Agenda

- Current Beacon Status
- Presentations on ‘operational’ use of beacon
  - Data Viewers
    - Berghmans
    - Pick
    - Russell?
  - Automated Event Detection
    - Robbrecht – CME’s
    - Podladchikova – EUV dimmings
  - Modelling efforts
    - Biesecker – Geometric Localization
    - Others?
- Break?
- S/WAVES Space Weather Plan – M. Kaiser
- MuSTAnG Space Weather Muon Telescope – F. Jansen
- Round Table Discussion
  - Review SWx ideas already known (on STEREO SWx website)
  - What have we missed?
  - SWx chapter of STEREO book
  - Other Topics?
Ground station network coming along
  - Turbo licensing issue almost resolved
- s/c beacon mode telecom testing
- Software to decode Viterbi and Turbo encoded data in work (Phil Karn)
Space Weather Beacon Processing

SSC
- Packet Handling Application
- Instrument Specific Applications
- Display, Serve, Archive, Browse
- S/C Transfer Frame Handling Application

APL MOC

NOAA Antenna Partners

NOAA & Public

Real-Time and Off-line

S/WAVES

SECCHI

PLASTIC

IMPACT

(NOAA & Public)

Real-Time

Off-line

APL & MOO

Packet Handling Application

Instrument Specific Applications

Display, Serve, Archive, Browse

(NOAA Antenna Partners)

NOAA & Public

Real-Time and Off-line

S/WAVESlib IDL package

(NOAA Antenna Partners)

NOAA & Public

Real-Time and Off-line

(NRL) “C” to assemble image; IDL to decompress

(UCB) “C” for MAG, SWEA, STE

(UCLA) coordinate transforms for MAG
Ground Station Partners

- Primary network – gives us the 24/7 coverage we need
  - NOAA and CNES (France) are signed on
    - Letters in hand
    - Toulouse (1.5E); Wallops (75.5W); Fairbanks (147.8W)
  - CRL (Japan) is likely
    - NOAA has made a formal request through International Affairs Office

- We’d like redundancy where possible
  - Probable is RAL (UK)
  - Possible is USAF (California), ACRES (Australia)
  - Others?
Beacon telemetry to begin after heliospheric orbits achieved

Tested basic functional transfer of beacon telemetry packets from NOAA/SEC (representing ground stations) to SSC
  - Based on ACE real-time solar wind telemetry system

ICD between NASA SSC and NOAA SEC almost finished?
Turbo

- Telemetry encoding options in the beacon mode are rate 1/6 Viterbi, rate ½ Viterbi, and Turbo encoding.
- Turbo encoding (decoding) improves $E_b/N_0$.
- Issues regarding Turbo were licensing and cost.
  - NOAA and France Telecom agree on wording of licensing agreement
    - Final draft not on the street, yet
  - Phil Karn (wrote decoder for ACE) will write Turbo decoder, free of charge
STERE O Science Center

- Real-time data displays
  - Images
  - Where is STEREO?
  - Javascript movies w/selectable time range
- CME detection bit in real-time
  - Another is being developed by JPL
  - Automated e-mail alert? (current manual LASCO alert)
What do NOAA forecasters plan to do with STEREO?

- 3-d viewer or some way to display what’s coming at us on the Sun-Earth line
  - SECCHI team
  - Others – Geometric Localization

- Predicting CME arrival – HI

- Anything that reliably and robustly describes some parameter of the data that doesn’t require looking at the huge volume of data.
Coronal Hole/High Speed Stream

- Enhanced electrons
- Minor/Moderate geomagnetic storms
- Who cares
  - Satellite operators
  - ...  
- 1 year into mission
  - ~1.5 days lead time
SEP events

- Event profile depends on observer position relative to event source
  - Radiation Storm

- Who cares:
  - Launch providers
  - Satellite operators
  - Astronauts
  - Airline pilots/stewards

![Graphs showing SEP events](https://example.com/graphs)

STEREO LAGGING  EARTH  STEREO LEADING
Geometric Localization Technique

- What ‘Geometric Localization’ (GL) does
  - Given observations of any structure from 2 different places
    - at the same time if a transient structure
    - It works on ‘any’ structure for which an ‘edge’ is visible
  - GL defines a volume which circumscribes that structure
STEREO Beacon Data

- 24/7 real-time beacon data
  - See Biesecker and Webb poster SH21B-0412
- Low-cadence, low resolution
  - in-situ
  - imaging
- 5-minute latency
- SECCHI/COR2 images
  - 4x per hour
  - 1/8 resolution (256x256 pixels ~ 120")
Schematic of ‘Geometric Localization’ Technique

- Need location of 2 spacecraft
  - Defines a plane
- Need location of ‘edges’ of CME
  - Defines a quadrilateral circumscribing CME
Geometric Localization

- Mark one edge – $L_{A1}$
  - $s/c - s/c$ – Sun plane: defines a line
  - Mark $L_{A2}$; and then in other $s/c$ image mark $L_{B1}$ & $L_{B2}$
- Choose a succession of starting points – thin slices

- e.g. STEREO Leading +35°
- e.g. STEREO Lagging -35°
The Resulting Localization

- Comparison of localization model to input CME
  - 3 perspectives
  - Geometric Localization circumscribes input CME
How well does it work?

- One measure of error
  - Ratio of area determined by GL to area of input CME \( \sim f(X) \)
  - Quantifiable – critical for forecasters
- Ideal separation 90°
  - Two years into mission
- Reasonable uncertainty (<50%)
  - Year 1 to Year 3

Comparing area of cross-section of model to cross-section of CME

Areal Localization Uncertainty

Spacecraft Separation \( \chi \) (deg)
Planned additional work

- Explore much broader range of examples
  - Vary CME shape, density distribution
- Making it an operational product
  - Improve/refine error analysis
  - Automated CME detection & edge detection
    - Apply to successive SECCHI COR2 images
      - Location, extent, velocity
      - If CME will arrive and when
      - How much of the CME Earth will see (strength and duration)
  - Streamline and document software
- Relate to polarization analysis (Moran and Davila 2004; Dere et al.)
  - GL removes plane of sky ambiguity
  - Polarization analysis provides info. on internal structural
On a pixel by pixel basis – finds C.O.M. along a line of sight
- Collapses a 3-d structure into ~2.5-d
- Gives spatial information
Polarization Analysis and Geometric Localization are complementary

- Geometric Localization resolves plane-of-sky ambiguities inherent in polarization analysis
- Polarization analysis can provide more information about CME structure *(i.e. mass distribution)*
\[ \psi(\rho, \zeta) = \frac{1}{\rho} \times \cos^{\left(\frac{p}{2}\right)}(2\zeta) \]
A pathetic attempt at demonstrating a visualization tool

View from the side

View straight down the barrel
What’s still missing?

- What info didn’t I present that FAB wants?
- What needs to be done before launch
  - Do we do lots of work to be ready for data?
  - Do we wait to see what we end up getting and using?
- Transition process?
Data Browsers and Viewers

- **SSC Beacon Data pages**

- **Solar Weather Browser** B. Nicula, D. Berghmans, R. van der Linden ROB
  - User-friendly browser tool for finding & displaying solar data & (SWB) context information.

- **STEREO Key Parameters** C. Russell & IMPACT, PLASTIC & SWAVES teams UCLA
  - An easily browseable Merged Key Parameter data display including the in-situ & SWAVE radio data from STEREO.

- **Carrington Rotation In-situ Browser** J. Luhmann, P. Schroeder UCB
  - Browser for identifying in-situ events & their solar sources at CR-time scales.
  - Includes near-Earth (ACE) data sets for third point views & image movies from SECCHI & near-Earth (SOHO).

- **JAVA-3D Synoptic Information Viewer** J. Luhmann, P. Schroeder UCB
  - JAVA-3D applet for viewing 3D Sun & solar wind sources based on synoptic solar maps & potential field models of the coronal magnetic field.

  - Ground radio imaging and spectra; movies; S/ WAVES
3-D Imaging Tools

- **Tie Point Tool** *E. DeJong, P. Liewer, J. Hall, J. Lorre* JPL
  - Manually create tiepoints between features in SECCHI image pair & solve for 3D location in heliographic coordinates.

- **Geometric Localization Of CMEs** *V. Pizzo, D. Biesecker* NOAA
  - Tool utilizing a series of LOS’s from two views to define the location, shape, size and velocity of a CME.
  - To be automated & used to decide whether and when a CME will impact Earth.

- **3D Structure of CMEs** *V. Bothmer, H. Cremades, D. Tripathi* MPI, Ger.
  - Program to compare analysis of SECCHI images on the internal magnetic field configuration & near-Sun evolution of CMEs with models based on SOHO observations.
  - Forecast flux rope structure; 3D visualization of CMEs.
Automated Detection and Identification

- **Computer Aided CME Tracking (CACTus)**  
  - Near-realtime tool for detecting CMEs in SECCHI images.
  - Outputs: QL CME catalog w/ measures of time, width, speed; NRT CME warnings.
  - Successfully tested on SOHO LASCO CMEs.

- **Computer Aided EUVI Wave & Dimming Detection**  
  O. Podladchikova, D. Berghmans, A. Zhukov ROB
  - NRT tool for detecting EUV waves & dimming regions.
  - To be tested on SOHO EIT images.

- **Velocity Map Construction**  
  J. Hochedez, S. Gissot ROB
  - Program to analyze velocity flows on SECCHI images; detect CME onsets & EUV waves; NRT warnings of fast CMEs; reconstruct 3D velocity maps of CMEs from 2D maps from each STEREO.

- **Automatic Solar Feature**  
  D. Rust, P. Bernasconi, B. LaBonte, JHU/APL
  - Tool for detecting and characterizing solar filaments and sigmoids Recognition & Classification in solar images. Goal is to meas. magnetic helicity parameters & forecast eruptions using filaments & sigmoids.
Heliospheric Studies

- **WSA Model Predictions** *N. Arge, J. Luhmann, D. Biesecker AFRL, UCB, NOAA*
  - The Wang-Sheeley-Arge and ENLIL 3D MHD solar wind models will be integrated
  - Provide routine predictions of vector s.w. velocity, polarity, s.w. density & temp. anywhere you like

- **Identifying & Tracking CMEs with the Heliospheric Imagers** *R. Harrison, C. Davis RAL*
  - Produce simulations to show model CMEs can be identified & tracked with the HIs.
  - Use triangulation to measure speed & direction of CMEs & forecast their Earth arrival.

- **Structural Context of Heliosphere Using SMEI Data** *D. Webb, B. Jackson BC/AFRL, UCSD*
  - Use analyses of SMEI images to provide structural context of the heliosphere for STEREO HI
  - Also provide complementary observations of transient disturbances.

- **Interplanetary Acceleration of ICME’s** *M. Owens BU*
  - Construct acceleration profiles of fast ICMEs over a large heliocentric range using multi-point HI to understand the forces acting on ejecta.
  - Improve predictions of arrival times of ICMEs at Earth.

- **Relationship between CMEs and Magnetic Clouds** *S. Matthews, MSSL*
  - Assess the potential geoeffectiveness of CMEs based their association with magnetic clouds.
  - What particular characteristics lead to production of a magnetic cloud?