AR10965 activity on 2007 May 19: The source of a STEREO multipoint ICME

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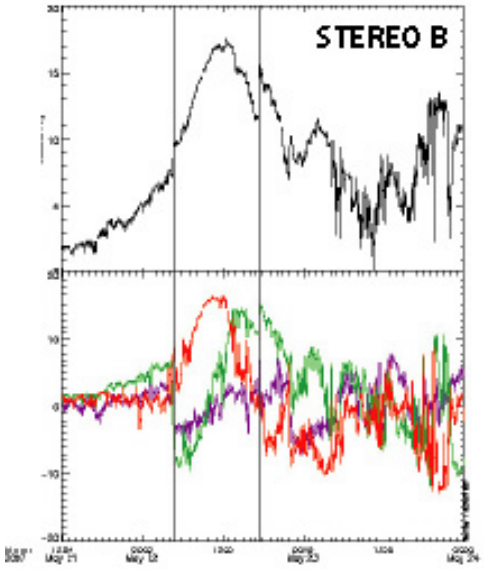
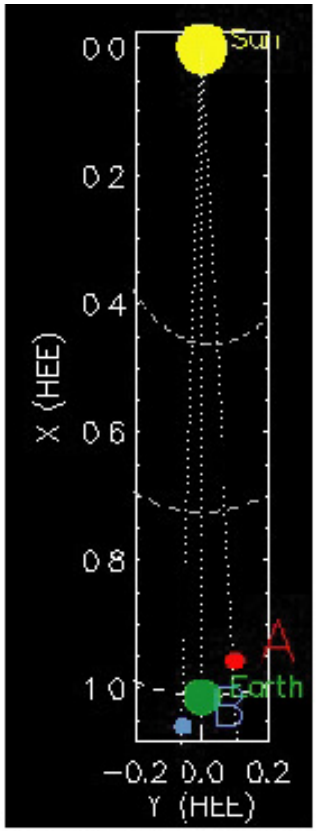
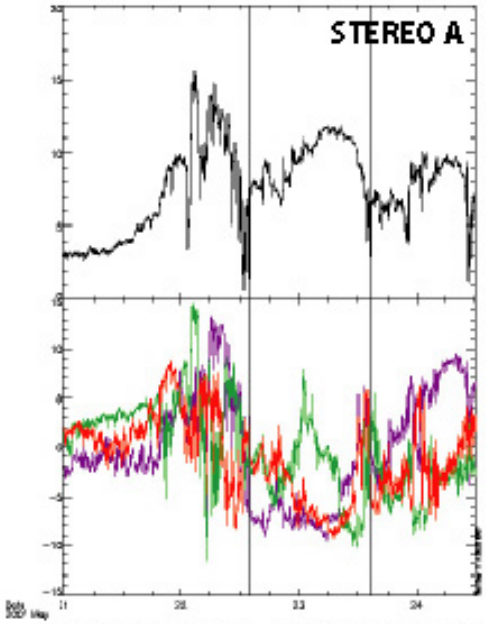
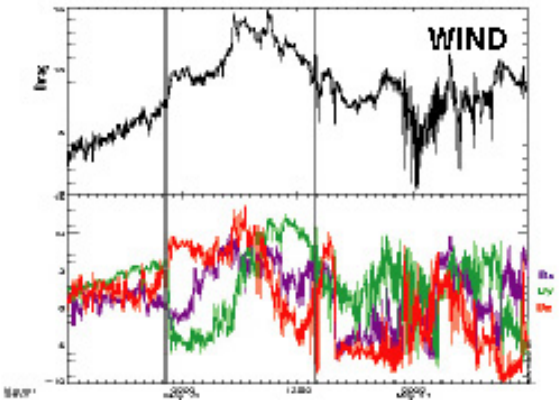


05/22 04:30 UT - 05/22 17:30 UT





05/22 14:05 UT - 05/23 14:55 UT



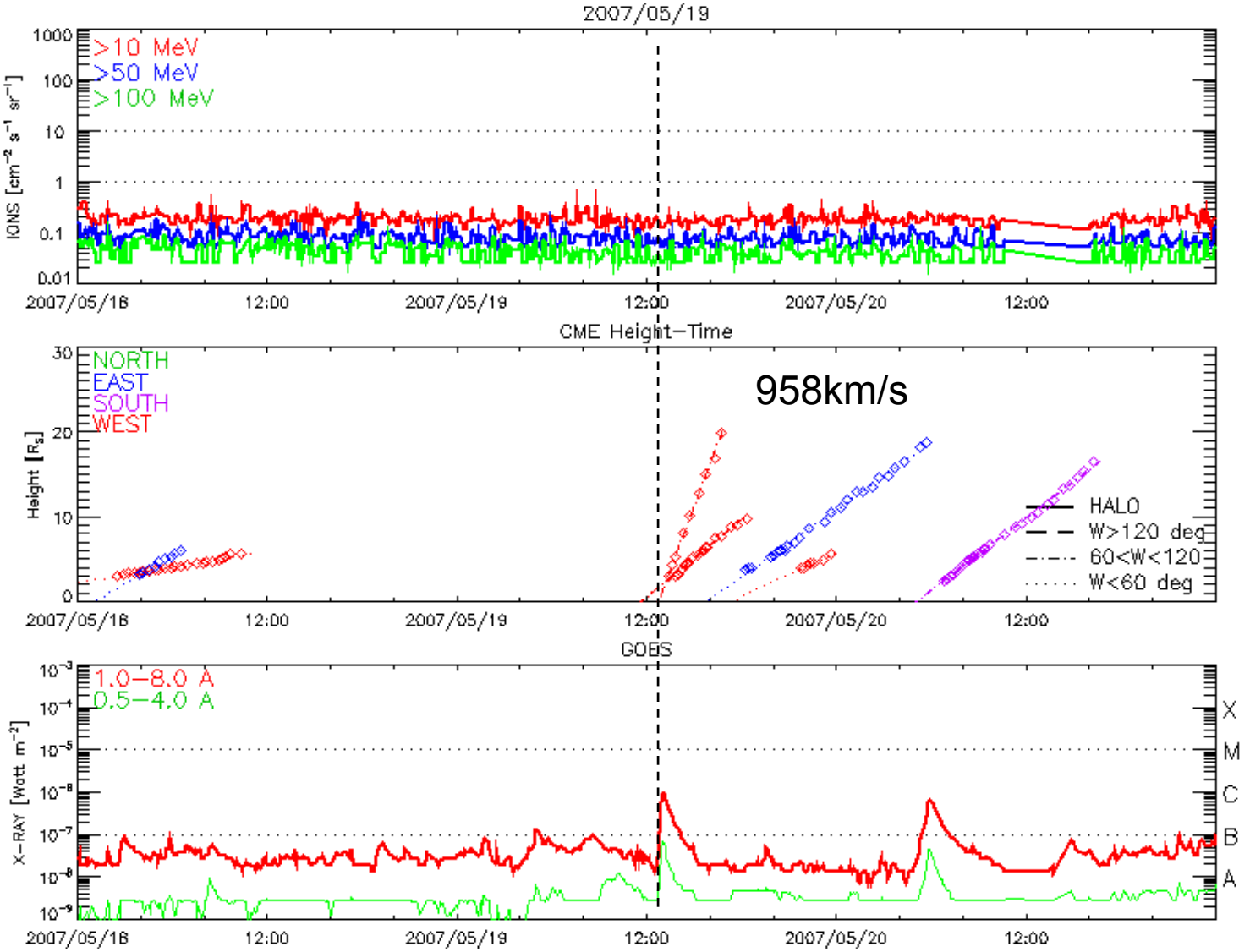
05/21 22:15 UT - 05/22 13:35 UT

(E. Huttunen)

Overview of the eruption

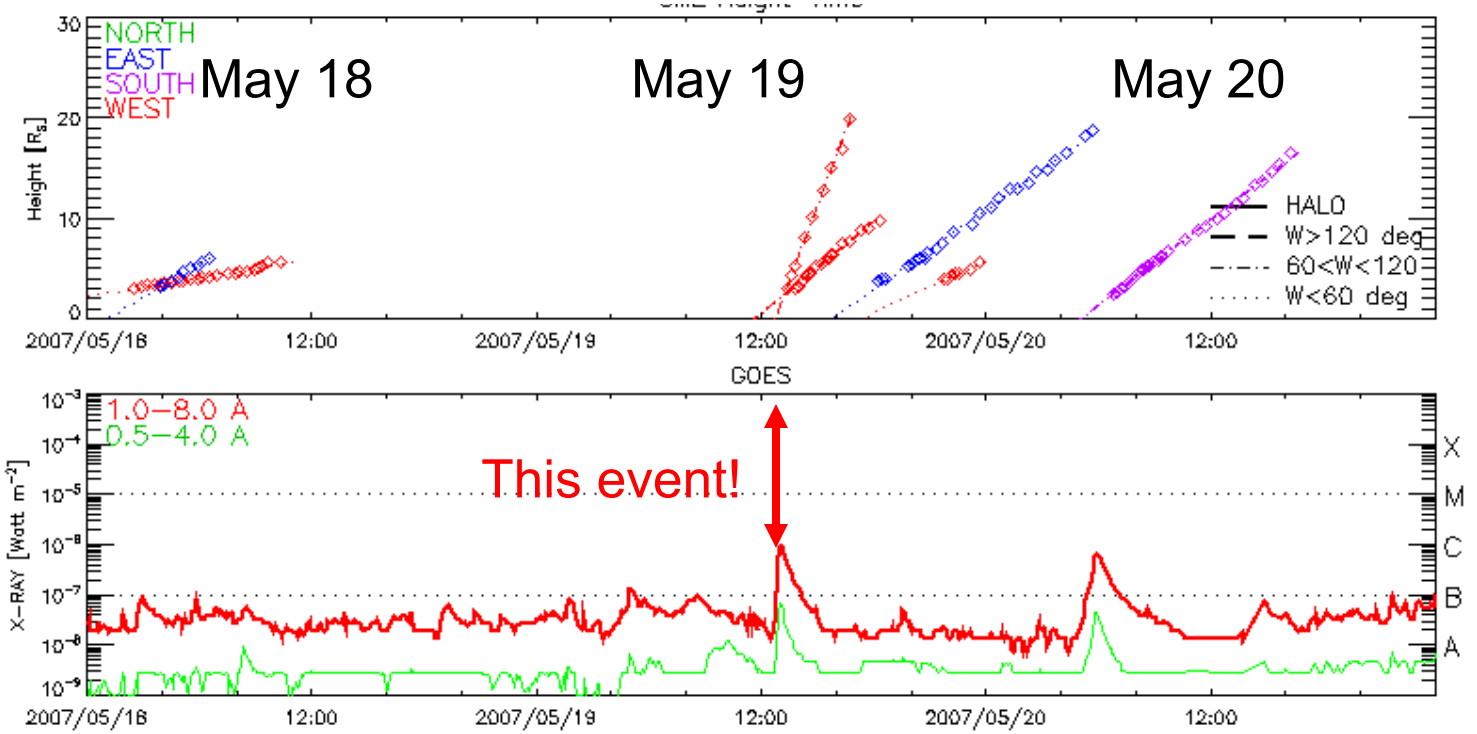
- A solar eruption occurred on 2007 May 19 from AR10956 (N03W01) near the disk center.
- The event included a B9.5 flare (12:48UT), a filament eruption, an EUV dimming (peaked at 13:12UT), and a possible multi-front CME.
- The coronagraph signatures may be the two CMEs at 13:24UT and 13:48UT in the LASCO CME catalog. The most rapidly expanding feature in white light images following the flare and filament eruption had a plane-of-sky speed of 958~km/s.

CME 2007-May-19 13:24UT
958km/s (LASCO CME catalog)



Linking the Cloud to May 19 Events

- Magnetic Cloud (ICME) at 1 AU has V ≈ 480 km/s
- If constant speed of 480 km/s, CME left Sun midday May 18
  - But no significant CMEs on May 18
- May 19 had double CME at 13UT with ☐X-ray flare, dimming and filament eruption
- LASCO catalog gives speed of **fast May 19 CME** as 980 km/s-
  - **We identify this CME as cause of magnetic cloud**

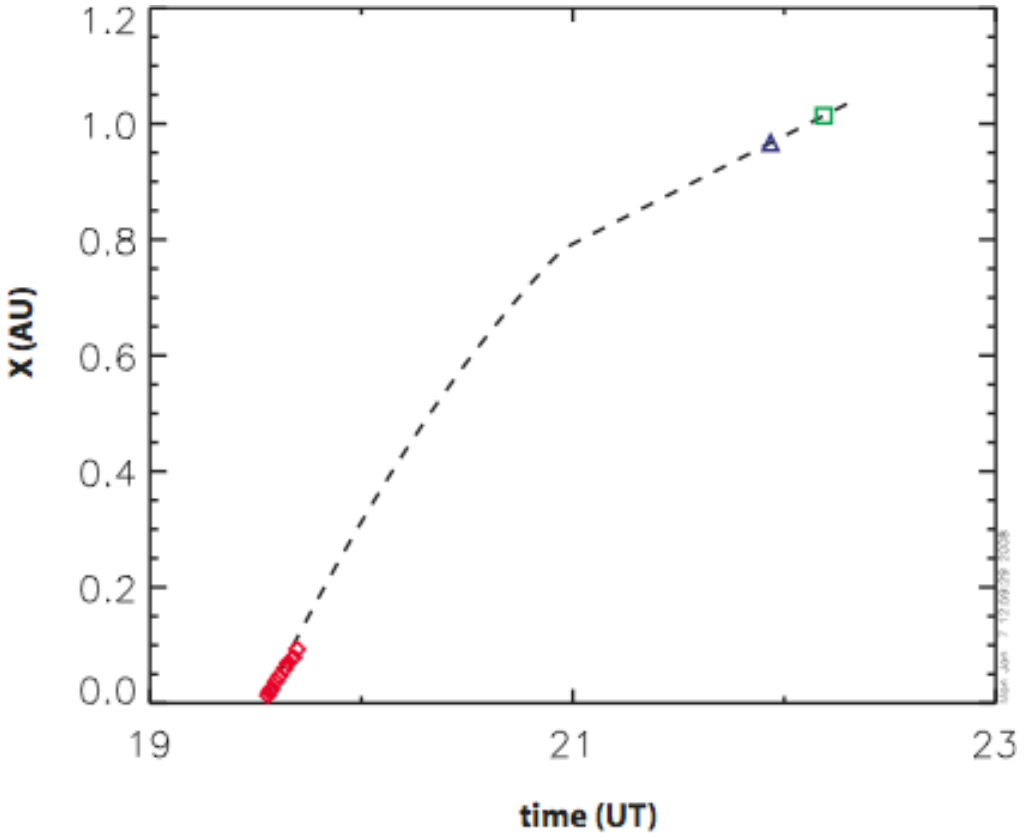


Linking the Cloud to May 19 Events

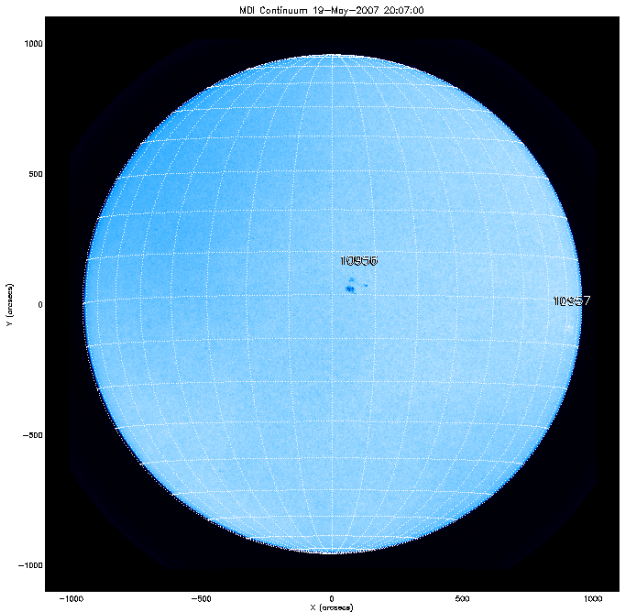
- If left Sun at 13:00 UT on May 19, <v> = 700 km/sec, comfortably between 980 and 480 km/s
- Graph: empirical formula of Gopalswamy et al (2001) using above initial and 1 AU velocities
- Good fit supports 13:00 UT May 19 CME as source of Cloud

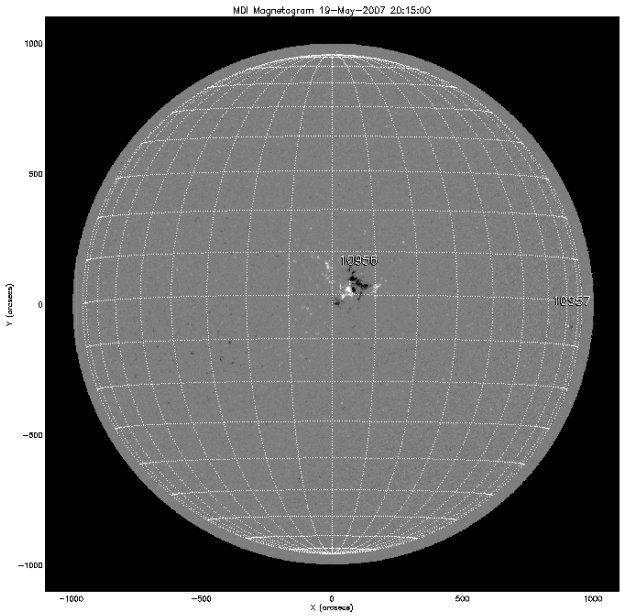
Red - LASCO May 18
Blue diamond - Wind
Green square - STEREO B

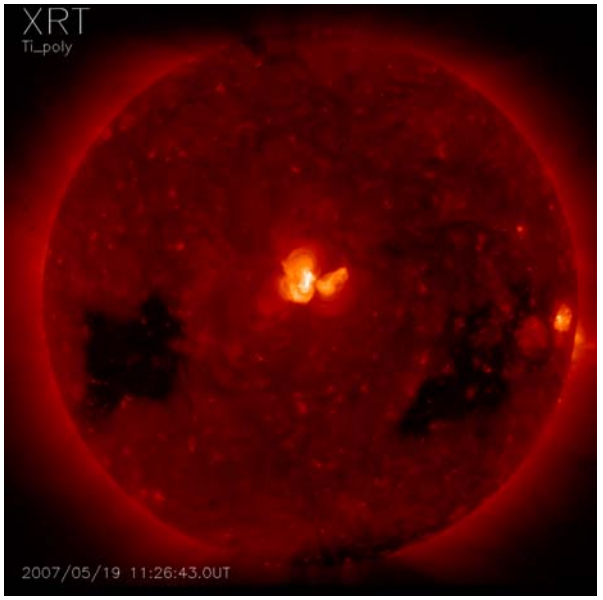
What about the Slow CME?
Same event, but projection effects of Earth-directed CME? (Leblanc 2001)

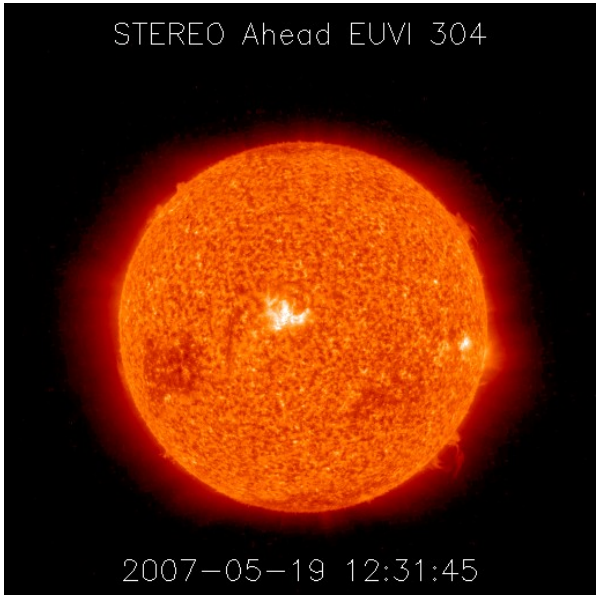


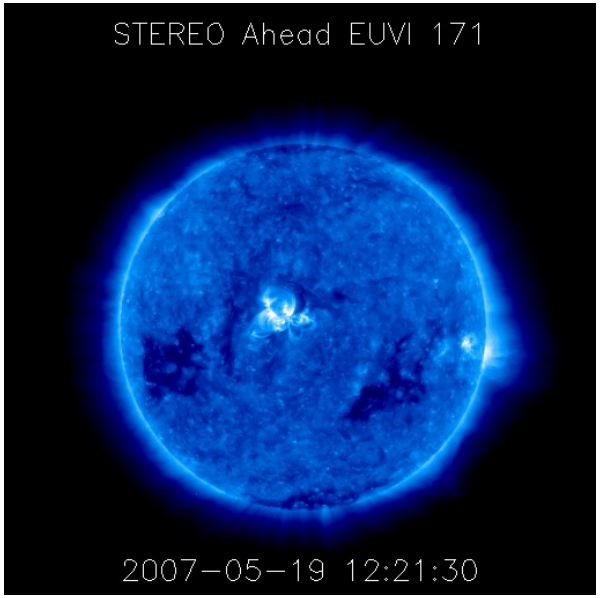
Multiwavelength solar images on 19 May, 2007

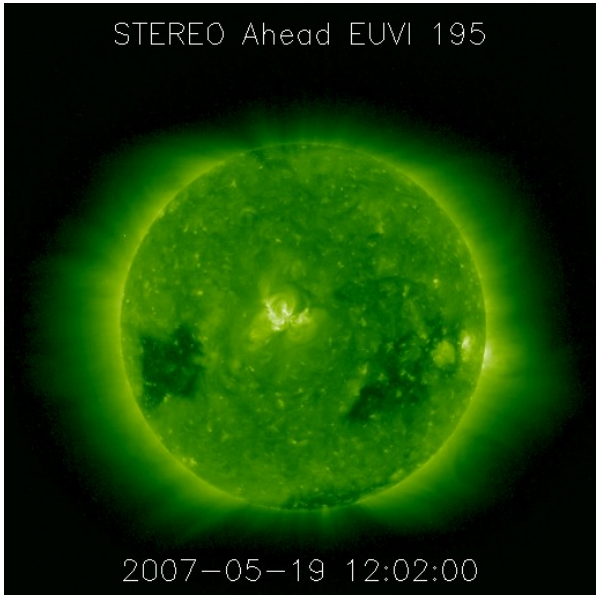


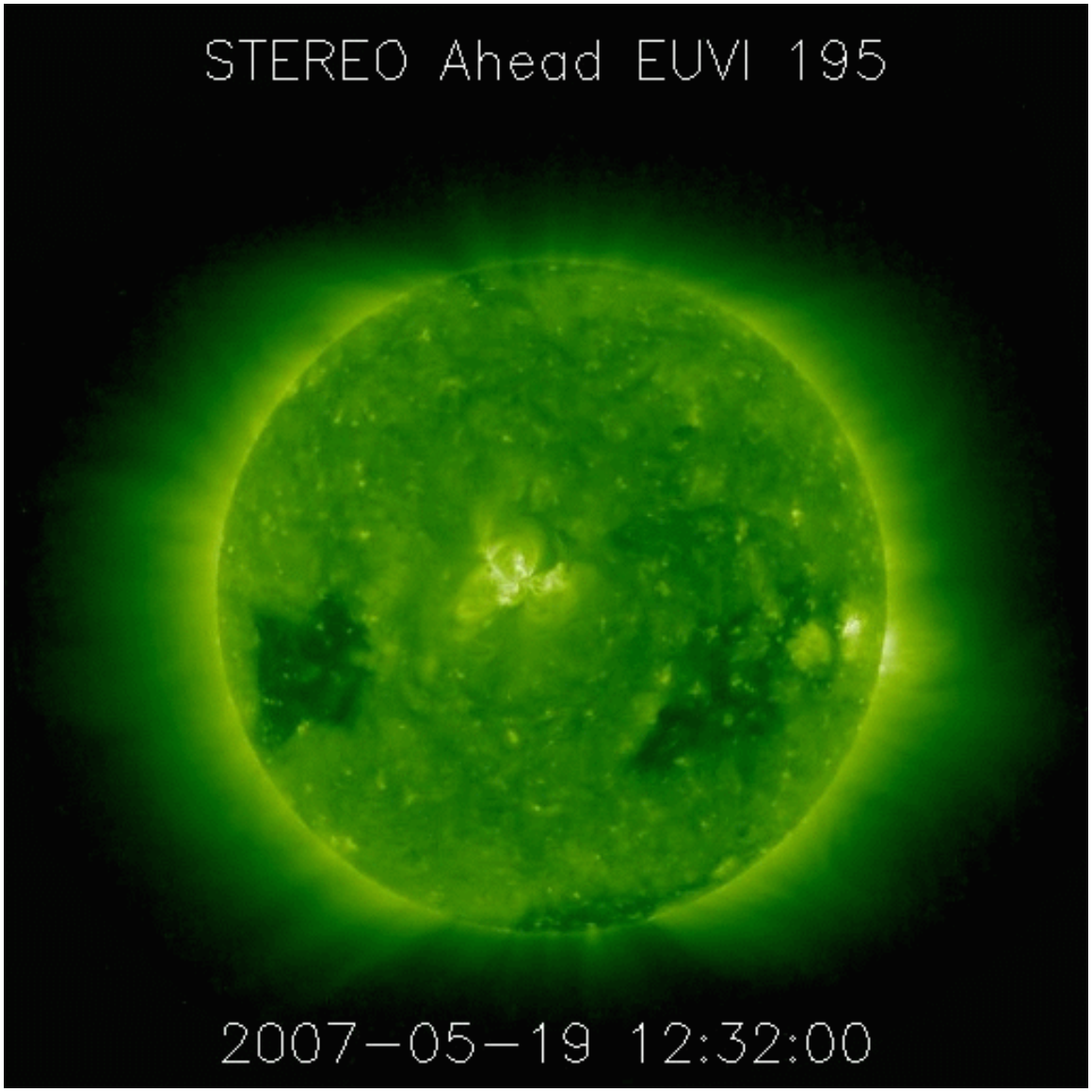






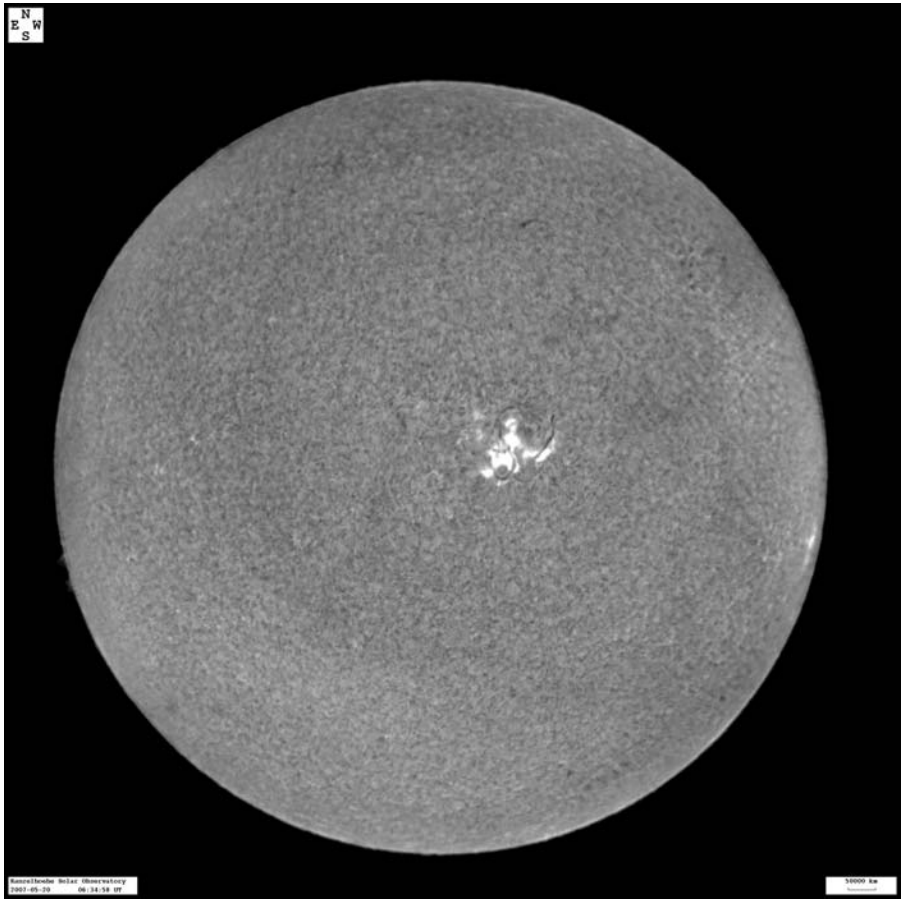





STEREO Ahead EUVI 195
2007-05-19 12:32:00

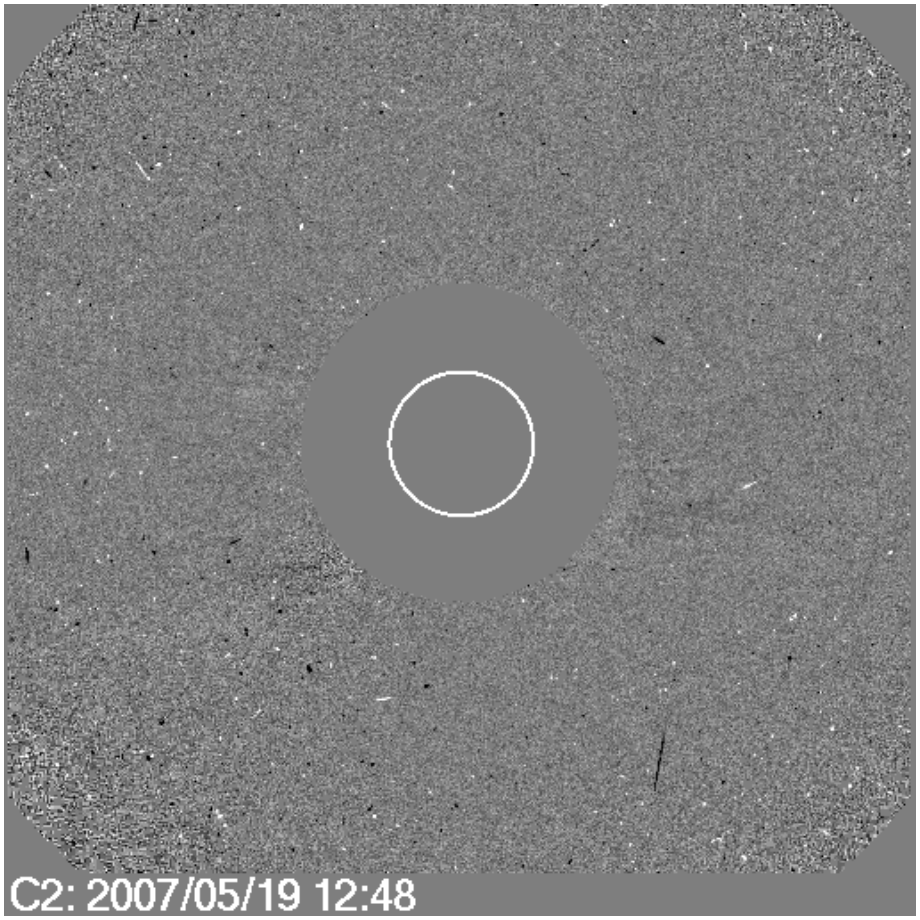
Erupting Filament 19-May-07
(BBSO Hα network)

Post eruption 20-May-07
(BBSO Hα network)

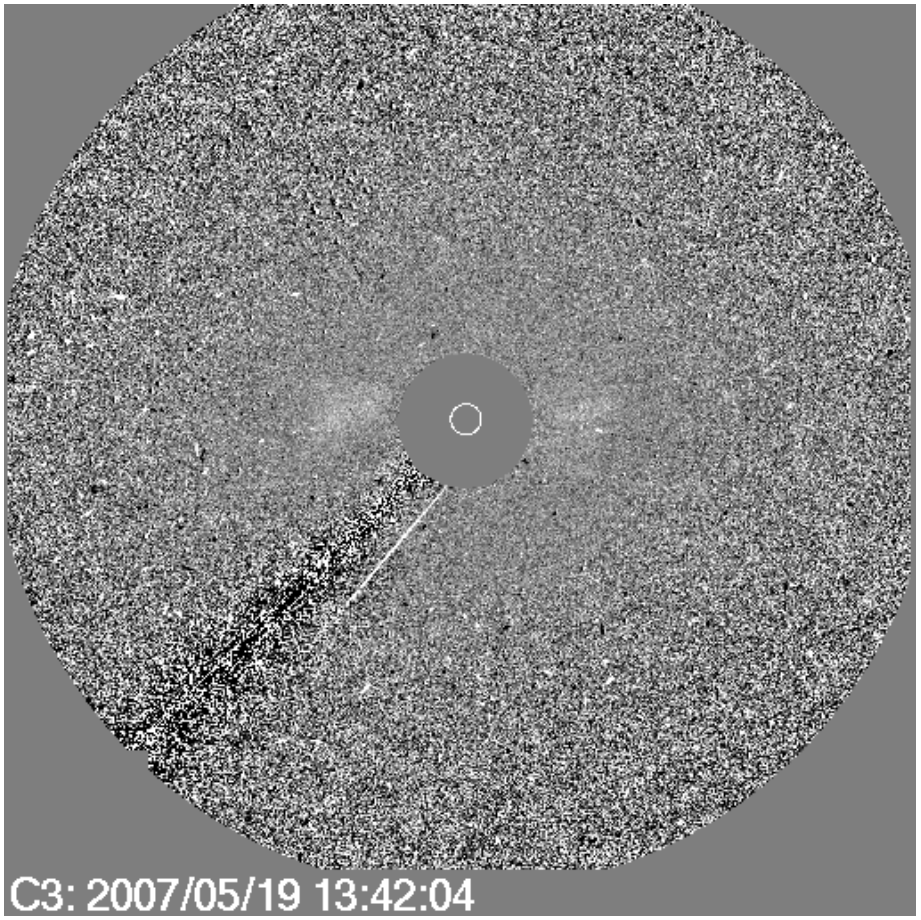


CME May-19-2007 13:24UT
958km/s (LASCO CME catalog, Yashiro et al.)

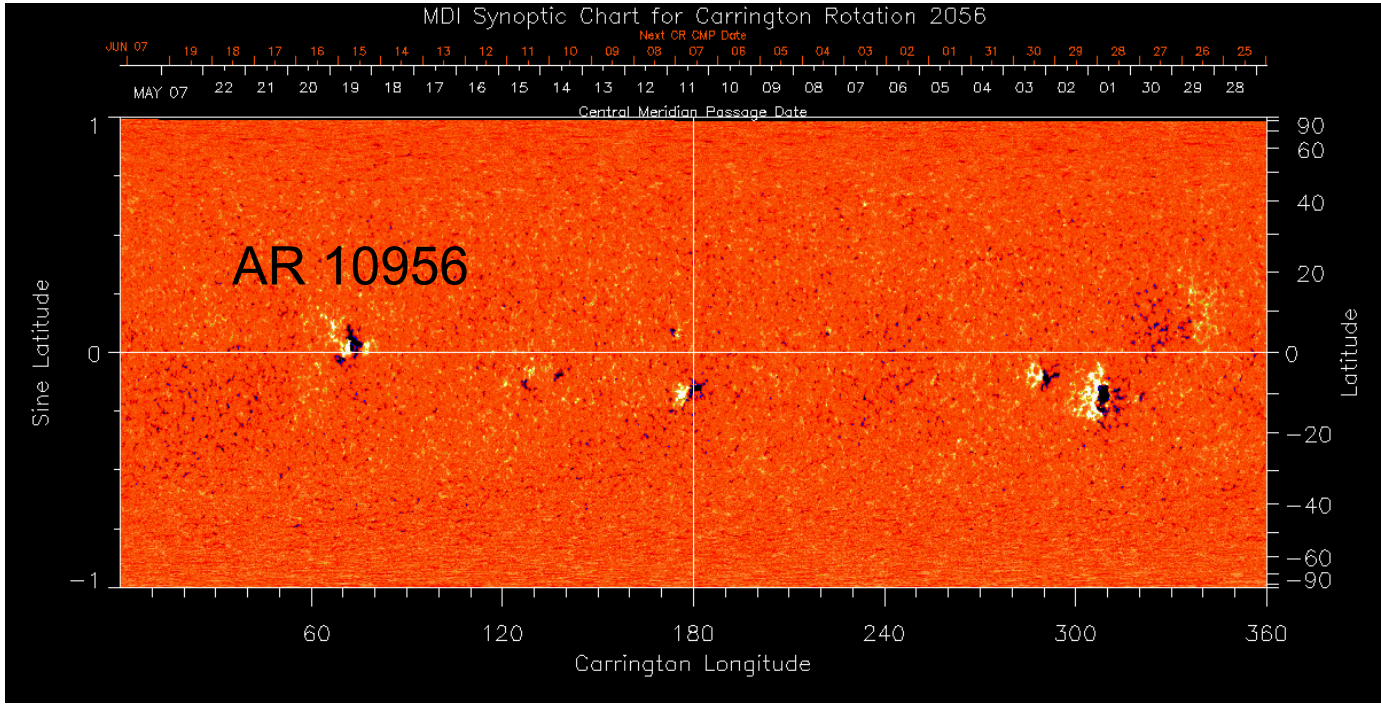
C2 difference images



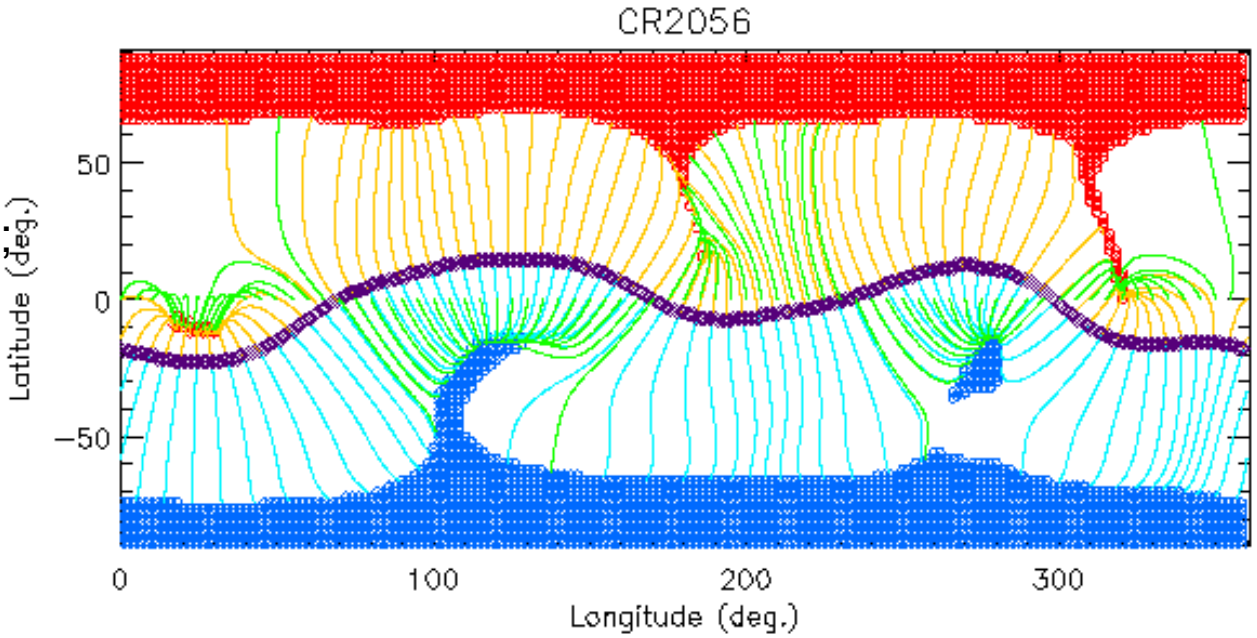
C3 difference images



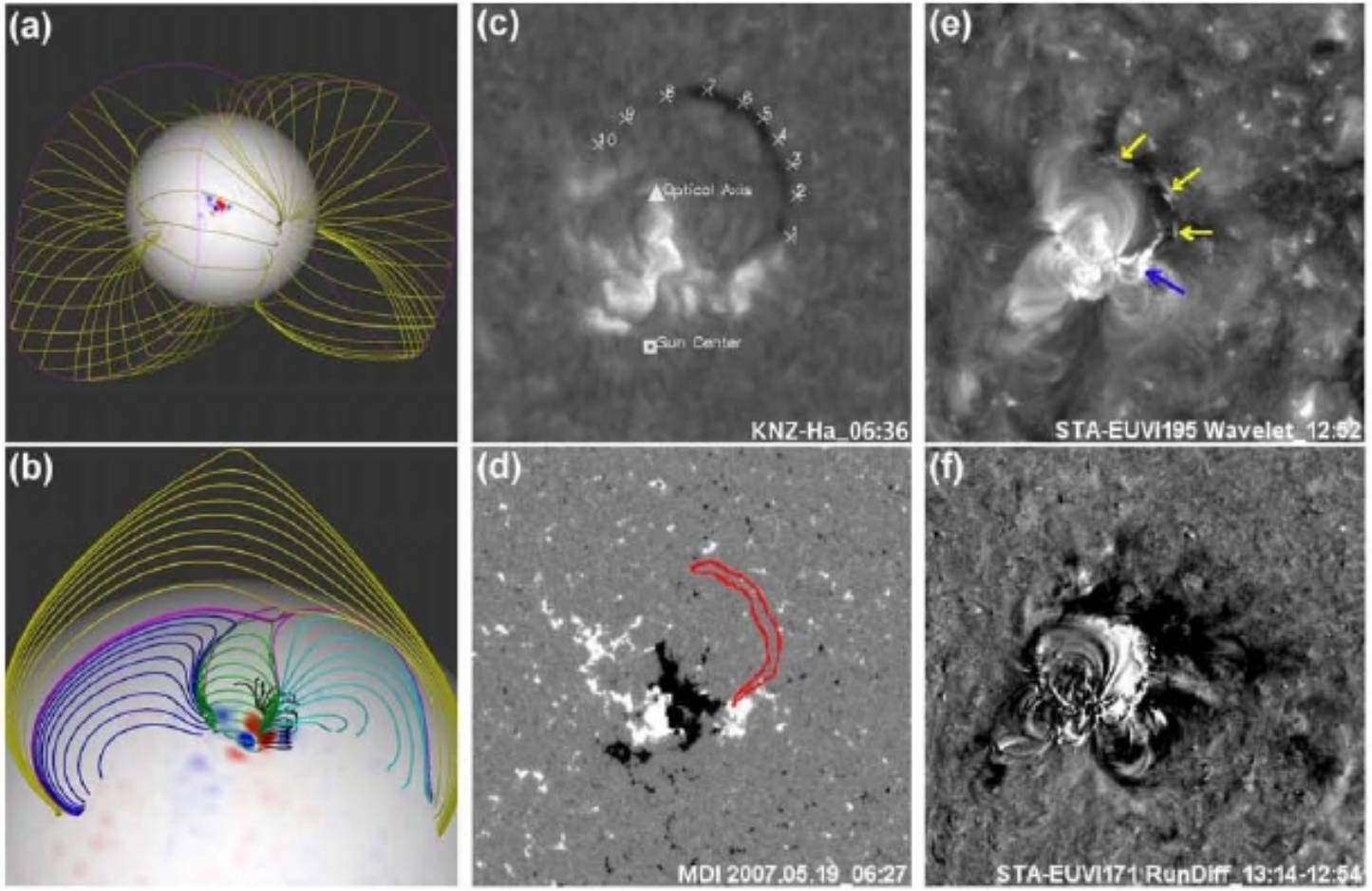
MDI synoptic map showing the global solar magnetic field. White: + Black: -



Coronal magnetic Structure obtained With a PFSS model
Red: neg.coronal holes -;
Orange and aqua lines: streamer belt;
Purple: heliospheric current sheet;
Green lines: equatorial field lines.
Blue: pos. coronal holes



Magnetic field topology and coronal dynamics



Caption for Figure on previous page

(a) PFSS model approximation of global coronal magnetic field structure of May 2007 with AR10956 at center view;

(b) PFSS field lines originated from AR10956. The erupting neutral line is overlaid with the black arcade. Flux systems are color coded as green (CNL arcade), dark blue (ENL arcade), light blue (WNL, the arcade over the erupting neutral line), purple (topological separation between the flux systems) and yellow (large-scale overlying streamer belt arcade).

(c) The reconstructed EUV304 Å filament over-plotted on the Hα image at 6:36UT;

(d) The boundary of the H α filament over-plotted on the magnetogram at 6:27UT;

(e) A partial STA EUVI195 Å wavelet-enhanced image at 12:52UT (also see attached movies), the arrows point to post-eruption bright arcades;

(f) A contrast-enhanced running difference image of the original STA EUVI171 Å images of 13:14UT minus 12:54UT, showing both the spatial extent of dimming (dark) and the rise of the central-arcade loops in adjacent flux system (white).

AR10956 magnetic field configuration (MDI)

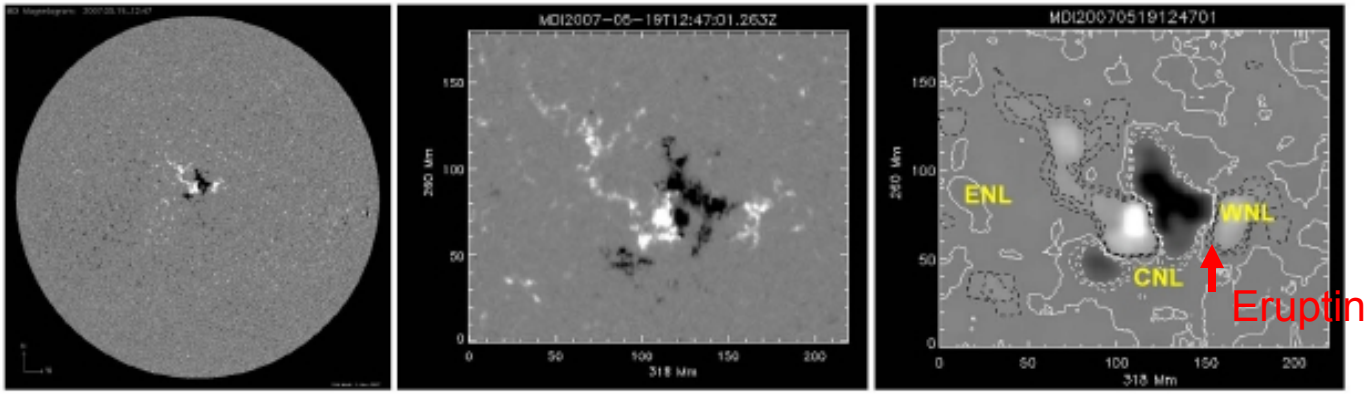


Fig. 2.— Left: MDI Magnetogram at 12:47UT on May 19 just before the eruption, positive polarity in bright and negative in white; Center: partial magnetogram centered on AR10956, the maximum field strength in this frame is ∼1200Gauss; Right: smoothed magnetogram with contours, solid white lines are magnetic NLs and dashed black and white lines are positive and negative contours, respectively. WNL:west neutral line, CNL:central neutral line and ENL:east neutral line. Movies of partial magnetograms are attached in the electronic version.

Magnetic flux change of AR 10956 (May 17-20)

Total magnetic flux in the region decreased by ~17% in two days before the eruption.

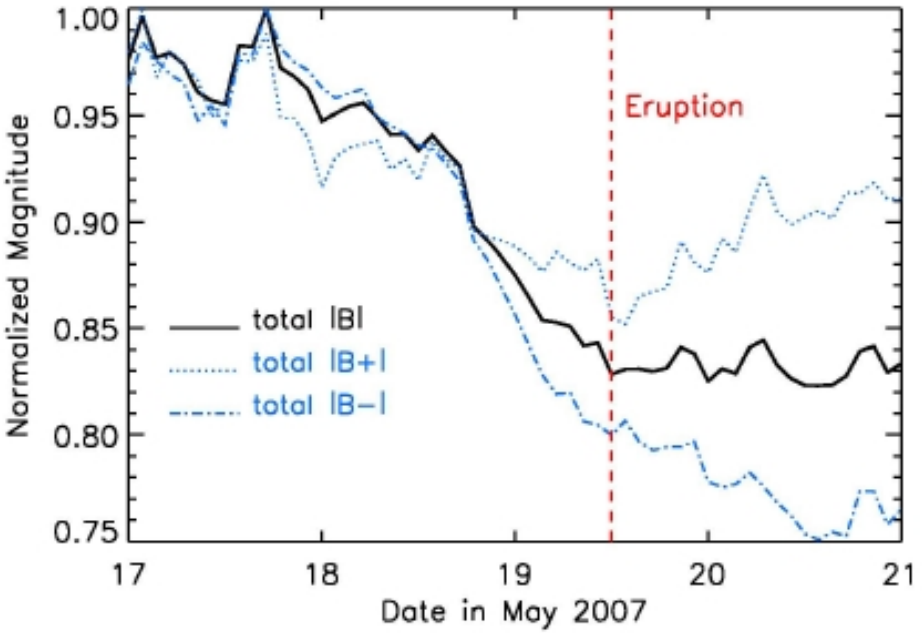


Fig. 3.— The magnetic flux evolution of the region from 2007 May 17 to 22. The vertical red dashed line marks the time of the flare. Solid black line represents the sum of the unsigned magnetic flux in the partial magnetogram; dotted blue line for the sum of positive flux and dot-dash-dot blue line for the sum of negative flux. The total unsigned flux shows a decrease of ∼17% in two days before the eruption.

Prospects for CME Initiation Models

- Observations of the eruption and our analysis showed complex properties of this eruption.
- Our results do not entirely support any current CME initiation model or rule out any of them.
- MHD simulators should be challenged to reproduce this event.