

STEREO Space Weather Group update

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**STEREO SWG-21
24-26 March 2010
Dublin**

- **Group leaders: Dave Webb & Doug Biesecker**
- **Website contains background on SWx, SWx-related meetings, PI SWx studies, tools/projects, references & links**
- **Member list with email addresses**
 - **Currently have ~130 members**
 - **Please provide updated addresses!**
 - **Contact me to join: david.webb.ctr@hanscom.af.mil**
 - **Can send your emails via: spaceweather@cronus.nrl.navy.mil**
(but please contact me first)
- **Maintain:**
 - **list of URLs/links that all PI teams can use**
 - **STEREO CME/event catalog links**
 - **reference list of key SWx papers**
 - **Tools/Projects list**
 - **Feedback, please!**



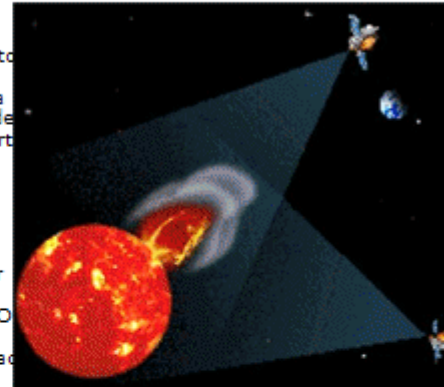
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CCMC STEREO Support
CISM
Predsci MHDWEB
SECCHI 3D R&V
STEREO IMPACT Modeling
UCSD SWx Forecast
WSA Predictions: L1(ACE)
WSA Predictions: STEREO
Related Links
ACE
AF SWx Ctr of Excellence
ESA SWx Program
GOES SXI
Hinode
Intl. Heliophysical Year
LESIA Radio Monitor
LMSAL Latest Events
NASA Living With a Star
NOAA SWPC
NSF Natl. SWx Program

THE STEREO SPACE WEATHER GROUP

Welcome to the Home page of the STEREO Space Weather Group. The intent is that this be an open web site, where anyone from the scientific community can follow our efforts to prepare computer programs, modeling efforts and research studies in preparation to use the STEREO observations as a tool for Space Weather. We also invite scientists from outside the SECCHI or STEREO consortia to join in the group's effort. We describe below the procedure to join the Space Weather group.

There are now two coordinators of the STEREO Space Weather group: David Webb, the SECCHI Space Weather Coordinator and a Co-I on the SECCHI Heliospheric Imager experiment, and Doug Biesscker, of the NOAA Space Environment Center and NOAA's coordinator of the STEREO Beacon data. This site is intended to be the repository of all pertinent details and information related to the STEREO Space Weather efforts. Our activities are closely coordinated with the STEREO Science Center at [GSFC](#) where the Beacon data will reside. Our site will be updated as new information and revisions dictate. A general discussion of Space Weather, the role of coronal mass ejections, and the use of the STEREO instruments for space weather is [HERE](#). We recently completed a chapter on STEREO Space Weather that will appear in the STEREO Instrument book. The current version is [HERE](#).



The overall purpose of the Space Weather Group is to help coordinate space weather efforts involving the STEREO mission and its instruments, including that of individual team members, and to help coordinate those efforts that lead to tools and products that can be tested and used before and after the STEREO launch. The STEREO real-time Beacon is a major STEREO effort having Space Weather implications. Other activities of the group include incorporating and interfacing STEREO data and space weather activities with: (1) Imaging and in-situ data from other existing space missions such as ACE, Wind, SOHO, Ulysses, GOES-12 SXI, the Transition Region and Coronal Explorer (TRACE) and Solar Mass Ejection Imager (SMEI), and ground-based observations such as interplanetary scintillation (IPS), optical line and broadband and radio emission, and future missions planned for the STEREO timeframe, such as Solar-B, GOES-13 SXI, and the Solar Dynamics Observatory (SDO); (2) The Geospace community to understand the coupling of and responses to CMEs and other transient disturbances by encouraging and participating in space weather campaigns; (3) The Community Coordinated Modeling Center (CCMC) and other simulation and modeling groups to use STEREO data as input to space weather models; (4) The SECCHI 3D Reconstruction and Visualization Team to develop models that have a space weather context; (5) The various virtual observatories that are being developed; (6) The International Heliophysical Year (IHY) program in 2007-08; (7) Meetings and workshops involving space weather; and (8) NASA's PAO EP/O and other outreach activities.

last updated 03/09/2009

<http://secchi.nrl.navy.mil/spwx/>

STEREO Space Weather Event Pages

- Contains an event summary, online data, modeling & links to other data
- Continue to update “Sun-STEREO” Events
 - Recently added: Jan. 17-20 and March 13-17, 2010 events
 - There are now 11 events; probably should be more
- Need your **feedback** on these Event pages!
 - Incorporate or link to other STEREO data:
 - Beacon (NRT quicklook)
 - SECCHI & SWAVES imagery
 - PLASTIC & IMPACT in-situ data
 - Modeling/simulation results
 - Need more geo inputs!
 - Try to incorporate new events/pages soon after events occurrence
 - Any **missing events**, new data links, revisions/corrections?



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Sun-STEREO Events

INTRODUCTION

Despite being in solar activity minimum, there have been a number of events in which a CME observed at the Sun by one or both STEREO spacecraft passes over one of them (or the Earth) as detected from in-situ data. These form a special class of space weather-type events that can provide information on the characteristics of the geometry, propagation and internal structure of ICMEs. Important to this study are the remote imaging observations from the SECCHI Heliospheric Imagers (HIs) and, occasionally, also from the Solar Mass Ejection Imager (SMEI) in Earth orbit.

We call these Sun-STEREO (Earth) Connection Events. Here is the current list of such events with some notes about them and references to analysis results. The first two events are well known and have their own pages on this site. If there is sufficient interest and data available for the other events, we will produce separate pages on them as well. The list is very preliminary and will be updated as necessary. Please send additions/corrections/comments on these events to David.Webb@hanscom.af.mil.

Sun-STEREO (Earth) Connection Events

2006 Dec. 13-15

Two X-flares/CMEs near sun center; ICME/flux rope/SEPs at Earth. The only true STEREO (Earth) space weather event so far. See <http://secchi.nrl.navy.mil/spwx/index.php?p=20061213event>

2007 May 19-22

Two events near Sun center observed with Hinode and STEREO. 3D views of filament eruptions and loops. Magnetic cloud/flux rope observed at STEREO and Earth. Includes radio observations. See <http://secchi.nrl.navy.mil/spwx/index.php?p=20070519event>

2007 November 14-18

Three separate events over several days, including one at Sun center observed by LASCO, SECCHI and SMEI. 3D modeling and heliospheric density structure. Howard and Tappin (2008)

2008 February 4-8

See next: Wood et al. (2009a)

2008 June 2-6

This and the above events were followed from initiation at the Sun, until interaction with one of the STEREO spacecraft. The earlier dates in the time span (Feb 4, Jun 2) are the days on which the eruptions occurred, while the second dates (Feb 8, Jun 6) are the days when the interaction with STEREO occurred.

2008 April 26

This event near sun center had a fast CME and EUV wave seen by SECCHI on both STEREO's A and B, and also detected in-situ by ACE and by STEREO-B. 3D shape modeling, velocity, etc.

2008 May 17

Another Sun-STEREO interaction event. Wood et al. (2009b)

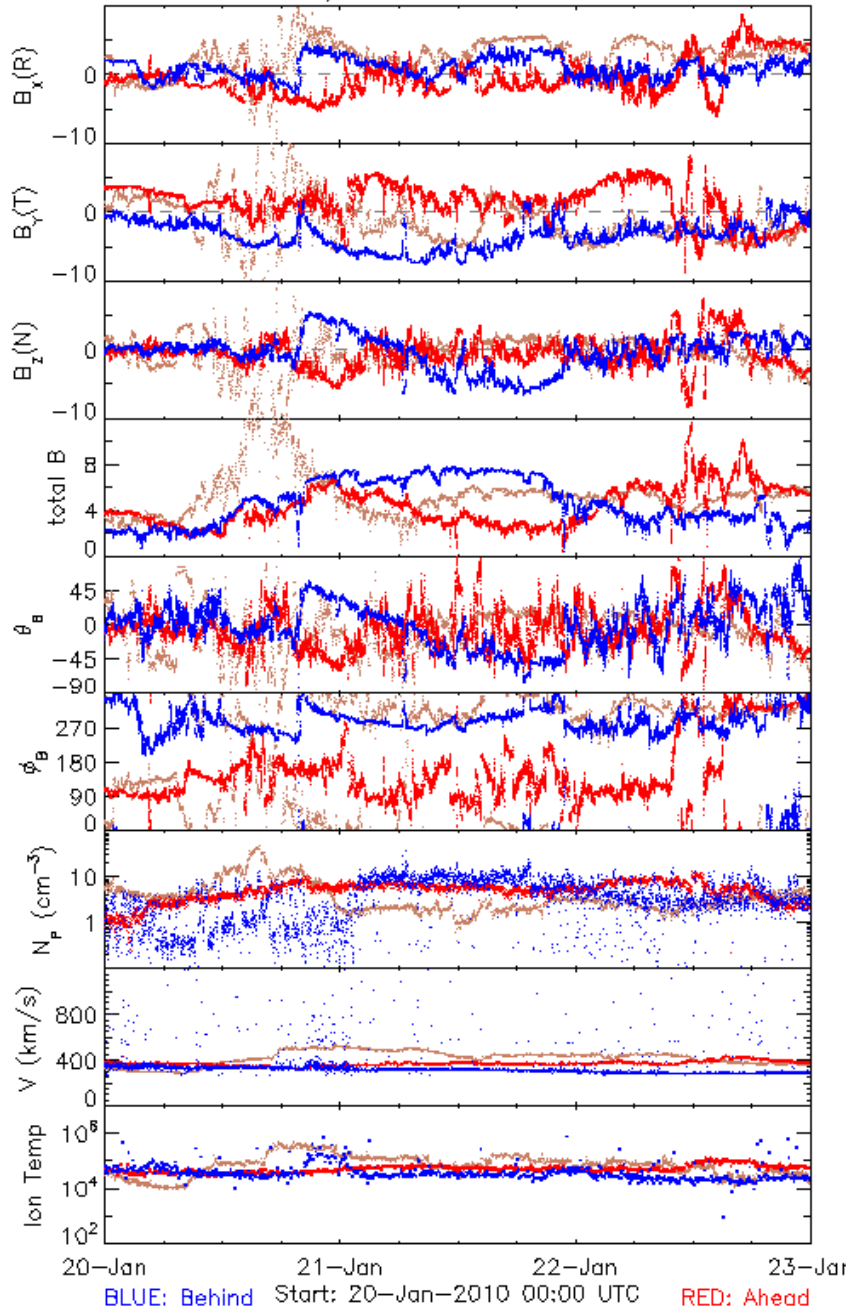
2008 June 6

Magnetic cloud at STEREO B

IMPACT/PLASTIC 21-Jan-2010

{nanoTesla, RTN}

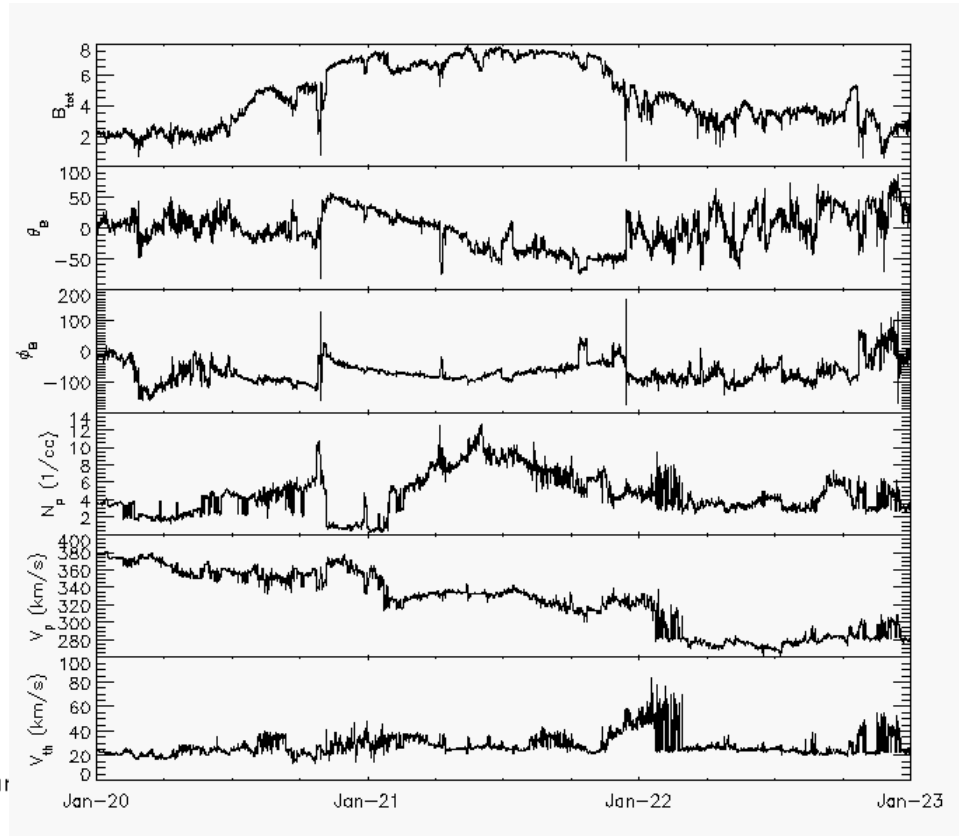
Brown: ACE equivalents



Beacon In-Situ Plots

Bill Thompson's current program produces 1, 3, 7 day plots as on left. For my analysis of a recent event, I wanted a plot as below:

- 1) Data for ST-B only
- 2) "Useful" plasma data (PLASTIC).



Questions/Discussion:

1) Ability to plot Beacon data separately for each S/C?

2) Plotting of Beacon PLASTIC (plasma) data

- Ion temp. or thermal velocity
- Want option for variable or fixed ranges?
- UNH provide near-real time data from L0 data (1-2 days old)?

3) NOAA SWPC Beacon Data:

http://www.swpc.noaa.gov/stereo/STEREO_data.html

- NRT 6-hour to 30-day plots of data from in-situ instruments, PLASTIC & IMPACT: Measurements of solar wind plasma, particles, magnetic field & SEPs. Each plot has estimate of the corotation time a structure at ST-B will take to arrive at L1 (ACE - or L1 to STEREO-A).
- BUT ... NOAA: MAG + PLASTIC data plotted only for last 24 hr.; not archived.
- PLASTIC data is available as 1, 3, 7 and 30 day plots.
- Of general importance to us:
 - Rise of solar activity → more SWx events
 - Decrease in DSN downlinks and lack of ground-based 24 hr. Beacon coverage

STEREO-B as a SWx Monitor

- **STEREO-B is now beyond (at 71°) the L5 point (60°), but still useful for SWx forecasting and assessing ST-B as a pathfinder for a possible SWx monitor mission.**
 - **View & study CMEs aimed Earthward, e.g., with SECCHI images, esp. COR2 and HIs; compare HI-2 views with those from SMEI at Earth.**
 - **ST-B also views beyond Earth-facing east limb, monitoring activity-producing regions for forecasting.**
 - **Paper to be submitted to COSPAR Journal.**

Discussion of Interactive Forecasting Using STEREO (Beacon)

- **Recent March 14 event triggered email discussion about how we can use STEREO data for SWx forecasting:**
 - **Forecasting tools (some already posted on SWx site)**
 - **Prediction/Discussion site for STEREO members**
 - **E/PO purposes**
- **C. Davis:** Estimated arrival time at Earth from STEREO HI Beacon data, using ST-B j-map but not ST-A as there is a gap in telemetry. Scaled leading edge to ascertain systematic errors in estimates, then fitted a speed and direction to each scaling assuming constant speed for the CME in the HI field of view (ala Sheeley and Rouillard). Estimated the speed of 413 ± 21 km/s, propagating at an angle of $21 \pm 17^\circ$ behind the Earth - estimated arrival time at Earth of 12:05 on the 18 March 2010 ± 6 hours. While we have had some success in tracking CMEs in the science data, this is the first time we have applied this technique to the Beacon data.
- **C. De Koning:** CIRES research team at NOAA/SWPC forecast using the geometric localization technique. The bulk of the CME to east of Chris' est., with bulk of the CME propagating N of the solar equator. And, not surprisingly, the CME is propagating slower in the COR2 FOV (223-268 km/s) than in HI, although I'm surprised that its that much slower. First time that polarization analysis has been used to make a space weather prediction.
- **C. Moestl:** In LASCO the halo CME is clearly elongated along the ecliptic; with angular width in COR2A/B being small (30-40°, mostly free of projection) - small MC axis inclination to ecliptic. The MC field components in GSE should be Bz N to S, By negative (origin in northern hemisphere, so probably left handed), and Bx near zero. Bmax ~ 20 nT. In summary, IF ICME hits Earth centrally, I predict that: Bmax ~ 20 nT +/-5 GSE components: Bz N to S, By negative, Bx close to zero. Geoeffective potential in the MC field (not of sheath) should be in the second half of the MC. If CME does not hit Earth centrally, Bmax and Dst values should be lower and field rotations different.

- R. McDowell/M. Reiner:

S/Waves, Waves radio data used to triangulate March 14 event. Not sure if a prediction was made, or a post-diction.

- Y. Lui: Recently at Berkeley we have developed a geometric triangulation technique based on stereoscopic imaging observations from STEREO, which can determine the propagation direction and radial distance of CMEs continuously from the Sun out to 1 AU (Liu et al. 2010, ApJL). We have applied the method to several events. Although at large distances the structures seen by the two spacecraft may begin to bifurcate (i.e., not necessarily the same part of the CME), this technique still shows reasonable accuracy in determination of CME kinematics. Both the tracking fitting technique and the geometric triangulation method are simple, efficient and easy to use, thus potentially useful for (forecasting).

- M. Dryer: Together with the Univ. of Alaska's GI and EPI (Fry) we put out the "Fearless Forecasts" (FF) in real time for IP shock arrivals (not CMEs per se). Put on internet, and the results (over most of Solar Cycle 23) were statistically analyzed, peer-reviewed, and published in JGR, Space Weather Journal, etc. No plans to continue this procedure into Cycle 24. As far as I know, neither NOAA nor the USAF's AFWA is doing this kind of R2O,; I suggest using their tool(s) to repeat/improve the FF procedure for Cycle 24 for shocks/CMEs. Results from various tools can be compared. Might be useful as necessary first step ... for our magnetospheric, radiation, etc., test bed prediction, operational and user colleagues, etc.

- ***D. Biesecker:*** Create a new page for each event. Something we found useful for SOHO is something that allows a user to post to a website (e.g., a blog) details on comets they believe they found in LASCO data. We've been running that on .nasa.gov and .nrl since ~1998. Do something similar, but create a new blog for each event, on the current SWx site at .nrl. Somebody types in an event descriptor and then that automatically becomes part of a pull-down menu. If someone wants to comment/add a prediction for that event, they select that event and put their info in a text box and hit 'submit.' Put in web links, predictions, commentary, whatever.

- ***J. Gurman/W. Thompson:*** There have been "hare and hounds" exercises in the community to test e.g. helioseismological inversion techniques, photospheric vector magnetic field inversion, etc. For earthward-directed CME's, we don't need to settle for moderator-created, synthetic data sets against which to test: we have the real thing. Somebody to set up a Website with links to, e.g. Sam (Freeland)'s GIF movies, and allowed predictors who registered with the site owner to post their own predictions (which would presumably get time stamped, so that one of the quality indicators could be earliness of prediction). Anyone at, say, a university might organize such an effort. I suspect if the volunteer worked for a STEREO PI team, we could probably modify the contract to cover some time to work on this. One option might be to use a web service like www.wikidot.com - used it for the coronagraph intercalibration wiki (<http://secchi-ical.wikidot.com/>). Or through NRL or Boston College, etc.

SPACE WEATHER TOOLS

General:

- ❖ **Geometric Localization of STEREO CMEs** (*V. Pizzo & D. Biesecker, 2004; NOAA*)
- ❖ **WSA Model Predictions** (*N. Arge, J. Luhmann, D. Biesecker; AFRL, UCB, NOAA; Arge & Pizzo, 2000*)
Leslie Mayer work, SWPC, incorporating STEREO locations into the WSA model. Will resemble standard output at: <http://www.swpc.noaa.gov/ws/> but w/ ST A & B added

CME Detection:

- ❖ **CACTUS – Computer Aided CME Tracking** (*E. Robbrecht & D. Berghmans, 2005; ROB*)
Latest COR2 runs at <http://sidc.oma.be/cactus/>
- ❖ **SEEDS – Solar Eruptive Event Detection System** (*J. Zhang et al.,; GMU*)
Being tested/used on LASCO & SECCHI CMEs:
<http://spaceweather.gmu.edu/seeds/index.php>
- **On-board Automatic CME Detection Algorithm** (*E. De Jong, P. Liewer, J. Hall, J. Lorre & R. Howard*) ; *JPL, NRL* Not implemented?

CME-Related Features Detection:

- ❖ **Computer Aided EUVI Wave and Dimming Detection**
(*O. Podladchikova, D. Berghmans, A. Zhukov; ROB; Podladchikova & Berghmans, 2005*)
Tested on SOHO EIT images: <http://sidc.oma.be/nemo/>. SECCHI soon?
- **Velocity Map Construction** (*J. Hochedez, S. Gissot; ROB*)