:15	14.02.2010	06:08:15	198	28	
34	347	24.02.2010	12:08:15	25.02.2010	01:08:15	340	-48	
35	351	01.03.2010	00:08:37	01.03.2010	07:08:37	19	47	
36	369	19.03.2010	10:08:15	19.03.2010	21:08:15	106	19	
37	373	26.03.2010	07:08:15	26.03.2010	17:08:15	21	24	
38	377	30.03.2010	00:08:15	30.03.2010	13:08:15	254	-52	
39	391	18.04.2010	21:08:15	19.04.2010	05:08:15	92	45	
40	392	19.04.2010	18:08:15	20.04.2010	00:08:15	86	50	

Online version of the “KINematic CATalogue” on the AFFECTS-FP7 homepage:

http://www.affects-fp7.eu/helcats-database/database.php

Next step:
- Inclusion of h-t-diagrams

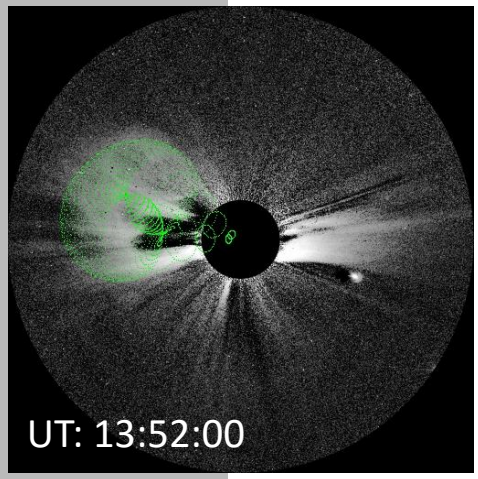
KINematic CATalogue – Legend

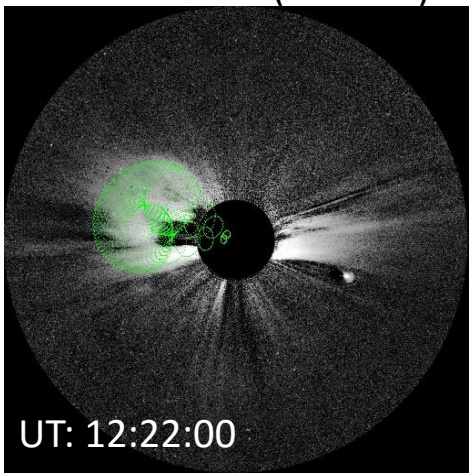
Table-Legends (Click to expand/collapse)

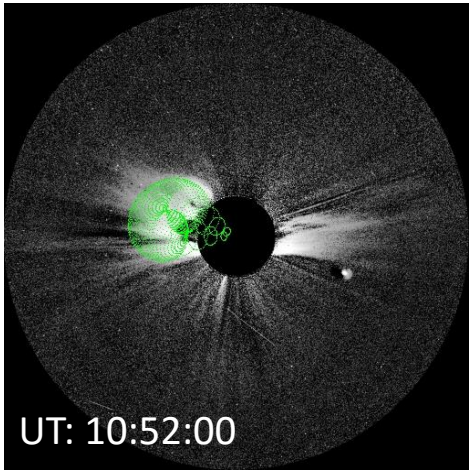
HEL no :	KINCAT Catalogue Number
CME no :	AFFECTS Catalogue Number
Preevent date :	Date for preevent image
Preevent time :	Time for preevent image
Last COR2 date :	Last image in COR2 with full visibility of the CME
Last COR2 time :	Last image in COR2 with full visibility of the CME
GCS carlon :	GCS source region longitude in carringoton coordinate system
GCS stony lon :	GCS source region longitude in stonyhurst coordinate system
GCS stony lat :	GCS source region latitude in stonyhurst coordinate system
GCS tilt :	GCS tilt angle
GCS Asp. Ratio :	GCS aspect ratio
GCS h_angle :	GCS half angle
HI first date :	First appearance in STEREO / HI
HI first time :	First appearance in STEREO / HI
APEX speed :	GCS apex speed in COR2 (linear fit)
CME mass :	CME mass
FPF speed :	Fixed Phi Fitting velocity
FPF lon :	Fixed Phi Fitting longitude in stonyhurst coordinate system
FPF lat :	Fixed Phi Fitting latitude in stonyhurst coordinate system
SSEF speed :	Self Similar Expansion Fitting velocity
SSEF lon :	Self Similar Expansion Fitting longitude in stonyhurst coordinate system
SSEF lat :	Self Similar Expansion Fitting latitude in stonyhurst coordinate system
HMF speed :	Harmonic Mean Fitting velocity
HMF lon :	Harmonic Mean Fitting longitude in stonyhurst coordinate system
HMF lat :	Harmonic Mean Fitting latitude in stonyhurst coordinate system

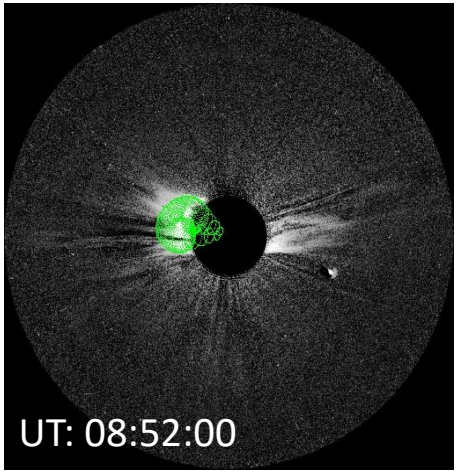
CME speed, GCS

CME observed on 12.12.2008 (COR2-A)



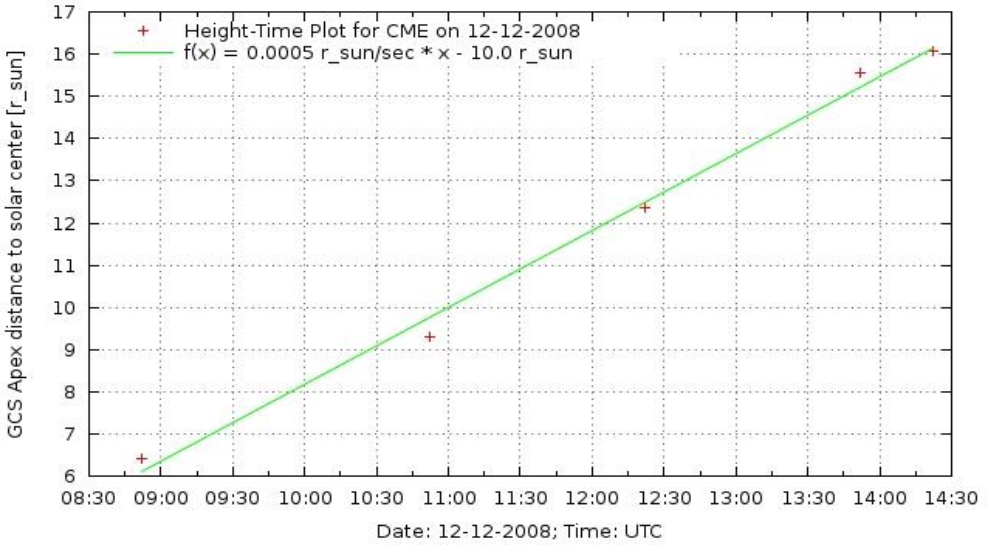






Time	Height	GCS	value
08:52:00	6.43	Longitude	70.434
10:52:00	9.29	Latitude	5.031
12:22:00	12.36	Tilt Angle	50.870
13:52:00	15.57	Aspect Ratio	0.268
14:22:00	16.07	Half Angle	10.061

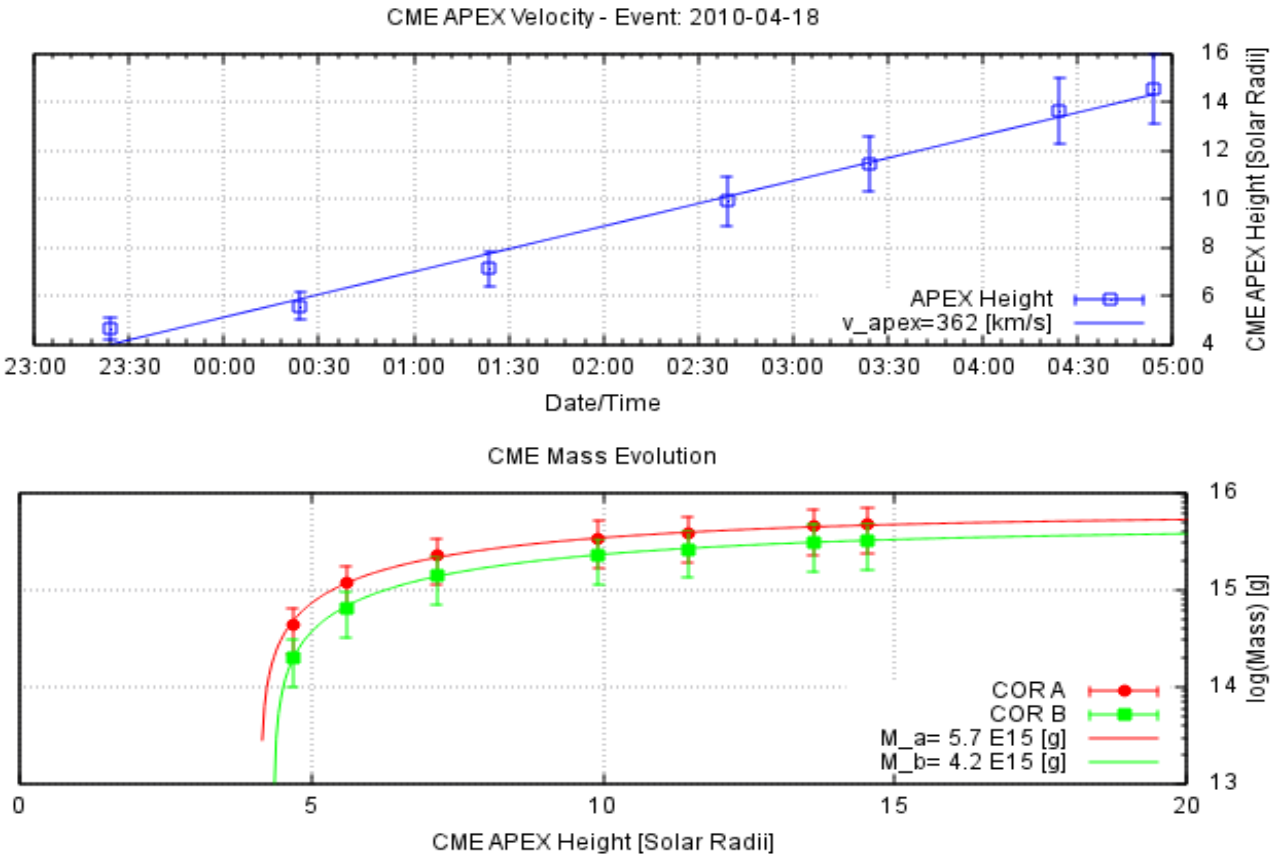
From linear fit: CME Speed = 420 km/s



GCS parameters fixed apart from height

Sample h-t and mass profiles – KINCAT v1

First version of KINCAT used a linear fit to determine the CME speed.



Update inverse modelling of STEREO/HI CMEs (Task leader: UGOE; Additional partner: TCD)

- Prototype the use of inverse modelling to derive typical parameters (speed, size and mass) for the CMEs in the CME catalogue (speed, size and mass) for photospheric and low coronal source regions

- List of STEREO/SECCHI HI shock-driving CMEs sent to WP3 members
- Placed online by TCD @ http://grian.phy.tcd.ie/helcats/ as low coronal event catalogue
- Awaiting SR analysis results update from TCD

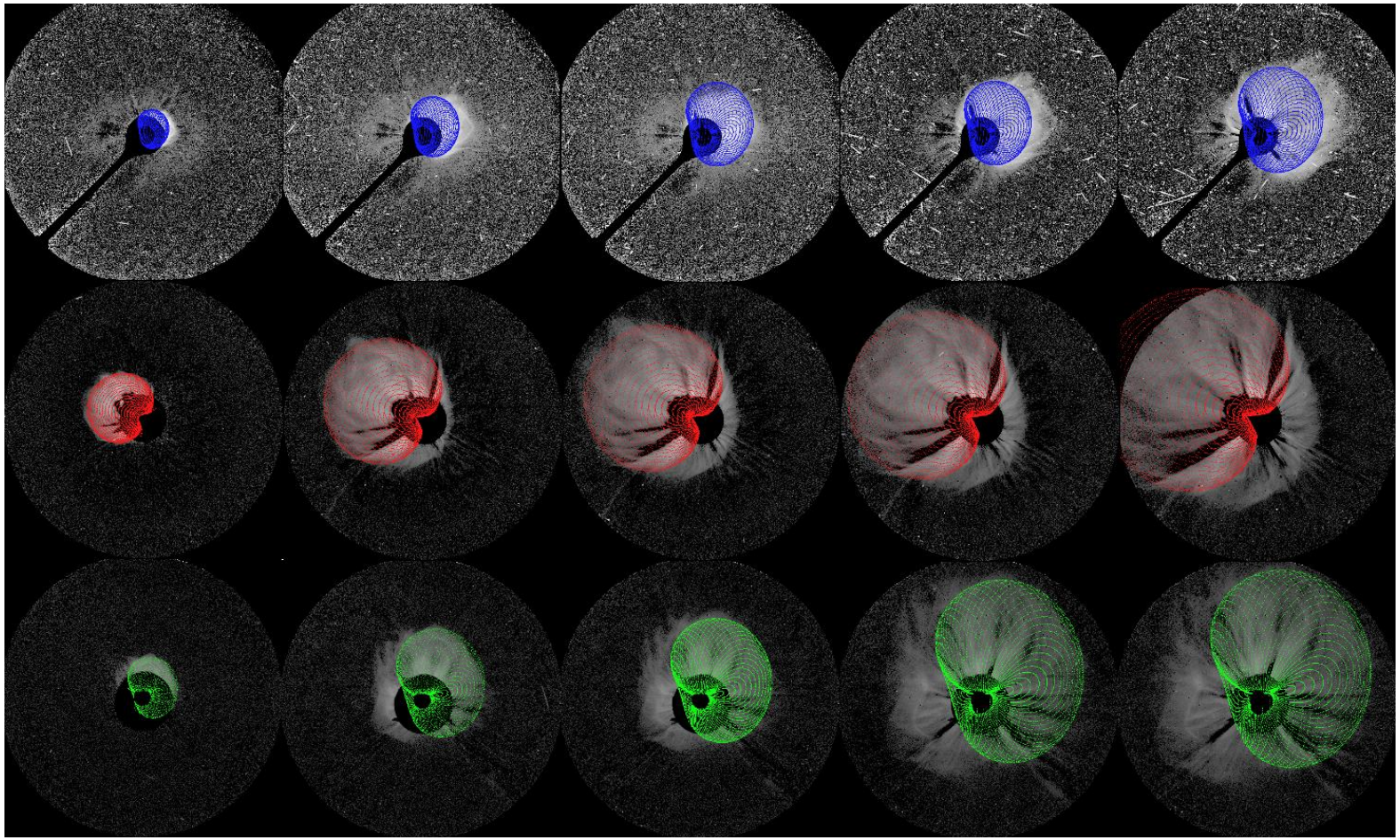
Low coronal event list

Low Coronal Event Catalogue

Some introduction about this table and its contents.

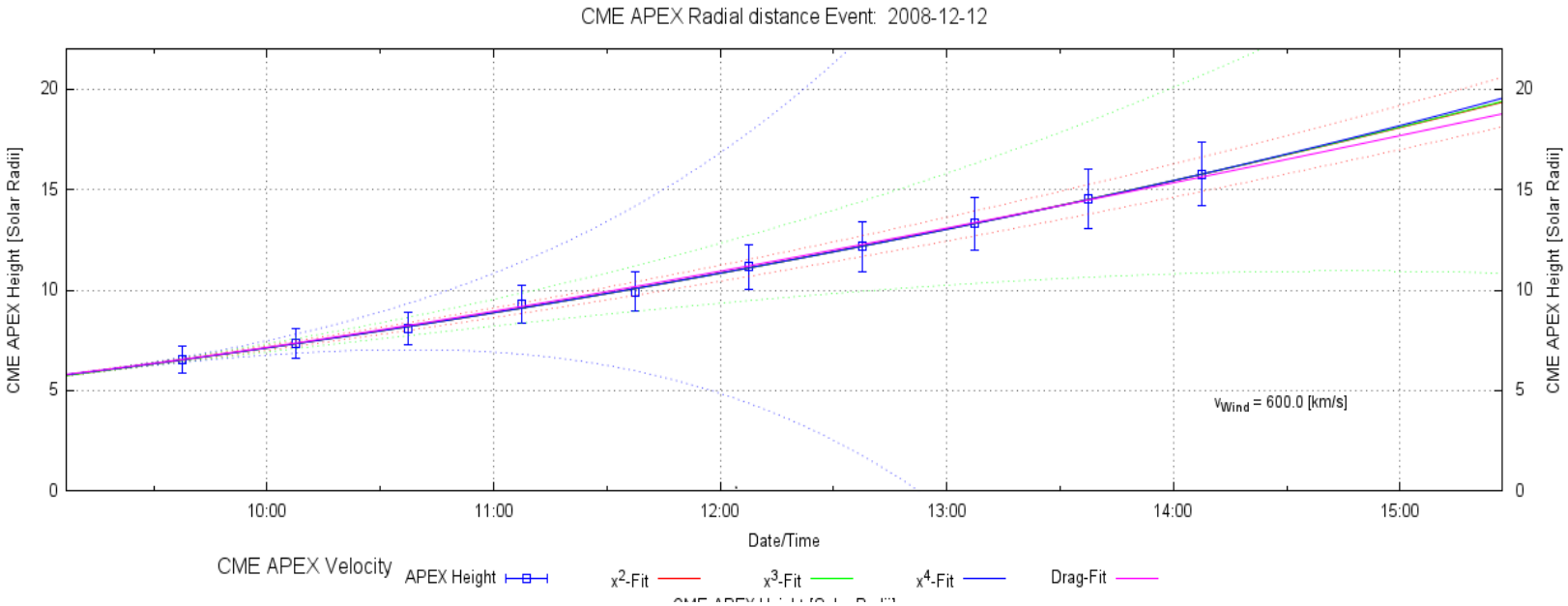
<1> No.	<2> Event Date	<3> NOAA Region (location)	<4> GOES Class	<5> Flare Time (Start, Peak, End) UT	<6> Hale Class	<7> EUV Wave (EUV Filter Å)	<8> CME (Time, speed, movies)	<9> Radio (NRH, DAM, Callisto)	<10> X-ray (RHESSI, FERMI)	<11> Maps (Desnity, PFSS, Alfven speed)
1	2010-Apr-03	11059 (S25W03)	B7.4	(09:04, HH:MM HH:MM)	β	None	10:33 UT 668 km/s CME Catalogue	Type II(?) Type III NRH 150 MHz	FERMI	Soon
2	2011-Jun-07	11226 (S22W66)	M2.5	(06:16, 06:30, 06:41)	β	HEK AIA 171, 193, 211	06:49 UT 1255 km/s CDAW Cactus	Complex	RHESSI FERMI	Soon
3	2011-Aug-03	11261 (N16W28)	M6.0	(13:17, 13:48, 14:10)	βγδ	HEK AIA 211	14:00 UT 610 km/s CDAW Cactus	Type II, III, IV NRH 150 MHz NRH 445 MHz	RHESSI	Soon
4	2012-Jan-19	11402 (N32E27)	M2.6	(13:43, 15:30, 16:30)	βγ	None	14:36 UT 1120 km/s CDAW Cactus CORIMP	Type II, III NRH 150 MHz NRH 432 MHz	N/A	Soon

3D CME modelling with STEREO and SOHO

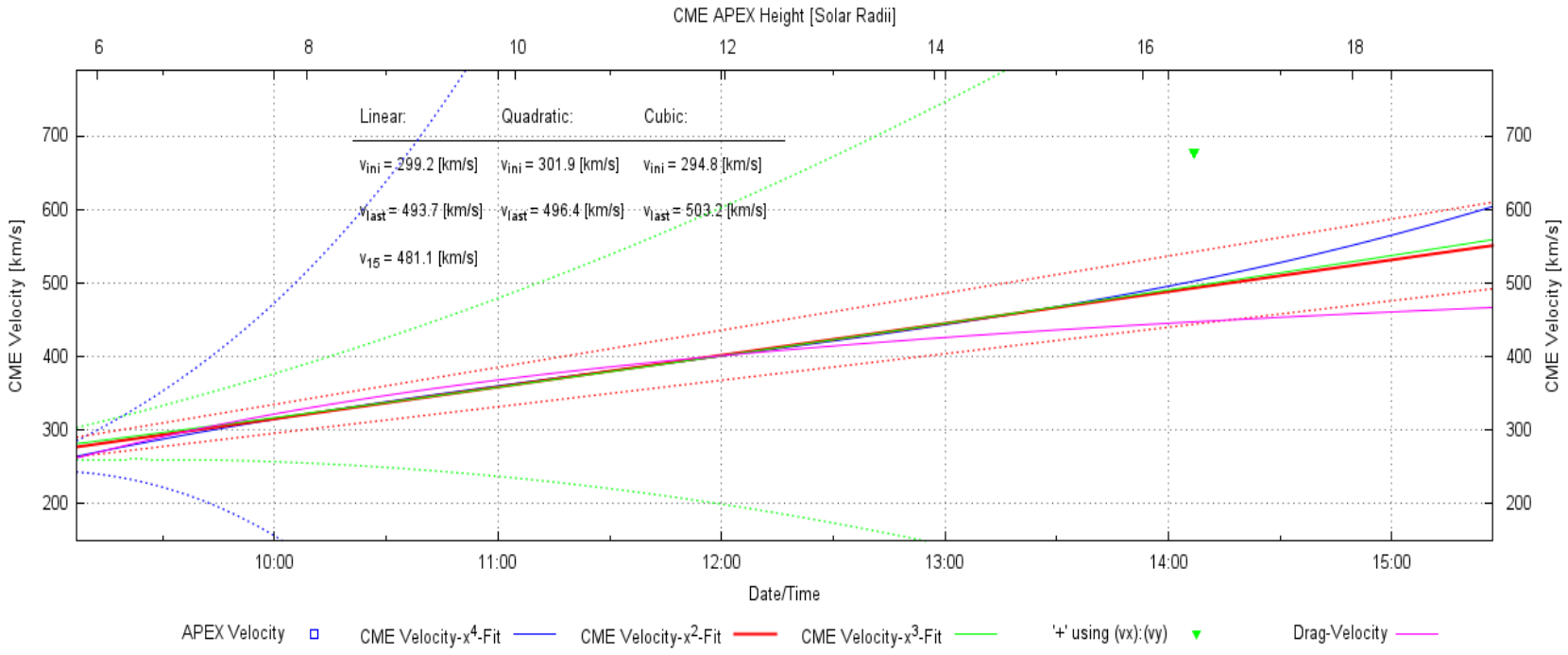


KINCAT v2 will include CME acceleration/deceleration based on multipoint analysis

- Velocity-profile
- Need for standardised initial speed



CME speed development with height



Sample CME - 18/19 April 2010