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STEREO

Solar-Terrestrial Probes (STP) Mission
Project Data Management Plan

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STEREO
A Solar-Terrestrial Probes (STP) Mission
Project Data Management Plan

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Table of Contents

Tables

STEREO

Project Data Management Plan

1.0 Introduction

This document describes the Project Data Management Plan (PDMP) for the Solar-TErrestrial RElations Observatory (STEREO) mission. STEREO is a National Aeronautics and Space Administration (NASA) Solar Terrestrial Probes (STP) mission with launch scheduled for November 2005.

1.1 Purpose and Scope

This PDMP is designed to be consistent with the STEREO Level-1 Requirements Document. It will describe the generation and delivery of STEREO mission data and science data products to the STEREO Science Center (SSC) and elsewhere, institutional responsibilities for data analysis, and the transfer of archival data products to the National Space Science Data Center (NSSDC). Covered in this plan are:

1. Brief description of the mission and instruments
2. Description of the data flow
3. Description of the science data products
4. Processing requirements and facilities
5. Policies for access and use of STEREO data
6. Data product documentation

1.2 PDMP Development, Maintenance, and Management Responsibility

The STEREO Project Scientist, Dr. Joseph M. Davila[1], is responsible for the development, maintenance, and management of the PDMP through the life of the mission. The point of contact for the PDMP is Dr. O. C. St. Cyr[2]. The STEREO PDMP will be modified and updated as required in accordance with the Configuration Management Plan for the STEREO mission.

1.3 References

(1) STEREO Level-1 Science Requirements, NASA Headquarters Solar Terrestrial Probes Program Plan, Appendix A-3.
(2) STEREO Mission Requirements Document, NASA-GSFC, 460-RQMT-0001, August 2000.
(3) STEREO MOC to POC and to SSC ICD, JHU/APL, 7381-9045, 10 December 2001.

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(4) STEREO Mission Concept of Operations, JHU/APL, 7381-9020.

2.0 Project Overview

An Announcement of Opportunity to provide instruments for the STEREO mission was published on April 28, 1999 (AO 99-OSS-01) by NASA Headquarters. The STP office at NASA's Goddard Space Flight Center (GSFC) has overall responsibility for the mission; Johns Hopkins University's Applied Physics Laboratory (JHU/APL) is the spacecraft provider and mission integrator. For the purposes of this document, "spacecraft" refers to the bus subsystems without instruments, while each spacecraft plus instruments will be referred to as an "observatory."

Four instrument teams were selected for development as a result of the Announcement of Opportunity: Plasma and Suprathermal Ion Composition (PLASTIC) from the University of New Hampshire, University of Bern, Max Planck Institute for Extraterrestrial Physics, and GSFC; Sun-Earth Connection Coronal and Heliospheric Investigation (SECCHI) from the Naval Research Laboratory, Lockheed-Martin Advanced Technology Center, GSFC, University of Birmingham, Rutherford-Appleton Laboratory, Centre Spatial de Liege, Max-Planck-Institut fur Aeronomie (MPAe), and Institute d'Astrophysique Spatiale; STEREO WAVES (S/WAVES) from Observatoire de Paris, GSFC, University of Minnesota, and University of California at Berkeley (UCB); and In-situ Measurements of Particles and CME Transients (IMPACT) from UCB, GSFC, California Institute of Technology, University of Maryland, University of Kiel, Centre d'Etude Spatiale des Rayonnements, Jet Propulsion Laboratory, European Space Research & Technology Centre, MPAe, and Los Alamos National Laboratory.

The Phase B study began in October 2000. The Mission Preliminary Design Review was held in December 2001. The Mission Confirmation Review is expected to be held in Spring 2002. The STEREO mission is scheduled to be launched November 2005.

2.1 Science Objectives

The primary goal of the STEREO mission is to advance the understanding of the three dimensional structure of the Sun's corona, especially regarding the origin of coronal mass ejections (CMEs), their evolution in the interplanetary medium, and their dynamic coupling with the environment at Earth. CMEs are the most energetic eruptions on the Sun, and they are responsible for the most severe geomagnetic storms and the largest energetic particle events. They may also be a critical element in the operation of the solar dynamo because they appear to remove dynamo-generated magnetic flux from the Sun.

The ejection of well-defined clouds of material from the Sun out through the corona was discovered in the early 1970's by the OSO-7 and Skylab coronagraphs. Although studies continued with coronagraphs on NASA's Solar Maximum Mission, the USAF P78-1, and the ESA/NASA Solar and Heliospheric Observatory, these investigations were limited to near-Earth vantage points that best showed CMEs that missed Earth. However, with two observatories sent in opposite directions away from the Sun-Earth line, the STEREO mission will finally allow unambiguous observation of those CMEs that directly impact

Earth. STEREO will also for the first time provide a stereoscopic view of the three-dimensional corona and the interplanetary medium and thereby advance the Sun-Earth Connection understanding of the heliosphere begun by the International Solar-Terrestrial Physics program.

The CME clouds can be sensed remotely and with in situ measurements, and both techniques are necessary to gain an understanding of the physical processes associated with their initiation and propagation. The STEREO mission consists of two identical observatories launched into heliocentric orbits that move symmetrically away from the Sun-Earth line, one ahead of Earth (STEREO-A) and the other behind Earth (STEREO-B). Each observatory carries both remote and in situ instrumentation designed to measure various aspects of CMEs. Science goals include both stereoscopic measurements of individual CMEs as well as quadrature measurements whereby CMEs are imaged remotely by instrumentation on one observatory and measured in situ by instrumentation on the other platform.

The remote sensing instrumentation will image the initiation of CMEs in the low corona by measuring intensities in extreme ultraviolet, white light, and at radio wavelengths. Remote sensing telescopes will track the propagation of CMEs from the low corona away from the Sun out to the distance of Earth. In situ high-energy particle measurements will be made as the magnetohydrodynamic shocks accelerate electrons and ions during propagation of the CME through the inner heliosphere. In situ magnetic field and electron, proton, and ion measurements will be made as the shock and CME encounter the location of each observatory.

The STEREO mission will provide the first imaging of the three dimensional structure of the Sun's corona and the inner heliosphere, and it will provide critical information toward understanding the causes of the most severe geomagnetic storms. There are no science requirements to launch STEREO at a specific phase of the solar activity cycle, since CMEs appear at all times. But with the fleet of spacecraft (*e.g.*, SOHO, ACE, Ulysses, TRACE, GOES, IMAGE, etc.) that are already in place, a STEREO launch in late 2005 will provide the CME measurements needed for comprehensive studies of the Sun-Earth Connection.

2.2 Mission Operations Concept

The STEREO mission payload consists of two identical observatories, each containing four instrument suites (described previously). The observatories are Sun-pointed and three-axis-stabilized. The STEREO mission summary is shown Table 1.

Table 1. STEREO Mission Summary

Orbit Description	Heliocentric STEREO-A orbits ahead of Earth. STEREO-B orbits behind Earth.
Launch Date	November 2005
Launch Vehicle	Delta II 7925-10L
Nominal Mission Duration	2 years after heliocentric orbit insertion
Potential Mission Life	5 year expendables
Spacecraft + Instrument Mass	473 kg per observatory (dry)
Attitude Control Accuracy	Pointing jitter less than 7 arc seconds
Attitude Determination	Roll angle from star sensor Fine pointing from Guide Telescope as part of SECCHI suite
On-Board Data Storage Capacity	1 Gbyte

The two STEREO observatories are scheduled to be launched in November 2005 stacked on a single Boeing Delta II 7925-10L expendable vehicle. From low Earth orbit, the stack will be spun up by the third stage solid rocket and will be sent into a trans-lunar orbit. After several phasing orbits around the Earth-Moon system, on-or-about mission day 60, the STEREO-B observatory will be injected into heliocentric orbit; on-or-about mission day 90, the STEREO-A observatory will be sent into its heliocentric orbit. The time during the lunar phasing orbits will be used for deployments, outgassing, instrument and subsystem commissioning, and other early-orbit checkout activities.

The nominal data return from each observatory will average at least five (5) gigabits (Gb) per 24 hours. With heliocentric orbits, the baseline is for the instruments to acquire data continuously, without interruptions of eclipses, South Atlantic Anomaly passages, etc. The nominal operations concept calls for a single contact through a Deep Space Mission System (DSMS) 34-meter X-band antenna with each observatory per 24 hours.

During these contacts, some real-time data will be routed from the DSMS station directly to the MOC. Those data could comprise up to 32 kilobits per second (kbps) and may include spacecraft and instrument housekeeping, some real-time science data for commissioning and trouble-shooting activities, and the real-time space weather beacon data. The real-time data will be made available to the instrument teams and SSC for further processing and online access.

During the initial operations phase, the instrument teams will be co-located with the Mission Operations Team (MOT) in the MOC at APL. After some to be determined (TBD) time, each instrument team will return to their home institution where they will establish a remote Payload Operations Center (POC) for all future instrument commanding and telemetry reception. The instrument team may relocate to the MOC for limited periods of critical operations, trouble-shooting, etc.

2.3 Science Instrumentation

The diverse and rich payload of STEREO exceeds brief description, but Table 2 shows some of the salient measurements offered by these instruments and their nominal data rates. The far-reaching payload is necessary to accomplish the challenging goals of understanding the initiation and propagation of CMEs and their interaction with Earth.

Onboard communication between the spacecraft subsystems and the Instrument Data Processing Units is through a MIL-STD 1553 bus. The primary science data, instrument housekeeping data, and space weather beacon data are all returned in CCSDS-formatted, fixed length (272 byte) telemetry packets. Each subsystem and instrument has an assigned range of Application Identifiers (ApIDs) to transmit their telemetry data to the SSR.

Table 2. Approximate Telemetry Allocations for STEREO Mission, per observatory

Instrument/Subsystem Name	Range	Average Data Rate
PLASTIC (Plasma composition)	Ions in the energy-per-charge range from 0.2 up to 100 keV/e	3.2 kbps
IMPACT (In situ suite)		3.2 kbps
STE	2-100 keV	
SWEA	~0-3 keV	
MAG	+/- 500 nT	
SEP	Energetic electrons, protons, & ions	
SECCHI (Remote sensing suite)		45 kbps
EUVI	Extreme UV emission from disk and low corona	
COR1	White-light corona from 1.25-4.0 Rs	
COR2	White-light corona from 2-15 Rs	
HI1	White-light corona from 12-80 Rs	
HI2	White-light corona from 80-215 Rs	
S/WAVES	Interplanetary radio burst tracking 2 kHz to 16 MHz	2.0 kbps
Spacecraft Housekeeping		3.0 kbps
Space Weather Beacon		0.6 kbps
	TOTAL AVERAGE DATA RATE	**57 kbps**

3.0 STEREO End-to-End Data Flow

3.1 Overview

The complete set of relevant STEREO mission data covered by this document can be defined as belonging to one of the categories shown in Table 3. A more detailed description of higher-level data for each instrument will be provided in later sections of this document.

Table 3. Definitions of Data Types for STEREO

Level-0 Data Sets	The complete packet telemetry stream from each observatory for a 24-hour period. There are five such data sets produced for each observatory (one file each for IMPACT, PLASTIC, S/WAVES, and spacecraft subsystems, and one data set consisting of six files for SECCHI). Each file contains all ApIDs in that instrument's range that have been received in the MOC, in time-order, with duplicates removed.
Spacecraft Engineering Data	Spacecraft housekeeping parameters routinely decoded into engineering units
Higher Level Science Data	Useful science data extracted from the Level-0 stream. Higher levels are defined differently for each instrument based on the type of measurement.
Space Weather Beacon Data	The continuous stream of highly compressed measurements and images from each observatory.
Mission Support Data	Ancillary data and files relevant to the mission.
Software Tools, Models, and Documentation	Relevant software tools and models, along with documentation, necessary to read and manipulate Level-0 and higher level science data.

The STEREO Level-0 data consists of the complete set of telemetry received by the MOC. Level-0 data will be assembled at the MOC and will be made available electronically to the instrument and subsystem teams and to the SSC. Higher-level scientific data will be available electronically for the international community of scientists and the public at the individual instrument team processing facilities and at the SSC, which will be co-located with the Solar Data Analysis Center (SDAC) at GSFC. These higher levels of data, along with the software routines and documentation necessary to access and manipulate them, will be frequently mirrored from the instrument team working archives to the SSC. All of these services will be available electronically to the public via the open Internet. At the end of the active life of the data, all relevant mission data (Table 3) will be transferred from the SSC to the NSSDC for permanent archive.

During the DSMS contacts (and perhaps from antenna partners) real-time space weather beacon data will be captured and processed at the SSC. Gaps in the real-time beacon data will be filled-in from the Level-0 data to provide a browse archive of the beacon data for the mission lifetime. Details of the real-time beacon data and the browse archive are described in the SSC section of this document.

As soon as feasible following the SSR playback, the data will be transferred from the DSMS Central Data Recorder to the MOC for initial Level-0 processing. Level-0 products will be produced for each observatory separately, and they will cover a 24-hour period

(00:00 through 23:59 Universal Time). There will be one Level-0 file produced for each of the IMPACT, S/WAVES, and PLASTIC POCs containing all of their ApIDs for a 24 hour period, and there will be 6 Level-0 files containing all SECCHI ApIDs (one file for each 4 hour segment of a 24 hour period). There will be an additional Level-0 file for the spacecraft subsystems. Each day these Level-0 data sets will be produced for the current day, the day prior to the current day, the day two days prior to the current day, and a day 30 days prior to the current day. Any data received that does not come from the current day through 30 days prior will be flagged as out of range and produce an out of range Level-0 data set. When this file is produced, the affected POCs and the SSC will be notified that they have out of range data that can be retrieved. If data is retrieved that falls between the current Level-0 data sets, the affected POC and the SSC will be notified so that they can perform a playback from the MOC archive and retrieve the data.

Mission Support Data consists of those files of ancillary information that will be necessary to satisfy the science requirements of the mission. Most of these data will be generated at the MOC and will be available electronically for the POCs and SSC. Examples of these data include: data completeness assessment; time-keeping history; attitude history file; command history file; stored command buffer report; event history log; daily status report; ephemeris generation file; telemetry data description; DSMS schedules; track plans; and as-run track plans.

After processing at the MOC, the instrument POCs will transfer those Level-0 data electronically to their respective science centers for processing into scientifically useful measurements and for further distribution and analysis (see details for each instrument in their respective sections of this document). The SSC will also transfer all Level-0 data from the MOC electronically for archival storage.

A block diagram showing significant components of the data flow is included at the end of this document. Here we present some of the details of data processing provided by each subsystem and instrument team. Where necessary, modifications from the plans stated in the individual Phase A reports have been incorporated into this document. All of the instrument teams have existing data processing sites available to the public, and those sites are referred to by specific Internet address where appropriate.

All STEREO instrument teams have adopted an open policy for access to all data, software, and documentation. The STEREO investigators also plan to build on the existing SolarSoft infrastructure that enables data access, display, and analysis for similar data from SOHO, ACE, and TRACE.

3.2 Spacecraft Subsystems

As part of the Level-0 product from the MOC, all of the spacecraft subsystem housekeeping parameters that are downlinked in the STEREO telemetry will be archived in the SSC. These data, along with the MOC flat-file for decoding the data, form an integral part of the complete set of mission data.

The MOC will also generate tables of agreed upon spacecraft housekeeping parameters decoded into engineering units. These data will be generated on a daily basis covering a 24-hour period. The engineering unit product will be available within 24 hours of receipt of the data in the MOC.

3.3 IMPACT Suite

The IMPACT team will identify an Operations/Data Manager (ODM) who will be responsible as the central point of contact to NASA and the APL MOT for sequencing commands and for monitoring instrument health. The ODM concept has been used successfully by UCB in their participation on the WIND spacecraft.

The ODM will be responsible for collecting the Level-0 data from the APL MOC and for disseminating those data to the individual IMPACT instrument teams. The individual providers are intimately familiar with the performance of their instruments, and they will be responsible for providing quality checks of their data and informing the ODM of any irregularities, which will be noted by the ODM in the data catalogs.

Level-1 data are obtained by running the Level-0 data through the calibration and IMPACT data processing software at UCB. The latter are collected by the ODM from each instrument provider prior to launch and updated as necessary. The Level-1 data, together with calibration and basic processing software and documentation will be submitted electronically to the SSC archives. The Level-1 data for IMPACT are also referred to as high (time) resolution data, and they contain all of the measurements made by IMPACT instruments, expressed in physical units.

The second stage of data processing occurs at the IMPACT summary data access site at UCLA, which provides Level-2 and Level-3 products and archiving. The Level-2 ("key parameter") data set consists of synchronized one-minute summary data sets containing the most frequently used quantities (*e.g.*, electron plasma moments, magnetic field, vector components, solar energetic particle fluxes in specific energy ranges, suprathermal electron fluxes versus energy and angle) from IMPACT. (Some higher level PLASTIC data will also be available at UCLA, as detailed below.) Level-3 products result from basic analyses of the IMPACT data, for example shock identifications and characterizations. The timeline for data processing is provided in Table 4.

Table 4. IMPACT Data Products Flow and Delivery

Data Type	**Processing Time (Location)**	**Data Format**
Check & verify Level-0, catalog	<3 hours (UCB)	Packet
Run calibration on Level-0→Level-1	24 hours (UCB)	
Transfer Level-1 data, software, and documentation to SSC archive	2 months (UCB)	Text [ASCII] Data [binary]
Process Level-2 (summary database)	2.5 months (UCLA)	

Transfer Level-2 products to SSC archive	2.5 months (UCLA)	Text [ASCII] Data [binary]
Create Level-3 value-added products	3 months (UCLA)	
Transfer Level-3 products to SSC archive	3 months (UCLA)	Text [ASCII] Data [binary]

Open access to the Level-2 summary data, which will be the workhorse for most scientific research, will be through the existing UCLA data display and dissemination system (www-ssc.igpp.ucla.edu). Specialized data products and displays will be accessed through hyperlinked instrument provider web sites.

The total archival data volume for the two-year nominal mission for IMPACT is estimated to be ~110 GigaBytes (GB), which includes Level-0, -1, -2, and -3 data for measurements of solar wind electrons, magnetic field, energetic particles, beacon data, burst mode, and software tools, models, and documentation.

3.4 PLASTIC

The basic data products from PLASTIC are the composition, distribution functions, and time history of the solar wind and suprathermal positive ions. Solar wind measurements and identification of structures will be possible under nearly all types of solar wind conditions, including high-speed streams, interplanetary CMEs, and slow solar wind.

A PLASTIC Data Center will be established and maintained at UNH. The PLASTIC team will have a designated data manager (DM) who will be responsible for overseeing the routine processing of data, from the collection of Level-0 data to the production of science-quality data and summary plots.

The Level-1 data will be obtained at UNH by applying software that will decommutate, decompress, and, where necessary, re-order the Level-0 data. An initial version of the software will be available and tested prior to launch, and the software will be updated as necessary. The DM will be responsible for quality checking the data and recording a database of any irregularities. The Level-1 data contain all of the measurements in raw units. Software and calibration files to convert the data to physical units, along with documentation and the database will be will be delivered electronically to the SSC archive.

The second stage of data processing provides Level-2 and Level-3 products. Level-2 (key parameter data) consists of one-minute summary data sets containing the most frequently used quantities from PLASTIC, such as ion plasma moments and lower time-resolution data sets of some key minor species. Level-3 products result from basic analyses of the PLASTIC data. The timeline for processing is shown in Table 5.

Table 5. PLASTIC Data Products Flow and Delivery

Data Type	Processing Time (Location)	Data Format
Check & verify Level-0, catalogue	<3 hours (UNH)	Packet
Level-1 processing	24 hours (UNH)	
Transfer Level-1 data, software, and documentation to SSC archive	2 months (UNH)	Text [ASCII] Data [binary]
Process Level-2 (summary database)	2.5 months (UNH)	
Transfer Level-2 products to SSC archive	2.5 months (UNH)	Text [ASCII] Data [binary]
Create Level-3 value-added products	3 months (UNH & elsewhere)	
Transfer Level-3 products to SSC archive	3 months (UNH & elsewhere)	Text [ASCII] Data [binary]
Merge with IMPACT Level-3 products	3 months (UCLA)	

Level-2 processing creates the combined, averaged set of data that will be the basis for most scientific research using PLASTIC. Anticipated summary data include: solar wind density, velocity, and kinetic temperatures, proton anisotropy referenced to the magnetic field (pending field data obtained from IMPACT), major ion species densities, and suprathermal ion fluxes and anisotropies in several energy ranges.

The PLASTIC team will maintain a web site at UNH with access to specialized PLASTIC plots and data products, as well as E/PO-related activities. The PLASTIC team will support the joint *in situ* data web site at UCLA proposed by IMPACT. The anticipated data volume for Level-1 and Level-2 is estimated at 20 GB for the two-year mission. The archival data follows the agreed-upon standards and includes the software used to produce the data, and documentation and software needed to access the data. These data and routines are sufficient for complete public access to the data.

3.5 SECCHI Suite

Processing of SECCHI data consists of two major task groups: routine processing and calibration processing. Autonomous routines will run continuously in ground computers to acquire and process Level-0 housekeeping and science data packets from the MOC.

The images from SECCHI are too large to fit into individual telemetry packets. Science packets from Level-0 that have been recombined into a single file and decompressed to form an image are called Level-0.5 data. At this stage and beyond, the data will be formatted as Flexible Image Transport System (FITS). Individual images and browse movies will also be available by some standard compression technique (*e.g.*, GIF or JPEG).

The SECCHI routine processing for Level-0.5 data will consist of those calibration steps that are considered to be well-understood and which are reversible. This will be the distributed data product. The remaining calibration steps will be available as an Interactive Data Language (IDL) software procedure and library that will be freely available as part of the SolarSoft library. Data suitable for all scientific analyses will be attainable by using this easy-to-use IDL procedure. The Level-1 product is defined as the Level-0.5 data in combination with the IDL calibration procedure and library.

The SECCHI images consist of three types of science data: (1) Emission line intensity images from EUVI at various wavelengths; (2) Total brightness images from HI1 and HI2, which include F-corona, K-corona, and stray light; and (3) Polarized brightness (pB) images, pB component images, and Brightness (B) from COR1 and COR2. Additional calibration images will be available such as darks, calibration lamps, door-closed, etc.

Quick-look and final SECCHI data will be produced at NRL's Data Reduction and Analysis Center. Community analysis of STEREO observations will be from a virtual center, in that data will be requested from the SSC and/or NRL and delivered to investigators via the open Internet.

SECCHI images will be available over the open Internet as soon as the routine processing steps have been completed. This is estimated to be within 30 minutes of receipt of the data packets necessary to form an image. At this stage images will be called "quick-look." After sufficient time has passed to allow for incorporation of any late packets (probably the 30 days adopted by the MOC), the images will be released as "final." These data will be delivered electronically to the SSC from NRL as available. An archival Digital Video Disk media (or whatever medium is the best choice, to be determined closer to launch) archive will be maintained at NRL. Data will be delivered electronically to select European sites. The decompressed scientific data (4 bytes/pixel) is estimated to be between 10-25 GB per day for both observatories during the prime (2 year) science phase of the mission.

All of these data, as well as the software tools and documentation to manipulate them, will be available for access through the open Internet.

Table 6. SECCHI Data Products Flow and Delivery

Data Type	Processing Time (Location)	Data Format
Check Level-0	24 hours (NRL)	Packet
Recombine Level-0 packets into images → Level-0.5	24 hours (NRL)	FITS
Browse images and movies	24 hours (NRL)	GIF
Catalogue/Database	24 hours (NRL)	Web-accessible (TBC)
Level-1 processing	As needed (anywhere)	FITS files plus IDL routine and libraries
Transfer Level-0.5 data, Level-1 software, and documentation to	2 months (NRL)	FITS,GIF, ASCII, etc.

SSC archive		

3.6 S/WAVES

The primary institution for S/WAVES science data processing is GSFC. Level-0 data will be acquired electronically through automated processes. A knowledgeable person will examine the scientific data five days per week. Daily graphical displays will give an excellent picture of instrument performance and potentially interesting scientific events. The data processing software will be based on the successful object-oriented model created for the WIND/WAVES experiment (lep694.gsfc.nasa.gov/waves/waves.html).

Level-1 data will consist of two products: (1) daily summary plots consisting of 24-hour dynamic spectra that will be automatically produced; and (2) daily 1-minute averaged data files for each frequency. All of these data, as well as the software tools and documentation to manipulate them, will be available for access through the open Internet.

Level-2 data consists of specific time periods containing scientifically interesting events that have been identified, such as Type II/IV radio bursts. Typically, such events should be found within a few days of receipt of the data, and catalogues and representative spectral graphic outputs will be generated and published on the web as the events are identified.

Level-3 data consists of further analysis of specific scientifically interesting events. These may include direction finding and tracking of radio bursts, and *in situ* analysis of plasma wave events.

A rough estimate of the data volume produced by S/WAVES (including all levels described above) is 20 GB per year.

Table 7. S/WAVES Data Products Flow and Delivery

Data Type	**Processing Time (Location)**	**Data Format**
Check Level-0	24 hours (GSFC)	Packet
Level-1 processing	24 hours (GSFC)	
Transfer Level-1 data, software, and documentation to SSC archive	2 months (GSFC)	Text [ASCII] Daily Summary Files [PostScript] Daily Summary Plots [GIF] 1-minute averages [IDL save sets]
Process Level-2	2.5 months (GSFC)	
Transfer Level-2 products to SSC archive	2.5 months (GSFC)	Text [ASCII and PostScript] Web-based plots [GIF]
Create Level-3 value-added products	3 months (GSFC & elsewhere)	
Transfer Level-3 products to SSC archive	3 months (GSFC & elsewhere)	Text [ASCII and PostScript] Web-based plots [GIF]

3.7 STEREO Science Center

The SSC will have four primary functions: (1) it will be the focal point for archiving STEREO data; (2) it will be the processing center for the space weather beacon data; (3) it will be the central point for science coordination between the instruments and other spacebased and groundbased campaigns; and (4) it will be the focal point for mission-related education, public outreach, and public affairs.

During the mission lifetime and for some period thereafter the data will be considered scientifically useful, and they will be readily available electronically to the public from the SSC. At some point in the future--certainly years and perhaps decades after the end of the mission--the data will be used less frequently by scientists. At that time, the data and software will be transferred to the NSSDC for permanent archive. The co-located SDAC has an agreement and an interface to the NSSDC, and STEREO will make use of the existing arrangement.

The SSC archive will include all levels of telemetry data from all sources, mission support data, and software and documentation necessary to manipulate the data. The archive will include data from all phases of the mission. Sources and estimates of data volumes have been described in previous sections.

During the DSMS contacts real-time space weather beacon data will be captured by the MOC, electronically transferred to the SSC, and processed at the SSC and made available for use by NOAA's Space Environment Center, the U.S. Air Force (USAF) and the public. Antenna partners are being sought to cover the remaining time when each STEREO observatory is not in contact through DSMS. It is likely that telemetry reception of the low rate space weather beacon will be achieved through partner antennas operated by other U.S. government agencies, international facilities, and educational institutions. The data from antenna partners will be sent electronically directly to the SSC for further processing and online access.

After the SSR playback, any gaps in the real-time beacon data during the previous 24 hours will be filled in from the Level-0 data. The real-time beacon data will be displayed graphically and will be made available electronically as data files. The data files will allow modelers of space environment conditions to have "live" data streams for input into their prediction algorithms. The beacon data will be automatically generated from the data stream using decommutation algorithms provided by the instrument teams. These data should be considered "quick-look" quality since they will be based on preliminary calibrations and will not be routinely checked for accuracy. They may even be subject to revision without notice, so the STEREO space weather beacon real-time data should only be cited with appropriate qualifiers.

A browse archive of the STEREO space weather beacon data will be maintained at the SSC for the life of the mission. The beacon browse archive will be generated from the

Level-0 packets. The archive is designed to allow researchers to select interesting time periods for further study and to allow space weather modelers to have a realistic data stream *post facto*. Like the real-time beacon data, the archived beacon data may be subject to revision and should only be cited with appropriate qualifiers.

During the early operations and commissioning phase, the STEREO instrument data may be of degraded or uncertain quality while instrument and spacecraft subsystem check-out takes place. This may also happen during anomalies and contingency operations. Such data should be so marked, and a catalogue of unreliable data quality should be maintained at the SSC.

Table 8. Space Weather Beacon Data Products Flow and Delivery

Data Type	Processing Time (Location)	Data Format
Real-time packet reception and decommutation (IMPACT, PLASTIC, S/WAVES)	~1 minute(SSC)	Time-series plots [GIF] Data files [ASCII]
Real-time packet reception and assembly into image (SECCHI)	~5 minutes (SSC)	Images [GIF]
Check & verify Level-0, catalogue	<3 hours (SSC)	Packet
Level-0→ Browse archive	<3 hours (SSC)	Time-series plots [GIF] Data files [ASCII] Images [GIF]

4.0 Acknowledgements

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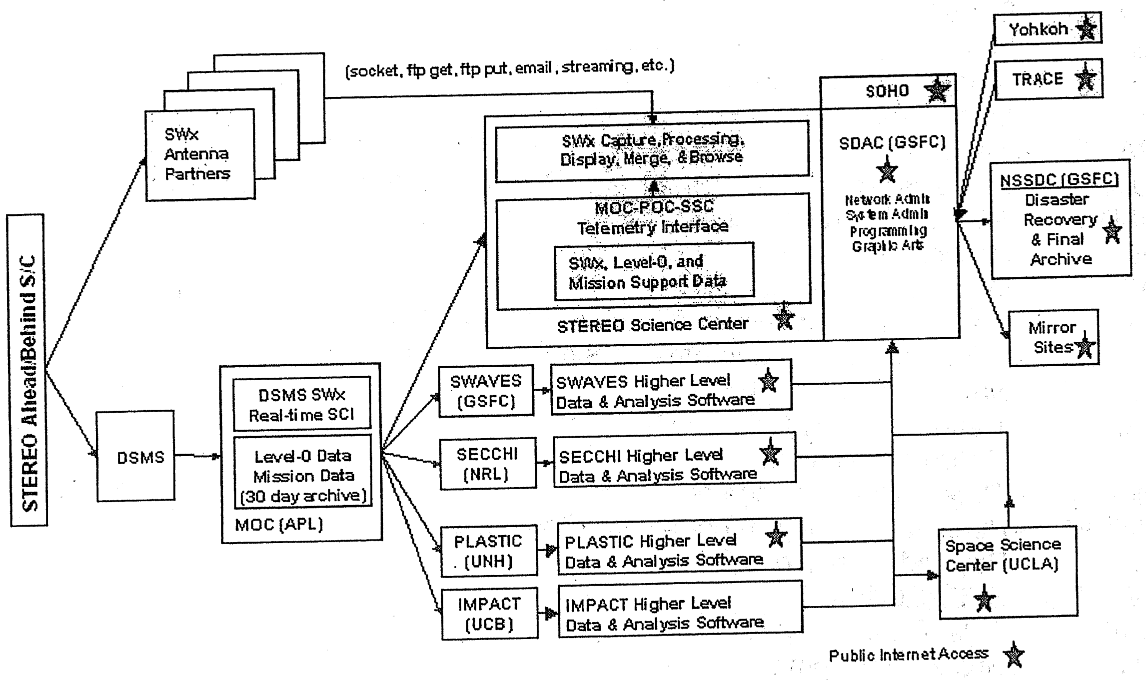
Data Flow/SSC Block Diagram



Appendix A - Acronym List

ApID - Application Identification
CME - Coronal Mass Ejection
DSMS - Deep Space Mission Services
FITS - Flexible Image Transport System
GSFC - Goddard Space Flight Center
IDPU - Instrument Data Processing Unit
IMPACT - In-situ Measurements of Particles and CME Transients
JHU/APL - Johns Hopkins University/Applied Physics Laboratory
MO&DA - Mission Operations and Data Analysis
MOC - Mission Operations Center
MOT - Mission Operations Team
NASA - National Aeronautics and Space Administration
NOAA - National Oceanic and Atmospheric Administration
NRL - Naval Research Laboratory
NSSDC - National Space Science Data Center
PI - Principal Investigator
PDMP - Project Data Management Plan
PLASTIC - PLasma And SupraThermal Ion Composition
POC - Payload Operations Center
S/WAVES - STEREO/WAVES
SDAC - Solar Data Analysis Center
SEC - Space Environment Center
SECCHI - Sun-Earth Connection Coronal and Heliospheric Investigation
SSC - STEREO Science Center
SSR - Solid State Recorder
SSW - Solar SoftWare
STEREO - Solar TErrestrial RElations Observatory
STEREO-A - STEREO observatory ahead of the Sun-Earth line
STEREO-B - STEREO observatory behind the Sun-Earth line
TBD - To Be Determined
UCB - University of California at Berkeley
UCLA - University of California at Los Angeles
UNH - University of New Hampshire
WWW - World Wide Web