ISEST WG4 Report: Campaign Events

Nariaki Nitta (LMSAL)

ISEST 2017 Workshop Jeju, Korea

Project ISEST

Article 2:

ISEST Working Group 4 Campaign Events Studies

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[1]Institute for Scientific Research (ISR), Boston College, Newton, MA, USA
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David Webb

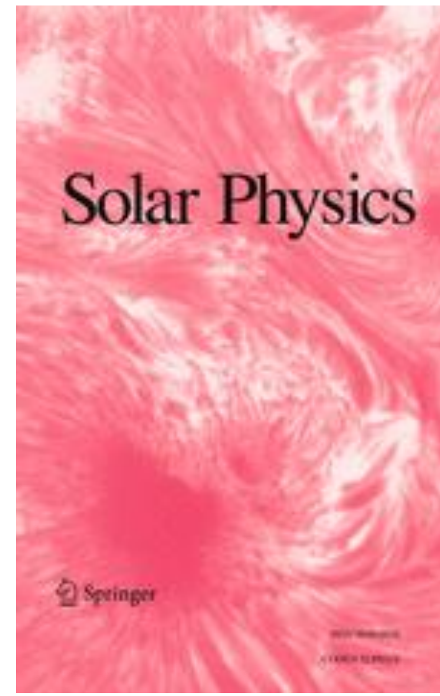

Nariaki Nitta

Solar transients, mainly Coronal Mass Ejections (CMEs), flares, and Corotating Interaction Regions (CIRs) are important aspects of coronal and interplanetary dynamics. CMEs are the dominant, short-term contributor because they inject large quantities of mass and magnetic flux into the heliosphere. CMEs can drive interplanetary shocks, a key source of solar energetic particles (SEPs). CMEs and their associated phenomena drive the most severe space weather at Earth.

VarSITI focuses on the period of the low solar-activity cycle 24 and its consequences at Earth. ISEST (International Study of Earth-affecting Solar Transients) is one of four VarSITI projects. Its goal is to (1) understand the origin, evolution and propagation of solar transients through the heliosphere to Earth, and (2) improve the prediction capability for the arrival of these transients and their potential impacts at Earth.

To study these issues in a global picture, the ISEST project has seven working groups (WGs). ISEST WG 4 focuses on the study of Campaign events and is led by the authors. Its task is to integrate theory, simulations and observations to better understand the chain of cause-effect activity from Sun to Earth for several carefully selected events. ISEST provides "textbook" or well understood cases to the community, but WG 4 also examines more controversial events, such as "stealth" CMEs and problem ICMEs to enhance our understanding. An emphasis of WG 4 is on why do forecasts fail and how can we improve our predictions?

VarSITI Newsletter 14, July 2017



Webb & Nitta, Solar Physics, Topical Issue, in press.

WG 4 Goals

- **Integrate observations, theory and simulations to understand chain of cause-effect dynamics from Sun to Earth/1 AU for carefully selected events.**
- **Develop/improve the prediction capability for these transients' arrival and their potential impacts at Earth.**
- **Textbook cases are provided for the community, but a focus is on less well understood events, such as stealth & problem CMEs.**
  - WG 4 wiki: *http://solar.gmu.edu/heliophysics/index.php/Working_Group_4*

• Textbook cases: Complete chain of a well-observed event from solar source, through IP propagation, to geoeffects.
• Not Textbook but Understood cases: Something is missing in the chain of a well-observed event but, *in retrospect,* we understand why.
• Problem cases: The chain is not complete and we do *not* understand why.

- ICME and storm but source is faint or missing (a "stealth" CME) or multiple sources
OR
- Source is expected to be geoeffective but is not.

Dave Webb slide at ISEST 2015 Meeting, Mexico

SCOSTEP → VarSITI → ISEST → WG4

- The 5-year (2014-2018) SCOSTEP program Variability of the Sun and Its Terrestrial Impact (VarSITI), focuses on the current period of the low solar activity cycle 24 and its consequences at Earth.

- ISEST (International Study of Earth-affecting Solar Transients) is the VarSITI project whose goal is to understand the origin, evolution and propagation of solar transients (CMEs, flares, CIRs) through the heliosphere between the Sun and Earth, and improve our prediction capability for space weather.

- A goal of ISEST Working Group 4 (Campaign Events) is to study a set of well-observed Sun-to-Earth events to better understand why some events are successfully forecast (textbook cases), whereas others become problem or failed forecasts.

WG4 participants includes: A. Asai, D. Biesecker, P. Gallagher, N. Gopalswamy, P. Hess, B. Jackson, E. Kilpua, Y. Liu, N. Lugaz, K. Marubashi, L. Mays, C. Moestl, T. Mulligan, T. Nieves-Chinchila, N. Nitta (Co-leader), D. Odstrcil, I. Richardson, L. Rodriguez, B. Schmieder, K. Shiokawa, T. Skov, N. Srivastava, M. Temmer, B. Thompson, A. Vourlidas, Y. Wang, D. Webb (Co-leader), C.-C. Wu, J. Zhang

Theme-Setting Talk: K. Marubashi "What we can learn from the ISEST WG4 campaignstudy of Sun-Earth events?" (Wednesday morning)

11 Campaign Events

Until recently, we have dealt with 11 events that are a mixture of textbook and non-textbook events.

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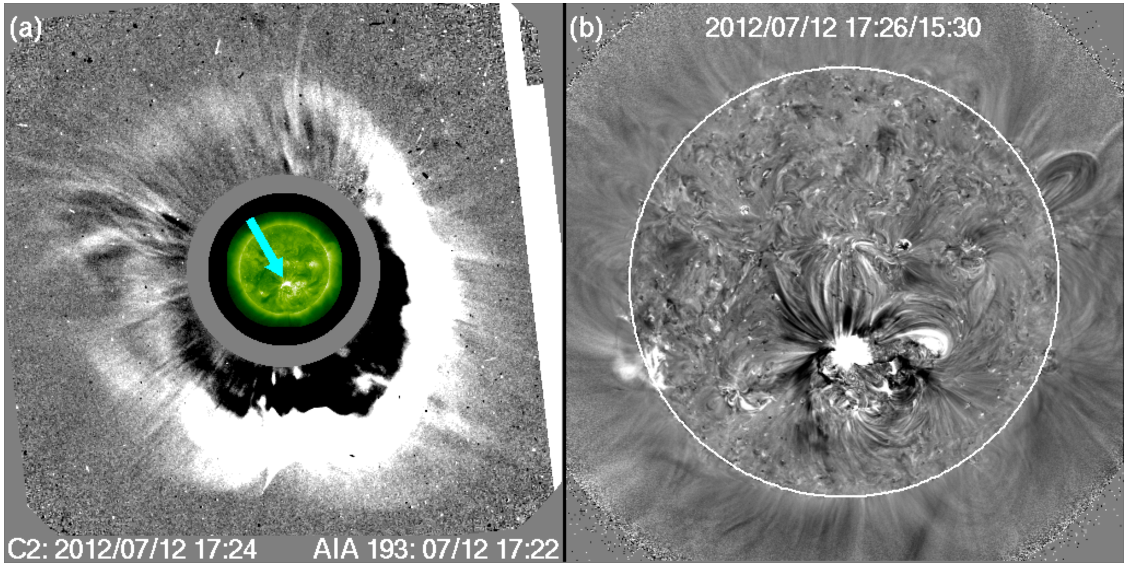
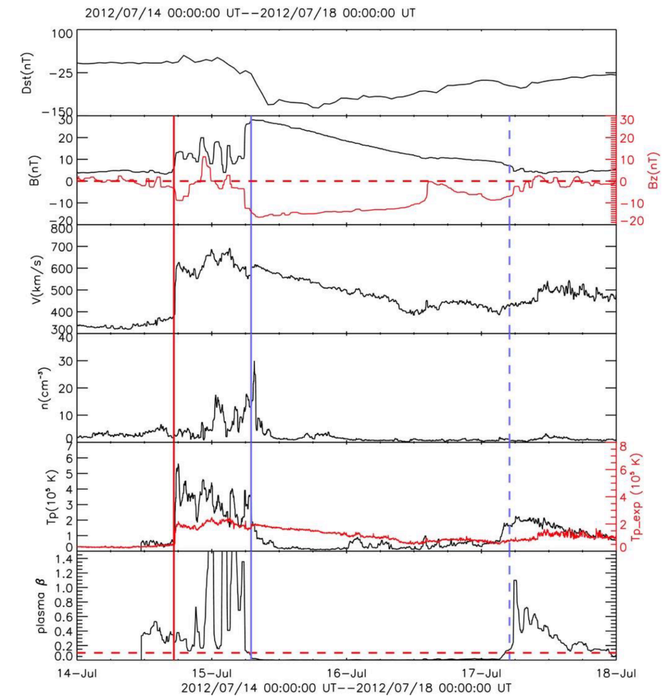
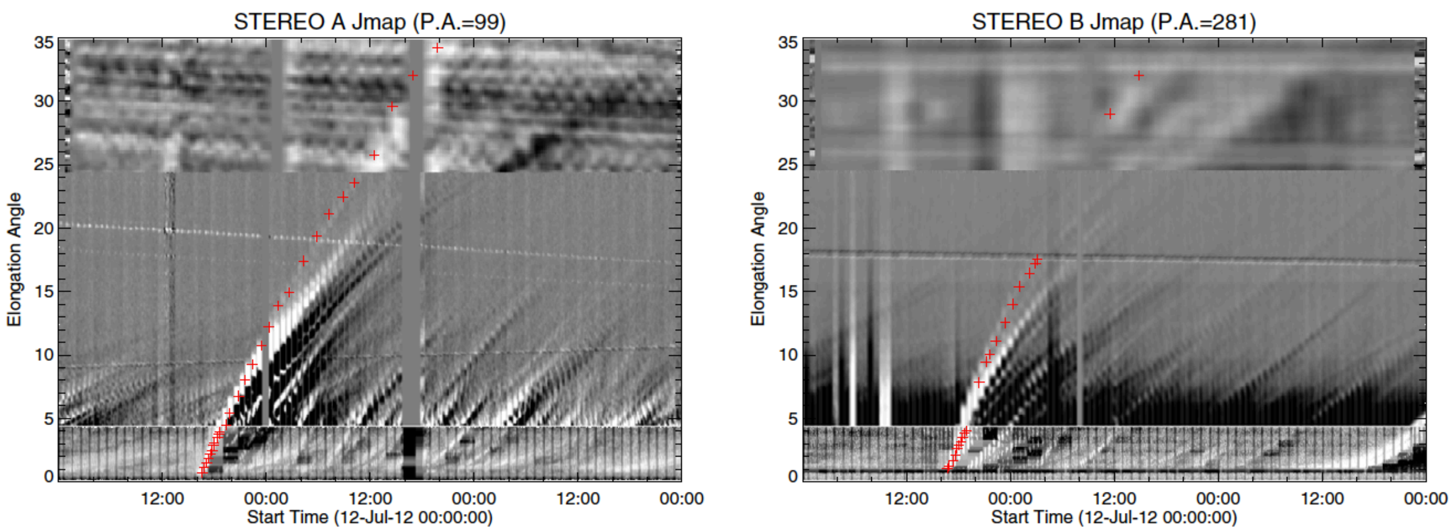
Textbook Event





Clear tracking of solar eruption → CME → ICME



Hess and Zhang 2014

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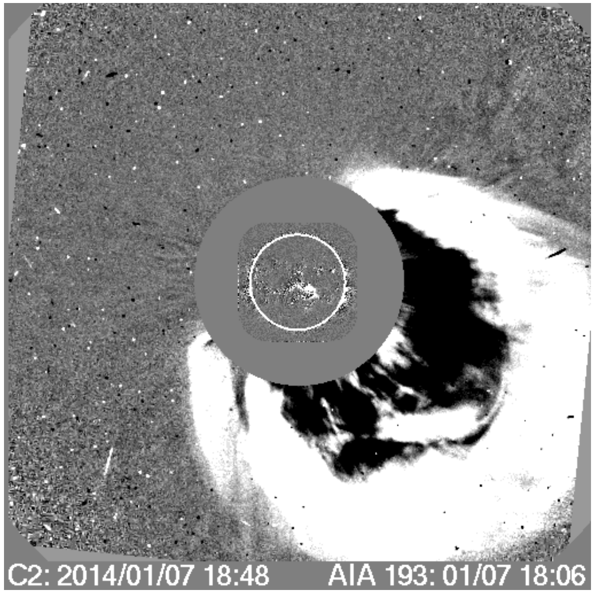
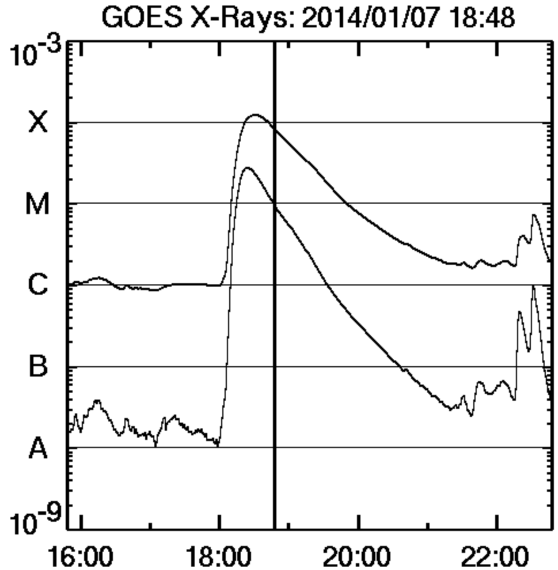
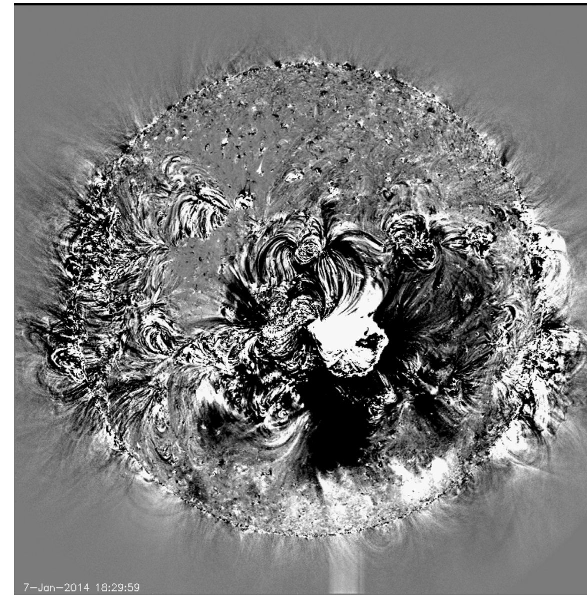
Big Eruption, Fast CME, Negligible 1 AU Signatures



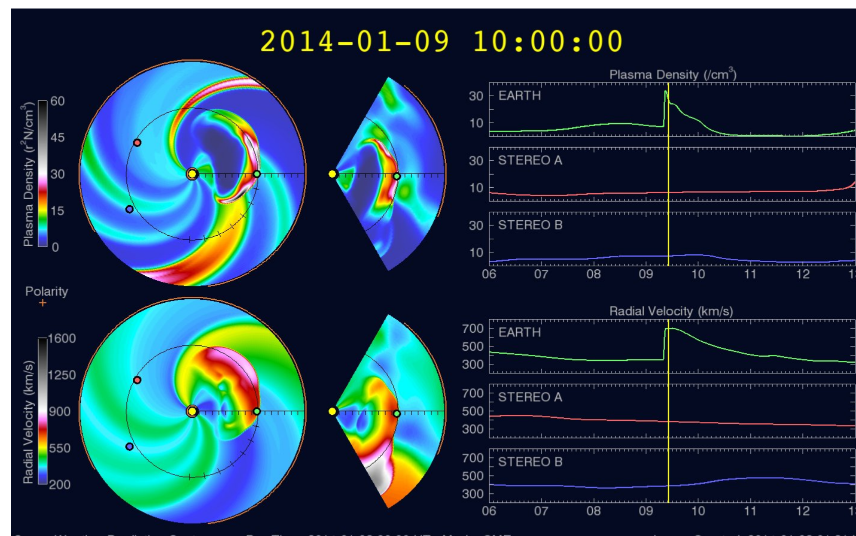




Big CME from near disk center

NOAA/SWPC forecast 2014 Jan 07 2200 UTC

Geophysical Activity Forecast: The geomagnetic field is expected to be at quiet to active levels on day one (08 Jan), active to major storm levels on day two (09 Jan) and unsettled to minor storm levels on day three (10 Jan).



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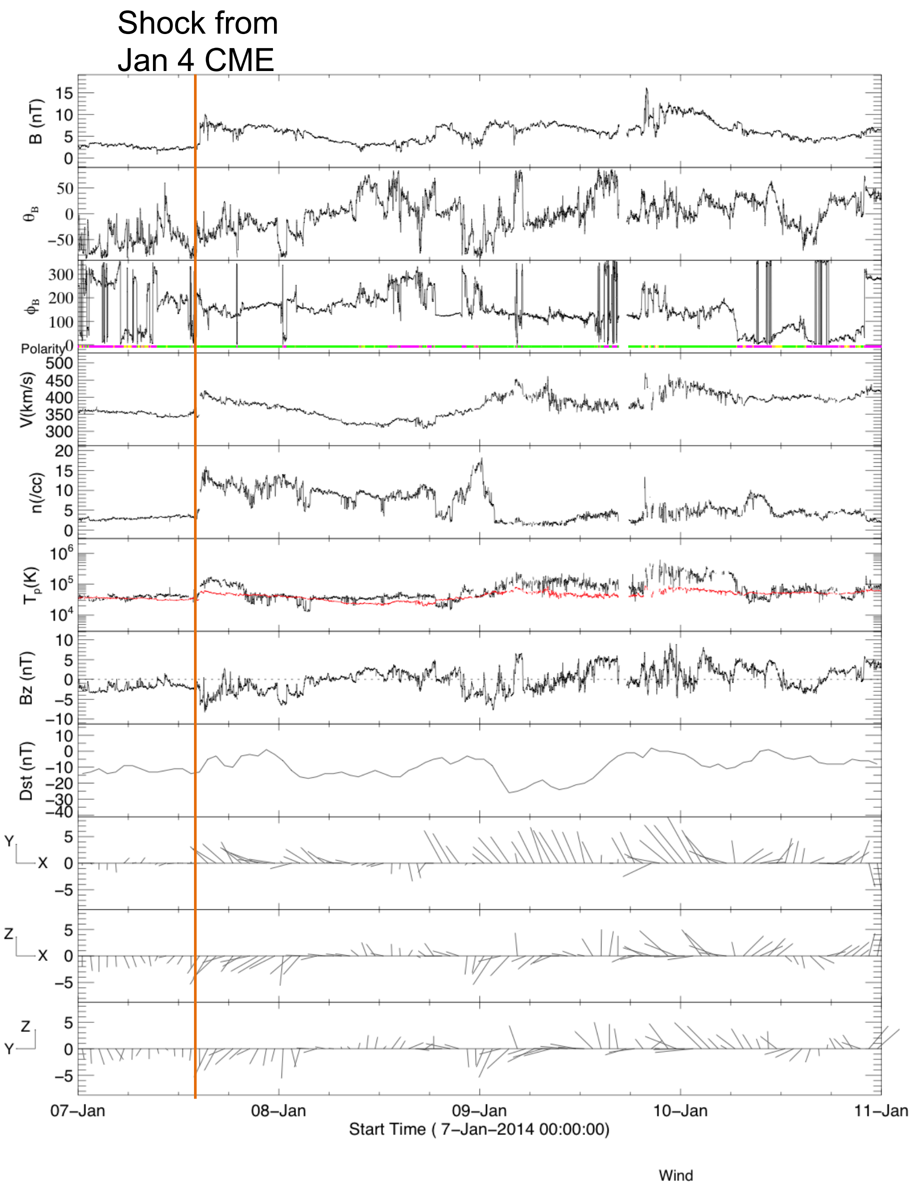

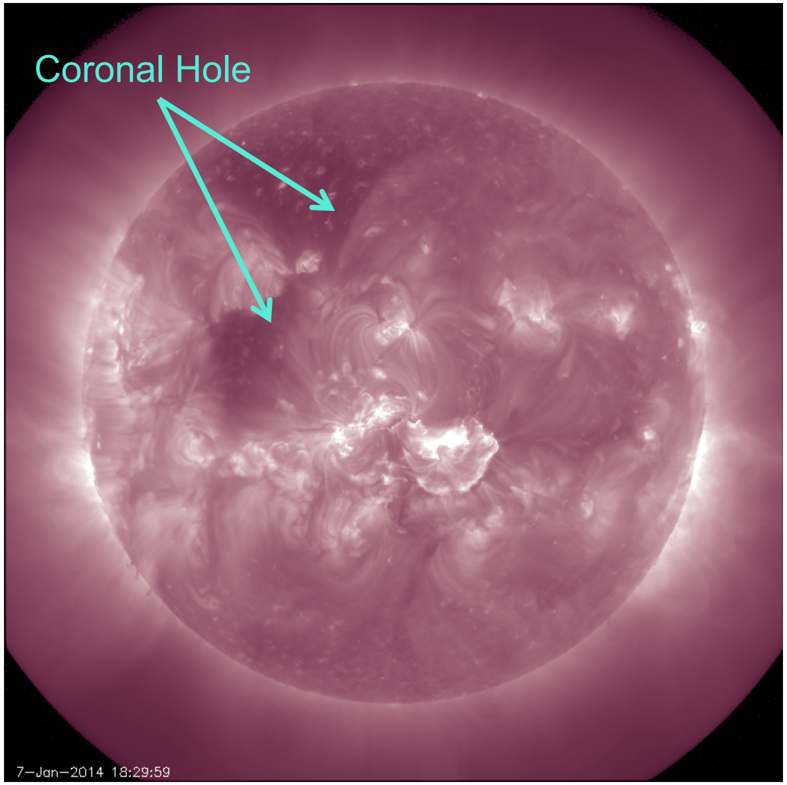

From Nat Gopalswamy
Subject **Re: EXTERNAL: Re: CCMC scoreboard site** 9.1.2014, 09:09
To Nariaki Nitta
Cc Mays, M. Leila, 'spaceweather@cronus.nrl.navy.mil'

Nariaki,

Looks like the coronal hole to the northeast of the source region really pushed the CME away from Earth! ... NG

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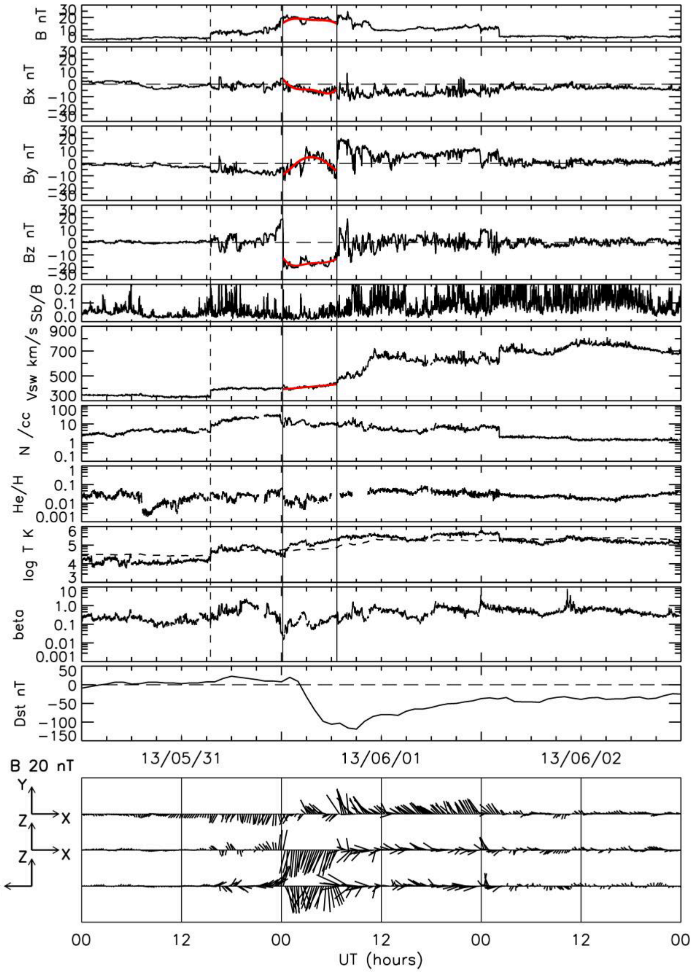
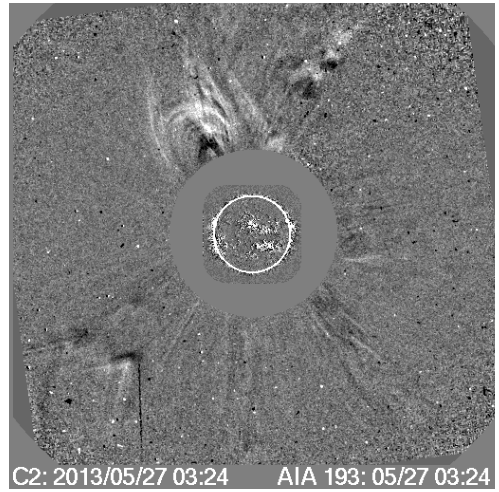
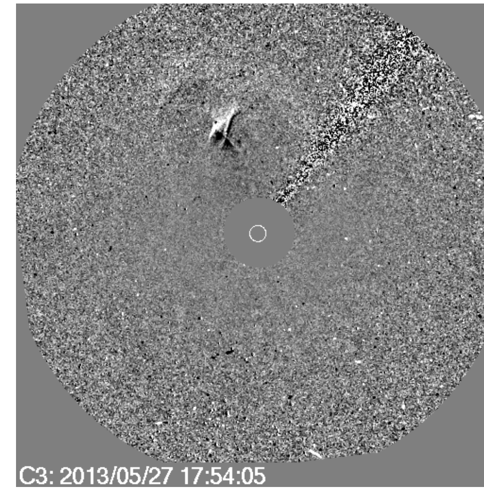
Coronal Hole Dominant – Need for a CME?

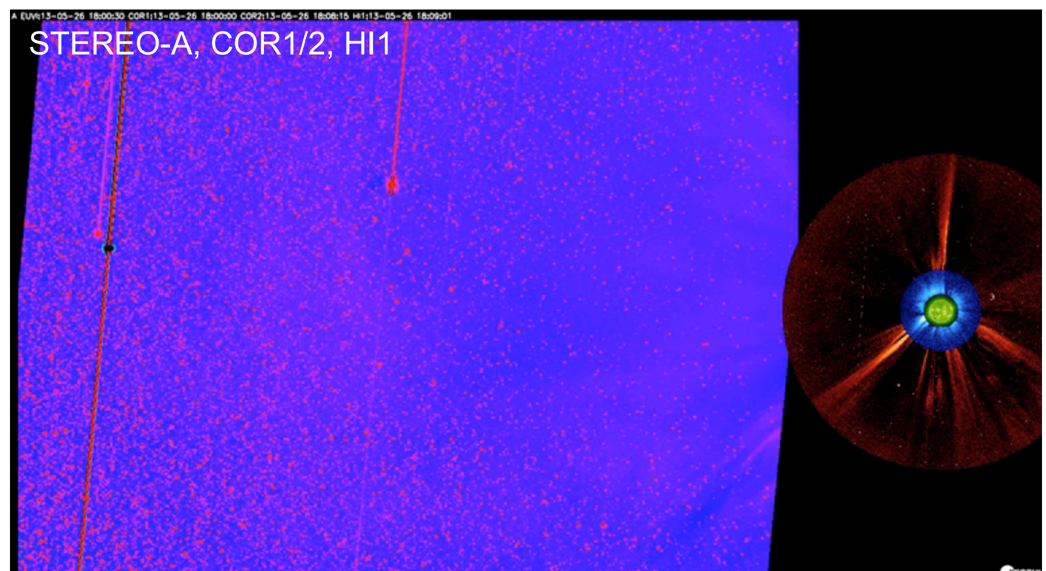
Did the slow CME heading to northeast contribute?



Marubashi, Cho, and Ishibashi 2017







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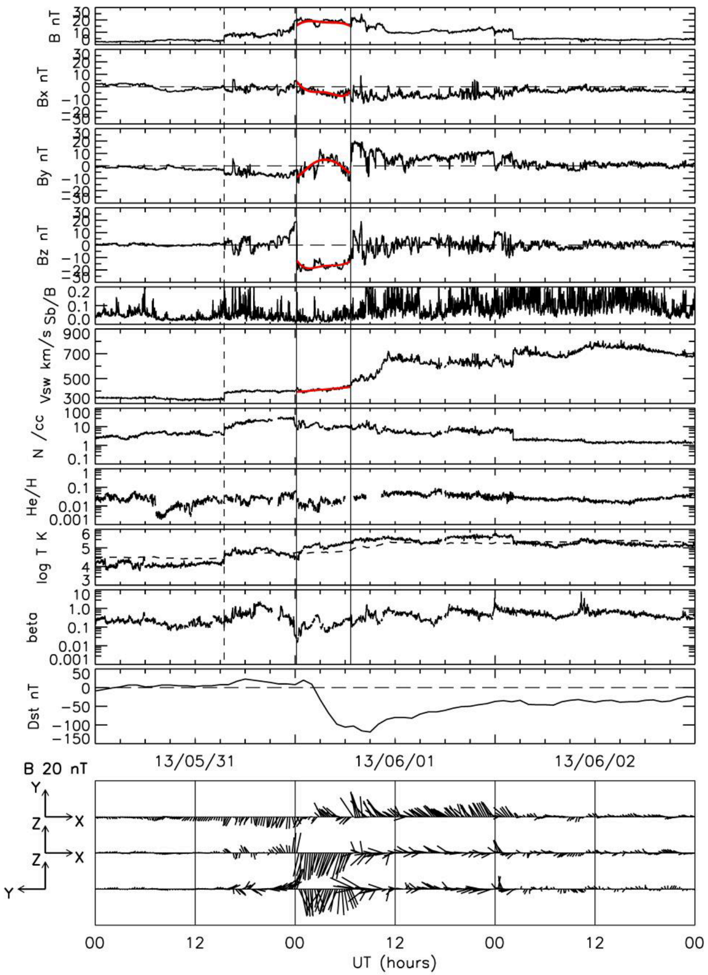
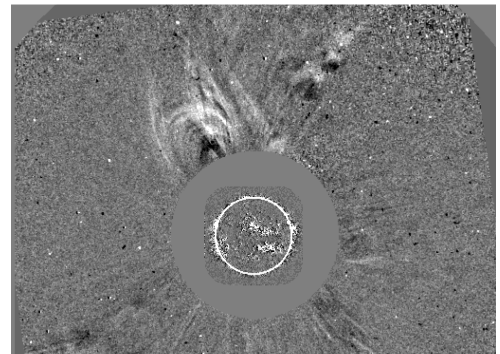
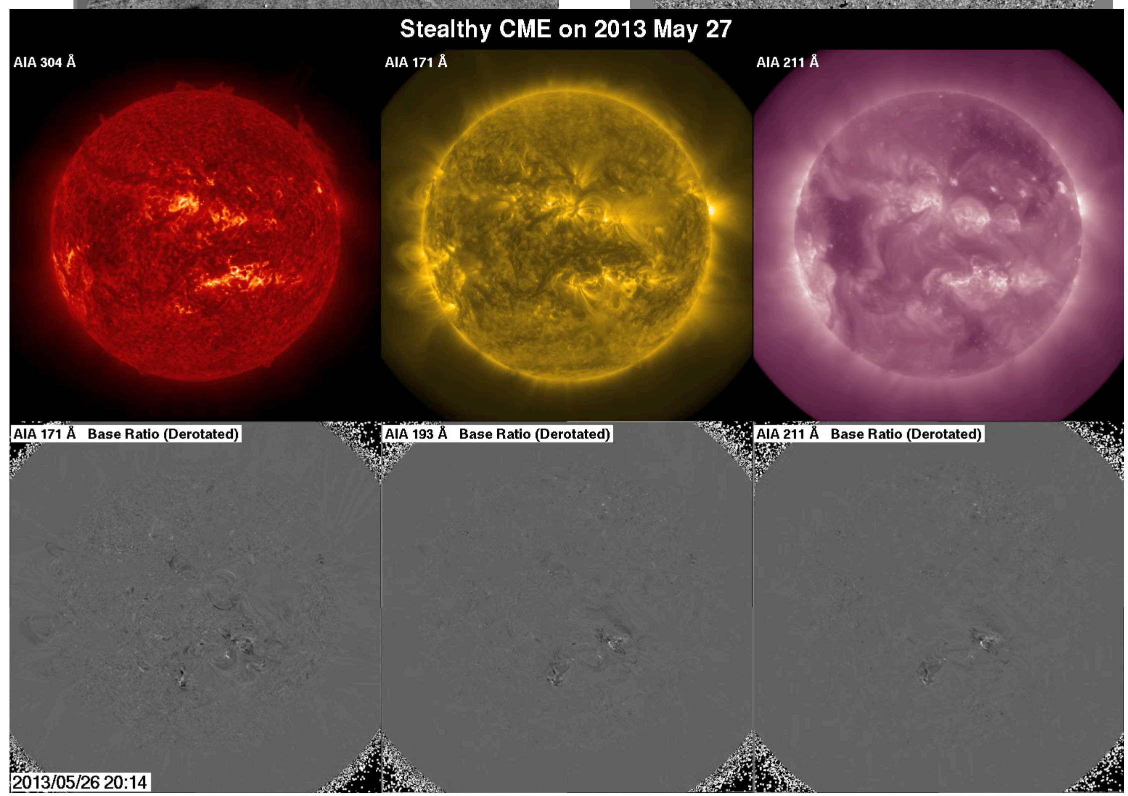


Marubashi, Cho, and Ishibashi 2017





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Arguable Stealth CME – 5 October 2012

On ISEST Wiki page,

http://solar.gmu.edu/heliophysics/index.php/10/08/2012_05:00:00_UTC

- This is a varSITI campaign event
- A good ICME, strong CME source, however, "stealth" surface signature (J. Zhang)
  - A good example of "stealth" CME: bright CME, but no or very weak surface signature (in terms of no flare, dimming, filament eruption etc)
- This event has a very difficult to distinguish source region, if you look very closely at S22 W38 just before 00:00 UT on the 10/05 it is possible to see a very small disturbance on the Sun, especially in 304 Angstroms. (Hess)
- M. Temmer: clear on-disk signatures - movie from SDO - are visible. It is a "silent" CME, hard to catch for space weather forecasters, but not a "stealth" in sense of no solar surface signatures at all.

See N. Nitta & T. Mulligan: Stealthy but Earth-Affecting CMEs (Wednesday morning)

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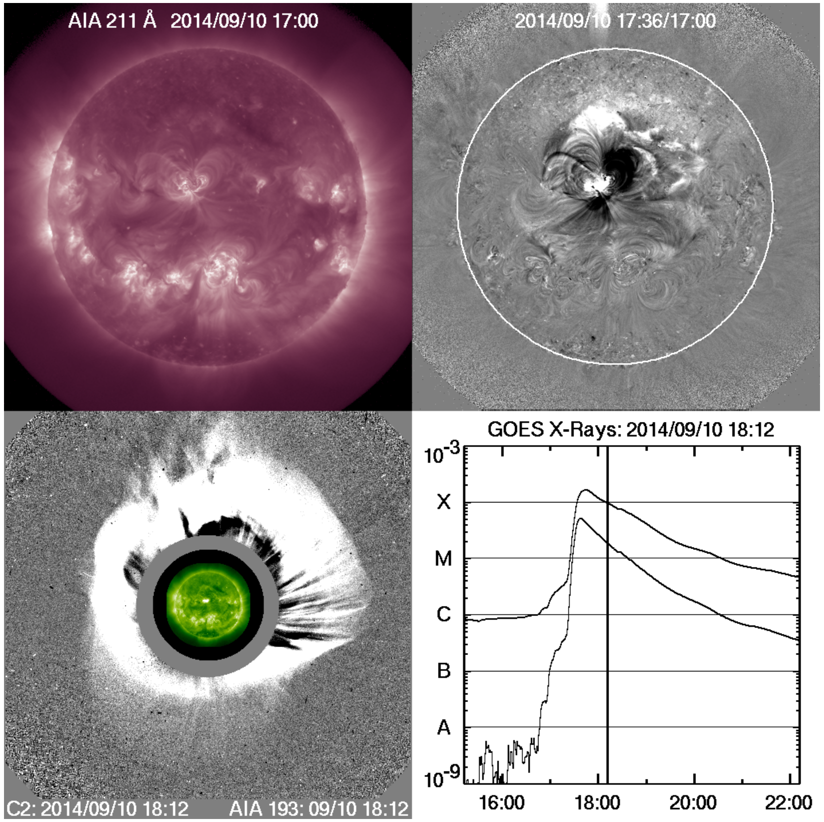
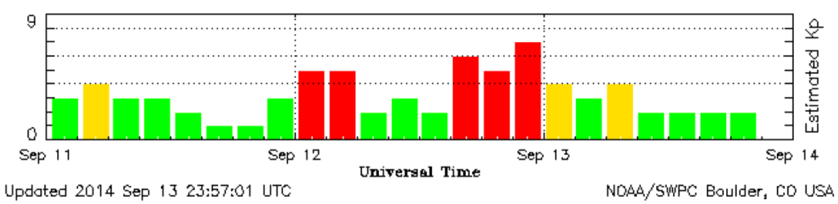
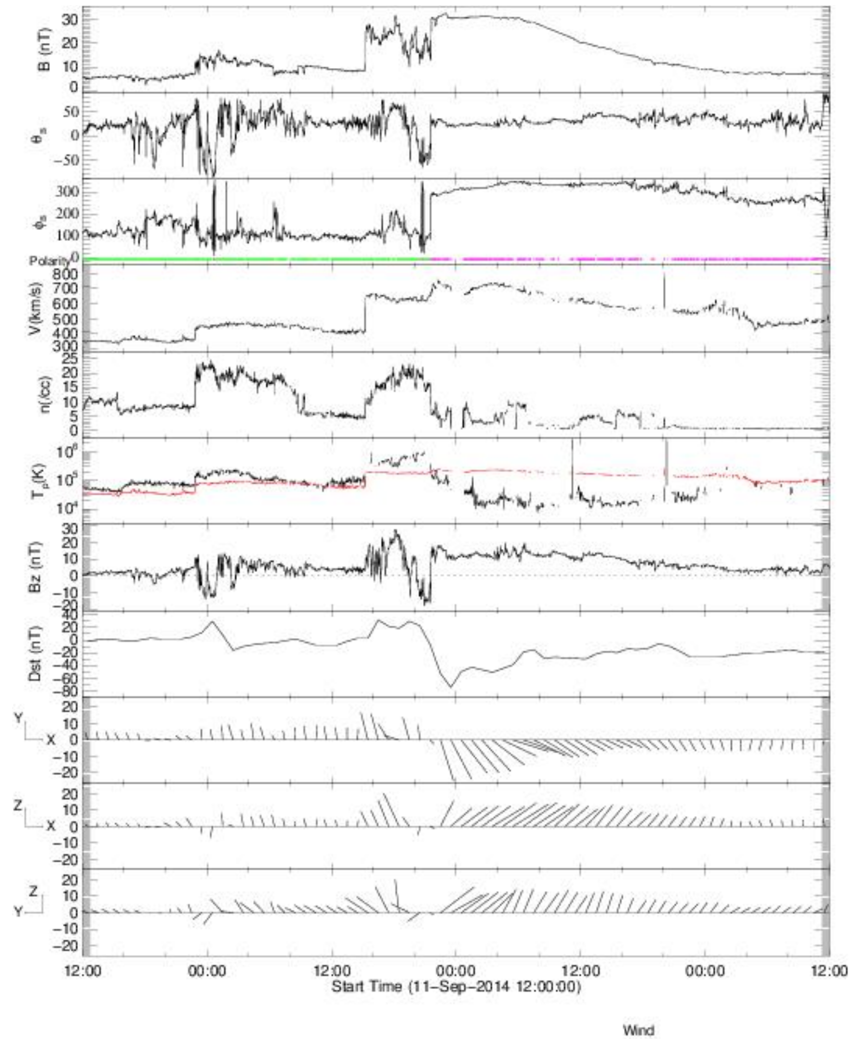
Gorgeous Eruption but Unfulfilled Consequences

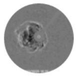


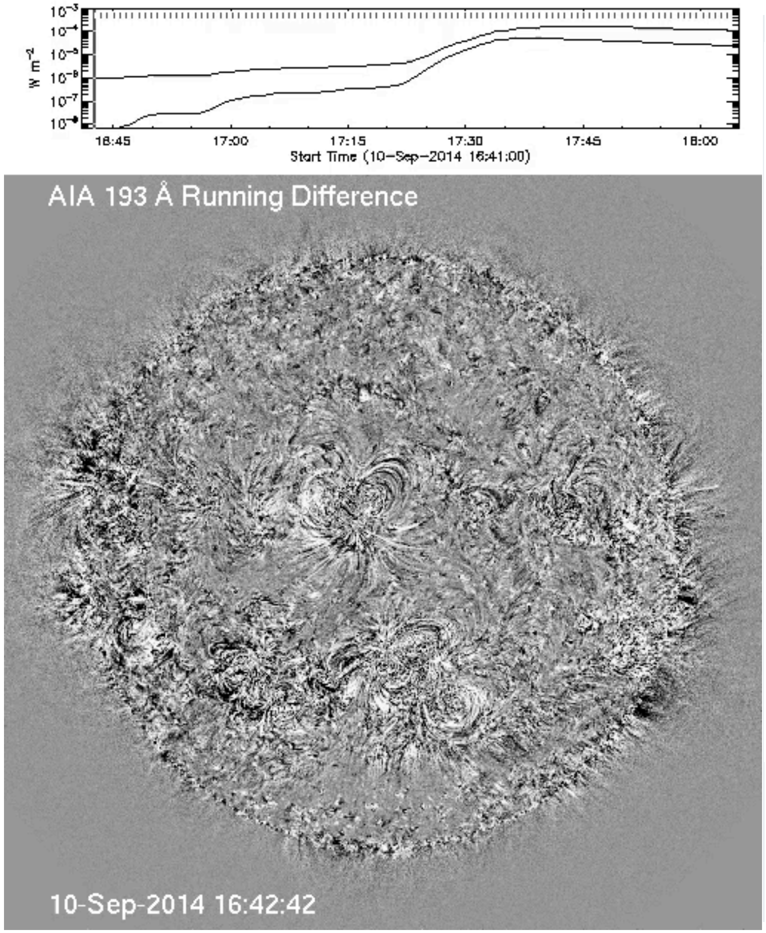




A G3 (Kp=7) storm occurred in the sheath region. The storm would have been stronger if the field in the flux rope had been southward.

Gorgeous Eruption but Unfulfilled Consequences

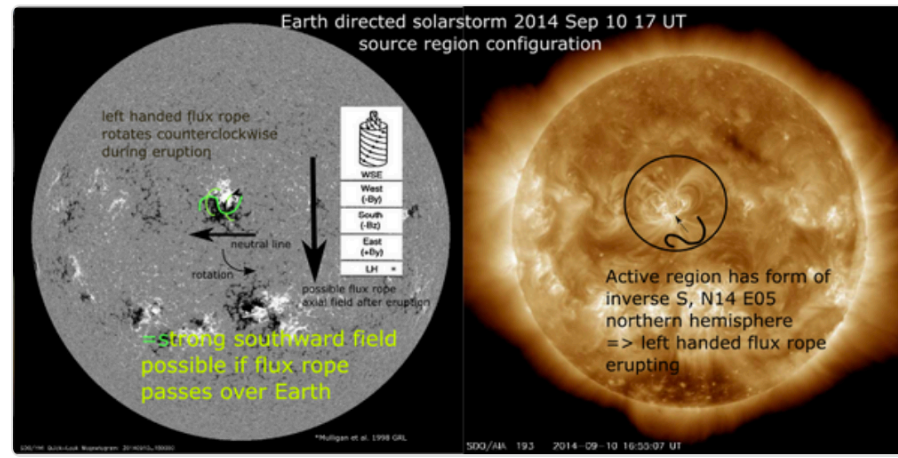




You Retweeted

Christian Möstl @chrisoutofspace · 11 Sep 2014

My quick take on 2014 Sep 10 #solarstorm source: if cloud hits Earth, strong -Bz likely!
@TamithaSkov @halocme



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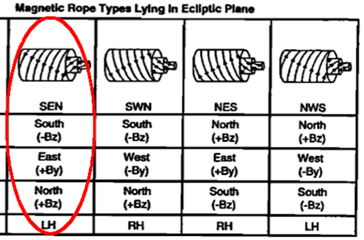
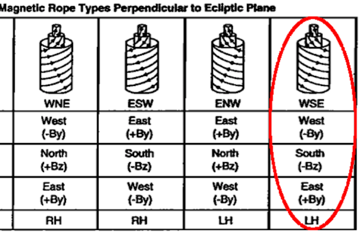
A left-handed flux rope (consistent with the general hemispheric rule) was predicted, whether or not it underwent CCW rotation.



Magnetic Rope Types Lying in Ecliptic Plane

Magnetic Cloud Type	SEN	SWN	NES	NWS
Leading Field	South (-Bz)	South (-Bz)	North (+Bz)	North (+Bz)
Axial Field	East (+By)	West (-By)	East (+By)	West (-By)
Trailing Field	North (+Bz)	North (+Bz)	South (-Bz)	South (-Bz)
Helicity	LH	RH	RH	LH

Figure 1. Four orientations of ecliptically oriented flux rope model and its magnetic signatures. Note N=north, S=south, E=east, W=west [after *Bothmer and Rust* [1997]].



Magnetic Rope Types Perpendicular to Ecliptic Plane

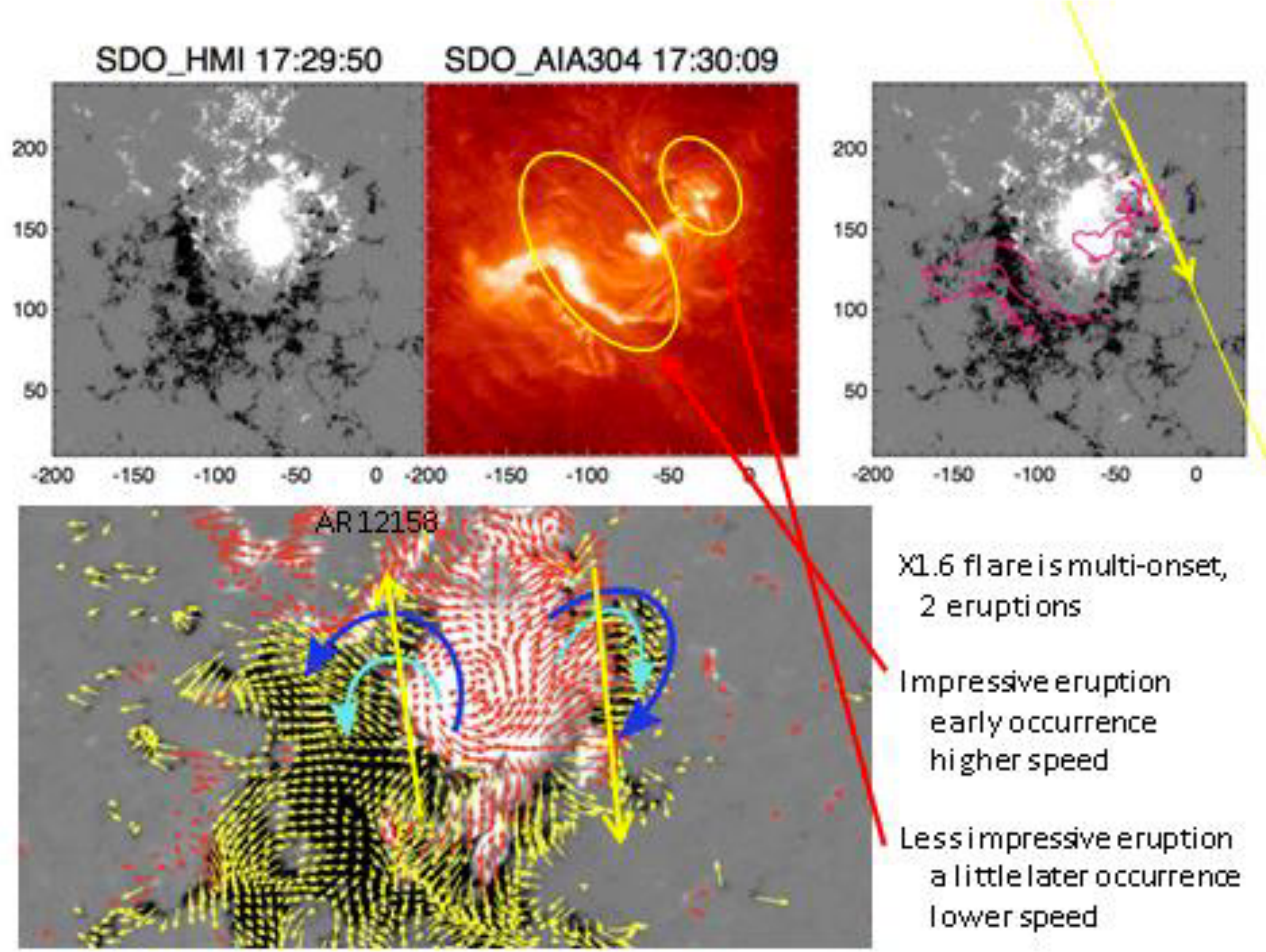
Magnetic Cloud Type	WNE	ESW	ENW	WSE
Leading Field	West (-By)	East (+By)	East (+By)	West (-By)
Axial Field	North (+Bz)	South (-Bz)	North (+Bz)	South (-Bz)
Trailing Field	East (+By)	West (-By)	West (-By)	East (+By)
Helicity	RH	RH	LH	LH

Figure 2. Four flux rope model orientations highly inclined with respect to the ecliptic plane. Note N=north, S=south, E=east, W=west [after *Zhao and Hoeksema* [1996]].

Mulligan and Russell (1998)

Gorgeous Eruption but Unfulfilled Consequences

Contrary to the expectations, the flux rope at Earth appears to be right-handed. Some speculate that another eruption close in time contributed to the ICME.



Courtesy of Marubashi (2017)

Updated WG 4 Event List

Dates	Source	Geo-response*	Dst	Kp/G Level	Forecast Success
VarSITI-wide Campaign Study Events					
1) 2012 July 12-14	X1 flare, wave, fast CME	Shock, MC, Strong storm	-127	7/G3	Under-predicted
2) 2012 Oct. 4-8	CME; weak surface signs.	Shock, MC, HSS, Moderate stm	-105	6+/G2	Under-predicted
3) 2013 March 15-17	M1 fl, wave, EF, IV, fast halo	Shock, MC? SEP, Strong storm	-132	6+/G2	
4) 2013 June 1	Slow CME on 27 May? CH influence?	Cause of Strong stm unclear;CIR?	-119	7/G3	Failed-not pred.
5) 2015 March 15-17	C9;C2 fl, wave, EF, fast CME	Shock, sheath, MC, Severe storm	-223	8+/G4	Under-predicted
6) 2015 June 22-24	2 M-fls, waves, fast halo CMEs	Shock, sheath, MC, SEP, Severe storm	-204	8+/G4	Mostly successful
Other ISEST Study Events					
7) 2012 March 7-9	X5 flare, wave, fast CME	Shock, MC, Strong storm	-131	8/G4	
8) 2012 July 23-24	2 flares? Wave, EFs	Extreme ST-A event; “Strong storm“ (Carr.-type) ---			
9) 2012 January 6	CME <2000 km/s, over WL	GLE at Earth	No	---	
10) 2014 January 7-9	X1 fl, wave, fast asym halo	Shock, SEP. No storm- CH deflection; AR channeling?	No	≤3	
11) 2014 Sept. 10-13	X2 flare, wave, sym halo	Shock, MC, Moderate storm	-75	7/G3	Over-predicted
12) 2015 January 3-7	Slow CME	Brief ICME, MC, HSS, Mod. stm	-99	6+/G2	
13) 2016 October 8-12	Slow CME	Shock, MC, HSS, Moderate stm	-104	6+/G2	
14) 2017 Sept 4-10	Act. series; M5,X9,X8, etc	Shocks, MCs, Strong storm(s), FD	-142	8/G4	

CME = coronal mass ejection; AR = active region; EF = erupting filament; CH = coronal hole; MC = magnetic cloud; SEP = solar energetic particle event; CIR = corotating interaction region; GLE = ground-level event; HSS = high speed stream

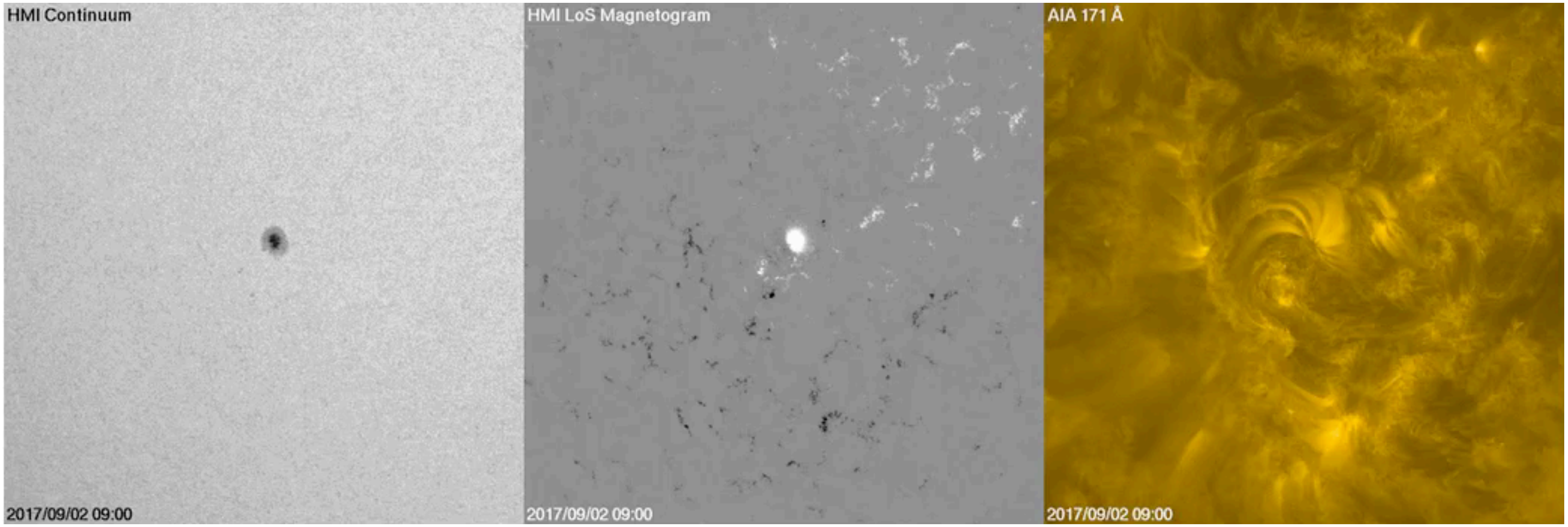
xx) Events featured in Webb & Nitta (2017)

xx) Problem events featured in Nitta & Mulligan (2017)

WG 4 wiki: ***http://solar.gmu.edu/heliophysics/index.php/Working_Group_4***

September 2017 Space Weather: #AR12673

Amazing Flux Emergence



From Nariaki Nitta

Subject Re: EXTERNAL: [sot_co:24592] *DRAFT* XRT Plan for 2017/09/05 -- 2017/09/07 (xrt_co: sot_co: eis_co:)

4.9.2017, 16:36

To masuda@isee.nagoya-u.ac.jp, sot_co@solar.isas.jaxa.jp, xrt_co@solar.isas.jaxa.jp, EIS_CO <eis_co@solar.isas.jaxa.jp>

Cc iris_planner@lmsal.com

```
AR 12673 seems to be recently revitalized with vigorous flux emergence. There may be more M-class flares.


Satoshi Masuda wrote on 03.09.17 23:44:
 Dear all

 This is a draft plan covering the period from 2017/09/05 - 2017/09/07.

 Summary:
     Two day plan to be uploaded on Tuesday
     Data Volume allocated: 2.14 Gb
     Est. data volume used: 2.23 Gb

 Plans:
 + HOP 81
    - South-pole obs. (fast)
    - Al-poly and Al-mesh (384 x 384)

 + AR 12677 obs. with IRIS (limb-to-limb tracking)
    - AR standard obs. with Al-poly and thin-Be
    - 384 x 384 (90s cad.)

 + AR 12674 obs.
    - AR standard obs. with Al-poly and thin-Be
    - 512 x 512 (72s cad.)

 + CME watch (during EIS sensitivity monitor)
    - 4x4 pixel full sun (360s cad.)

 + Synoptic program
        - one 7-filter synoptic at 17:57 UT on September 5
        - three normal synoptic around 18UT and 6UT

 For more details, please see the information below.

 Satoshi Masuda
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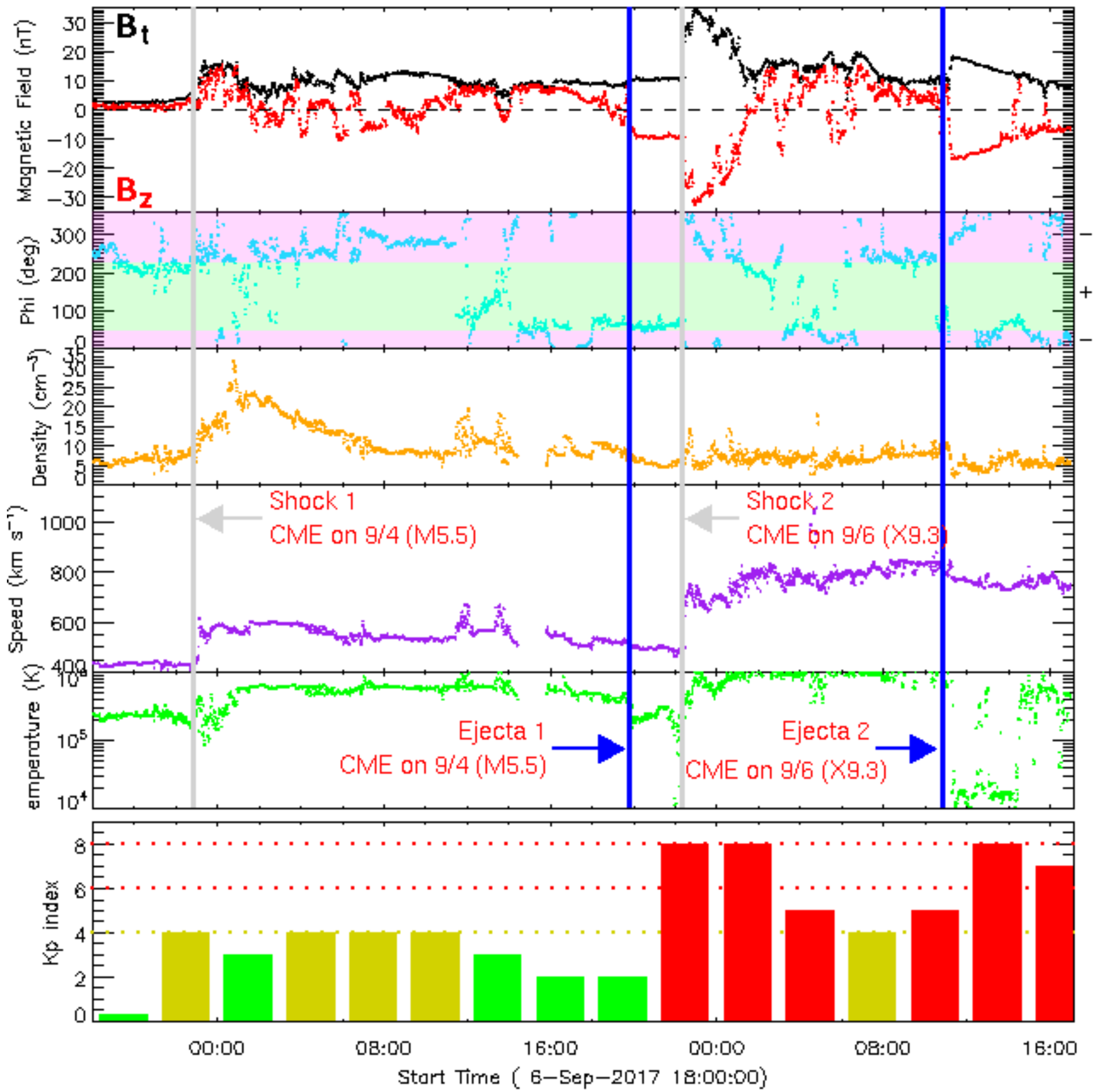
September 2017 Space Weather: #AR12673

Consequences - disk events

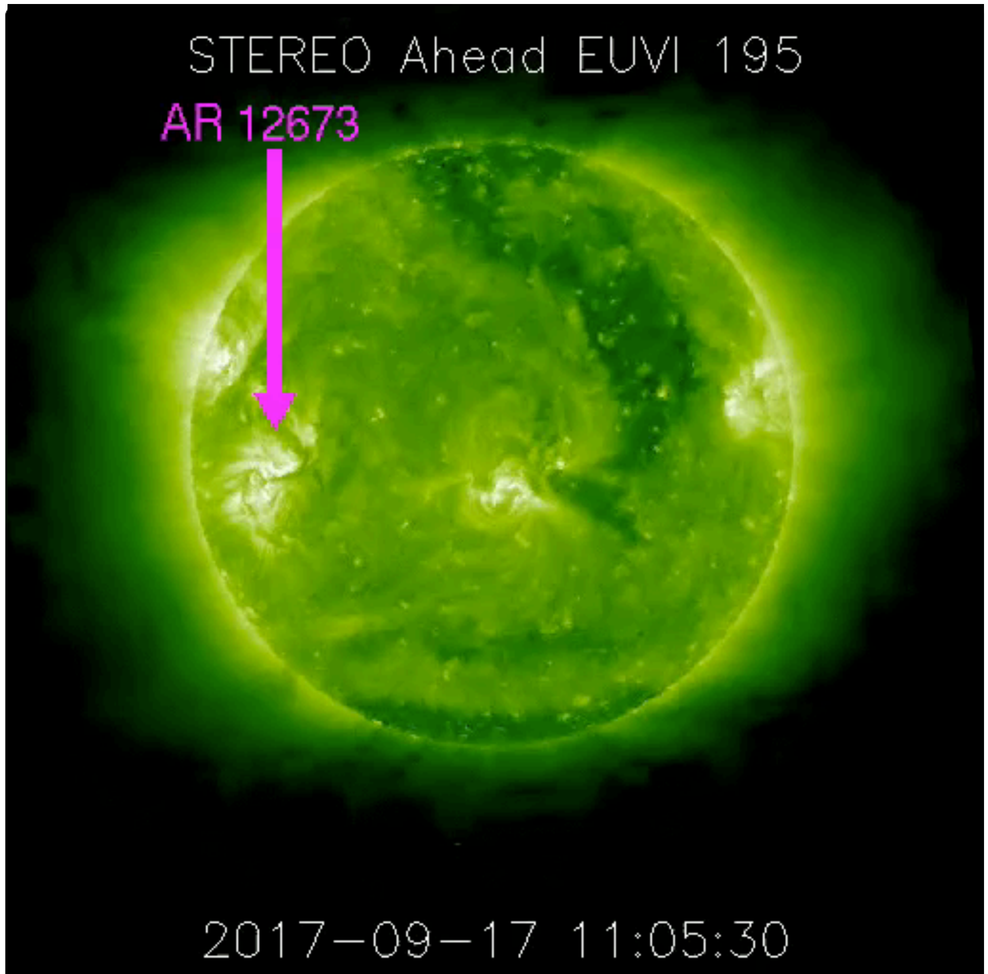


September 2017 Space Weather: #AR12673

Still active

Halo CME @halocme · 3h

#AR12673 was key player of space weather during 4-12 Sep, incl. possible Carrington event on the 10th. It is still active on the far side.



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