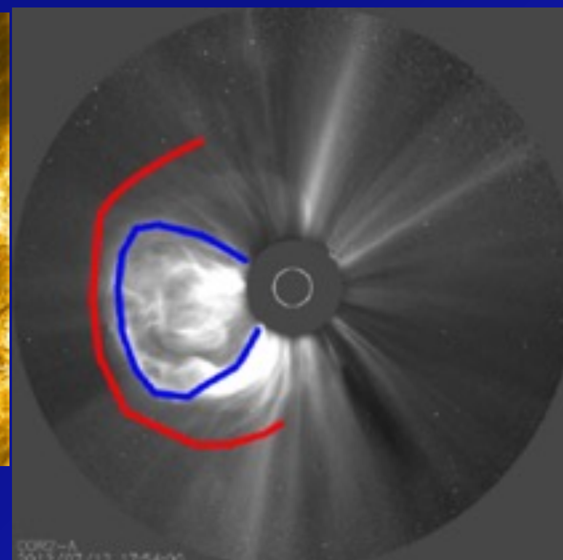
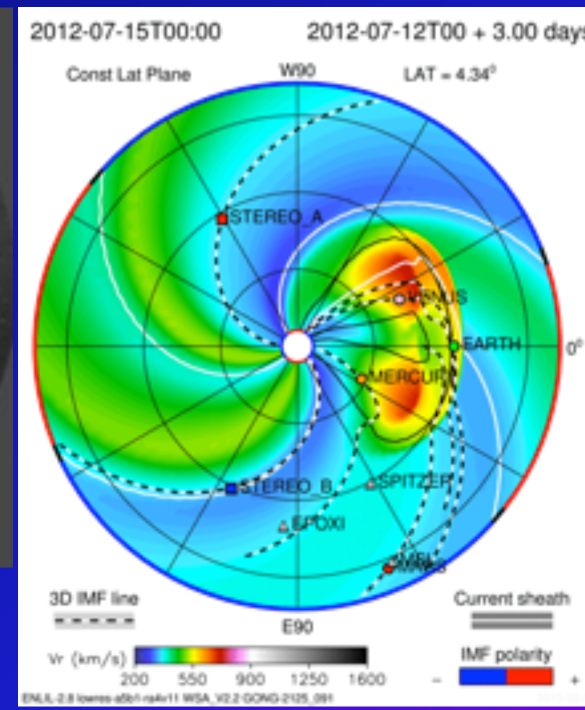
ISEST Data Products and Campaign Study





Jie Zhang

GEORGE MASON UNIVERSITY

The Outline

1. ISEST

2. Data Products: Knowledge Base and Knowledge Sharing Through WIKI

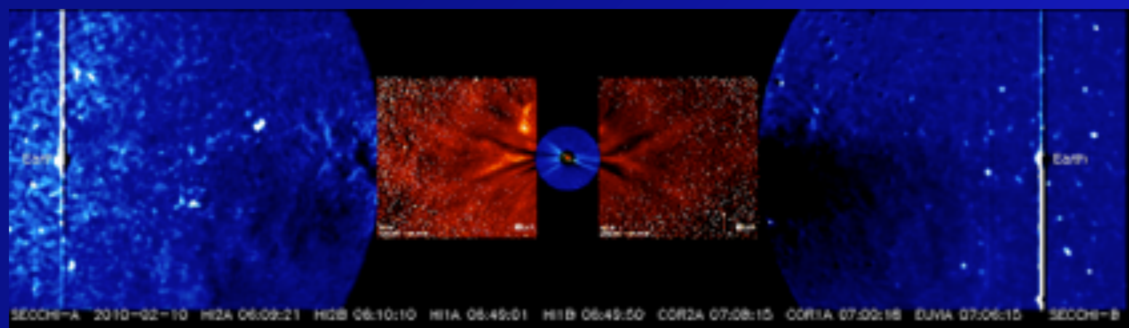
3. Campaign Study

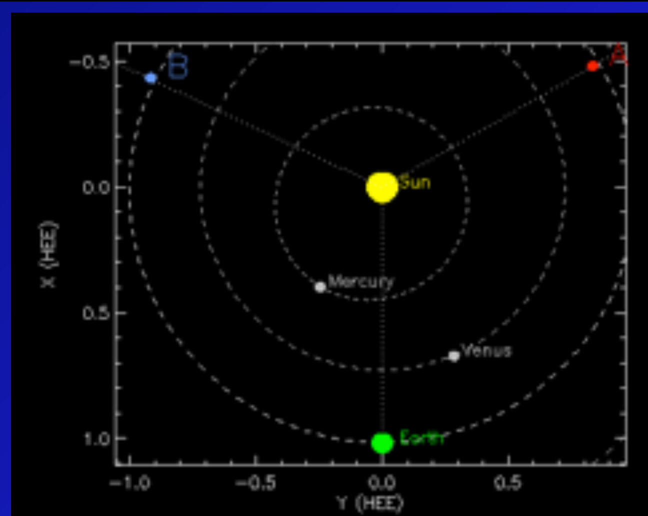
The Physical System

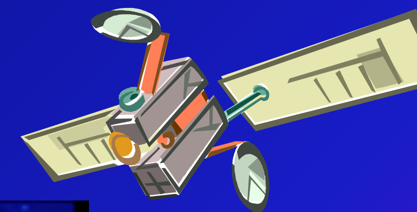
Sun	Interplanetary Space	In-situ

SOHO
SDO
HINODE
…

STEREO-A
STEREO-B







ACE
WIND

ISEST

International Study of Earth-Affecting Solar Transients

One of the four projects sponsored by SCOSTEP/VarSITI program from 2014-2018

Project ISEST/MiniMax24

International Study of Earth-affecting Solar Transients

J. Zhang[1], M. Temmer[2], and N. Gopalswamy[3]

[1]School of Physics, Astronomy and Computational Sciences, George Mason University, Fairfax, VA, USA

[2]Institute of Physics, University of Graz, Styria, Austria

[3]NASA Goddard Space Flight Center, Greenbelt, MD, USA


Jie Zhang

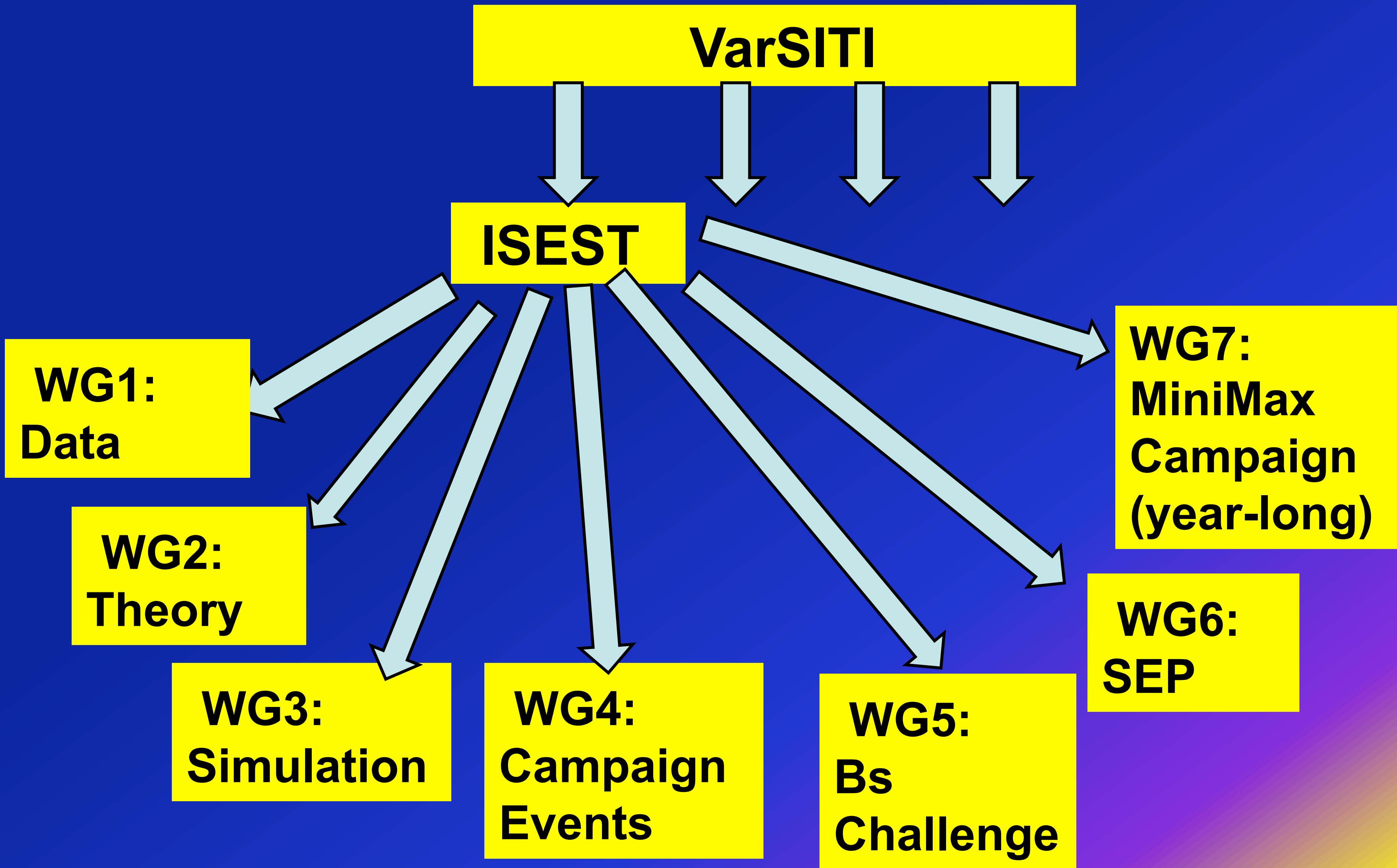

Manuela Temmer


Nat Gopalswamy

The Scientific Goal

Understand the origin, propagation and evolution of solar transients through the space between the Sun and the Earth, and develop the prediction capability of space weather

Working Groups



ISEST Wiki

http://solar.gmu.edu/heliophysics/index.php/Main_Page

A web-based interactive data portal, allow scientists or users to

1. Access data and information
2. register for security
3. edit the text: provide information and participate in discussions
4. upload images in a variety of format, and embed and edit images in texts
5. Native wiki database does not store video files, thus not allow video upload. We have implemented an interface to allow users to upload video files into our own file server.

ISEST Wiki - WG page

Working Group 1

Data group led by Jie Zhang (USA) and Christian Moestl (Austria)

A brief summary of the activity of WG1 at the workshop can be found here.

Contents

ISEST Wiki - Data Table Page

GMU CME/ICME List

Provided by Phillip Hess (phess4@gmu.edu) and Jie Zhang (jzhang7@gmu.edu)

ICME EVENT START	ICME EVENT END	CME in LASCO	ICME TYPE	AR	SURFACE LOCATION	FLARE MAGNITUDE	FLARE ONSET TIME	SEEDS VEL C2	SEEDS VEL A	SEEDS VEL B	AVG. VEL.	VELOCITY	Transit time	DST PEAK	DST PEAK TIME	EJECTA START TIME	Q R
11/20/2007 00:00:00	11/20/2007 11:00:00	11/16/2007 08:50:00	MC+SH	-	N07 W04	-	-	160 km/s	-	253 km/s	474.80	462.8 km/s	87:10:00	-63	11/20/2007 21:00:00	11/20/2007 00:00:00	2
12/17/2008 02:00:00	12/18/2008 15:00:00	12/12/2008 09:06:00	MC		N36 W10	-	-	-	259 km/s	306 km/s	366.58	323.8 km/s	112:54:00	-	-	12/17/2008 02:00:00	2
01/26/2009 05:00:00	01/26/2009 15:00:00	01/21/2009 21:08:00	MC, CIR?	-	-	-	-	114 km/s	-	303 km/s	398.46	347.7 km/s	103:52:00	-	-	01/26/2009 05:00:00	3
02/03/2009 19:00:00	02/04/2009 16:00:00	01/31/2009 01:54:00	MC+SH+CIR?	-	N06 E12	-	-	229 km/s	211 km/s	238 km/s	449.37	355.9 km/s	89:06:00	-48	02/04/2009 18:00:00	02/03/2009 22:00:00	3
09/30/2009 06:00:00	09/30/2009 18:00:00	09/25/2009 08:06:00	MC?+SH?	11027	N24 W09	-	-	-	-	-	351.04	348.5 km/s	117:54:00	-	-	09/30/2009 06:00:00	3
10/29/2009 07:00:00	10/29/2009 22:00:00	10/23/2009 15:54:00	MC	-	N09 E15	-	-	-	-	-	306.34	371.3 km/s	135:06:00	-	-	10/29/2009 07:00:00	1
11/14/2009 03:00:00	11/14/2009 23:00:00	11/09/2009 20:06:00	MC+SH?	11030	N25 W52	-	-	-	271 km/s	-	402.21	311.2 km/s	102:54:00	-	-	11/14/2009 03:00:00	2
01/01/2010 22:00:00	01/03/2010 10:00:00	12/27/2009 21:30:00	MC	11039	S26 E31	B8	12/27/2009 11:39:00	124 km/s	1010 km/s	2771 km/s	343.46	283.4 km/s	120:30:00	-	-	01/01/2010 22:00:00	1
02/19/2010 15:00:00	02/22/2010 00:00:00	02/13/2010 19:54:00	Flank CME?	11045	N19 W77	M1	02/13/2010 17:52:00	141 km/s	-	1308 km/s	297.53	404.6 km/s	139:06:00	-	-	02/19/2010 15:00:00	3
03/10/2010 02:00:00	03/10/2010 10:00:00	03/06/2010 07:51:00	MC?		N30 E30	-	-	318 km/s	828 km/s	626 km/s	459.09	406.4 km/s	90:09:00	-	-	03/10/2010 02:00:00	3
04/05/2010 08:00:00	04/06/2010 15:00:00	04/03/2010 10:33:00	MC+SH	11059	S25 W03	B7	04/03/2012 09:54:00	484 km/s	810 km/s	924 km/s	845.50	630.4 km/s	45:27:00	-77	04/06/2010 15:00:00	04/05/2010 11:30:00	1

ISEST Wiki - Event Page

03/17/2015 04:00:00 UTC

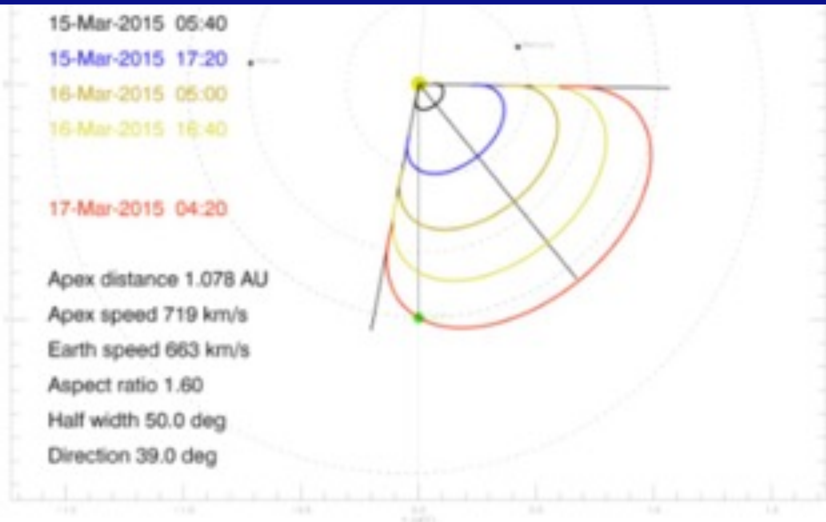
Mail - Jie Zhang - Outlook

Contents

Comment Section

- varSITI campaign event
- Largest geomagnetic storm at Earth for solar cycle 24, this event registered a Dst peak of -228 nT.
- Based on both the in-situ signature of the event and the ENLIL solar wind prediction for this date, I think it is likely a CIR played a role in making it so strong. There is a strong coronal hole at the South Pole and the ENLIL simulation ([[1]]) shows a fairly fast stream that interacts with the CME, and this fast speed stream (~600 km/s) shows up in ACE data as well. Based on the C2 and C3 images for the day, it appears there is a slow CME launching around noon on the 14th with a small but visible filament. On the morning of the 15th a partial halo CME, associated with a long duration flare that fell just short of M class (C9.1) and from the same active region (AR 12297), launched propagating to the East of the Sun Earth line. I think it is likely that an interaction between the CME+shock of this event and the previous blob CME, as well as the added energy from the CIR and fast speed stream behind the CME caused the severity of the geomagnetic activity at the Earth (Hess)
- This super storm is produced through a combination of effects: (1) strong magnetic field in the sheath region (> 25 nT at peak)) and ejecta (>30 nT at peak, (2) Bs field encompasses the entire duration of the ejecta, due to that the axis of the flux rope is highly inclined toward the north-south direction, (3) the interaction with CIR, and almost contained in a CIR region. Such containment by CIR prevents the expansion of the flux rope, thus makes the flux rope small in size by strong in magnetic field (Jie Zhang).
- This may be a kind of CME-CME interaction event. We have a large filament, embedded in a magnetic flux rope, close to the AR which released this highly geoeffective CME. Part of the filament (or flux rope) erupted - or at least, left the low corona - already on March 14 (around 12UT). The final and major eruption on March 15 seems to interact with the first disturbance. The interacting sectors might propagate close to Earth direction. This might be a reason for the complex in-situ signatures (two flux ropes?) as well as the increased geoeffectiveness (Manuela Temmer).

ISEST Wiki - Event Page



Video Data

AIA 171 movie
AIA 193 movie
AIA 304 movie
AIA 1600 movie
HMI movie
C2 movie
C3 movie
movie from CORIMP catalogue: http://alshamess.ifa.hawaii.edu/CORIMP/realtime/soho/lasco/detections/2015/03/15/cme_ims_orig_20150315_000006/movie_C3.html

References

- ElEvo model: Möstl et al. 2015 Nature Communications, open access: http://www.nature.com/ncomms/2015/150526/ncomms8135/full/ncomms8135.html

- P. Gallagher press release: http://files.mail-list.com/m/iswinewsletter/2015-07-space-weather-scans-solar-storms.pdf

- Kataoka, R., D. Shiota, E. Kilpua, K. Keika, JGR-A, accepted, July 2015.

- Kamide, Y. & K. Kusano, Space Weather, 13, 2015.

- Gopalswamy et al., Proc. 14th International Ionospheric Effects Symposium, May 12-14, 2015, Alexandria, VA.

- Liu, Y. at al., Plasma and Magnetic Field Characteristics of Solar Coronal Mass Ejections in Relation to Geomagnetic Storm Intensity and Variability, subm. ApJL, arXiv:1508.01267v1.

Campaign Study

1. Intensive collaboration within solar and heliospheric physics communities on joint studies of observations, theories and modelings

2. Allow a comprehensive understanding of observed phenomena

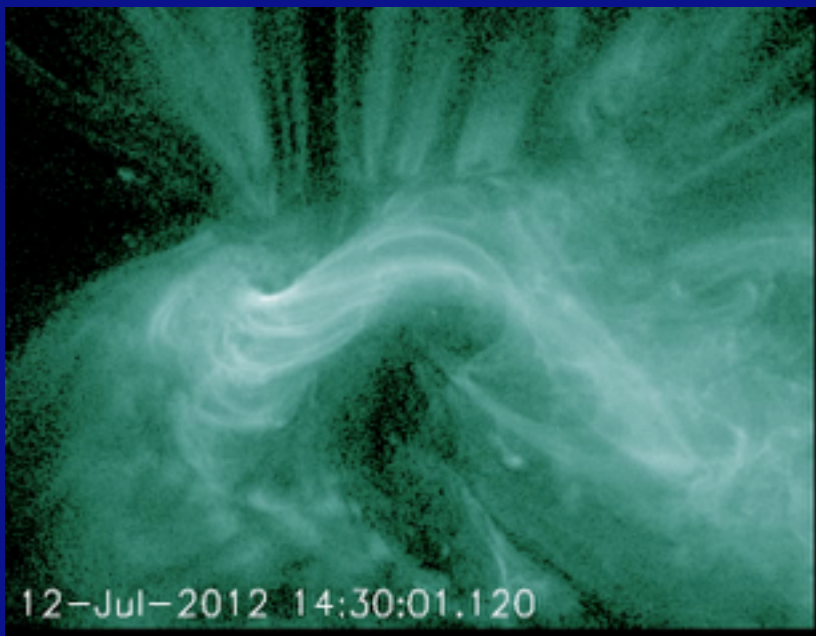
3. Foster collaboration with neighboring disciplines, e.g, magnetosphere, ionosphere, and upper atmosphere etc

July 12-14, 2012 Event: “text-book” event

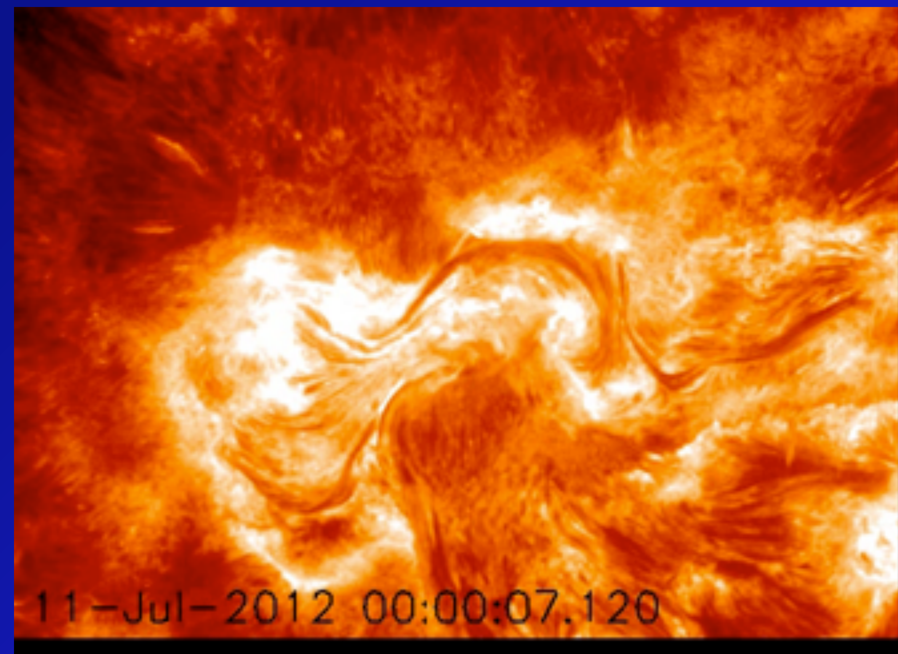
•07/12 15:37 UT: Flare onset (epoch)	0 hr
•07/12 16:49 UT: Flare peak (X1.4, S17W08, AR11520)	1 hr 12 min
•07/12 16:48 UT: CME first appearing in C2	1 hr 11 min
•07/12 18:54 UT: CME at 20 Rs	3 hr 17 min
•07/13 00:49 UT: CME at 50 Rs	9 hr 12 min
•07/13 06:49 UT: CME at 80 Rs	15 hr
•07/14 17:00 UT: Shock arrival at 1 AU	49 hr
•07/15 06:00 UT: Magnetic Cloud arrival at 1 AU	62 hr
•07/15 19:00 UT: Peak time of Dst (-127 nT)	75 hr
•07/17 14:00 UT: Magnetic Cloud end at 1 AU	118 hr

CME Initiation

“The “text-book” event: 2012 July 12



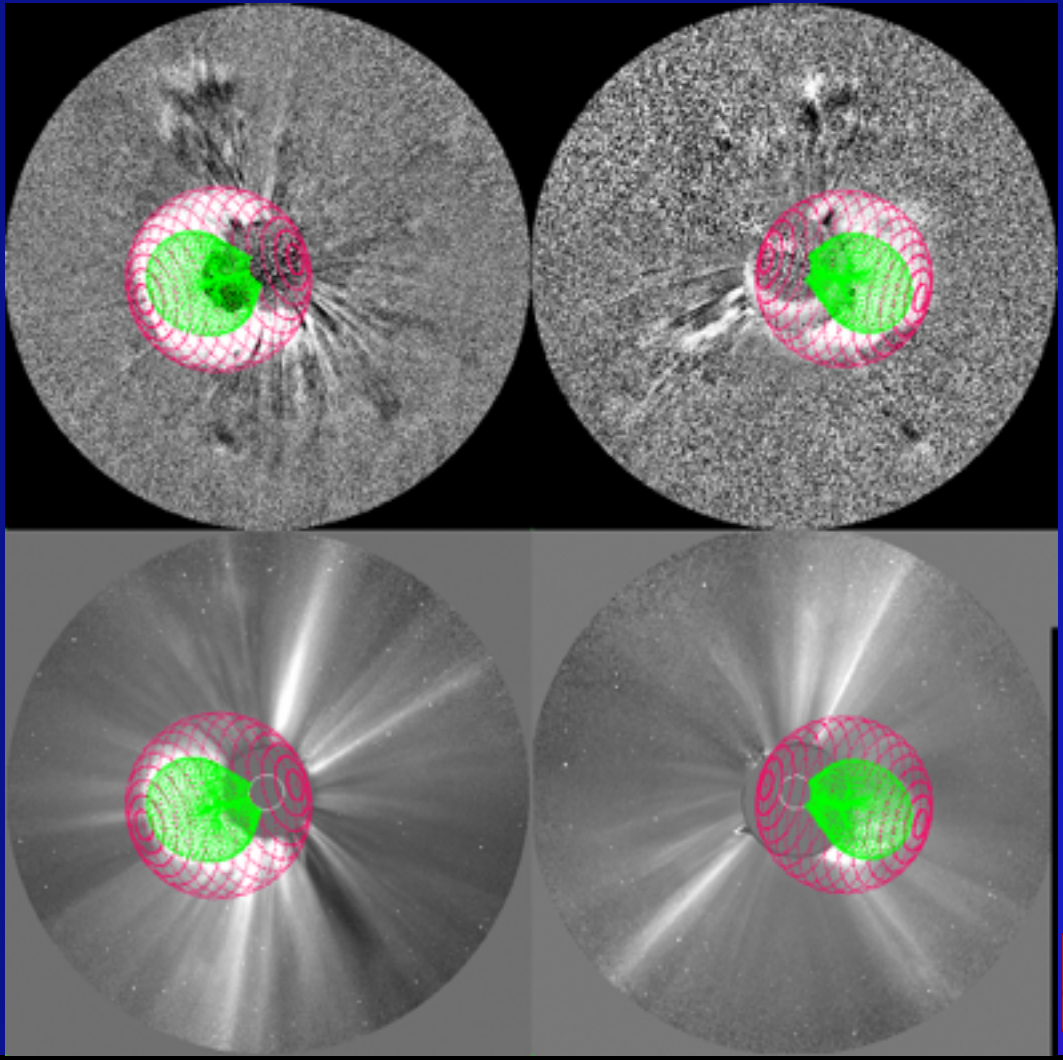
SDO AIA 94 Å
Fe XVIII, 6.4 MK



SDO AIA 304 Å
HeII, 0.05 MK

Largely consistent with standard CSHKP eruptive flare model: sigmoid, flare ribbons, post-flare loop arcade, and likely a flux rope eruption

3D Measurement



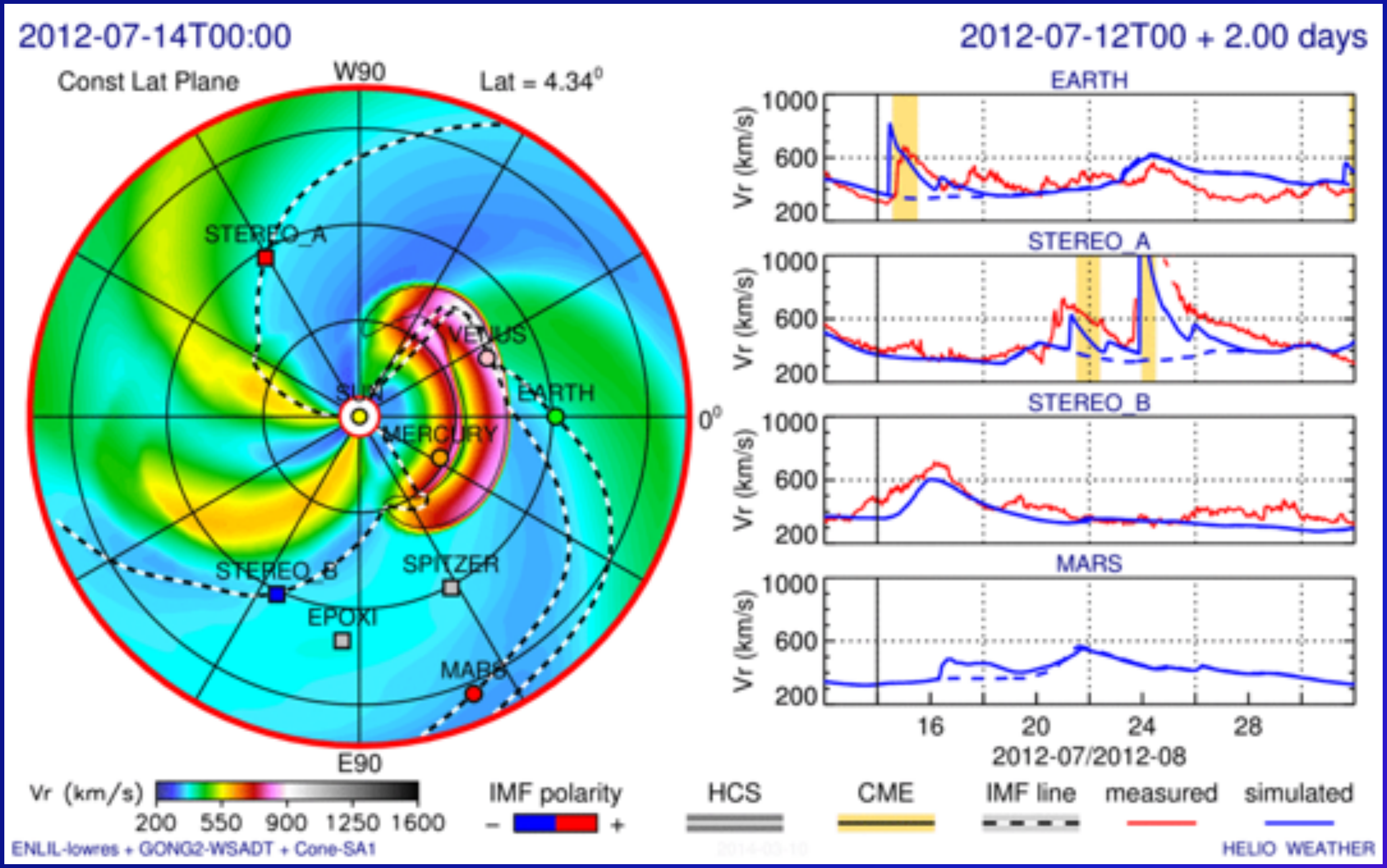
Propagation Direction

Lat: S10º
Lon: W01º

(Hess & Zhang 2014)

•Shock Front: spherical model
•Ejecta Front: GCS model

MHD Simulation of 2012 July Event



ENLIL model (Dusan Odstrcil)

Multiple publications on this event (Dudlik et al. 2014; Cheng et al. 2014; Moestl et al. 2014; Hess & Zhang 2014; Shen et al. 2014)

March 15-17, 2015 Event: St. Patrick Day's event: the largest geomagnetic storm in solar cycle 24th

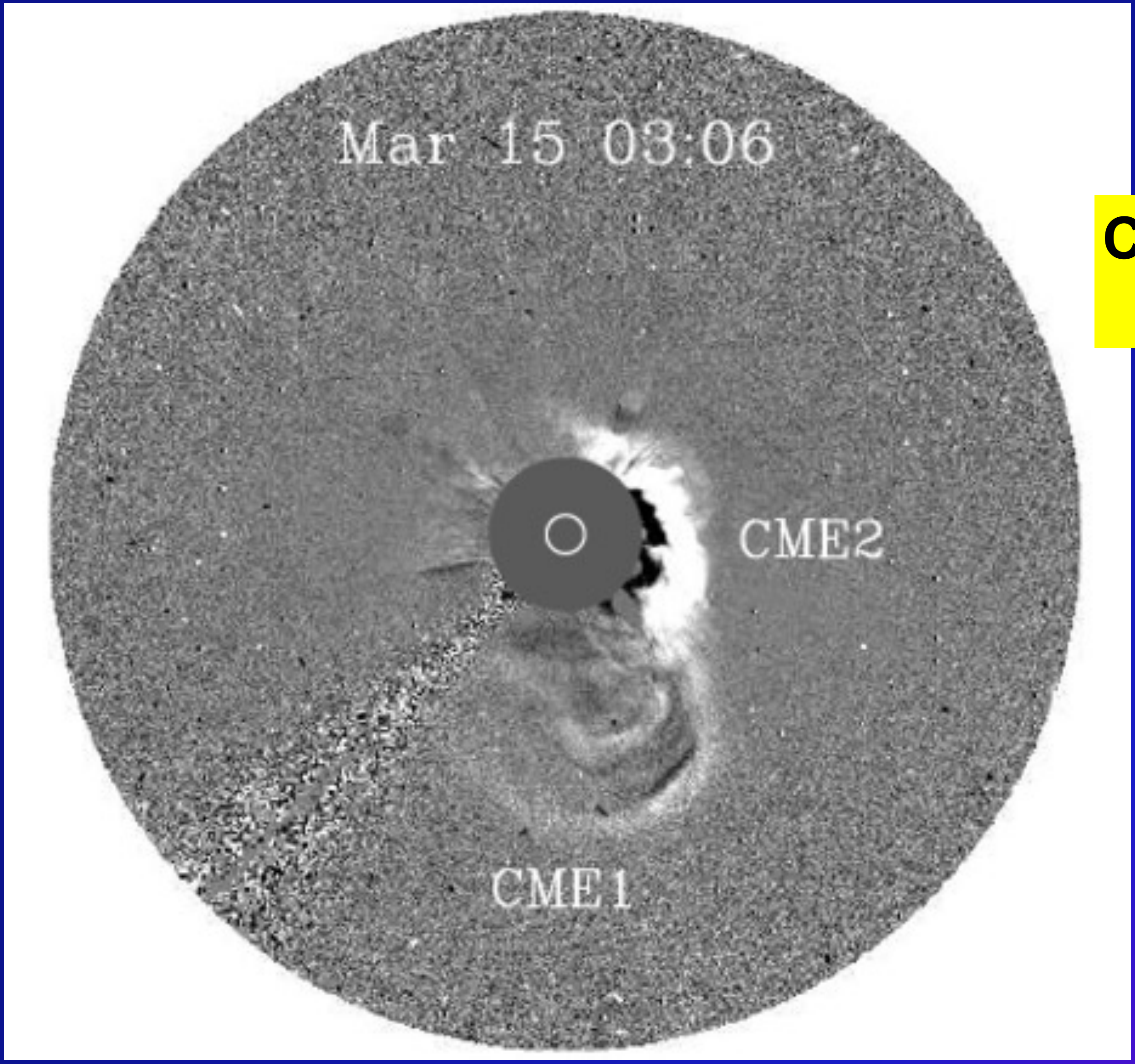
• 03/15 01:15 UT:	Flare onset (the epoch)	0hr
• 03/15 02:13 UT:	Flare peak (C9.1, S22W29, AR 12297)	0hr 58min
• 03/15 02.00 UT:	CME first appearing in C2	0hr 45min
• 03/15 02:00 UT:	at 4 Rs, ~ 1000 km/s	0hr 45min
• 03/15 06:06 UT:	at 20 Rs, ~720 km/s	4hr 51min

……… no STEREO observation due to conjugation…..

• 03/17 04:01 UT:	Shock arrival	50hr 46min
• 03/17 23 UT:	Peak Time of Dst (-223 nT)	70hr

This is an un-expected super storm, given its weak flare and non-full-halo-CME appearance

June 21-24, 2015 Event:

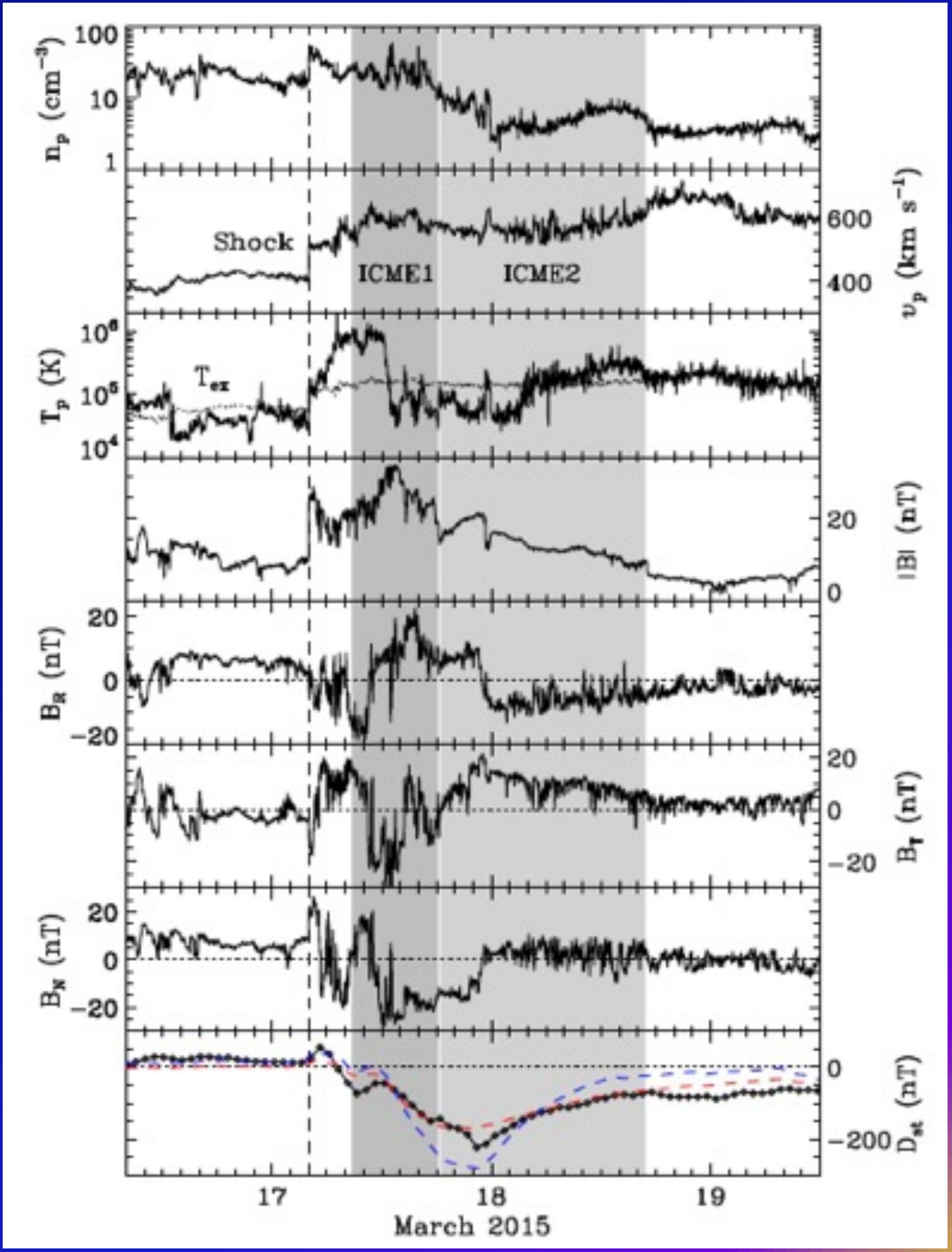


CME-CME Interaction?

June 21-23, 2015 Event:

Compound ejecta:
shock +
ICME1+
ICME2+
CIR

(Liu et al. 2015)



Summary

- ISEST project will generate a knowledge base for almost all geo-effective events for solar cycle 24
- Looking into collaboration with geo-space scientists through campaign study

The End

Backup

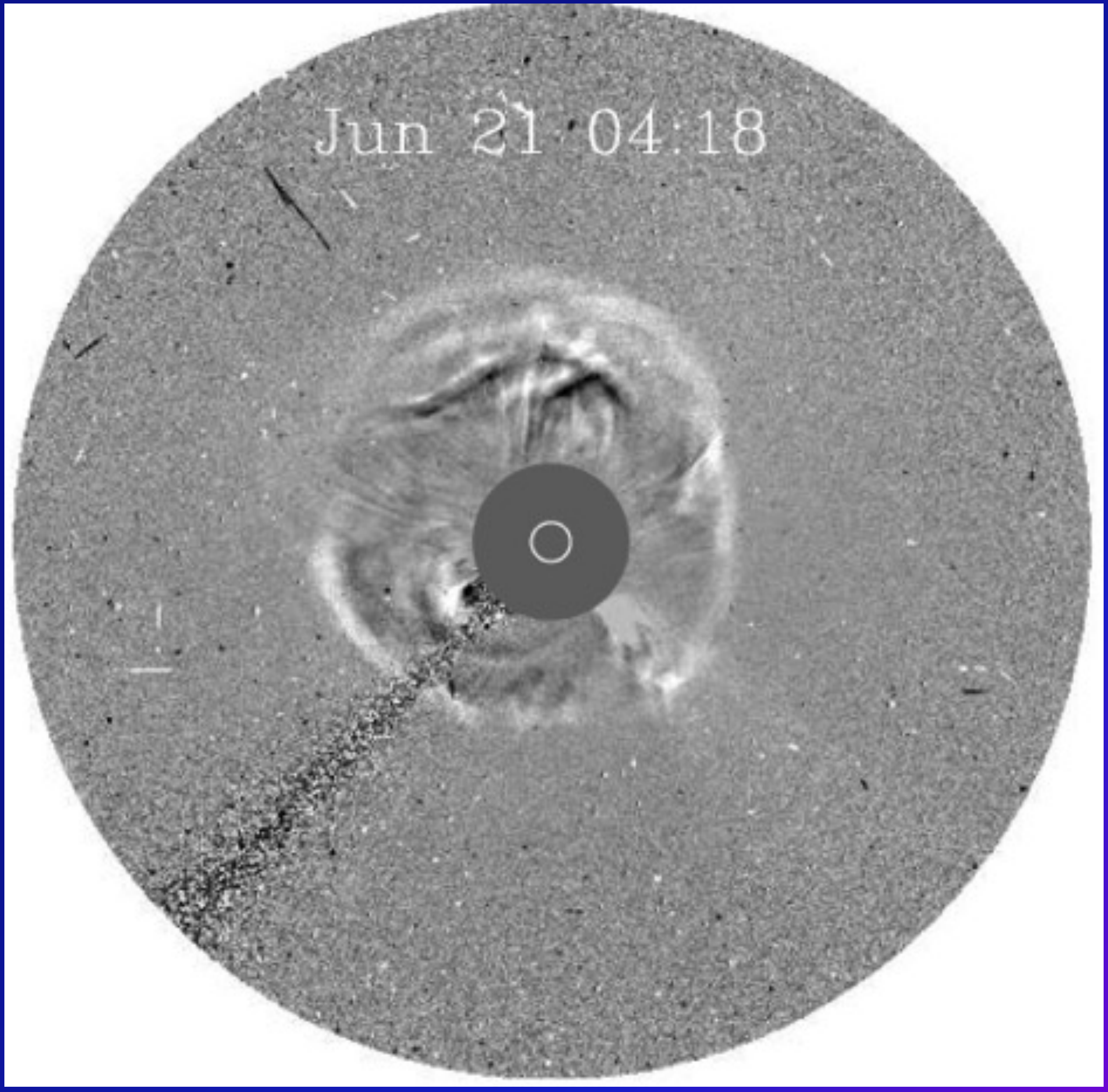
June 21-23, 2015 Event: Summer Solstice Event

- 06/21 02:04 UT: Flare onset (the epoch) 0hr
- 06/21 02:34 UT: Flare peak (M2.7, N12E16, AR 12371) 0hr 30min
- 06/21 02.36 UT: CME first appearing in C2 0hr 32 min

……… no STEREO observation due to conjugation…..

- 06/22 18:00 UT: Shock arrival 39hr 58min
- 06/23 05 UT: Peak Time of Dst (-204 nT) 51hr

June 21-23, 2015 Event



June 21-23, 2015 Event:

(Liu et al. 2015)