PLASTIC Overview
STEREO SWG 23

March 29 2012
A.B. Galvin & Team

PLASTIC

- Instrument Status
- Operations (Popecki)
  - Includes DPU software update
- Publications
- Selected Science Snapshots (Team Members)
- Data revisions/updates

Instrument Status

Operation remains nominal on both STA and STB.

Gain changes on microchannel plates (MCP)

- Extra degradation caused by “leakage” of high flux particles through the Entrance System (no change since launch*)
- Command MCP bias are increased to compensate for gain changes (operations, next slide)
- Densities, speeds, thermal speeds, N/S flow determination not affected
- E/W flow determination is affected - looking at alternative algorithms including using utilizing s/c roll data as an in-flight calibration cross-check.

- *http://stereo.sr.unh.edu/data/PLASTIC_Resources/data_analysis_issues.html

STEREO PLASTIC Operations

STA

- S-ch switch adjustment 1/11/11
- DPU checksum error occurred in PLASTIC moments code space 1/14/11;
  - 3 more DPU checksum errors occurred in 2011.
- Data logic upset (cause unknown), instrument restarted 4/9/11
- Increased MCP voltage after restart
- Uploaded new DPU software with new capabilities for telemetry reduction 6/16-18/11
- Reduced telemetry by increasing integration periods on the spacecraft for selected data products, on 6/24/11
- Restarted 9/19-20/11after a DPU high current anomaly on 9/19/11
- Reduced telemetry further 9/28/11

STB

- Restarted 1/11/11 after a DPU high current anomaly 1/8/11.
- 1553 error 6/16/11 - no impact on PLASTIC
- Uploaded new DPU software with new capabilities for telemetry reduction 6/28-29/11
- DPU checksum error occurred on 7/2/11, with a telemetry effect.
- Reduced telemetry 7/13/11 by increasing integration periods on the spacecraft for selected data products
- MCP voltage increase: 10/13/11
- 1553 error 10/14/11 - no impact on PLASTIC

DPU/PLASTIC Flight Software Development by Microtel and Testing by UNH in 2011

- DPU software changes were needed to accommodate low telemetry bit rates in the extended mission.
- Changes in software allow:
  - Disabling of selectable ApIDs, and
  - Extension of heavy ion integration periods, up to 255 minutes (presently ≤ 10 minutes)
- Related changes:
  - Logic was added to detect and report *data overflow* in the heavy ion products and associated data within the PLASTIC Beacon Data (ApID 0x370)
  - Status bytes were added to the PLASTIC digital housekeeping packet (ApID 0x313) indicating *which* ApIDs have been disabled.
  - Software changes:
    - written by Microtel (W. Mocarsky)
    - tested at UNH with:
      - spare instrument / DPU / spacecraft emulator hardware (M. Popecki)
      - data processing and analysis software (L. Ellis)

Example: Minimization of Data Loss Through Reduced Telemetry

Excerpt from W. Thompson' STEREO Ops weekly minutes 3/6/11:

- On day 059 (Feb28), for the DSS-14 support for Ahead, the *antenna was declared red due to a mechanical problem and the entire 5.4 hour track was lost.* As the next track was only six hours later, SSR pointers were reset for the *in-situ instruments only* to minimize the impact to science data continuity.
- A 1.4 hour DSS-32 track was also added on DOY 063 to start at 0640z. In spite of these efforts, this anomaly caused the SSR data loss listed below. See DR# G112415 for more information.
  - IMPACT reached 95% full: **0.3** hours beginning at 061-1417z (Mar 1), **17.7** hours beginning at 061-2213z (Mar 1)
  - **PLASTIC** reached 95% full: **0.7** hours beginning at 062-1457z (Mar 2)
  - SECCHI data loss: **25.9** hours beginning at 058-1845z (Feb 27)
  - SWAVES reached 100% full: **16.5** hours beginning at 061-2311z (Mar 1)

PLASTIC Telemetry Reductions

- PLASTIC A and B telemetry has been reduced by increasing integration periods for selected data products created in the DPU.
- Telemetry reduction is a new capability contained in recent DPU software modifications written by Bill Mocarsky at Microtel.
- Current telemetry rates have minimized data loss for PLASTIC during unplanned losses of downlink opportunities.
- **Without telemetry reduction software, PLASTIC would experience substantially greater discontinuity in data coverage.**

Science

PLASTIC Publications
May 2011- March 2012

Dresing, N., R. Gomez-Herrero, Y. Y. Kartavykh, W. Dröge, A. Klassen, B. Heber, B. Klecker: ***Multi-spacecraft observations during a series of three solar energetic particle events in May, 2009***. In: Proc. 32nd Intern. Cosmic Ray Conf., Beijing, China, Vol 10, p. 115-118, 2011.

Dröge, W., R. Gomez-Herrero, Y. Y. Kartavykh, A. Klassen, N. Dresing, B. Klecker, B. Heber, L. Sun, R. Müller-Mellin: Multi-spacecraft observations of solar energetic electron events during the rising phase of solar cycle 24. In: Proc. 32nd Intern. Cosmic Ray Conf., Beijing, China, Vol 10, p. 86-89, 2011.

Farrugia, C.J, D. B. Berdichevsky, C. Moestl , A. B. Galvin, M. Leitner, M. A. Popecki, K.D.C. Simunac, A. Opitz, B. Lavraud, K. W. Ogilvie, A. M. Veronig, M. Temmer, J. G. Luhmann, J.A. Sauvaud, ***Multiple, Distant (40◦) in situ Observations of a Magnetic Cloud and a Corotating Interaction Region Complex***, JASTP, 73, p. 1254-1269, doi:10.1016/j.jastp.2010.09.011, 2011.

Foullon, C.,B. Lavraud, J. G. Luhmann, C. J. Farrugia, A. Retino, K. D. C. Simunac, N. C. Wardle, A. B. Galvin, H. Kucharek, C. J. Owen, M. Popecki, A. Opitz, and J.-A. Sauvaud, ***Plasmoid releases in the heliospheric current sheet and associated coronal hole boundary layer evolution***, The Astrophysical Journal, 737:16, doi: 10.1088/0004-637X/737/1/16, 2011.

Gomez-Herrero, R., Y. Y. Kartavykh, W. Dröge, A. Klassen, N. Dresing, B. Klecker, B. Heber, O. Malandraki, R. Müller-Mellin, and the SEPT Team: ***The August 18, 2010 solar energetic particle event - Multipoint observations and propagation modeling***. In: Proc. 32nd Intern. Cosmic Ray Conf., Beijing, China, Vol 10, p. 202-205, 2011.

Kartavykh, Y. Y., W. Dröge, G. Kovaltsov, R. G洋ez-Herrero, N. Dresing, B. Klecker, B. Heber: ***Three-dimensional anisotropic transport simulations: a parameter study for the interpretation of multi-spacecraft solar energetic particle observations.*** In: Proc. 32nd Intern. Cosmic Ray Conf., Beijing, China, Vol 10, p. 194-197, 2011.

PLASTIC Publications
May 2011- March 2012

Liu, Ying, D., Janet G. Luhmann, Christian Moestl, Juan C. Martinez-Oliveros, Stuart D. Bale, Robert P. Lin, Richard A. Harrison, Manuela Temmer, David F. Webb, and Dusan Odstrcil, ***Interactions between coronal mass ejections viewed in coordinated imaging and in situ observations***, Astrophys. J. Lett., 746:L15 (7pp), doi: 10.1088/2041-8205/746/2/L15, 2012.

Liu, Yong C.-M., M. Opher, Yuming Wang, and T.I. Gombosi, ***Downstream structure and evolution of a simulated CME-driven sheath in the solar corona***, accepted for publication, Astronomy & Astrophysics, 527, A46, *doi:* 10.1051/0004-6361/201014384, 2011.

Möstl, C., T. Rollett, N. Lugaz, C.J. Farrugia, J.A. Davies, M. Temmer, A.M. Veronig, R. Harrison, S. Crothers, J.G. Luhmann, A.B. Galvin, T.L. Zhang, W. Baumjohann, H.K. Biernat, ***Arrival time calculation for interplanetary coronal mass ejections with circular fronts and application to STEREO observations of the 2009 February 13 eruption***, ApJ, **741,** 34 doi: 10.1088/0004-637X/741/1/34, 2011.

Nieves-Chinchilla, T., R. Gomez-Herrero, A.F. Vinas, O. Malandraki, N. Dresing, M.A. Hidalgo, A. Opitz, J.-A. Sauvaud, B. Lavraud, and J.M. Davies, ***Analysis and study of the in situ observation of the June 1st 2008 CME by STEREO***, Journal of Atmospheric and Solar-Terrestrial Physics, 73, 1348-1360, doi: 10.1016/j.jastp.2010.09.026, 2011.

Rakowski, Cara E, J. Martin Laming, and Maxim Lyuikov, ***In situ heating of the 2007 May 19 CME ejecta detected by STEREO/ PLASTIC and ACE***, Astrophys. J., 730:30 (8pp), doi: 1088/0004-637X/730/1/30, 2011.

Rollett, T***., Propagation Direction and Kinematics of Coronal Mass Ejections in the Heliosphere***, Master thesis, Institute for Physics, University of Graz, Austria, 2011.

Rollett, T., C. Möstl, M. Temmer, A. M. Veronig, C.J. Farrugia, H.K. Biernat, ***Constraining the kinematics of coronal mass ejections in the inner heliosphere with in situ signatures***, Solar Physics, Volume 276, Numbers 1-2, 293-314, DOI: 10.1007/ s11207-011-9897-02012, 2012.

PLASTIC Publications
May 2011- March 2012

Sauvaud, J. -A., A. Opitz, L. Palin, B. Lavraud, C. Jacquey, L. Kistler, H.U. Frey, J. Luhmann, D. Larson, C.T. Russell, ***Far tail (255 RE) fast response to very weak magnetic activity,*** J. Geophysical Research, 16, A032215, doi:10.1029/2010JA016077, 2011.

Temmer, M., Rollett, T., C. Möstl, A. M. Veronig, B. Vrsnak, ***Influence of the ambient solar wind flow on the propagation behaviour of interplanetary CMEs,*** The Astrophysical Journal, 743, 2, 101, 2011.(55)

Thompson, Barbara J., Sarah E. Gibson, et al., ***A snapshot of the Sun near solar minimum: the Whole Heliosphere Interval***, Solar Physics, 274:29-56, doi 10.10007/s11207-011-9891-6, 2011.

PLASTIC Publications recently submitted or revised and re-submitted (Spring 2012)

Drews, C., et al., Inflow direction of interstellar neutrals deduced from pickup ion measurements at 1 AU, JGR, submitted, 2012.

Farrugia, C.F., et al., Deep solar activity minimum 2007-2009: Solar wind properties and major effects on the terrestrial magnetosphere, Solar Physics, revised, 2012.

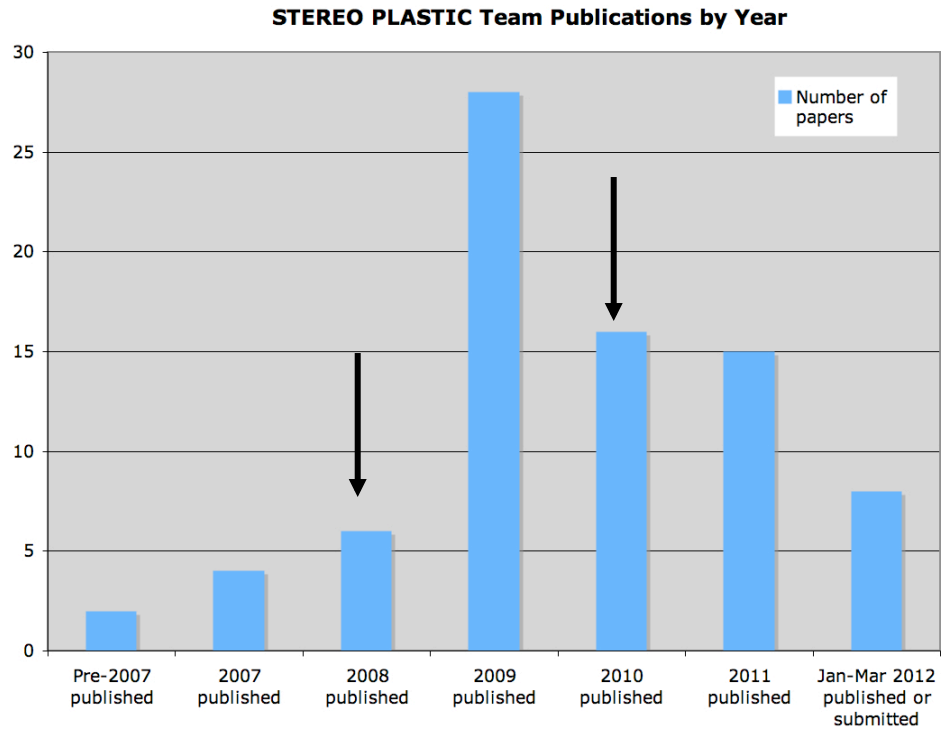
Lugaz, N., et al., Heliospheric observations of STEREO directed coronal mass ejections in 2008-2010: Lessons for future observations of Earth-directed CMEs, Solar Physics, revised, 2012.

Ruffenach, et al., Multi-spacecraft observation of magnetic cloud erosion by magnetic reconnection during propagation, xxx, submitted, 2012.

Simunac, K.C.D., et al., The heliospheric plasma sheet observed in in situ by 3 spacecraft over 4 solar rotations, Solar Physics, revised, 2012.

Webb, D., et al., Heliospheric imaging of 3-D density structures during the multiple coronal mass ejections of late July to early August 2010, Solar Physics, submitted, 2012.

PLASTIC Published Papers Overview



ALSO:

9 Dissertations/Theses
2 Honors Papers

Currently:
Two PhD graduate students and one undergraduate intern at UNH
One PhD graduate student at CAU

PLASTIC Talks/Posters
Conferences May 2011 - June 2012

Meetings supported last year with PLASTIC Team presentations:

ISSI Workshop on Particle Acceleration in Cosmic Plasmas - May 2011
IUGG/IAGA - June-July 2011
The Sun 360 - July 2011
ICRC - August 2011
LWS/SDO-3/SOHO-26/GONG-2011 - November 2011
AGU - December 2011

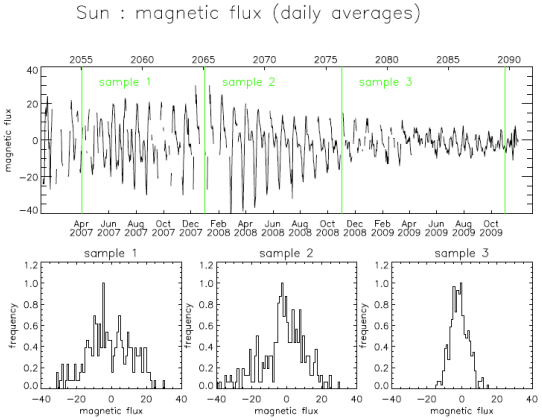
Upcoming with PLASTIC Team presentations:

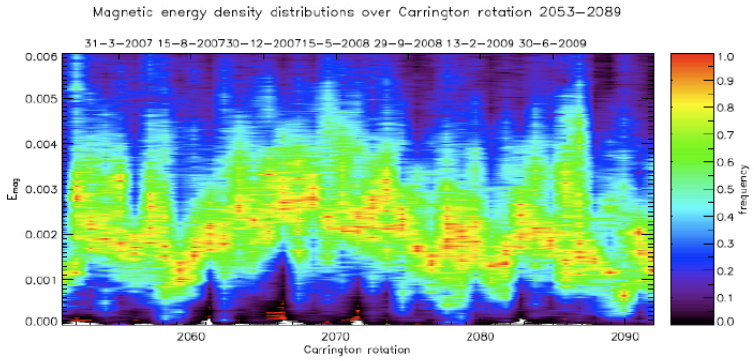
EGU - April 2012
Workshop on Heliospheric Processes - May 2012
Solar Wind 13 - June 2012
In Situ Workshop - September 2012

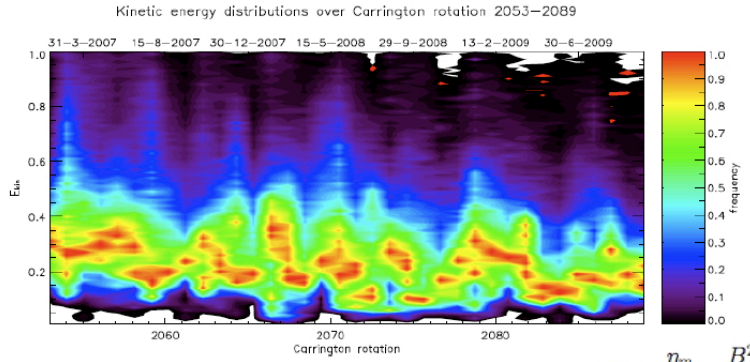
Selected Science Snapshots

Deep Solar Minimum Solar Wind and Response by the Earth's Magnetosphere (Farrugia et al., Sol. Phys., revised 2012)

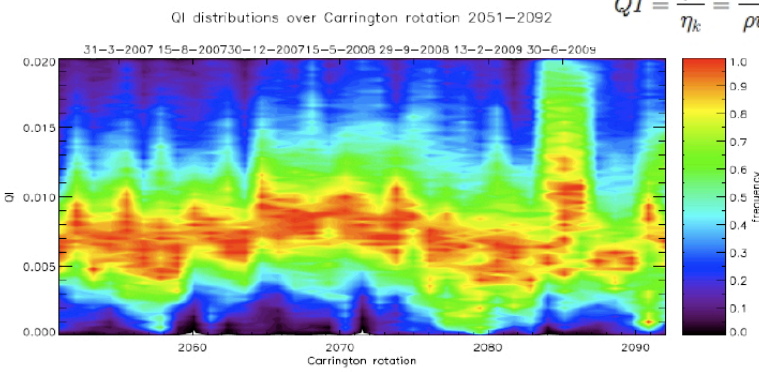
- Interplanetary Solar Wind Properties and Energy Budget using STEREO A (PLASTIC & IMPACT)
  - Magnetic and Kinetic Energy Densities decreased compared to previous solar minima
  - Quasi-invariant was unusually low
- Full disk open flux density (Sanford Solar Observatory) smaller than than previous minimum







$$QI = \frac{\eta_m}{\eta_k} = \frac{B^2/8\pi}{\rho v^2/2} = M_A^{-2}$$



Deep Solar Minimum Solar Wind and Response by the Earth's Magnetosphere (Farrugia et al., Sol. Phys., revised, 2012)

- Bow Shock and Magnetopause Response using Wind, Geotail, Cluster 1, Themis B&C
- 328 unambiguous MP crossings and 271 BS crossings over 3-month period while solar wind densities reached their lowest values in the 3-year survey
- Fitted magnetopause compared against Fairfield (1971, not shown), and models of Shue et al. (1997, red) and Sibeck et al. (1991, dark blue). Fitted bow shock compared against Fairfield (1971, red).
- Models underestimate flaring of magnetopause and underestimate stand off distance (by 25% or 1 Re).

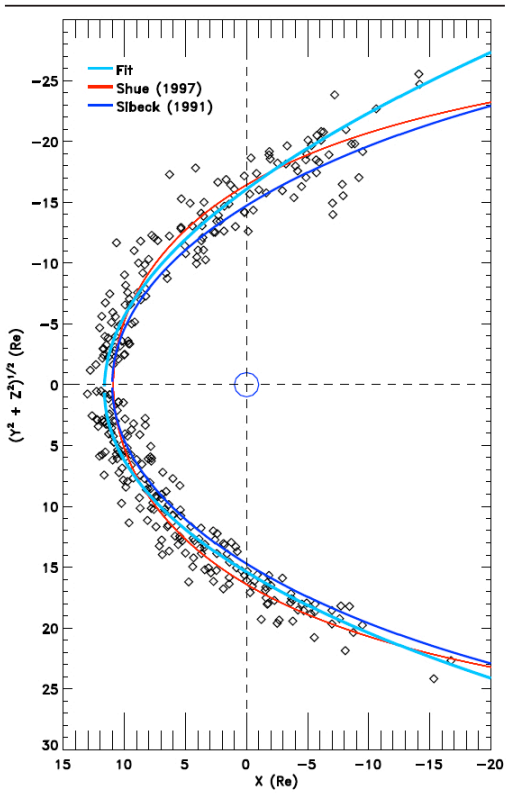


Figure 19. The solar minimum magnetopause (blue trace) compared with the Sibeck et al. (1991; green) and the Shue et al. (1997; red) model magnetopauses. For calculating these model shapes the average solar minimum values for the dynamic pressure and B_z were used.

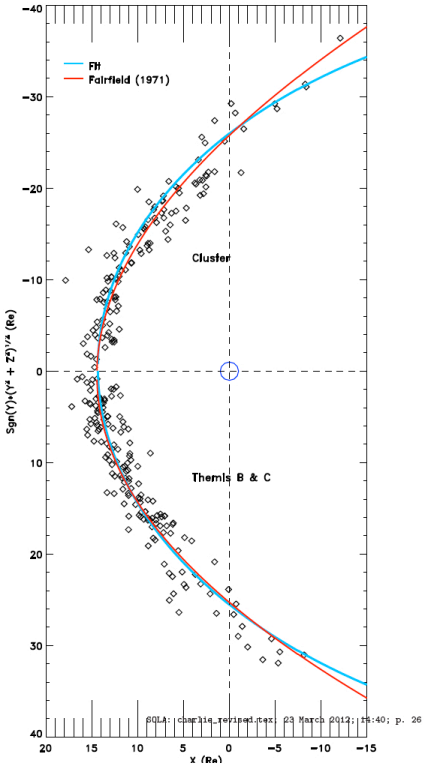
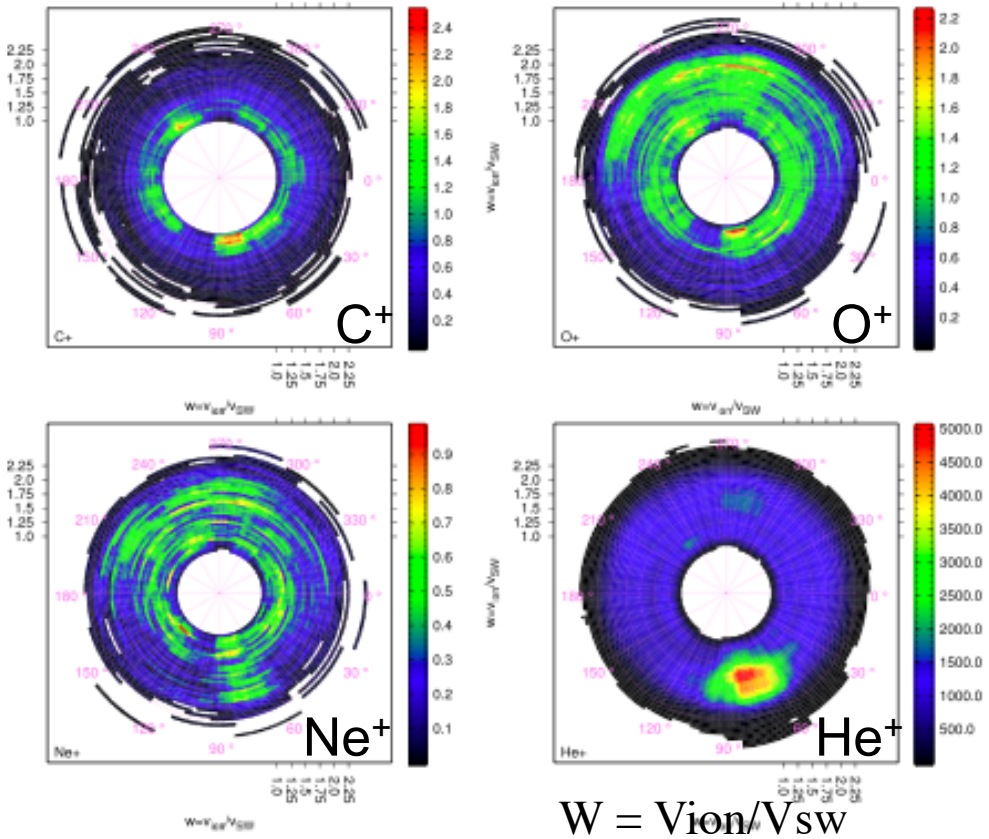


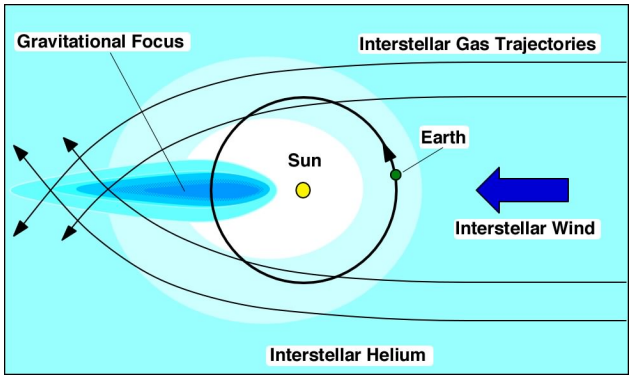
Figure 20. Solar minimum bow shock (blue). In red is the Fairfield (1971) model bow shock.

- Increased M_A (low QI) in solar wind and repetitive high speed streams provided favorable conditions for the Kelvin-Helmholtz instability to grow, which played a major role in transferring SW energy and momentum to the magnetosphere.

INFLOW DIRECTION OF INTERSTELLAR NEUTRALS:
New Results from Pickup Ion Measurements with PLASTIC
(Drews et al., submitted to JGR)



w - Spectra of C^+, O^+, Ne^+, He^+
Sorted in ecliptic longitude



- PLASTIC / STEREO provides excellent measurements of PUI intensities at 1 AU
- The good counting statistics allows us to determine the inflow direction from the focusing cone (He^+, Ne^+) and from the crescent signature (Ne^+, O^+).

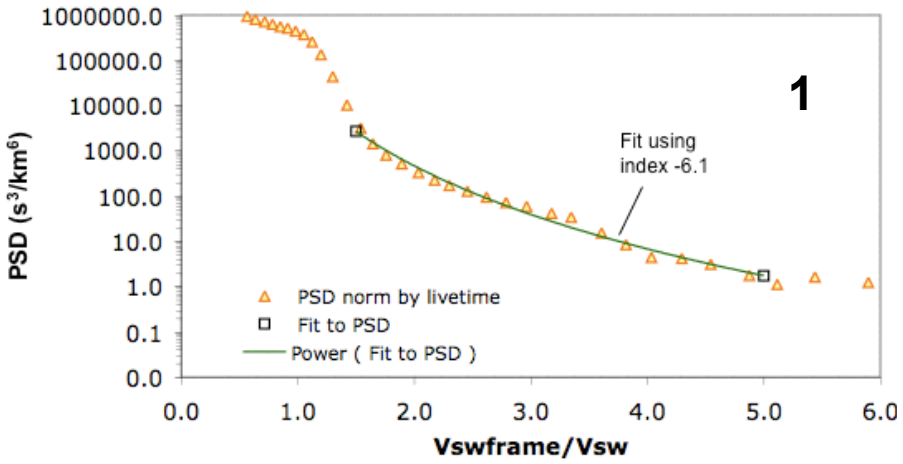
He: $\lambda_{cone} = 77.37° \pm 1.93°$;

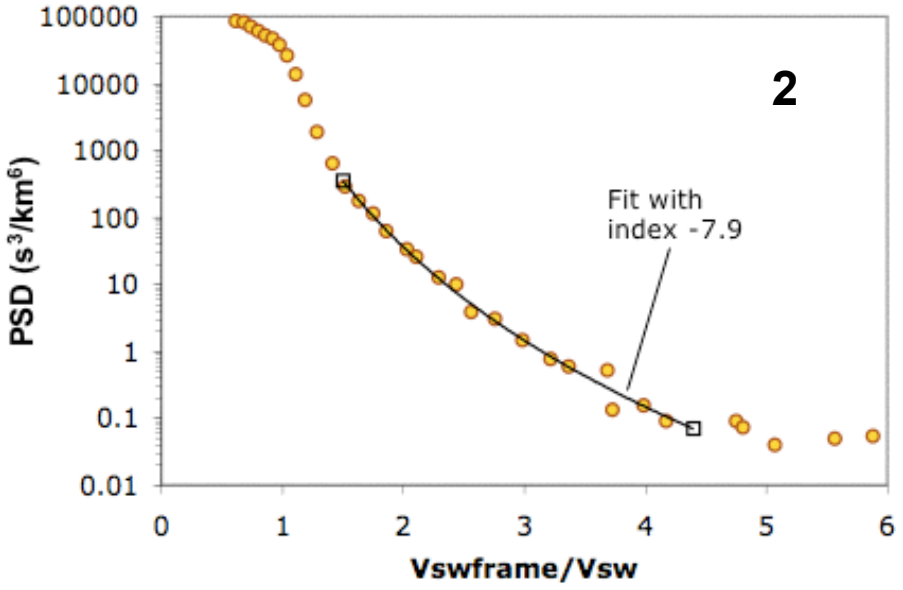
Ne: $\lambda_{cone} = 77.44° \pm 4.95°$; $\lambda_{cresc} = 79.42° \pm 2.62°$

O: $\lambda_{cresc} = 78.42° \pm 3.08°$

Systematically larger than previously observed (e.g. $\lambda_{He,cone} = 74.43° \pm 0.33°$; ACE), but consistent with IBEX $\lambda_{ISM} = 79°(+3°/-3.5°)$

SUPRATHERMAL TAILS OF PICKUP HE^+ (Popecki et al., ISSI workshop 2011, work in progress)





Study of suprathermal tails of pickup He+ for different interplanetary conditions.

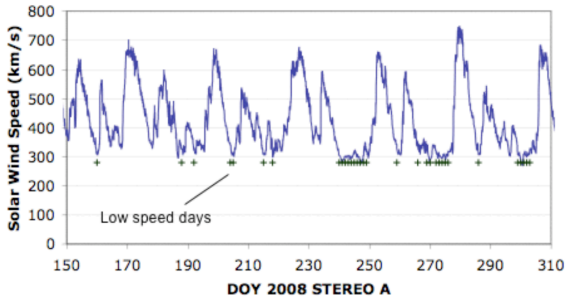
1. Time average for Jan to Oct 2008
2. Average for times with low solar wind speed (Vsw < 327 km/s)

Result:

10 months average spectrum (PSD in solar wind frame; PSD ~ $V/V_{sw}^{-\gamma}$) **γ = 6.1± 0.9**

Spectra during slow solar wind periods are softer with an average slope (PSD in solar wind frame) of **γ = 7.9 ± 0.7**

Difference probably due to the fact that slow wind periods do not include compression regions.



Example of slow wind period selection

CME Multi-Spacecraft Studies

Möstl et al. combine STEREO and Venus Express to test forecasting techniques of arrival times.

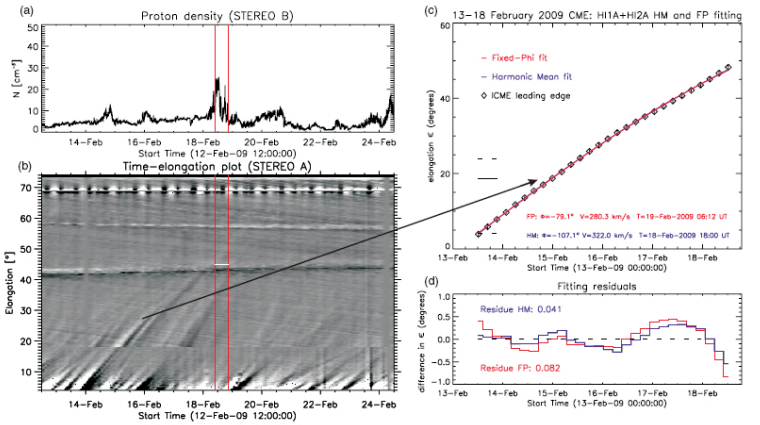


Figure 3. (a) Proton density observed by *STEREO-B/PLASTIC*. Enhanced densities (up to 25 protons cm^{-3}) in front of the flux rope are delimited by two vertical lines, with the left one setting the arrival time. (b) Jmap along the ecliptic plane with the elongation of *STEREO-B* marked by a white horizontal line. It is seen that a track, starting on February 13, reaches the elongation of *STEREO-B* and *VEX* early on February 18, which matches very well the single density jump observed by *STEREO-B*. (c) Best HMF/FPF fits for the ICME leading edge. Both functions are able to reproduce the observed function $\epsilon(t)$. (d) Residuals between the fitting functions and the observations. The time development of $\epsilon(t_i) - \epsilon_{fit}(t_i)$ is similar for both techniques, and the summarized residue σ^2 for HMF is half the value for FPF.

(A color version of this figure is available in the online journal.)

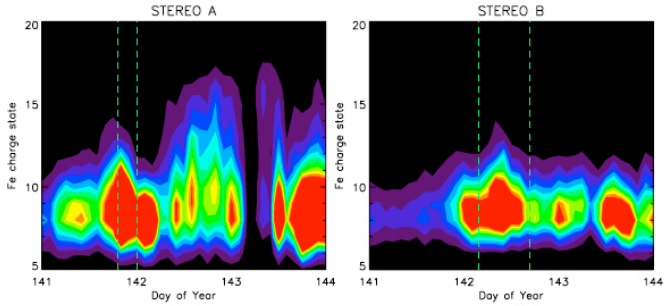


Figure 1. Fe charge state distributions detected by *STEREO A* and *B* during the 2007 May 19 CME passage. Highest Fe charge states are detected by *STEREO A*, though the magnetic cloud is more clearly detected in *STEREO B*. Magnetic field and other data indicate cloud passage between 3:36 hr and 16:34 hr on day 142 (May 22) for *STEREO B* and May 21 19:12 until May 22 00:14 for *STEREO A* (Liu et al. 2008). The dashed vertical lines show the temporal extent of the magnetic cloud (or flux rope) in this event.

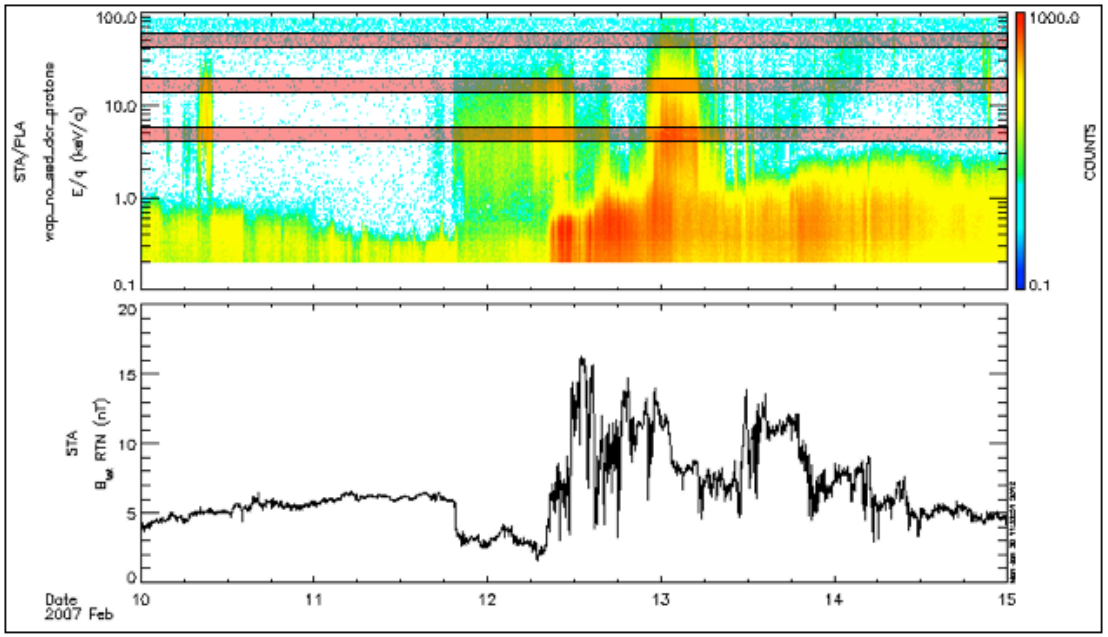
(A color version of this figure is available in the online journal.)

Rakowski et al. test a spheromak model for expanding CMEs combining observations from STEREO and ACE.

Data Updates

Suprathermal Event Lists*

This data product contains a list of automatically identified suprathermal proton events measured by the suprathermal portion of the STEREO/PLASTIC instrument. This list can aid a user in identifying energetic proton events related to Stream Interaction Regions (SIRs), shocks, upstream events, magnetospheric events, etc.



This product is part of the PhD work by J. Barry (UNH)

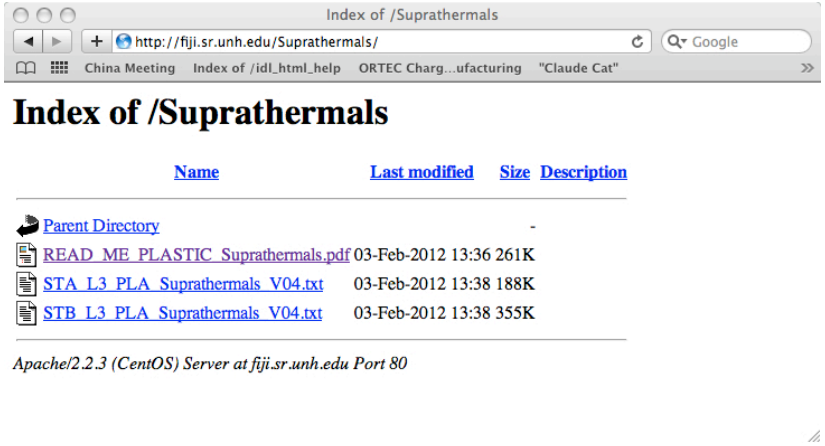
The top panel shows a PLASTIC energy spectrogram (0.3-80 keV) of solar wind and suprathermal protons while the bottom panel shows the magnitude of the magnetic field (IMPACT). The red horizontal bands indicate the energy bands used in the automatic process to define suprathermal proton events.

Suprathermal Event Lists

Lists include the following information:

- Event Number
- Start and Stop Times, Duration
- Average Solar Wind Speed and Standard Deviation
- Earth Separation (Re), Linear Miss (as in Desai et al., 2000) and Standard Deviation. Uses IMPACT/ MAG data.
- Overlap of SIR, ICME, Shock, SEP events, using IMPACT level 3 event lists
- Which Energy Rate Bins Triggered

STA/STB lists are currently updated through 9/30/2011



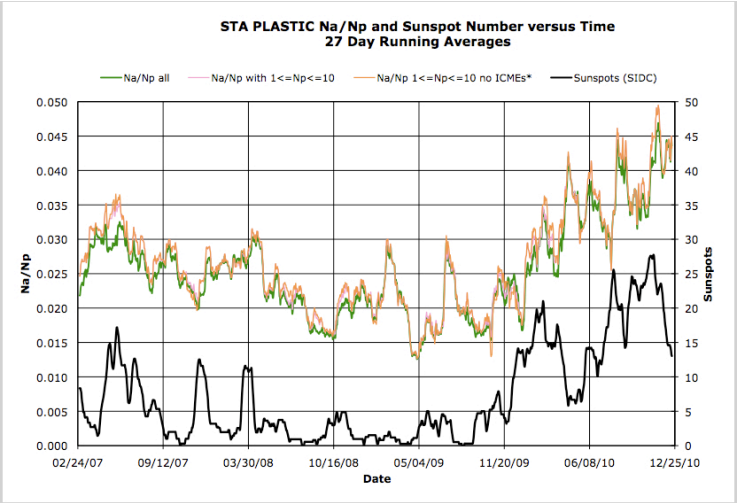
Helium Processing Revision

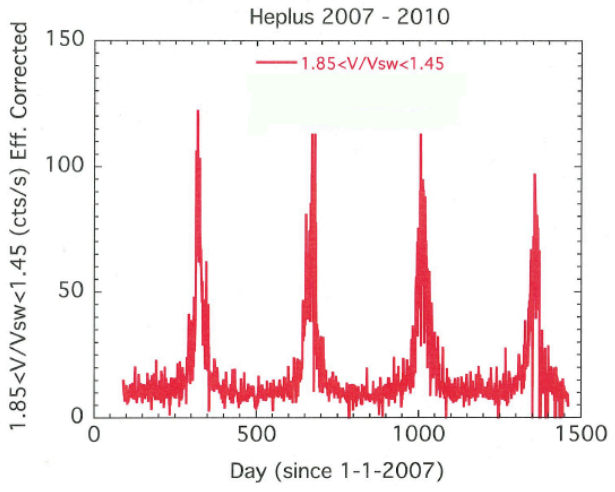
Revised algorithm implemented for alpha processing. Re-processing completed up through 2010 (10min). Data for 2011 in progress.

Pickup helium is available through 2010. Fluxes for 2011 will be completed in next month.

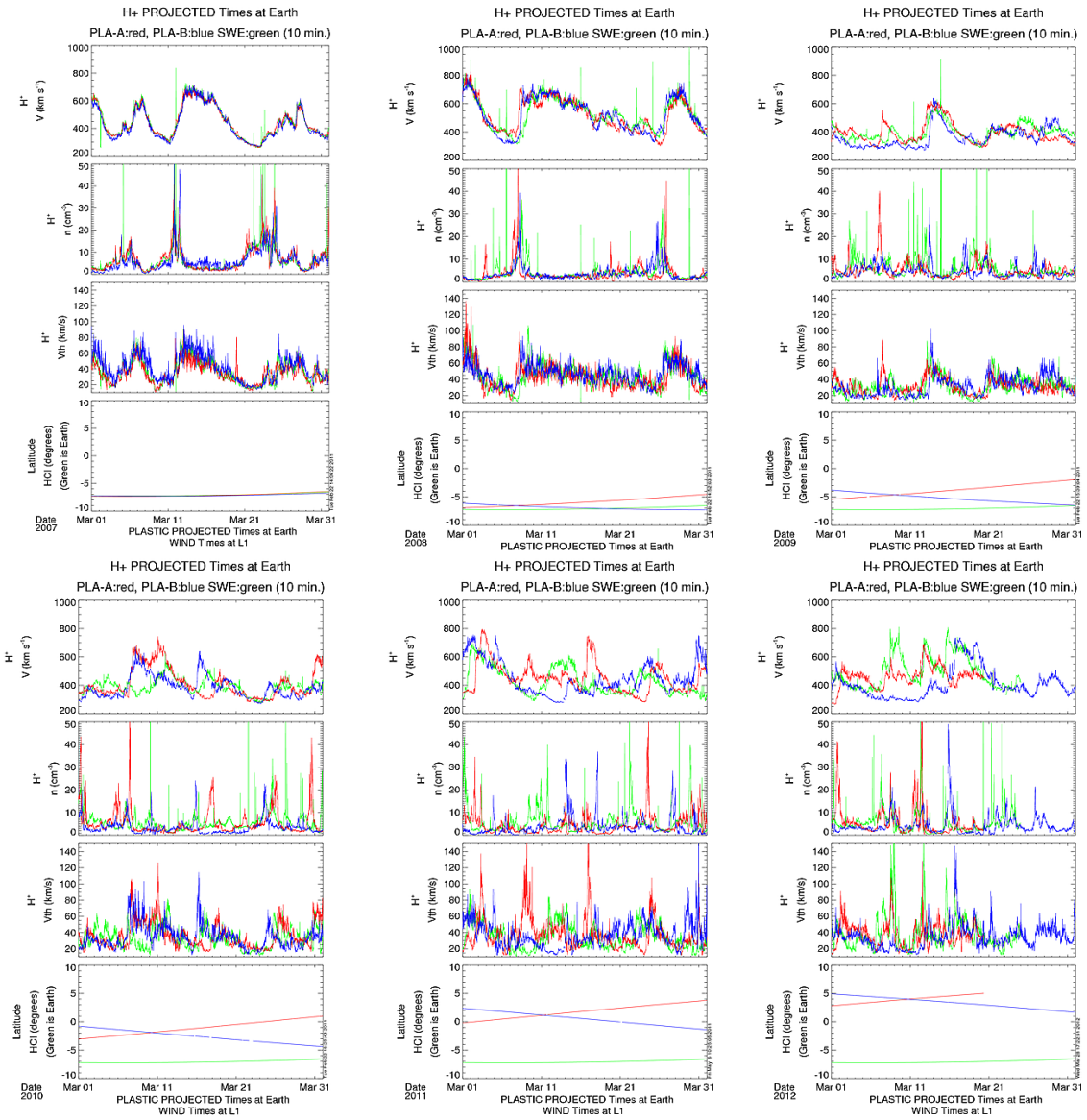
Courtesy B. Klecker: interstellar He+ focusing cone traversals

Galvin et al., Sun 360, 2011





Solar Wind @ Earth Projections



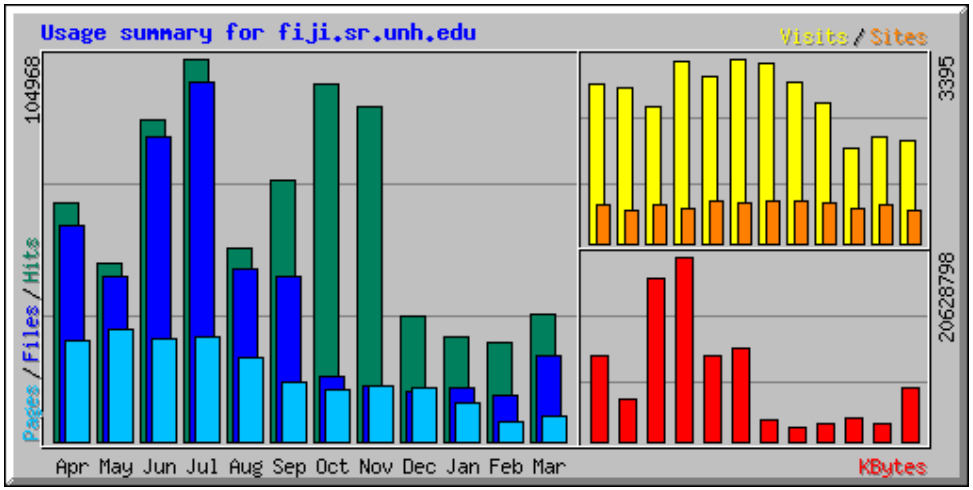
STB is projected into the “future” and STA into the “past” and compared against recent Wind SWE data. Spacecraft latitude also provided.

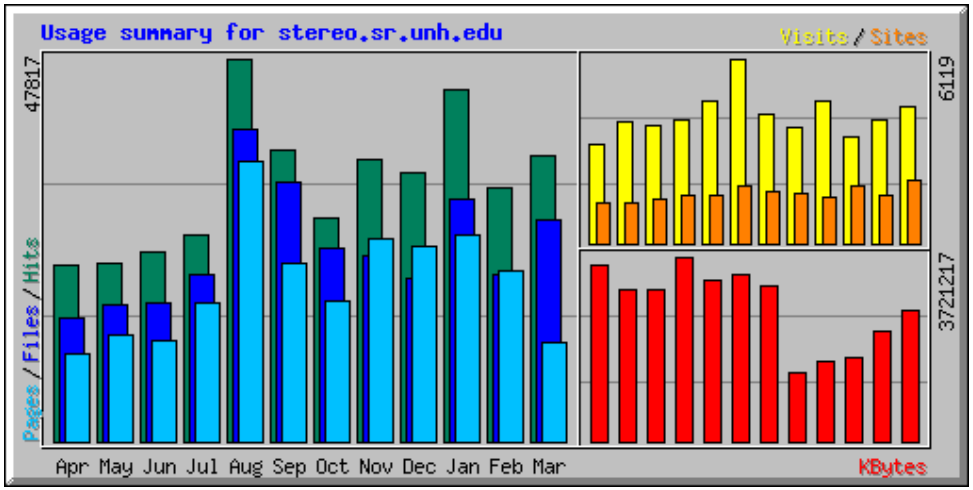
Updated nightly with Level 1 data. Shown: March 2007-2012.

Aids in evaluating temporal changes in solar wind profiles and aids the rocket launch community in determining usefulness of STB for predictions.

Level 2 (1min, 10min, 1hr) currently processed through January 2012 (ascii and cdf).

Web Data Downloads (UNH only)





Two servers are involved at PLASTIC data center.

These are in addition to downloads from STEREO SSC archive.